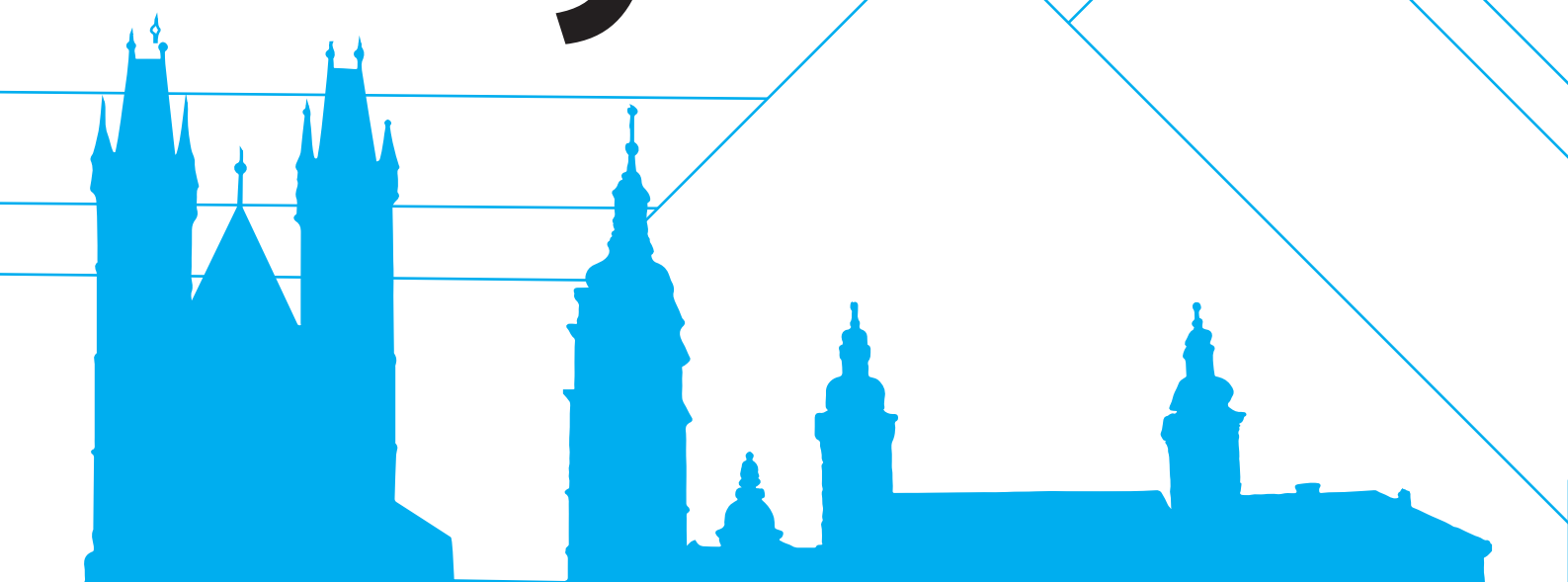




University of Hradec Králové
Faculty of Informatics and Management

Hradec Economic Days



Vol. 11

proceedings of the international scientific conference
Hradec Economic Days 2021

March 25–26, 2021
Hradec Králové, Czech Republic



University of Hradec Králové
Faculty of Informatics and Management

Hradec Economic Days

Vol. 11(1)

proceedings of the international scientific conference

Hradec Economic Days 2021

March 25–26, 2021

Hradec Králové, Czech Republic

Publishing partner:



MDPI

open access journal
on organization studies

Conference partner:



Jihočeská univerzita
v Českých Budějovicích
University of South Bohemia
in České Budějovice



Project no. CZ.02.2.69/0.0/0.0/16_014/0000628, Development of technology transfer office



EUROPEAN UNION
European Structural and Investing Funds
Operational Programme Research,
Development and Education



Editors: Jan MAČÍ, Petra MAREŠOVÁ, Krzysztof FIRLEJ, Ivan SOUKAL

Publisher: University of Hradec Králové

© 2021 by the authors. Licensee University of Hradec Králové, Hradec Králové, Czech Republic.

These proceedings are open access proceedings distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

Proceedings were not a subject of a language check. The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use. The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Articles can be cited as **a conference contribution in edited proceedings:**

Lastname, A. (YYYY). Title of conference article. In J. Maci, P. Maresova, K. Firlej, & I. Soukal (Eds.), *Hradec Economic Days, part 1, 2019* (pp. page #–page #). University of Hradec Králové. <https://doi.org/10.36689/uhr/hed/2021-01-###>

or as **a conference contribution in periodical proceedings or journal:**

Lastname, A. (YYYY). Title of conference article. *Hradec Economic Days*, 11(1), page #–page #.
<https://doi.org/10.36689/uhr/hed/2021-01-###>

ISSN 2464-6059 (Print)

ISSN 2464-6067 (Online)

ISBN 978-80-7435-822-7

DOI: 10.36689/uhr/hed/2021-01-000

Preface

Ladies and gentlemen, dear colleagues, the Hradec Economic Days conference has been traditionally and continuously held since 2003. The University of Hradec Králové organized the 19th Hradec Economic Days conference in cooperation with the Wrocław University of Economics, the Cracow University of Economics, and the Office of Transfer of Technologies at the University of South Bohemia. The conference was held from March 25 to March 26, 2021. It aimed to promote the idea of communication and cooperation of scientists from various fields with practitioners. The conference was in 2021 subtitled "Crisis management".

Hradec Economic days conference has undergone dynamic development since the first year in both quality and quantity. In 2021 we again cooperated with the MDPI publishing and their journal indexed in the Emerging Sources Citation Index (ESCI) and Scopus. The highest quality papers are to be revised for possible inclusion in the Administrative Sciences journal's special issue.

All submitted papers underwent careful selection and were reviewed by two or three reviewers. We selected the best 95 articles in English that were published in electronic proceedings. Authors of the conference papers are scientists and practitioners from the Czech Republic, Poland, China, Slovakia, Russia, Ukraine, Malaysia, Germany, Norway, Ireland, Hungary, Bulgaria.

I am very pleased we succeeded in the Web of Science indexation of the 2020 proceedings. They also successfully underwent the Scopus pre-evaluation. Now, the proceedings are under the Elsevier CSAB evaluation in consideration to be indexed by Scopus. I firmly believe that the changes the conference has undergone will contribute to regular indexation in the Web of Science and result in the Scopus coverage.

Even though the HED2021 conference again had to face organizational challenges due to a COVID-19 epidemic, we managed to hold the conference with high-quality articles, special guests, and foremostly keynote speakers:

- Zdeněk Tůma (Chairman of the Supervisory Board) representing ČSOB a.s.,
- Pavel Čejka (Regional Vice President – CEE, Russia & CIS) representing Tableau,
- Tiam-Lin Sze (Head) representing IPI Singapore.

I firmly believe that on the jubilee 20th Hradec Economic Days, we will welcome you in person. I want to thank all who participated in organizing the conference: thank you for your high-quality work. My special thanks go to our long-term editor and conference founder, Pavel Jedlička, who decided we should let younger colleagues carry the torch. I wish our newest editing team member Jan Mačí to be as successful and dedicated to the conference as our dear colleague Jedlička was. My thanks also go to the authors, keynote speakers, and guests for their trust and support. I am looking forward to seeing you all at HED2022.

Hradec Kralove, March 22, 2021



Assoc. Prof. Petra Marešová
General Chairman of Hradec Economic Days
Faculty of Informatics and Management
University of Hradec Kralove

CONTENT

PREFACE	3
EVALUATION OF PROJECT PORTFOLIO MANAGEMENT PERFORMANCE: LONG AND SHORT-TERM PERSPECTIVE	
Matilda ALEXANDROVA	11
STUDENTS FURTHER LEARNING PREFERENCES IN HIGHER EDUCATION	
Patrik BAŠA, Enikő KORCSMÁROS and Bence CSINGER	22
TURNING DIGITISATION INTO DISRUPTION	
Stephan BAURIEDEL	29
SHARING ECONOMY IN THE CZECH REPUBLIC	
Marie BEDNARIKOVA and Jana KOSTALOVA	36
OFFICIAL AUTHORITIES AND EDUCATION IN FINANCIAL LITERACY – THE ROLE OF CENTRAL BANKS IN THE CZECH REPUBLIC AND POLAND	
Dorota BEDNARSKA-OLEJNICZAK, Libuše SVOBODOVÁ and Jaroslava DITTRICHOVÁ	48
SOCIAL CAPITAL AND INNOVATION IN THE COUNTRIES OF THE VISEGRAD GROUP	
Beata BĘDZIK and Sylwia GOŁĄB	60
DIVIDEND POLICY MODELS AND POSSIBILITIES OF THEIR UTILIZATION IN THE CONDITIONS OF A PARTICULAR COUNTRY – ASSESSMENT AND PROPOSALS	
Kristýna BĚLUŠOVÁ and Karel BRYCHTA	74
RATE OF WAGE LEVELLING OR DIVERSIFICATION OF OECD MEMBER COUNTRIES: IN WHICH COUNTRIES ARE WAGE MORE INEQUALITY?	
Diana BÍLKOVÁ	86
SALES OF CONSUMER CHEMICALS IN ZERO-PACKAGING STORES - A CHALLENGE FOR SMALL AND MEDIUM-SIZED CHEMICAL COMPANIES	
Lenka BRANSKA, Michal PATAK, Katerina HROMADNIKOVA and ZUZANA PECINOVA	98
EXPORT OF CZECH ANIMAL PRODUCTION TO SELECTED COUNTRIES OF EUROPEAN UNION	
David BROŽ, Miroslava NAVRÁTILOVÁ and Markéta BERANOVÁ	107
IS THE SLOVAK PENSION SYSTEM PREPARED FOR THE NEXT DECADES?	
Jakub BUČEK, Michal TOMČO	115
CAUSAL LOOP DIAGRAMS AND AUTOMATED IDENTIFICATION OF FEEDBACKS IN ECONOMIC SYSTEMS	
Vladimír BUREŠ	123
CONTEXTUALISATION OF THE CURRENT KNOWLEDGE AND TECHNOLOGY TRANSFER-RELATED LITERATURE: THE TEXT ANALYSIS	
Vladimír BUREŠ and Tereza OTČENÁŠKOVÁ	134
FORECASTING OF THE STOCK PRICE USING RECURRENT NEURAL NETWORK – LONG SHORT-TERM MEMORY	
Michal DOBROVOLNY, Ivan SOUKAL, Ali SALAMAT, Anna CIERNIK-EMERYCH and Ondrej KREJCAR	145
THE POTENTIAL OF LOW-CARBON DEVELOPMENT OF THE POLISH ECONOMY	
Maria DZIKUĆ, Szymon SZUFA, Janusz ADAMCZYK, Maciej DZIKUĆ and Piotr KUŁYK	155
IS THERE A FUTURE FOR CARBON CAPTURE AND STORAGE?	
Anders EKELAND, Rong KANG, Jaroslav KOVÁRNÍK and Eva HAMPLOVÁ	168

FUNCTIONAL DATA ANALYSIS IN ECONOMETRICS Kateřina FRONČKOVÁ and Pavel PRAŽÁK	176
SPATIAL DIFFERENTIATION OF TAX COLLECTION COSTS IN POLAND Lukasz FURMAN and Paulina KOZA	188
ARE RURAL STAKEHOLDER NEEDS COMPLIANT WITH THE TARGETS OF THE EUROPE 2020 STRATEGY? TEXT MINING ANALYSIS OF LOCAL ACTION GROUP STRATEGIES FROM TWO POLISH REGIONS Marek FURMANKIEWICZ, Krzysztof JANC, Iwona KACZMAREK and Iga SOLECKA	195
PREDICTING FINANCIAL DISTRESS IN COMPANIES USING THE ORIGINAL CCB MODEL Vitezslav HALEK	207
BUSINESS ACTIVITY AND ITS CONCENTRATION IN THE CZECH REPUBLIC AND POLAND IN THE YEARS 2018–2020 Eva HAMPLOVÁ, Beata BAL-DOMAŇSKA and Kateřina PROVAZNÍKOVÁ	217
SELECTION OF A SUITABLE AGILE METHODOLOGY – CASE STUDY František HAŠEK and Hana MOHELSKÁ	225
IMPACTS OF COVID-19 ON THE LABOUR MARKET – EVIDENCE FROM THE CZECH REPUBLIC Martina HEDVIČÁKOVÁ and Zuzana KOZUBÍKOVÁ	232
ANALYSIS OF THE MORTGAGE MARKET IN THE CZECH REPUBLIC Martina HEDVIČÁKOVÁ and Alena POZDÍLKOVÁ	242
SUITABILITY OF MACHINE LEARNING METHODS FOR PREDICTION OF POPULARITY ON SOCIAL MEDIA IN COMPARISON OF DIFFERENT DATA SETS Jan HRUŠKA	251
THE INFLUENCE OF MODERN EDUCATION SYSTEM IN THE SELECTION OF A HIGHER EDUCATION INSTITUTION Erika S. HUSZÁRIK, Kamilla SÁNTA and Patrik BAŠA	260
A STUDY ON THE EVALUATION OF AGRICULTURAL MODERNIZATION IN CHINA Yanhua CHANG and Bo SHI	271
THE INFLUENCE OF TAX INFORMATION EXCHANGE AGREEMENTS ON THE BEHAVIOUR OF SLOVAK COMPANIES IN RELATION TO TAX HAVENS Michal IŠTOK and, Marcela TAUŠOVÁ	278
MANAGEMENT OF SUSTAINABILITY, ITS MEASUREMENT AND RELEVANCE IN THE ENTERPRISE Patrícia JÁNOŠOVÁ and Emese TOKARČÍKOVÁ	287
THE USE OF PR TOOLS AND ANALYSIS OF THEIR EFFECTIVENESS AS VIEWED BY MANAGERS OF CZECH CHEMICAL COMPANIES Martina JELINKOVA, Hana LOSTAKOVA and Katerina MACHACKOVA	297
CONTRACTING AS PART OF NEW PUBLIC MANAGEMENT: FOCUS ON SERVICES PROVIDED FOR PATIENTS WITH ALZHEIMER'S DISEASE IN THE CZECH REPUBLIC Daniela KANDILAKI, Kristina RANDLOVÁ and Peter PAŽITNÝ	309
HEALTHCARE WORKER CAPACITIES IN SOCIAL SERVICES FOR ELDERLY CARE: QUALIFICATION AND DEMOGRAPHIC STRUCTURE Lenka KOMÁRKOVÁ, Petra MAREŠOVÁ, Peter PAŽITNÝ, Daniela KANDILAKI, Filip ZEMEK and Zuzana TRUHLÁŘOVÁ	317
EFFICIENCY COMPARISON OF MUNICIPAL PUBLIC TRANSPORT IN THE SELECTED CITIES OF THE CZECH REPUBLIC Veronika KOMOROUSOVÁ and Jana HINKE	328

WHAT IS THE REAL TAX BURDEN IN SLOVAKIA? Zlatica KONÔPKOVÁ	338
INTEGRATIVE ESTIMATION OF REGION ECONOMIC STABILITY AS IN THE CASE OF THE RUSSIAN FEDERATION Stanislava KONTSEVAYA, Aleksander METLYAHIN, Lyubov YARYGINA, Elvira ORLOVA, Nadezhda NIKITINA and Lubos SMUTKA	345
METHODOLOGY OF ESTIMATION OF AGRO-INDUSTRIAL CAPACITY AND FOOD CONSUMPTION (AS IN THE CASE OF THE REGION OF NORTH-WESTERN FEDERAL DISTRICT OF THE RUSSIAN FEDERATION) Stanislava KONTSEVAYA, Oksana MORONOVA, Aleksander METLYAHIN and Lubos SMUTKA	357
CSR WEB COMMUNICATION BY CONTROVERSIAL COMPANIES: THE EXAMPLE OF CHEMICAL COMPANIES OPERATING IN NORWAY Jan KOPRIVA and Libena TETREVOVA	368
HIGHER EDUCATION INSTITUTION IN THE 21ST CENTURY – KEY FACTORS FOR PROSPECTIVE STUDENTS Enikő KORCSMÁROS, Szilvia T. KOSÁR and Bence CSINGER	378
AN INNOVATIVE TEACHING METHOD AND ITS PRACTICAL APPLICABILITY – FOCUS ON THE PLAYFUL INTERACTION AMONG THE STUDENTS Enikő KORCSMÁROS, Renáta MACHOVÁ, Lilla FEHÉR and Zsuzsanna TÓTH	386
DIGITAL TWIN MODELS: BIM MEETS NETLOGO Milan KOŘÍNEK, Ondřej TÁZLAR and Kamila ŠTEKEROVÁ	394
SUSTAINABILITY IN PROJECT MANAGEMENT: TWO SIDES OF THE SAME COIN OR POLES APART? Jana KOSTALOVA and John McGRATH	401
THE COVID-19 PANDEMIC AND THE PROFESSIONAL SITUATION ON THE REAL ESTATE MARKET IN POLAND Maciej KOSZEL	412
GROUP FACTORS OF VOLUNTARY EMPLOYEE TURNOVER IN ORGANIZATIONS FROM IT SECTOR Anna KOSZELA	426
COMPARISON OF MUNICIPAL DEVELOPMENT PLANS OF CZECH CITIES Adam KOVÁCS, Tibor ZSIGMOND and Renáta MACHOVÁ	438
ASSESSMENT OF THE COMPETITIVE POSITION OF THE V4 GROUP COUNTRIES IN THE FOREIGN TRADE OF AGRI-FOOD INDUSTRY PRODUCTS Anna S. KOWALSKA, Klaudia GURKOWA, Anna OLSZAŃSKA, Ivan SOUKAL and Martin MATEJICEK	449
IMPACT OF HOUSING ALLOWANCE AND HOUSING SUPPLEMENTS IN THE CZECH REPUBLIC Martin KRÁL and Martin MATĚJÍČEK	461
IMITATION AS A COMPETITIVE STRATEGY Kazimierz KRZAKIEWICZ and Piotr BARTKOWIAK	471
COEFFICIENTS OF REAL ESTATE TAX: CASE STUDY OF THE CZECH REPUBLIC Gabriela KUKALOVÁ, Daniela PFEIFEROVÁ, Ivana KUCHAROVÁ, Olga REGNEROVÁ, and Dana ŠTURMOVÁ	484
IMPACT OF COVID-19 ON THE AVIATION BUSINESS IN THE RUSSIAN FEDERATION Alfiya KUZNETSOVA	495

ECONOMICS AND MANAGEMENT OF AGRICULTURAL PRODUCTION IN THE REPUBLIC OF BASHKORTOSTAN IN THE CONTEXT OF THE COVID PANDEMIC	
Alfiya KUZNETSOVA	507
DEVELOPMENT OF DISRUPTIVE GROWTH ENGINE: DOUBLE CASES STUDY BASED ON ALIBABA AND TENCENT	
Wei LI, Yuchen LEI and Yutian LIU	515
INCOME DISTRIBUTION AND INDUSTRIAL STRUCTURE IN CHINA'S URBAN AND RURAL AREAS	
Guobin LIU, Beibei SHI and Rong KANG	528
RELATIONSHIP BETWEEN CLIMATE CHANGE AND AGRICULTURAL DEVELOPMENT TRANSITION	
Yanni LIU and Jingrun SU	541
INDUSTRY 4.0 – RELATIONSHIP BETWEEN CAPITAL EQUIPMENT AND LABOR PRODUCTIVITY	
Peter MARINIČ and Pavel PECINA	555
UNIVERSITY SPIN-OFF: EFFECTIVE SOLUTION ON TECHNOLOGY TRANSFER IN AEC INDUSTRY FOR INTELLIGENT CITY TRANSFORMATION	
Raihan MASKURIY, Ali SELAMAT, Kherun Nita ALI, Akbariah MAHDZIR, Petra MAREŠOVÁ and Ondřej KREJCAR	564
DIFFERENT TYPES OF FEE CALCULATIONS ON THE RCBS MARKET IN THE CZECH REPUBLIC	
Martin MATĚJÍČEK and Anna S. KOWALSKA	571
MULTICRITERIAL ANALYSES OF THEORETICAL MODELS OF INNOVATION USE IN BUSINESS PRACTICE WITH A FOCUS ON OPEN INNOVATION AND TRANSFER TECHNOLOGY	
Pavla MATULOVÁ	580
MEASURING CHATBOT EFFECTIVENESS	
Hana MOHELSKA and Marcela SOKOLOVA	589
GENDER PAY GAP IN THE CZECH INFORMATION AND COMMUNICATION TECHNOLOGY PROFESSIONALS	
Lea NEDOMOVA, Milos MARYSKA and Petr DOUCEK	599
BUSINESS NETWORKING AS A TOOL OF THE INFORMATION AND KNOWLEDGE MANAGEMENT OF THE OWNERS OF SMALL AND MIDDLE ENTERPRISES – CASE OF STUDY	
Lucie NOVOTNA	611
TAX REVENUES AND EXTERNAL SHOCK. HOW COVID-19 INFLUENCED PUBLIC REVENUES IN POLAND AND CZECHIA	
Jarosław OLEJNICZAK and Jan MAČÍ	620
THE ASPECT OF ETHICS DETERMINED BY TECHNOLOGICAL IMPACT	
Marcin PASKA	633
A MODIFICATION OF THE VEHICLE ROUTING PROBLEM	
Jan PELIKÁN	645
THE LEVEL OF ENERGY POVERTY IN POLAND COMPARED TO OTHER EUROPEAN UNION COUNTRIES	
Arkadiusz PIWOWAR	652
DIGITAL GAP IN EU COUNTRIES AND ITS IMPACT ON LABOUR PRODUCTIVITY AND GLOBAL COMPETITIVENESS	
Tetiana POLOZOVA, Irina KOLUPAIEVA and Iryna SHEIKO	659

TIME SERIES MOVEMENTS IN ART PRICES	
Alena POZDÍLKOVÁ, Jaroslav MAREK and Marie NEDVĚDOVÁ	671
ALTRUISM AND THE PRIVACY CALCULUS	
Tomáš SIGMUND and Jiří KORČÁK	680
IMPACTS OF THE TAX PACKAGE IN 2021 ON THE TAXATION OF EMPLOYEES AND SELF-EMPLOYED PEOPLE IN THE CZECH REPUBLIC	
Jiří SLEZÁK and Barbora KAHÁNKOVÁ	687
SPATIAL MODELING OF LABOR MARKETS IN THE AREAS OF CRACOW-BALICE AND WROCLAW-STRACHOWICE AIRPORTS	
Agata SURÓWKA	698
CORPORATE SOCIAL RESPONSIBILITY AND AUTOMOTIVE INDUSTRY IN THE CZECH REPUBLIC	
Libuše SVOBODOVÁ and Dorota BEDNARSKA-OLEJNICZAK	710
CORPORATE EDUCATION WITH FOCUS ON UTILIZATION OF ICT – CASE STUDY IN THE CZECH REPUBLIC	
Libuše SVOBODOVÁ and Miloslava ČERNÁ	720
IDENTIFICATION OF STRATEGIC POSITION OF E-COMMERCE ENTERPRISES IN FASHION INDUSTRY	
Zuzana SVOBODOVÁ	728
IS CITIZEN TRACKING ACCEPTABLE?	
Jana SYROVÁTKOVÁ and Antonín PAVLÍČEK	737
IMPACT OF VUCA ENVIRONMENT IN PRACTICE OF RURAL TOURISM	
Eva ŠIMKOVÁ and Martina HOFFMANNOVÁ	746
TECHNOLOGY TRANSFER AS THE THIRD ROLE OF UNIVERSITIES & NATIONAL PLATFORM IN THE CZECH REPUBLIC	
Růžena ŠTEMBERKOVÁ, Dagmar ŠKODOVÁ-PARMOVÁ, Petra MAREŠOVÁ and Petr OČKO	758
WHY AND WHEN PARADOXICAL LEADERSHIP PREDICTS FOLLOWERS' UNETHICAL PRO-ORGANIZATIONAL BEHAVIOR: A MULTILEVEL MODEL	
Le TAN, Po HAO, Xiao YANG and Xinge YE	767
B2B SHARING AS PART OF THE SHARING ECONOMY MODEL	
Libena TETREVOVA and Pavla KOLMASOVA	780
HOW DOES THE FIVE-YEAR PLAN PROMOTE CHINA'S ECONOMIC DEVELOPMENT?	
Hongzhi TIAN and Hui LI	790
THE INFLUENCE OF NETWORK ECONOMY ON THE HIGH-QUALITY DEVELOPMENT OF CHINA'S ECONOMY	
Hongzhi TIAN and Qiuli WANG	801
THE VITAL BASIS OF TECHNOLOGY TRANSFER SEEN FROM THE PERSPECTIVE OF THE SECI AND BA MODEL: STRUCTURAL INSIGHT	
Josef TOMAN, Petra MAREŠOVÁ and Blanka KLÍMOVÁ	812
THE ECONOMIC AND SOCIAL IMPORTANCE OF FARM DIVERSIFICATION TOWARDS NONAGRICULTURAL ACTIVITIES IN EU	
Gabriela TRNKOVÁ	823
JOB SATISFACTION AND INTENTION TO LEAVE ACCORDING TO THE SIZE OF THE ORGANIZATION	
Ladislav UHLÍŘ and Petr ŘEHOŘ	832

CORPORATE SOCIAL RESPONSIBILITY AND INTERNATIONALIZATION OF CZECH TRANSPORT ENTERPRISES	
Emil VELINOV and Simona CINCALOVA	842
EXAMINATION OF RELATIONSHIP BETWEEN GOAL ORIENTATION, WORK ENGAGEMENT AND SELF-EFFICACY	
Marek VICH	849
STRATEGY OF SERVITIZATION AS A TOOL FOR ACHIEVEMENT OF SUSTAINABLE DEVELOPMENT	
Vladimira VLCKOVA, David VLCEK and Lucie KANOVSKÁ	858
THE APPROACH OF CZECH BUSINESS ENTITIES TO THE PROMOTION AND APPLICATION OF THE CORPORATE SOCIAL RESPONSIBILITY	
Pavla VRABCOVÁ and Hana URBANCOVÁ	870
EFFECTS OF HIGH-SPEED RAIL ON REGIONAL ECONOMIC GROWTH AND EMPLOYMENT IN CHINA	
Li WANG, Lu SHEN and Fei XUE	881
INFRASTRUCTURE, AGGLOMERATION AND REGIONAL ECONOMIC GROWTH IN CHINA: A PANEL VAR ANALYSIS	
Li WANG, Ningning JIA and Fei XUE	892
THE INFLUENCE OF DIGITAL ECONOMY ON EMPLOYMENT IN CHINA'S LABOR MARKET: MECHANISM, CHARACTERISTICS AND STRATEGIES	
Chenzi WU	900
THE IMPACT OF TRANSPORTATION INFRASTRUCTURE ON EXPORT TRADE: EVIDENCE FROM 31 PROVINCES IN CHINA	
Lei WU and Rong KANG	910
NEW INFRASTRUCTURE AND CORPORATE VALUE CREATION: THEORY AND PRACTICE IN CHINA	
Zhixin XUE and Xiaojing CHAO	922
COST CALCULATION IN RESEARCH AND DEVELOPMENT OF NEW VALIDATION METHODS	
Alexandra ZAHORSKA, Simona MUNZAROVA and Jana KOSTALOVA	929
SECURITY CONCERNS OF SOCIAL LOGIN USAGE AT THE 3RD PARTY CLOUD SERVICES	
Martin ZBOŘIL	939
THE IMPACT OF GOVERNMENT SUBSIDIES ON BUSINESS PERFORMANCE OF PUBLIC UTILITY COMPANIES	
Weiwei ZHAO	948
THE LEVEL OF JOB SATISFACTION IN THE CZECH REPUBLIC	
Vaclav ZUBR and Marcela SOKOLOVA	957

Evaluation of Project Portfolio Management Performance: Long and Short-Term Perspective

Matilda ALEXANDROVA

University of National and World Economy, Sofia, Bulgaria; matildaa@unwe.bg

Abstract: The complexity of project portfolio management /PPM/ is widely recognized in the specialized literature as well as its multidimensional link to the measurement of its success. In light of the variety of portfolio administration issues thoroughly studied, there is not any comprehensive model developed for the evaluation of PPM performance. Here we agree on the basic proposition that PPM success should not be evaluated by any simple consolidated result derived as a sum of the individual performance of each project. The paper presents selected results from a study of PPM success in 184 Bulgarian project-oriented organizations where several indicators have been experimentally measured. It provides insights on the measurement of project portfolio management success in both short and long-term perspective. The long-term perspective is captured by two dimensions of the strategic alignment – the first one relates to the achievement of strategic goals of the organization through selection and realization of projects. The second one is focused on the strategic resource allocation. Short-term perspective is measured by the level of projects' success accounting for three dimensions – meeting the project's budget, schedule, and quality of delivery. These dimensions reflect the efficiency of organizational resources utilization which can be achieved through high degree of coordination of project planning, execution, monitoring and control within an operational system of project portfolio management. Here we assume that successful governance should lead to a better alignment of projects in the portfolio with the organizational strategy. Initial findings about these dimensions of PPM success are reported and discussed in the paper.

Keywords: project portfolio management; project portfolio evaluation; long term perspective; short term perspective; Bulgaria

JEL Classification: O22; M10

1. Introduction

Project management proved to be effective for enhancing the competitiveness of business organizations in light of the substantial expansion of project-based activities worldwide. Together with the enlargement of project-based funding, many organizations have chosen to transform their structures into project-oriented ones. At the same time, practices of inappropriate selection, ineffective prioritization or suboptimal balancing of projects are frequently met which reflects into unsuccessful performance of project execution and under-delivery of project goals (Cooper et al., 2000). In many organizations even a limited number of projects are hardly accomplished as expected due to ineffective implementation of project methodologies, inadequate project management structure, or lack

of project coordination (Kendall & Rollins, 2003). As a result, inefficient resource allocation and related losses as well as misalignment of project deliveries and strategic goals of organizations have been identified in project management practices.

In response to such challenges in both managerial theory and practice a specific approach to project management has been developed, namely project portfolio management (PPM), which gained increasing popularity and found a wider implementation in organizations of various size and industry (Charvat, 2003). This managerial approach is based on principles of coordinated selection, prioritization, balancing, and control over the execution of multiple projects in a project-based organization (Alexandrova, 2020). The projects' goals should be aligned with the organizational strategy matching the long-term perspectives for organizational development. The need for additional research on particular issues related to PPM performance evaluation is considered as a general deficiency especially for organizations implementing the project portfolio management approach (Kleinschmidt et al., 2007).

The anticipation of enhanced PPM performance is related to the role of project portfolio manager and its interaction with other levels of organizational management (Jonas, 2010). One possible justification of PPM success originates from this core role, i.e. a significant impact of management involvement, potentially in both aspects (positive and negative), on PPM performance. This way, the task of boosting PPM performance is associated to transforming the formal role of project portfolio manager into real authority, leadership, and strategic involvement. Furthermore, the projects in a portfolio compete for scarce organizational resources requiring committed top management intervention for efficient resource allocation through prioritization and balancing of the organizational project portfolio. This way the enhancement of PPM performance can be facilitated by effective portfolio management in conditions of time and resource limitations (Cooper et al., 1997).

PPM outperforms the traditional framework and mechanisms of project management due to the substantial changes required for an effective implementation of portfolio structures leading to complex synergetic effects on organizational performance. In a turbulent business environment and globalized economy PPM approach has gained an increasing popularity worldwide as well as in Bulgarian project-oriented organizations (Alexandrova et al., 2015). In a multi-project environment this approach contributes to the enhancement of competitiveness by maximizing the value added by separate projects along with minimizing the costs and risks associated to their execution. This way, PPM has proved to be a source of competitive advantage for the implementing organization by boosting the performance of its project portfolio.

The aim of this paper is to provide insights on the specifics of PPM evaluation in both short and long-term perspective. The long-term perspective is captured by two dimensions of the strategic alignment – the first one relates to the achievement of strategic goals of the organization through selection and realization of projects. The second one is focused on the strategic resource allocation. The short-term perspective is assessed by the level of projects' success accounting for three dimensions – meeting the project's budget, schedule, and quality of delivery. These dimensions reflect the efficiency of organizational resources

utilization which can be achieved through high degree of coordination of project planning, execution, monitoring, and control within an PPM system. Here we assume that the enhancement of PPM performance should be influenced by a better alignment of projects in the portfolio with the organizational strategy. The paper presents selected results from a study of PPM success in 184 Bulgarian project-oriented organizations where several indicators have been experimentally measured.

2. Literature Review

Currently, expanding number of companies which simultaneously execute multiple projects systematically develop their capacity for implementation of project portfolio management approach. This approach turns to be a key strategic instrument for gaining competitiveness and overall business success (Dietrich & Lehtonen 2005). Although initially project portfolio management has been focused on the selection of projects based on the link between project risks and benefits, nowadays it is associated to a much wider range of aspects, e.g. project monitoring and control, project prioritization, portfolio balancing, risk evaluation and management, reporting of portfolio results (Blichfeldt & Eskerod, 2008).

The definition for PPM adopted in the current study follows the one developed by Blichfeldt and Eskerod (2008) that emphasizes on managerial activities focused on *“the initial screening, selection and prioritization of project proposals, the concurrent reprioritization of projects in the portfolio, and the allocation and reallocation of resources to projects according to priority”*. Furthermore, the concept of Thiry (2006) is also supported in the study according to which PPM is based on resource analysis and allocation within the organization directed to achievement of organizational goals and thus maximizing the stakeholders' value. The development of PPM approach its performance evaluations is based on a variety of aspects (De Reyck et al., 2005) e.g.:

- centralization and formalization of the rules and procedures for project execution;
- portfolio optimization through provision of support by standardized processes, forms, and software tools;
- financial and risk analyses at both levels: individual project and overall portfolio;
- accounting for the constraints on resources shared by projects;
- emphasizing on assessment during selection and prioritization of projects;
- assuring the quality of governance at both levels: individual project and portfolio.

Following this framework, various issues related to mechanisms for PPM implementation and evaluation have been identified, e.g. assessing the scope of project portfolio, ranking of values and benefits, appraising uncertainty and risks of projects and project portfolios, etc. (Levine, 2005). The task of attaining effective PPM appears to be a significant challenge to many project-oriented organizations as far as its content and specifics are still subtle for project portfolio managers. Often the effectiveness of processes related to PPM, e.g. project selection, prioritization, assessment, etc., is not precisely defined and frequently is just generally stipulated as *“doing right projects”* (Cooper et al., 1998). An

important direction in this respect is the development of concepts, instruments, and tools specifically designed for evaluating PPM performance and its success.

Conceptually, the current study reflects a variety of suggestions about the dimensions of PPM performance, considered in a wider prospect, as well as PPM success in a narrow sense of project portfolio goals achievement. The latter is based on the premise that the success of single projects is a necessary but not sufficient condition for the overall PPM success (Martinsuo & Lehtonen, 2007). Different elements and factors have been identified as influencing the portfolio success, among which project performance during the execution phase and future awareness of PPM (Shenhav, 2001); single project success, in respect of time, budget, and quality of delivery (Atkinson, 1999); alignment of the portfolio to the business strategy (Cooper et al., 2002); emerging synergy between projects within the portfolio (Meskendahl, 2010); portfolio balance regarding the organizational capabilities and resources (Teller et al., 2014), etc.

According to Jonas (2010), a framework for evaluation of PPM success must be “*capable to capture*” PPM performance as a whole, using a set of appropriately postulated success criteria related to each other in a “*causal chain relationship*”. From this point of view, the analysis of PPM success is integrated into a complex overall assessment system at organizational level that takes into account three dimensions: process effectiveness, portfolio success, and portfolio-related corporate success. Such ideas have been considered by Shenhav et al. (2001) stating that the assessment of projects’ success needs to reflect their performance during the execution and the achievement of the targeted results. Drawing on this premise, these authors derive two dimensions at portfolio level: business success (current market success and commercial performance) and corporate success (long-term economic effects regarding the portfolio).

Other authors focus on more specific indicators for PPM performance: project teams autonomy, human resource qualifications, shared knowledge and information, top management support, project stakeholders integration, etc. (Kleinschmidt et al., 2007). However, in search of constant improvement of single project performance, a risk originating from the rivalry between projects for key organizational resources may expel the gains for any single project leading to deterioration of the overall PPM performance. For example, a recent empirical study utilizing data from 181 project portfolios provides evidence for the positive effect of project portfolio information systems for achieving PPM quality and success. This study confirms the moderating effects of formalization processes at single project, portfolio, and risk management for achieving the benefits of information systems for PPM (Kock et al., 2020). Another recent study pays attention to project performance analysis that is typically based on core indicators for project success, also termed as “*project health analysis*”. In line with this, a “*healthy portfolio*” cannot perform adequately if risk management is ineffective and PPM performance reflects directly the success of business operations of project-oriented organizations (Micán et al., 2020).

One of the major dimensions of PPM performance is defined as “average project success” and typically captures the achievements of traditional performance criteria: budget, schedule and quality – the so called “iron triangle” of project management (Atkinson, 1999).

For the goals of the current study these criteria are assessed in a short-term perspective. Besides, the synergy due to coordinated management of projects in a portfolio adds value to the summary benefits from the individual projects. The other major dimension of PPM performance is the achievement of strategic fit of the portfolio that indicates the extent to which the project goals reflect the organizational strategy (Unger et al., 2012). Such a strategic reflection is considered as a long-term perspective that contributes not only to the alignment of project goals but also to the optimal allocation of organizational resources.

3. Methodology

3.1. Data Source

The empirical analysis in the current study is based on data collected by a questionnaire survey conducted in the period 2017-2018 among representatives of 184 project-oriented organizations that operate in Bulgaria. Since there is no specific register or other kind of statistical frame to facilitate a random drawing, the respondents have been selected by a purposive sampling scheme. A specific questionnaire has been developed and sent to 200 respondents (project management experts, project managers, project portfolio managers, and representatives of the top management boards). The method of individual self-interview has been applied by participation in online survey or by submitting a filled questionnaire by email. Appropriate respondents have been reached through the channels of professional networks (LinkedIn; Bulgarian Association for Project Management). All respondents have professional duties and competences in the area of project management performed in a multi-project environment. Moreover, some of them have a key role in the management of a project portfolio operated by the respective organization. Due to substantial non-response 16 questionnaires are excluded from data processing and analysis.

3.2. Survey Instrument

For the goals of the current study a two-perspective model of PPM performance has been developed based on a selection of core measures distinguished by short and long-term prospects. The short-term perspective is based on a popular construct suggested by Gardiner and Stewart (2000) that requires evaluation of the three components: cost, schedule, and quality of delivery. It actually evaluates the “cumulative success” of the projects in the portfolio by relating the “average project success” to these components of project management triangle. This approach evaluates the project performance at the level of the entire portfolio by taking into account not only the individual projects’ characteristics but also the interdependences between them – this way incorporating the synergy effect.

The long-term prospect is related to the strategic alignment of all projects in the portfolio regarding the organizational strategy. This perspective implies measurement of two main aspects: strategic fit of project objectives and strategic relevance of resource allocation (Hendriks et al., 1999). This way the current study adopts a set of measures regarding the strategic fit reflecting the degree to which: (i) the individual project objectives contribute to the achievement of overall strategic objectives of the organization; (ii) the

resource allocation by projects is as much effective as possible in order to provide support to those projects which have highest strategic relevance.

Hereafter a selection of empirical results is presented regarding the evaluation of project portfolio management performance and success in Bulgarian project-oriented organizations. It is generally of explorative nature and emphasizes on the operationalization of PPM performance and success constructs through appropriate survey tools. The definition of measures and variables is based on conceptual arguments from the specialized literature and suggested solutions from recent literature sources. Among other issues, the questionnaire survey was focused on aspects related to the characterization of the two dimensions of the model (short- and long-term perspective).

The questions used for constructing necessary variables were close-end utilizing a 7-rank Likert scale ranging from 1- "strongly disagree" to 7- "strongly agree". Each item required an opinion concerning a specific aspect of project portfolio success.

Short-term perspective – a set of items capturing the "average project success" by encompassing the criteria of cost, time, and quality (Jonas et al., 2012):

- "On average, our projects achieve a high schedule adherence" – schedule accomplishment;
- "On average, our projects achieve a high budget adherence" – cost constraints;
- "On average, our projects achieve a high quality adherence" – quality attainment.

Long-term perspective – a set of items capturing the strategic fit concerning goals alignment and resource allocation (Biedenbach & Müller, 2012):

- "Our project portfolio is consistently aligned with the future of the company";
- "The corporate strategy is being implemented ideally through our project portfolio";
- "We have the right number of projects for the resources available";
- "The allocation of resources (people, time, and fund) to the projects reflects our strategic objectives".

Each set of items has been evaluated in respect of their reliability using Cronbach's alpha and the respective variables for short- and long-term perspectives of project portfolio success have been extracted by averaging the ranks from the individual answers.

4. Results

4.1. Profile of Respondents

A variety of personal attributes, both demographic and professional, were recorded during the survey. The pool of respondents is relatively balanced by gender, however, the age structure shows predominantly middle-aged individuals (over 70% in the range 31-50) and about one fifth with age up to 30. The sectoral structure of employment shows that almost half of them work in organizations operating in sector "IT and communications". The next more frequently recorded sectors are "Public administration" (22%) and "Construction" (14%).

An important characteristic is the experience of the interviewed – over one third indicated a long period of general work experience (over twenty years) whereas about 11% declared just a recent experience: up to 5 years. The professional experience in project management has been identified by the number of years working in project management (project team member, project office expert, project manager, project portfolio manager). The major share (about 60%) is held by respondents with specific experience 6-15 years, and over 20% indicate professional experience over 16 years (Table 1).

Table 1. General and professional experience of respondents.

Professional experience	General experience					Total
	Up to 5	6-10	11-15	16-20	Over 20	
Up to 5	100.0%	48.1%	2.9%	5.9%		19.6%
6-10		51.9%	48.6%	14.7%	8.8%	22.8%
11-15			48.6%	67.6%	39.7%	36.4%
16-20				11.8%	42.6%	17.9%
Over 20					8.8%	3.3%

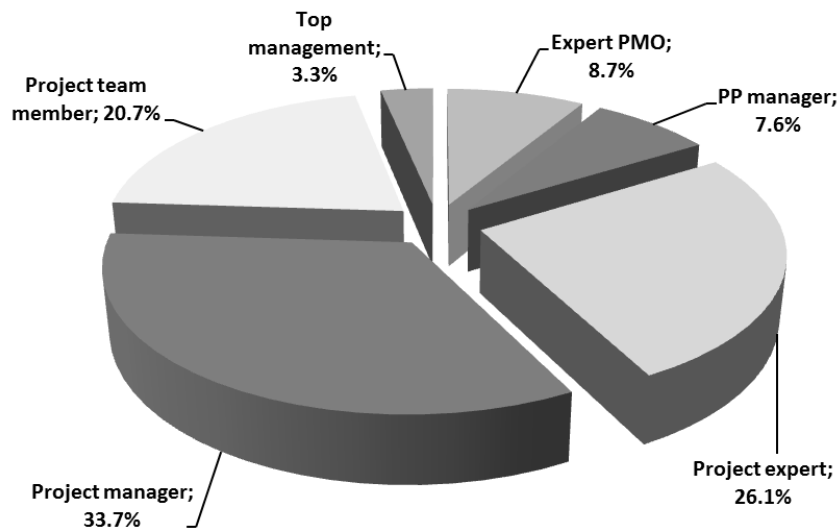


Figure 1. Distribution of respondents by position held at the organization.

Additional to the experience, the survey provides information on the positions held at the moment of filling the questionnaire. About one third of respondents act as project managers at their organization – a position which holds the largest share in the sample (Figure 1). About a quarter of the interviewed occupy various positions of project experts, followed by members of project teams (21%) and project office experts (9%). The position of “project portfolio manager” is rarely met, but still, about 8% of respondents indicate such occupation. Albeit rarely, representatives of top management of project-oriented organizations have also participated in the survey.

4.2. Descriptive Statistics of the Variables

The results from the questionnaire survey presented hereafter include the descriptive statistics for the selected items and construct variables, the reliability measures as well as the correlation coefficient between the aggregated variables. Table 2 presents the descriptive

statistics of all items and derived variables in order to provide an overview of the primary data characteristics.

Table 2. Descriptive statistics of items and variables.

Items and constructs	Min	Max	Mean	STD	CV(%)
On average, our projects achieve a high schedule adherence	2	7	4.89	1.12	22.9%
On average, our projects achieve a high budget adherence	3	7	5.45	1.06	19.4%
On average, our projects achieve a high quality adherence	3	7	5.34	1.18	22.1%
AVERAGE PROJECT SUCCESS	3.27	6.82	5.34	0.83	15.5%
Our project portfolio is consistently aligned with the future of the company	3	6	4.77	0.98	20.5%
The corporate strategy is being implemented ideally through our project portfolio	2	6	4.25	0.83	19.5%
We have the right number of projects for the resources available	3	6	5.42	1.03	19.0%
The allocation of resources (people, time, and fund) to the projects reflects our strategic objectives	3	6	4.36	0.78	17.9%
STRATEGIC ALIGNMENT	3.38	6.17	4.92	0.73	14.8%

In general, according to these results the mean levels are centered somewhat higher than the middle of the Likert scale, so the answers can be considered as showing higher perception on the status of the items involved. The high average scores by some items (above 5.0) are indicative about the relatively high ranks put by the respondents about the evaluated measures, especially for short-term perspective items. The lowest mean ranks level is observed for the item “The corporate strategy is being implemented ideally through our project portfolio” (4.25) – considering the moderate degree of variation (CV = 19.5%) here we find a relatively unfavorable opinion indicating some degree of misalignment of individual project goals and overall organizational strategy. On the contrary, the highest level is estimated for the short-term item “On average, our projects achieve a high budget adherence” (5.45) which shows a relatively high degree of financial discipline and reliable cost control during the project execution phase (according to the opinion of the respondents). On average, the mean score for the strategic alignment variable (4.92) is lower than the mean score for the average project success variable (5.34). Most likely, this result is due to relatively lower ranks assigned by respondents to items “The corporate strategy is being implemented ideally through our project portfolio” (4.25) and “The allocation of resources (people, time, and fund) to the projects reflects our strategic objectives” (4.36) – still, the long-term dimension of portfolio decision making is to gain a better focus by project portfolio managers.

4.3. Reliability Measures for Items and Variables

Table 3 presents the results on the internal consistency (reliability) measures obtained by the Cronbach’s alpha indicator. Both construct variables have scores around the threshold (0.7) considered as acceptable in respect of the reliability of the instruments. Although a diversity of practices and related attitudes of respondents is observed regarding PPM processes – which are still in a phase of development in the country – the instrument has proved to be reliable. This is valid especially for the short-term perspective items where

the construct variable shows quite high value (0.882); the removal of any of its component items would lead to unfavorable reduction in its value. The situation is not the same with the long-term perspective items, even though the overall reliability of the respective package is acceptable (0.734). Here the result for item 3 “We have the right number of projects for the resources available” shows that, if removed, the reliability of the instrument measuring the long-term perspective (strategic alignment) will clearly increase (0.773).

Table 3. Reliability measures for items and variables.

Items and constructs	Alpha	Alpha if item deleted
On average, our projects achieve a high schedule adherence		0.857
On average, our projects achieve a high budget adherence		0.713
On average, our projects achieve a high quality adherence		0.865
AVERAGE PROJECT SUCCESS	0.882	
Our project portfolio is consistently aligned with the future of the company		0.535
The corporate strategy is being implemented ideally through our project portfolio		0.675
We have the right number of projects for the resources available		0.773
The allocation of resources (people, time, and fund) to the projects reflects our strategic objectives		0.542
STRATEGIC ALIGNMENT	0.734	

In respect of the interrelation between the two perspectives of PPM performance, the Pearson product-moment correlation coefficient has been estimated. Its value (0.784) shows a relatively high degree of covariation of the two construct variables which additionally supports the initial findings and assumptions about the instrument implemented for the goals of this study. There could be a variety of arguments and motivations in search of explanation for the existing discrepancies in the patterns of variation of the two variables and their constituent items, however, these issues are beyond the scope of this paper.

5. Conclusions

This study provides certain implications about the initial stage of project portfolio management research in Bulgaria. The emerging practices of introduction and enhancement of PPM approach in Bulgarian project-oriented organizations require further investigation of various aspects of its performance, effectiveness, and overall success. This study is focused on the assessment of PPM performance in two dimensions, namely, short- and long-term perspectives, along with their empirical measurement and testing for the reliability of the applied instrument.

The results presented in this study provide orientation about the directions of next stage advancement in the analysis of PPM performance. For instance, a conceptual model of the determinants of PPM performance is necessary to reveal the causal links between the characteristics of PPM practices in project-oriented organizations. Further studies of PPM performance are expected to reflect the degree of maturity of such practices. A further study of the determinants of success and PPM performance is still a challenge for project

management research in Bulgaria which can be combined with benchmark evaluations and comparative analyses in search of empirical evidence about a variety of relevant research hypotheses.

Acknowledgments: This research is supported by Project NID NI-21/2018, Research Program 2018-2020 of the University of National and World Economy, Sofia, Bulgaria.

References

- Alexandrova, M. (2020). Impact of organizational culture on project portfolio management. In P. Jedlicka, P. Maresova, K. Firlej, & I. Soukal (Eds.), *Hradec Economic Days 2020*, (pp. 11–18).
<https://doi.org/10.36689/uhk/hed/2020-01-001>
- Alexandrova, M., Stankova, L., & Gelemenov, A. (2015). The role of project office for project portfolio management. *Economic Alternatives*, 1, 19–30.
- Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management*, 17(6), 337–342.
[https://doi.org/10.1016/S0263-7863\(98\)00069-6](https://doi.org/10.1016/S0263-7863(98)00069-6)
- Biedenbach, T., & Müller, R. (2012). Absorptive, innovative and adaptive capabilities and their impact on project and project portfolio performance. *International Journal of Project Management*, 30(5), 621–635.
<https://doi.org/10.1016/j.ijproman.2012.01.016>
- Blichfeldt, B. S., & Eskerod, P. (2008). Project portfolio management – there's more to it than what management enacts. *International Journal of Project Management*, 26(4), 357–365.
<https://doi.org/10.1016/j.ijproman.2007.06.004>
- Charvat, J. P. (2003). *Project management methodologies: Selecting, implementing and supporting methodologies and processes for projects*. Hoboken, NJ: J. Wiley & Sons Inc.
- Cooper, R., Edgett, S., & Kleinschmidt, E. (1997). Portfolio management in new product development: Lessons from the leaders II. *Research Technology Management*, 40(6), 43–52.
<https://doi.org/10.1080/08956308.1997.11671170>
- Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (1998). Best practices for managing R&D portfolios. *Research Technology Management*, 41(4), 20–33. <https://doi.org/10.1080/08956308.1998.11671219>
- Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2000). New problems, new solutions: Making portfolio management more effective. *Research Technology Management*, 43(2), 18–33.
<https://doi.org/10.1080/08956308.2000.11671338>
- Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2002). Portfolio management: fundamental to new product success. In Belliveau, P., Griffin, A., & Somermeyer, S. (Eds.), *The PDMA Toolbook for New Product Development*. NY: John Wiley & Sons.
- De Reyck, B., Grushka-Cockayne, Y., Lockett, M., Calderini, S. R., Moura, M., & Sloper, A. (2005). The impact of project portfolio management on information technology projects. *International Journal of Project Management*, 23(7), 524–537. <https://doi.org/10.1016/j.ijproman.2005.02.003>
- Dietrich, P., & Lehtonen, P. (2005). Successful management of strategic intentions through multiple projects – reflections from empirical study. *International Journal of Project Management*, 23(5), 386–391.
<https://doi.org/10.1016/j.ijproman.2005.03.002>
- Gardiner, P. D., & Stewart, K. (2000). Revisiting the golden triangle of cost, time and quality: the role of NPV in project control, success and failure. *International Journal of Project Management*, 18(4), 251–256.
[https://doi.org/10.1016/S0263-7863\(99\)00022-8](https://doi.org/10.1016/S0263-7863(99)00022-8)
- Hendriks, M. H. A., Voeten, B., & Kroep, L. (1999). Human resource allocation in a multi-project R&D environment: resource capacity allocation and project portfolio planning in practice. *International Journal of Project Management*, 17(3), 181–188. [https://doi.org/10.1016/S0263-7863\(98\)00026-X](https://doi.org/10.1016/S0263-7863(98)00026-X)
- Jonas, D. (2010). Empowering project portfolio managers: how management involvement impacts project portfolio management performance. *International Journal of Project Management*, 28(8), 818–831.
<https://doi.org/10.1016/j.ijproman.2010.07.002>
- Jonas, D., Kock, A., & Gemünden, H. G. (2012). Predicting project portfolio success by measuring management quality: A longitudinal study. *IEEE Transactions on Engineering Management*, 60(2), 215–226.
<https://doi.org/10.1109/TEM.2012.2200041>
- Kendall, G., & Rollins, S. (2003). *Advanced project portfolio management and the PMO*. J. Ross Publ.

- Kleinschmidt, E. J., de Brentani, U., & Salomo, S. (2007). Performance of global new product development programs: a resource-based view. *Journal of Product Innovation Management*, 24(5), 419–441. <https://doi.org/10.1111/j.1540-5885.2007.00261.x>
- Kock, A., Schulz, B., Kopmann, J., & Gemünden, H. (2020). Project portfolio management information systems' positive influence on performance – the importance of process maturity. *International Journal of Project Management*, 38(4), 229–241. <https://doi.org/10.1016/j.ijproman.2020.05.001>
- Kral, P., Valjaskova, V., & Janoskova, K. (2019). Quantitative approach to project portfolio management: Proposal for Slovak companies. *Oeconomia Copernicana*, 10(4), 797–814. <https://doi.org/10.24136/oc.2019.036>
- Levine, H.A. (2005). *Project portfolio management: A practical guide to selecting projects, managing portfolios, and maximizing benefits*. Jossey-Bass.
- Martinsuo, M., & Lehtonen, P. (2007). Role of single-project management in achieving portfolio management efficiency. *International Journal of Project Management*, 25(1), 56–65. <https://doi.org/10.1016/j.ijproman.2006.04.002>
- Meskendahl, S. (2010). The influence of business strategy on project portfolio management and its success—a conceptual framework. *International Journal of Project Management*, 28(8), 807–817. <https://doi.org/10.1016/j.ijproman.2010.06.007>
- Micán, C., Fernandes, G., & Araújo, M. (2020). Project portfolio risk management: a structured literature review with future directions for research. *International Journal of Information Systems and Project Management*, 8(3), 67–84. <https://doi.org/10.12821/ijispm080304>
- Shenhar, A. J. (2001). One size does not fit all projects: exploring classical contingency domains. *Management Science*, 47, 394–414. <https://doi.org/10.1287/mnsc.47.3.394.9772>
- Shenhar, A. J., Dvir, D., Levy, O., & Maltz, A. C. (2001). Project success: a multidimensional strategic concept. *Long Range Planning*, 34(6), 699–725. [https://doi.org/10.1016/S0024-6301\(01\)00097-8](https://doi.org/10.1016/S0024-6301(01)00097-8)
- Teller, J., Kock, A., & Gemünden, H. G. (2014). Risk management in project portfolios is more than managing project risks: a contingency perspective on risk management. *Project Management Journal*, 45(4), 67–80. <https://doi.org/10.1002/pmj.21431>
- Thiry, M. (2006). Managing portfolios of projects. In J. R. Turner (Ed.), *Gower Handbook of Project Management*. Aldershot, UK: Gower Publishing.
- Unger, B. N., Kock, A., Gemünden, H. G., & Jonas, D. (2012). Enforcing strategic fit of project portfolios by project termination: an empirical study on senior management involvement. *International Journal of Project Management*, 30(6), 675–685. <https://doi.org/10.1016/j.ijproman.2011.12.002>

Students Further Learning Preferences in Higher Education

Patrik BAŠA, Enikő KORCSMÁROS and Bence CSINGER*

J. Selye University, Komarno, Slovakia, patrik.basa111@gmail.com; korcsmarose@ujs.sk;
csinger.bence@gmail.com

* Corresponding author: csinger.bence@gmail.com

Abstract: In the 21st century, education plays a key role in people's lives. With the help of higher education, we can have a huge number of opportunities and it contributes to the increase of the overall quality of life. Higher education helps to train in the chosen field, to understand the contexts by teaching students analytically and to communicate effectively. The timeliness of our study is primarily due to the fact that education is one of the key factors in the 21st century knowledge-based society. The aim of our research is to examine the preferences of graduating high school students with an excellent and good academic average for further education. In the course of our quantitative research, the opinion of these students came specifically into focus. Our results demonstrate that the factor considered most important by the two groups is different. Our study based on a survey of 270 students in Hungarian institutions.

Keywords: decision-making process; preferences; higher education system; enrollment strategy

JEL Classification: I20; I21; I23

1. Introduction

Our choice of the topic was basically determined by our interest in a competitive higher education system and our personal experience for the topic was highly motivated. The significance of our study is given by the fact that in today's knowledge-based society, education is one of the most indispensable factor in people's lives. Based on these, our primary goal was to examine that what are the most important motivational factors that play a role in the life of students when they are facing the choice of a higher education institution.

For most people, education is an investment that plays off for both the individual and society. (Riggert, Boyle, Petrosko, Ash, & Parkins, 2006)

The 21.st century students have a lot of expectations about a higher education institution. Universities need to keep pace with both the expectations and needs of students. (Irvine-Code-Richards, 2013)

The motivation for our research is to understand what are the most important influencing factors that influence students today in terms of their intention to continue their studies.

In the first part of our study, with the help of domestic and international literature, we examine the influencing factors that affect students in terms of further learning. This is

followed by the presentation of the purpose of the research and the methodology we used. As a next step, we provide a comprehensive picture of the validity of the formulated hypotheses and the results of our study. Based on the results the conclusions and recommendations on the topic are formulated. With the help of primary data collection, we conducted a survey among graduating high school students in Hungary.

1.1 The Decision of Making Process of Students

It is now internationally recognized that student decisions are influenced by a number of influencing factors and that the main effects of student decision-making processes need to be explored for successful marketing activities of institutions. It is necessary to understand the influencing factors of this process that play a role in the choice of university or college. During the choices, students show the forms of motives for customer behavior. Such motive effects may be different for the social class. In 1995, Kotler and Fox identified five phases in the decision-making process:

- collection of information,
- evaluation of alternatives,
- decision-making process,
- post-decision behavior.

The model helps higher education institutions to understand the mindset of students at different stages of selection. However, the leading factor in the selection of universities and colleges is the close relationship between individual disciplines and career paths. One of the most popular ways to gather information is to visit the institutions 'website, followed by information from current university students. The next step in the decision-making process is to evaluate the alternatives, which includes gathering information about university alternatives and narrowing them down. Students then choose an alternative from their choice set. In the assessment phase, students objectively justify their decision, i.e., compare the characteristics of each institution. In the lives of students, there are some people who extremely influence their selection process. The number one person includes parents, friends, and school teachers, while the group of persons number two includes persons such as university lecturers. In 2013, Haynes et al found that parents have significant influence over their children. (Nemar & Vrontis, 2016)

The primary task of students entering higher education is to prepare for their future profession. Apart from this, the ability to solve problems, work in a team, communicate properly are essential to making professional decisions today. (Chernikova, Heitzmann, Stadler, Holzberger, Seidel, & Fischer, 2020)

1.2 Motivational Factors for Students in Choosing a Higher Education Institution

Choosing the right university is increasingly becoming a kind of critical investment choice. Institutions are more attractive if they are able to communicate their value perceptions through interactions with prospective students. Regarding the selection process, we can talk about certain preferences, which can be personal preferences, parental preferences,

admission scores, university rankings, counselors and friends. One of the most influential factors is, of course, personal preference, as students rely heavily on their own ideas and desires. According to Soutar and Turner (2002), students attach important importance to the general preference criteria, which are:

- the type of courses available,
- the university environment,
- the quality of faculty education,
- type of university,
- the academic reputation of the university.

In addition, it is important to mention personal preferences, the location of the institution, the family's perception of the university, and which university / college the student's friends will go to. In determining the most important factors, students rank the level of importance of each preference. (Nemar & Vrontis, 2016)

One of the most important factors among students' pre-qualification experience is the choice of higher education institution. Students whose values and beliefs fit the chosen institution will be satisfied with the choice, which will contribute to obtain a higher education degree. Selection involves matching students' individual characteristics and values to the institution. Selection itself can be defined as a three-step process that includes the following elements: predisposition, search and choice, which contribute to the student's behavior and attitude towards the higher education institution. The influencing factors of all three stages include the economic and social situation. (Nora, 2004)

In their 1981 research, Hooley and Linch identified six variables that students take into account when selecting an institution. The six factors are the location of the university, the distance from home, the suitability of the courses, the reputation of the university, the type of university, and the advice of parents and high school teachers. (Hooley-Linch, 1981)

In a 2002 study, Soutar and Turner (2002) concluded that the factors most influencing the student selection process are suitability of the course, reputation, job opportunities, and the quality of teaching.

In their 2008 study, Jusof, Ahmad, Tajudin, and Ravindran (2008) found that prospective university / college students and their parents found financial assistance to students to be one of the most important influencing factors. Their research concluded that the availability of the required program also plays a key role in the selection process. In support of this finding, in 2009, Wagner and Fard noted that the cost, value, and quality of a degree in education are the three most important factors influencing student choice.

The choice of higher education institution is a group decision that determines the future of the student, within which the family has an extremely important role to play. It is important to emphasize that, over time, student decision-making is much more the responsibility of the individual, but the influential role of the family remains. In his doctoral dissertation Rámháp (2017) states that the students in Hungary can be classified taking into the account their further learning attitude into the following groups: prestige-oriented, experience seekers and considered. For the first group it is important to acquire outstanding

knowledge, has serious career plans and an important role is played by the standard of instructors and good university reputation. For the second group in contrast the good community and atmosphere is the most important factor. For the, meeting the minimum conditions is the main goal. For students in the third group, the primary considerations are comfort, affordability and favorable future job opportunities. Today, this information can play a key role in shaping the marketing and communication strategy of universities.

The basic of a well-developed marketing strategy is to keep the target group informed. In her doctoral dissertation in 2007, Kuráth (2007) distinguishes between external and internal influencing factors. External influencing factors include the demographic environment, the accessibility of different university buildings, their unique nature and the different funding methods. Groups of internal influencing factors include admission requirements, marketing activities, quality of education, training scale, university equipment, career opportunities and research opportunities. Cultural opportunities offered by the institutions can also be influencing factors. Enrollment marketing activities can play an important influential role in students decision-making processes.

In 2011, Császár and Németh (2011) distinguished five different roles in terms of further learning decision-making. The initiator is the student who would like to continue her/his studies. In the case of parents, we can talk about a person whose goal is for their child to continue their studies. The influencing category is extremely broad. These include parents, friends, acquaintances, society and the workplace. There is often a situation where parents consider individual goals, but in terms of funding, they make the final decision. Thus, the financial situation of the family also plays an essential role in the selection. At the stage of the decision-making process, when the settlement choice and housing are the focus, mutual decisions are often made. It is important that the parents provide their children with good advice and experience when they make a decision.

As a final step, it is important to mention that the final decision is often related to the obvious and hidden costs of higher education. Especially nowadays, it is an extremely important influencing factor for students whether an institution offers some kind of financial incentive support. Canché's (2018) study also shows that students do not ignore institution characteristics either, the local accessibility of a higher education institution has a positive effect on the willingness of local students to continue their studies.

2. Methodology

The main goal of our research is to expand the published literature on the topic by providing an insight into the motivational factors which have an influential effect when students are faced with the choice of a higher education institution. In our study we would like to point out the student decision-making process and the most significant influencing factors. For the rest of our work, our goal is to provide a comprehensive picture of the topic in Hungary, which can help to expand the literature on the subject. To perform our research, we performed primary data collection, which took the form of quantitative survey. Our questionnaire was created using Survio and Google Form Builder software. During our contact with the secondary schools, we asked the teachers of each institution to fill in the

questionnaire only with their graduate students, which was sent to them in the form of direct mail. We thought that we could provide an authentic and comprehensive picture of the influencing factors that arise in Hungarian students only if we specifically addressed them. The first step was to encode the feedback data using Microsoft Excel. Subsequently, we examined the correctness of our hypotheses with the help of SPSS program. Our questionnaire contained 8 questions. The structure of the question groups is shown in Table 1.

Table 1. Structure of question groups

Question group 1.	Question group 2.	Question group 3.	Question group 4.	Question group 5.
Classification based on study results	Intention to continue learning	Influencing factors in the selection of a higher education institution	Preference for domestic or foreign institutions, justification, factors influencing change in decision	Demographic data

A total of 311 high school graduates joined our data collection. The number of completed and evaluable responses was 270 that could be used in the analysis. In examining our hypotheses, we used descriptive statistical methods, including cross-tabulation analysis. A significance level of 5% was determined during the evaluation. Chi-square test was used to analyze the variables.

3. Results

Following the theoretical review of the study, we present the results of our research. With the hypotheses related to the topic, our goal was to examine the influencing factors affecting Hungarian students when they choose a higher education institution. Following a review of the literature, the following research question was formulated in us:

RQ: What are the main factors that are the most important motivating factors for choosing a university for Hungarian students with an excellent and good academic average?

The following hypotheses have been formulated on the topic:

Assumption 1: Students who belong to the group of students with an excellent academic average are the most important factor in choosing a higher education institution is the standard of the university.

Assumption 2: For students with an excellent academic average, the reputation of the higher education institution is more important to them for students with a good academic average.

In the first round, we were curious to see if there was a difference between students with good (4) and excellent (5) averages for the factors considered most important. The distribution of responses is summarized in Figure 1. It is clear that the two lines follow an almost identical curve. There are some differences between two variables, which are the standard of the university and the reputation of the university, which excellent students rated as a more important factor when choosing a higher education institution. We hypothesize that because excellent students are the best, they require that the best decision be made when selecting higher education institutions.

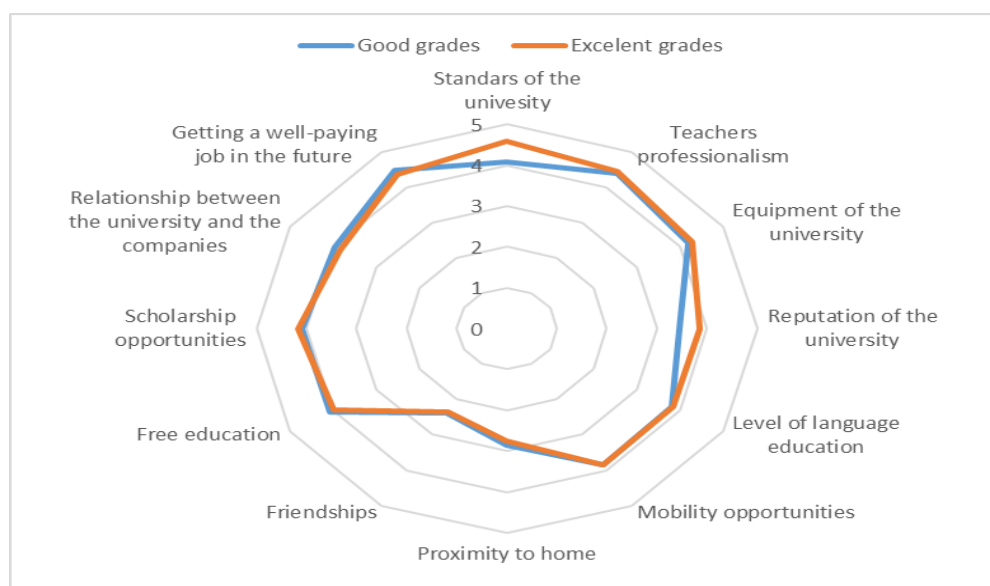


Figure 1. Responses from students with excellent and good grades about the importance of each factors

Based on the figure, it can be concluded that the first assumption is true. The figure clearly shows that for students with an excellent academic average, the most important motivating factor is the standard of the university. Our second assumption was also confirmed, as it is clear that the university standard is a more important factors for students with the best academic average. The figure also helps to encourage Hungarian students to continue their studies in Hungarian higher education institutions.

4. Discussion

The first part of our research, we examined the individual steps of the student decision-making process in the 21st century with the help of domestic and foreign literature. The significance of the model is that it helps universities and colleges to understand a student's way of thinking, which plays a key role in shaping the enrollment strategy. After that we provided in insight into the preferences that arise during the selection process. Based on the literature review, one of the most important factors in the selection process is the personal preference for students. As a next step we put great emphasis on the three steps of the decision-making process and reviewed how and to what extent the significance of each influencing factor has changed over the years. Following the literature review, the aim and the methodology of the research were presented, followed by the results of the work. In this chapter, a research question and two assumption related to the topic were formulated, in which we focused exclusively on the students who performed well and best. In the last part of the study, we summarized the results of the work and formulated conclusions and suggestions.

5. Conclusions

The main aim of our research was to examine those Hungarian high school graduates who have a good or excellent study average. Based on this our research question was formulated, on the basis of which it can be established that for students with the best

academic average, the most important motivating factor is the standard of the university, which is followed by the professionalism of the lecturers. In contrast, for students with a good academic average, the most important is to get a well-paying job in the future. The professionalism of the lecturers is in the second place in their case as well. The results can serve as a good starting point for universities and colleges in creating an enrollment strategy. That is why we set a goal for the future, after the end of the health crisis situation, to expand our database as a first step in relation to Hungary, in order to get an even more comprehensive picture of the topic. In the distant future our aim is to expand the research to an international level.

Acknowledgments: The scientific article is a partial output from the KEGA project 005UJS-4/2019 entitled "Streamlining Managerial Skills of the generations Z and Y by gamification on the context of linking science and practice", which is solved at the Faculty of Economics and Informatics of the J. Selye University in Komárno.

References

- Canché, G. S. M. (2018). Nearby college enrollment and geographical skills mismatch: (Re)conceptualizing student out-migration in the American Higher Education System. *The Journal of Higher Education*, 89(6), 892-934. <https://doi.org/10.1080/00221546.2018.1442637>
- Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-based learning in higher education: A meta analysis. *Review of Educational Research*, 20(10), 499-541. <https://doi.org/10.3102/0034654320933544>
- Császár, M. Z., & Németh, J. (2011). Some aspects of human capital production in Hungarian higher education. *Central European Regional Policy and Human Geography*, 1(1), 27-35.
- Hooley, G. J., & Lynch, J. E. (1981). Modeling the student university choice process through the use of conjoint measurement techniques. *European Research*, 9(4), 158-170.
- Irvine, V., Code, J., & Richards, L. (2013). Realigning higher education for the 21st-century learner through multi-access learning. *MERLOT Journal of Online Learning and Teaching*, 9(2), 172-186.
- Kuráth, G. (2007). *A beiskolázási marketing szerepe a hazai felsőoktatási intézmények vonzerőfejlesztésében.* (The role of enrollment marketing in the attraction development of Hungarian higher education institutions. Doctoral dissertation) Pécsi Tudományegyetem Közgazdaságtudományi Kar. Regionális Politika és Gazdaságtan Doktori Iskola. Doktori értekezés.
- Nora, A. (2004). The role of habitus and cultural capital in choosing a college, transitioning from high school to higher education, and persisting in college among minority and nonminority students. *Journal of Hispanic Higher Education*, 3(2), 180-208. <https://doi.org/10.1177/1538192704263189>
- Rámháp, S. (2017). *Felsőoktatási továbbtanulási motivációk Magyarországon. A változó ifjúság és a piacosodó felsőoktatás tükrében. Doktori értekezés tervezet.* (Motivations for further education in higher education in Hungary. In the light of changing youth and marketable higher education. Doctoral dissertation draft.) Széchenyi István Egyetem. Regionális- és Gazdaságtudományi Doktori Iskola
- Riggert, C. S., Boyle, M., Petrosko, M. J., Ash, D., & Parkins, R. C. (2006). Student employment and higher education: empiricism and contraction. *Review of Educational Research*, 76(1), 63-92. <https://doi.org/10.3102/00346543076001063>
- Soutar, G. N., & Turner, J. P. (2002). Students' preferences for university: A conjoint analysis. *The International Journal of Educational Management*, 16(1), 40-45. <https://doi.org/10.1108/09513540210415523>
- Yusof, B. M., Ahmad, B. B. N. S., Tajudin, M. B. M., & Ravindran, R. (2008). A study of factors influencing the selection of a higher education institution. *Unitar e-Journal*. 4(2), 27-40.

Turning Digitisation into Disruption

Stephan BAURIEDEL

Ekonomická univerzita v Bratislave; Bratislava; Slovenská republika; bauriedel@digital-action.de

Abstract: Digitisation can lead to disruption. This theory describes four steps that allow an entrepreneur to actively shape disruption. The goal is to show the entrepreneur a pragmatic way to take advantage of the business benefits of digitisation. If disruption of markets is possible, the entrepreneur should go for it. This concept comprises points which need to be connected. The starting point is digitisation and the goal is disruption. It is known that platforms reduce transaction costs and that the reduction can lead to a possible monopoly. All four points were first examined, then the connecting steps were added, arranged in a chain of effects and supported by arguments. The chain of effects describes the process that transforms digitisation into disruption. The result shows four steps that an entrepreneur must address after going-live in order to reap the benefits of digitisation. It also illustrates that cost reduction determines the leverage for disruption. Thus, cost reduction becomes the primary goal of any digital strategy. Knowing the chain of effects demystifies disruption for the entrepreneur.

Keywords: digitisation; disruption; entrepreneurship

JEL Classification: O33; O44; M21

1. Introduction

Digitisation can lead to disruption. Disruption is a threat for every company. But if disruption is possible, the company must go for it. Otherwise, a competitor or a new entrant will do it and overtake. A disruption comes quickly and violently. Well-known examples of this are Nokia and Kodak.

To foresee the impact of digitisation is difficult for the entrepreneur, because the digital world is subject to different laws. It is necessary to decipher the new success factors and use them for oneself. The theory presented here states that digitization is a business objective. After the successful transformation, however, another goal emerges: disruption. It takes both goals to be successful. This article examines argumentatively which steps are necessary that digitisation leads to disruption.

Digitisation is closely linked to disruption. For anyone to observe, Uber has completely transformed the cab business and iTunes has completely changed music distribution in a short period of time. Salim Ismail states in the context of his theory of exponential organisations, "An information-based environment creates fundamentally disruptive opportunities." (Ismail et al., 2017)

There are many descriptions of digitisation in the literature. Klaus Macharzina calls it a technology that connects people and therefore companies (Macharzina & Wolf, 2018). Klaus Schwab describes it as the "fourth industrial revolution" (Schwab, 2016) and Peter Glaser

marks it as an inevitable event: "Everything that can be digitised will be digitised. Everything." (Glaser) It quickly becomes apparent that digitisation is a nebulous homonym. The author has begun to elaborate the characteristics of digitisation by comparing the way internet startups like Uber, Airbnb, and Booking.com work with the way analog organisations work. The result is the following definition: "Digitisation is an epochal leap in productivity with the character of an industrial revolution." This definition describes why digitisation is both an opportunity and a threat.

Disruption encompasses various theories, which build on each other. Joseph A. Schumpeter (Schumpeter, 1942) advocated the theory of the constant renewal of markets as early as 1942. He assumed that an idea is suitable until a new, better idea replaces the old one. Richard Foster (Foster, 1986) stated in 1986 that there is a dependency between the effort for improvements of a technology and its performance. He developed the first S-curve model. Clayton Christensen (Christensen, 2016) later took Foster's idea and extended the model to a multiple S-curve model. He recognized that disruptive innovations initially perform worse. At a certain point, the new technology overtakes - in rapid steps - the predecessor and becomes the leading technology. Rebecca Henderson (Henderson & Clark, 1990), a professor at Harvard University, created the term Architectural Innovation. She does not consider a product as a whole, but divides it into different components and thus examined the structure. Architectural Innovation in this context is a great challenge for companies because the structure of the product changes. The basic structure of the product is different and the knowledge about the design of the product is erupted. Finally, Joshua Gans defined the term disruption as follows: "I define disruption as what a firm faces when the choices that once drove a firm's success now become that destroy its future." (Gans, 2017)

In the context of this paper, two other characteristics of digitisation are worth mentioning. First, there is evidence that digitisation lowers marginal costs, and second, there is a phenomenon of monopoly formation. Digitisation significantly changes the cost structures of companies. Fixed costs increase and variable costs decrease. The implementation of a digital strategy requires investments in building the platform, while transaction costs are reduced to a minimum. Hagen Krämer (Krämer, 2019) shows in his working paper how the costs of an industrial product change compared to a digital product. Building the platform results in the first transaction having the highest cost and for each subsequent transaction the marginal cost remains constant at a minimum. This phenomenon is called first copy cost. In contrast to industrial costs, product costs fall steadily with output quantity (unit cost degression (Clement et al., 2019)). Florian Bartholomae (Bartholomae, 2018) studied two different effects, gradual and drastic cost reduction, in his working paper. While gradual cost reduction results in a shift in competition, Bartholomae assumes that drastic cost reduction can lead to a monopoly. This phenomenon is called "the winner takes it all" (Clement et al., 2019) and describes how the digitisation of business models can lead to a single dominant provider.

2. Methodology

Digitisation shows the character of an industrial revolution, as it has technological, managerial and social implications. The state of the problem demonstrates that there are very many isolated theories, which do not mesh well. This paper focuses on pragmatic recommendations for action for an entrepreneur who is already established in the market (B2B) and is planning a digital strategy.

2.1 The Missing Link

The methodology to develop the theory listed here is relatively simple. Several times it is stated in literature that disruption can be triggered by digitisation, but there is no guidance or theory on how to actively bring about disruption. The author has developed the Digital Action model (Bauriedel, 2020c), which breaks down the development of a digital strategy into 7 planning steps. The model is used to transform an analogue organisation into a platform-oriented business model. It has been shown that the going-live of the platform is not the end. The technical goal of digitisation is achieved, but there is no connection to disruption. The first insight is that after the completion of the digital transformation, the process should go further. There is a gap between digitisation and really disruptive change that no one had described before.

2.2 Connecting the Dots

The second step was to identify all the known fixed points. The idea is that digitisation is the starting point and disruption is the result. The connection between the two points would be a process (Hammer & Champy, 1994) with several sequential steps necessary to achieve this outcome. The goal of digitisation is to systematically replace manual and intellectual work in operational processes (“algorithms replace employees” (Bauriedel, 2020b)). Therefore, digitisation leads to a reduction in costs. The entrepreneur now has two options: increase profits or reduce prices. Higher returns are lucrative, but they do not lead to disruption. And it does not solve the problem of third-party disruption. Therefore, the next logical step is to lower prices. The measure that the company must take after digitisation is price reduction. Interestingly, it is not mentioned in connection with digitisation. And it will be necessary to launch marketing activities to publicise the price advantage and to draw attention to the platform.

2.3 Creating a Theory

The methodology for the theory was to observe, question and conclude. The chain of effects established shows analogy to other epochal developments, such as the steam engine. But in a digital world time for action is much shorter. Therefore, the entrepreneur needs from the beginning a strategy for digitisation and a second strategy for disruption. The task was to provide an argumentative support to this theory. An upcoming multi-case study will test the theory on companies who have already gone through the digital transformation.

2.4 Work experience

The author also has 30 years of experience in strategy, business, technology and change. As a management consultant, he has gained deep knowledge of the organisational structure of companies and their IT infrastructure in numerous projects. He has been researching and publishing on digital strategies and their implementation for five years (Bauriedel, 2017).

3. Results

The operation of the platform is not the end of the digital strategy, but the beginning of disruption. The company has realised a leap in productivity with digitisation, which must now be exploited consistently. The micro-economists have recognised that digitisation reduces transaction costs and they have observed that this can lead to monopoly formation. From the entrepreneur's point of view, the connecting steps to actively shape the results are missing. Considering the laws of business management, the following intermediate goals (Figure 1) are required to make digitisation a success: Drastically reduce costs, significantly reduce prices, explosively increase volume and successively take over market share. The emphasis is on drastic and explosive, because we are not talking about incremental improvement, but about a leap in productivity of ten percent and more.

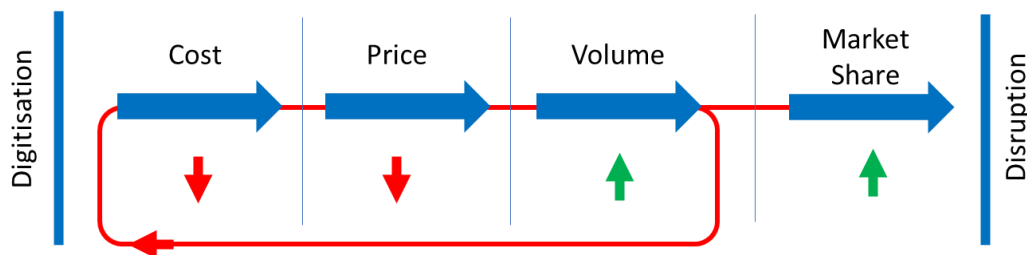


Figure 1. Chain of effects for digital success.

Costs - Digitisation is a cost killer. It minimises transaction costs and has an impact on all subsequent costs. The first goal of any digital strategy should therefore be to reduce costs. An industrial company, for example, typically has a strong sales force that accounts for 20 percent of costs and downstream marketing that comprises five percent of costs. That means 25 percent of the price achieved is spent on initiating business. With a digital strategy based on online marketing, a sales platform and personal support for all key accounts, the costs for marketing and sales would only be an estimated ten percent. All A customers, which account for 80 percent of the business, would continue to receive individual support via key account management and all B and C customers would be redirected to the platform. An estimate by the author states that digitisation enables a cost reduction of ten to 99 percent. The minimum goal here is achieved simply by eliminating work in operational processes, and the maximum goal when converting to a digital asset.

Prices - In tight markets, there is constant price competition. Firms are subject to the Bertrand principle (Clement et al., 2019, p. 71), where price is oriented just above marginal cost. If a market player exploits the cost advantages of digitisation, it can offer its products

far below the marginal costs of the competition. Therefore, the first step - reducing costs - determines the leverage effect of the following steps. After all the higher the cost reduction the more aggressive the price reduction.

The second step in the chain of effects has as its goal to lower prices and to do so as much as possible. Jeremy Rifkin states in his book "The Zero Marginal Cost Society" that a productivity gain through innovation always leads to lower costs and lower prices. He writes, "Attempts to inhibit economic progress are inevitably doomed to failure because new entrepreneurs are constantly lurking at the margins of the system, their eyes open for innovations that increase productivity and reduce costs, which allows them to go after consumers with lower prices than their competitors." (Rifkin, 2014)

Chris Anderson argues this move by citing one of Bertrand's conclusions, "that firms are more likely to cut prices to increase market share than to cut production in order to impose higher prices in the marketplace" (Anderson et al., 2009). He has also described in detail in his book "Free" how companies attract customers by offering a free service. If marginal costs are close to zero, parts of the offering can be made available for free in order to promote the paid offerings.

Volume - An aggressive price cut changes customer behavior and markets. Customers react quickly to price cuts and start to switch providers. In addition, German industrial companies have a low return on sales of only two to four percent (Statista GmbH, 2020). Due to the low return and high marginal costs, competitors cannot counter a drastic price reduction of ten to 20 percent. The digital provider gradually takes over the business volume of the analog competitors. In this third step of the chain of effects, the aim is to bring about an explosion in business volume. All measures that lead to exponential growth must be applied.

According to the Jevons paradox (Jevons, 1866), a lower price also leads to an increase in consumption. That is, by having a high availability and a low price, the market grows. Peter Diamandis (Diamandis & Kotler, 2012) in his book "Abundance" even speaks of waste. He argues that a scarce good can become a product in abundance due to the continuous innovations. Salim Ismail (Ismail et al., 2017) takes up this idea and describes how digital goods in particular (photos, music and movies) grow from scarce goods to exponentially consumed products.

Market share - The increasing volume of business shifts market shares. It can be assumed that market shares by revenue will initially fall as a result of the drastic price reduction and then quickly grow again. Market shares by products sold will increase immediately after the price reduction. As is well known, the unit cost regression already mentioned leads to further cost savings, which should be used for an additional price reduction and then leads to even more volume. Dominance is only properly applied when the competitor gives up. This phenomenon is called "the winner takes it all" and illustrates that the digitisation of business models can lead to a single dominant supplier.

4. Discussion

Digitisation is difficult to describe. Politicians, associations and entrepreneurs refer to digitisation as the topic of the future and yet cannot explain it. Digitisation eliminates all

employees in operational processes and replaces them with a platform. Platforms reduce transaction costs to zero and increase output to infinity. Amazon.com can serve a billion customers simultaneously while offering 200 million products (Brandt, 2017) around the clock. The three levers of productivity, capital, labor and resources, are erupted. It takes less capital, no labor, and digital goods require no resources (Bauriedel, 2020a). The conventional thinking no longer works.

It is hard for the entrepreneur to accept the new success factors, having been very successful in his former business for decades. Micro-economists have recognised that digitisation reduces transaction costs and they have observed that this can lead to monopoly formation. From the entrepreneur's point of view, the connecting steps to actively shape the results are missing. The question I followed was: "How did Uber became an internet giant." If you ask the entrepreneur, he thinks they are smart. If you ask the technology providers, they talk about web, app and cloud. If you ask the digital consultants, they explain the business model to you. So how does it come that Uber became a giant and all the others failed? I believe the chain of effects for digital success shows the invisible master plan behind a disruptive strategy. The visible part of Uber is the app, but the invisible part consists of a destructive price war for dominance in the passenger transportation segment. Uber cut the price for the ride and delivers high volumes at the same time. If it appears to be so obvious, why do all the others fail?

In summer 2021, the theory will be further investigated in an upcoming multi-case study. Several entrepreneurs who claim that they have already digitized their company will be surveyed. For this purpose, dedicated system queries will be initiated in the companies' business applications to build up an objective database. The aim is to record the impact of the digital transformation on the company's results. A partial result is the verification or rejection of the theory stated here.

References

- Anderson, C., Schöbitz, B., & Vode, D. (2009). *Free - Kostenlos: Geschäftsmodelle für die Herausforderungen des Internets*. Campus-Verl.
- Bartholomae, F. W. (2018). Ökonomische Auswirkungen der Digitalisierung auf den internationalen Wettbewerb und die internationale Arbeitsteilung. *SSRN Electronic Journal*. Advance online publication. <https://doi.org/10.2139/ssrn.3218164>
- Bauriedel, S. (2017). *Die Digitalisierung der Geschäftsmodelle: Die 18 wichtigsten Business Cases für digitale Geschäftsmodelle in der Industrie*. Unternehmensberatung.
- Bauriedel, S. (2020a). *Die drei Killerargumente für die Digitalisierung*. www.digital-action.de
- Bauriedel, S. (2020b). *Die fünf Gesetze der Digitalisierung*. www.digital-action.de
- Bauriedel, S. (2020c). Procedure model for the developement of digital strategies. In P. Ondra (Ed.), *DOKBAT 2020 - 16th International Bata Conference for Ph.D. Students and Young Researchers* (pp. 49–56). Tomas Bata University in Zlín. <https://doi.org/10.7441/dokbat.2020.04>
- Brandt, M. (2017). *229 Millionen Produkte auf Amazon.de*. <https://de.statista.com/infografik/7849/bei-amazon-deutschland-gelistete-produkte/>
- Christensen, C. M. (2016). *The Innovator's Dilemma: When new technologies cause great firms to fail. The management of innovation and change series*. Harvard Business Review Press.
- Clement, R., Schreiber, D., & Bossauer, P. (2019). *Internet-Ökonomie: Grundlagen und Fallbeispiele der digitalen und vernetzten Wirtschaft*. Lehrbuch.

- Diamandis, P. H., & Kotler, S. (2012). *Abundance: The future is better than you think*. Free Press.
<http://www.loc.gov/catdir/enhancements/fy1205/2011039926-s.html>
- Foster, R. N. (1986). *Innovation: The attacker's advantage*. Summit Books.
- Gans, J. (2017). *The Disruption Dilemma* (MIT Press new paperback edition). The MIT Press.
- Glaser, P. *Aussage Digitalisierung*.
- Hammer, M., & Champy, J. (1994). *Reengineering the Corporation: A manifesto for business revolution*. Harper Business.
- Henderson, R. M., & Clark, K. B. (1990). Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly*, 35(1), 9.
<https://doi.org/10.2307/2393549>
- Ismail, S., Malone, M. S., & van Geest, Y. (2017). *Exponentielle Organisationen: Das Konstruktionsprinzip für die Transformation von Unternehmen im Informationszeitalter*. Verlag Franz Vahlen.
- Jevons, W. S. (1866). *The Coal Question: An Inquiry concerning the Progress of the Nation, and the Probable Exhaustion of our Coal-mines*. <https://oll.libertyfund.org/title/jevons-the-coal-question>
- Krämer, H. (2019). Digitalisierung, Monopolbildung und wirtschaftliche Ungleichheit. *Wirtschaftsdienst*, 99(1), 47–52. <https://doi.org/10.1007/s10273-019-2394-z>
- Macharzina, K., & Wolf, J. (2018). *Unternehmensführung: Das internationale Managementwissen: Konzepte - Methoden - Praxis* (10. vollständig überarbeitete und erweiterte Auflage). Lehrbuch. Springer Gabler.
<http://www.springer.com/>
- Rifkin, J. (2014). *Die Null-Grenzkosten-Gesellschaft: Das Internet der Dinge, kollaboratives Gemeingut und der Rückzug des Kapitalismus*. Campus Verlag GmbH.
<http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&AN=1052156>
- Schumpeter, J. A. (1942). *Capitalism, Socialism and Democracy* (First edition). Harper.
- Schwab, K. (2016). *Die vierte industrielle Revolution*. Pantheon.
- Statista GmbH (Ed.). (2020). *Deutsche Metall- und Elektroindustrie - Umsatzrendite bis 2019*.
<https://de.statista.com/statistik/daten/studie/153677/umfrage/ertragslage-der-metall--und-elektroindustrie-in-deutschland-seit-1997/>

Sharing Economy in the Czech Republic

Marie BEDNARIKOVA and Jana KOSTALOVA*

University of Pardubice, Pardubice, Czech Republic; marie.bednarikova@upce.cz; jana.kostalova@upce.cz

* Corresponding author: jana.kostalova@upce.cz

Abstract: The sharing economy started to evolve significantly as a new trend at the end of last decade. An important impulse for this evolution was the technological development, which made it possible, together with the arrival of Web 2.0, to create platforms of the sharing economy. The sharing economy appears in a lot of variations, with local and worldwide accessibility, and the number of shared items is growing continuously. The focus of this paper is to map the spread of this new trend in the Czech Republic. It aims to identify individual areas of the sharing economy and to show their strengths and weaknesses. The paper includes the outcomes of a research dealing with identification of the areas of the sharing economy in the Czech Republic and with the experience with its use.

Keywords: sharing economy; peer-to-peer (P2P); categories of sharing economy; development of sharing economy in the Czech Republic

JEL Classification: D16

1. Introduction

Sharing Economy (SE) allows more effective optimization of resources thanks to the possibility of sharing unused property, services, or unused capital (Gurau & Ranchhod, 2020). The main potential of this economic model lies in the possibility of its application in almost all the existing branches of economy. Sharing property is not a contemporary phenomenon. For decades, there have been services that comply with certain signs of SE. However, together with the massive development of modern technologies, with the spread of the Internet and mainly of smart phones, sharing free resources of an individual has become easily accessible and undemanding (Bardhi & Eckhardt, 2017). The basic advantage of sharing through a technological platform is the factor of increased confidence, which is created by a mutual user evaluation system.

The society is in Stage 4 of the Industrial Revolution, which is a result of development in a lot of areas – quicker communication and work with data, new manufacturing technologies and materials, comprehensive digitalization and automation of processes (Petrjanos, 2019; Basselier et al., 2018). Within this “Revolution”, networking is established among persons, machines, products, and information systems. Industry 4.0 brings new forms of economy and extends the existing forms of flexible work (Dev et al., 2019). And SE, which is connected with this trend, has become a phenomenon of the recent years (Barancova, 2017).

SE concept - Sharing is a form of a social exchange occurring between people who know each other and who do not make any profits from it. Sharing used to be a substantial part of life of our ancestors, who survived whole centuries just on the principle of sharing. It was a tool mitigating impacts of low productivity in the then world. Sharing was supported by the

fact that people lived in relatively small communities, which enabled a higher rate of control – and thanks to the control, the community enjoyed the necessary confidence, and the confidence led to the willingness to share. (Deloitte, 2017) Even today, sharing is demonstrably a part of our lives, but to a significantly smaller extent – it is a tool for maintaining primary social bonds, especially within a family or with friends (Eckhardt, 2018). As years went by, the society moved from sharing to barter and subsequently to classic trading. Classic market models are based on a property ownership conveyance between two persons. Such a conveyance can be voluntary (by donation) or for a fee. However, SE is based on a so-called peer-to-peer (P2P) relationship, which represents direct interconnection of the supply and demand in the form of a digital platform.

At the moment, there is no generally accepted definition of the term of SE. According to the definition of Lexico, the Online Oxford Dictionary (2019), it is an “economic system in which assets or services are shared between private individuals, either free or for a fee, typically by means of the Internet.” Another source describes SE as an economic model supporting utilization of possessions and enabling optimization of consumption through sharing, exchange (bartering), hiring out and lending goods and services (Botsman & Rogers, 2010). A big advantage of SE is its ability to decrease the provider’s (owner’s) transaction costs and, at the same time, to contribute to a higher comfort of the service users. It is a way of the economy in which the participants prefer sharing the access to the property or services, rather than their individual possession (Matocha, 2017). Within the effort to find the best definition of the new trend, new designations are being created for SE: collaborative economy, on-demand economy, gig economy, access economy, P2P, etc.

SE Entities - In the SE environment, there are three basic entity categories – a provider, a user, and an agent. Service providers typically dispose of certain assets in the form of property, time, or skills, and they share them actively for the purpose of earnings or decreasing their costs. A service provider can be a private individual providing property or services occasionally only (a peer), or a person providing services of property within performance of their occupation (a professional provider). A user is a person that does not dispose of necessary assets, resources, or skills, and so they use services or property of a provider. Then they both use a platform created by an agent. In view of the character of the relationship a user and a provider enter into through an agent (a digital platform) as two (in most cases) non-entrepreneurs, it is necessary to consider protection of both contracting parties due to certain absence of information transparency on both sides – the contracting parties do not know each other, and in some cases, they even cannot meet personally (Elischer, 2018). In some cases, there is even no direct relationship between the user and the provider, as the provider performs a service, sends the result to the agent, who then sends it to the user and pays the provider a fee (Rehorova, 2017). In some other cases, a platform plays the role of an agent, which can be generally understood as an entity mediating communication, and it makes it possible to connect the service provider and the user. An agent usually ensures connection of owners and users through a digital platform, whether in the form of a website or, in practice most frequently, in the form of an application installed

both by the providers and by the users in their smart phones (The Section for European Affairs of the Office of the Government of the Czech Republic, 2017).

SE Benefits - SE mitigates negative impacts on the environment, which result from consumerism of the today's society. It tries to decrease wasting (Cheng, 2016). If unused property is shared, it can prevent senseless overproduction, which can subsequently lead to a lower consumption, which is better compatible with the concept of permanently sustainable development (Marek, 2016). The SE model supposes that we can satisfy more user needs without the necessity of producing more and more (Veber et al., 2016).

Sharing property also significantly decreases the owners' transaction costs of the given property. We can divide them into searching and information costs, bargaining costs, and implementation costs. Transaction expenses are incurred in the case people have an item which they do not use or which they want to get rid of at home. However, such a sale or donation require a lot of time and energy. Nevertheless, if the seller uploads their offer to a suitable platform, the entire process becomes cheaper and less time-consuming. Thanks to suitable filters, such an offer gets quickly to those interested in it. People's willingness to share, sell, and donate increases thanks to the simplicity, and the risk that useless, but well-preserved, items will be preserved decreases. SE came with a new model of interconnecting the supply and demand through a digital platform. For users, this means comfort, and the application is its information and communication tool. In most cases, use of applications is very simple and intuitive. For providers, this means the possibility of addressing a much larger spectrum of potential customers.

Another advantage of SE is that providers have the possibility of getting involved in the model of "microbusiness". This model is characterized by a significant rate of independence, flexibility, lower entrance barriers, and self-sufficiency (Demianenko, 2017). SE creates more jobs, mostly with flexible working hours (Valentova, 2018). An increase in flexibility of independent workforce has a direct influence on the effectiveness and quality of the offered services (Böcker & Meelen, 2017). SE also largely affects the existing branches of business. Traditional services, such as taxis, hotels and loans had to respond to the incoming competition in the form of SE services. Their response, in most cases, meant improvements in services for the end customer in a traditional industry. SE also makes luxury goods accessible to such users who cannot afford to own them.

SE Problems and Challenges - The biggest problem of SE is that it is not clear what belongs to the sharing economy and what is an ordinary business activity (Gonzalez-Padron, 2017; Arthurs, 2018). Some SE services are a form of lease through the Internet. Therefore, the term SE is overused (Parente et al., 2018). If a person owns something and somebody else borrows the given item through an agent (a platform) for a fee, it is not a case of sharing, but an access. It is the access economy.

However, it is obvious that the term "SE" has had great marketing potential – in the public it evokes a better feeling than the depersonalized term of "platform economy" or similar terms, and so it supports some kind of ignoring negative effects (Gregory & Halff, 2017). This phenomenon was very well seen in the boom of SE in 2012-2013, where people practically ignored everything bad. Nowadays, people are healthily skeptical, which also

helps to establish proper regulation of SE. For years, SE platforms belonged to the area of grey economy, and it is only now possible to regulate them somehow. Regulation is still unclear in some cases, but a few measures that keep SE within the confines of the law order have been implemented in the Czech Republic (CZ) in the last year (Pichrt, 2018).

Regulation is important not only for tax collection and lawfulness of the platform activity, but also for the answer to the question: “Who is liable for a potential damage to the property or a bodily harm?” If a society has not come across a similar situation yet, it has not probably implemented any or almost any measures or instruction how to behave in such situations and who is responsible for subsequent activities.

At the beginnings of SE, authorities did not pay much attention to this new phenomenon, particularly because they were small amounts of small platforms, often shared free of charge or just to cover the costs. As the time passed, these small businesses became, in some cases, international giants. Nevertheless, most of these platforms still simply ignored payment of taxes and tried to exist outside legally defined limits. Governments of individual countries did not catch the arrival of digital platforms, so all the measures are being taken later than desirable (Krivosova, 2018).

SE complies with the requirements concerning increasing work flexibility, but this flexibility is not counterbalanced by basic security. Platform operators are not employers and they do their best not to play this role. Therefore, there is a group of workers who are outside the protective framework of the labour law (Hulka, 2017). A typical worker is either a self-employed person performing their activity within a so-called dependent self-employment, or a person who is unilaterally marked as a self-employed person, but they meet the characteristics of an employee (so-called bogus self-employment).

A dependent self-employed person works under the conditions that are similar to employment, but they do not enjoy the same rights and protection as employees. These persons have only limited access to social protection, or they only have minimal working condition standards (working overtime, rest periods at work, or determination of a minimum salary). Some EU countries have already implemented this term into their domestic legal orders (Spain, the Netherlands, Germany, etc.). Legislation in these countries has awarded dependent self-employed persons more social rights than standard self-employed persons – better access to unemployment benefits (Portugal), mandatory participation in accident insurance (Spain) or pension scheme (Germany).

As for bogus (hidden) self-employment, they are mostly workers performing work that does not require any, or almost any, qualifications. For this reason, this work is completely replaceable and badly paid, very often below the level of the legally specified minimum salary for an employee (Darilkova, 2019). The price of an offered service is more affordable for an end user, but it is often below its real value. This is the way how e.g. freelancing platforms work. They often offer their skills below the real value of the given job. Workers get small orders, and they are forced to fulfil these orders within a very short period of time and to make sure the user actually pays them. Nobody pays these workers for the time that relates to the job but that is not a part of paid orders.

Performance of a job through a digital platform brings the risk of dehumanization of work. Workers and users are connected remotely, without direct contact, which brings the risk of perceiving a worker as a robot, but not as a real person. Workers are available 24 hours a day, 7 days a week, and they do not have a real face. There is a risk that they will be required to work as perfectly and smoothly as machines. This problem is also connected with prices of jobs below their real values. The reason why people accept a bogus self-employment is just the unfavorable economic situation of the given employee – flexibility and the possibility of making independent decisions about the working time are disappearing in this case.

As for the social protection, the Study suggests the inclusive approach within which a group of workers in non-standard forms of employment and self-employed persons will be created (The Section for European Affairs of the Office of the Government of the Czech Republic, 2017). Therefore, this group would include all working persons, so they should enjoy the same rate of social protection.

What SE misses is the user loyalty. In the upshot, it is not important for the users with which company they will travel, but how much it will cost. Users behave similarly in all the other SE sectors (Piletic, 2018).

SE Stratification in the World - Within SE definitions, it is possible to find a number of views of SE classification. For example, there are financial and non-financial SE forms, profit and non-profit SE forms, individual and group SE forms, actual SE forms and pseudoforms of SE, communal SE forms and commercial SE forms, SE of physical assets and virtual/intangible assets, SE between two participants, SE in the form of multisided sharing (Belk, 2014; Netter et al., 2019).

For the needs of stratification, an SE classification proposal from different points of view was drawn up on the basis of the literature review and discussion of different points of view.

Most frequently, SE is structured by area of operation. From this point of view, Deloitte (2017) divides SE into areas as follows: transport, accommodation, finance, commercial premises, services and work for hire, education, working equipment and another durable property, media and cloud services. The European Commission monitors SE in the following areas: accommodation, transport, food services, household services (repairs, gardening, babysitting, etc.), expert services (IT services, accounting, etc.), finance, and other areas.

Within this classification, the Office of the Government of the Czech Republic (2017) takes account of the property that is the subject matter of SE. They divide the property into tangible (transport and accommodation) and intangible (finance, services, and education).

Veber et al. (2016) specify classification of SE segments in more detail. Their concept has the following SE segments: travelling, equipment, electronics, pets, food, learning, home, luxury goods, entertainment, leisure time, premises, work, money, fashion, transport, children, services, and agriculture. Although this classification structures another segment in detail, it does not cover sharing in virtual space at all, e.g. in the form of cloud services.

For the need of SE stratification, a two-layer structure is used. The first layer is made of SE of tangible property, which includes: transport, accommodation, commercial premises, working equipment, and another durable property (books, clothes, furniture, household goods, tools, etc.). The second layer includes SE of intangible property, such as: finance,

services and work for hire, media (music, films, series, videos), education, and cloud services (here the cloud service provider shares hardware and software with the cloud service users for a fee)).

SE affects a number of industries, and their services are used by more and more people. Compared to traditional services and financial models, SE offers a lot of benefits. On the other hand, it is also accompanied by a lot of problems and criticism (Frenken & Schor, 2017).

The research aims to identify the areas where SE find its use, to specify representatives of platforms existing in respective areas, and to assess the pros and cons of application of SE in these areas.

2. Methodology

The primary research was based on the literature review involving professional publications dealing with SE on the basis of this research. The structure of the literature search was based on the basic available analyzes in the field of SE (Deloitte, 2017; Office of the Government of the Czech Republic, 2017; Veber et al., 2016; Botsman & Rogers, 2010) and on the data from COST Action No. CA16121 - "From Sharing to Caring: Examining Socio-Technical Aspects of the Collaborative Economy". It is based on the definitions of basic terms (concept, entities, advantages and disadvantages of SE). Basic key terms were used as search criteria, mainly: SE, collaborative economy, on-demand economy, gig economy, access economy, P2P, definition of SE, pros and cons of SE etc. An important point for structuring the research was SE stratification, for which the methods of classification available in the professional publications were found and based on that we identified the main areas affected by SE in the world. On the basis of this knowledge, we made assessment of the situation in the CZ, we found and described examples of platforms representing real use of SE in the main SE areas in CZ and in the world. Then, on the basis of the assessment of these platforms, we summarized the basic parameters typical for the respective main SE areas and identified the main advantages and disadvantages of SE in these main areas.

3. Results

On the basis of the literature review, we determined the basic SE areas, which were subsequently dealt with. Table 1 summarizes the areas of sharing. We chose a representative

Table 1. SE areas and their representatives in the World and in CZ

SE areas	Representative in the world	Representative in CZ
Transport	Uber	Uber, Lime, Rekola
Accommodation	Airbnb, PivotDesk	Airbnb, Moje chaty, InnoCrystal, WorkLounge
Financial area	Kickstarter	Hithit, Darujme.cz, Fundlift, Zonky
Cloud services	Dropbox	Dropbox, Algo Cloud
Sharing things	Library of Things	Půjčím.to, Nevyhazujto.cz
Work	TaskRabbit	Hlidacky.cz
Education	Linked In Learning, Coursera, EdX	Seduo
Media	Youtube, Netflix	Youtube, Netflix

of each area from the world and a representative operating in the CZ. In each platform, we also focused on the assessment of their benefits and problems.

The best-known example in the area of **transport** is Uber, which operates globally and offers an alternative to taxis. Uber Technologies Inc. is an American multinational transport and mobile company, which in the form of collaborative consumption enables ordering transport in a passenger car. The company was established in 2009, and it is based in San Francisco, California. The company deals with development, offering, and operation of the Uber mobile application, which makes it possible for the consumers to request a ride with a driver using their own car through a smart phone. Within a few years after its establishment, the company expanded to a lot of cities in the USA and elsewhere in the world. In the CZ, you have been able to use the service since 2014. Apart from personal transport, the company also focusses on meal distribution, they engage in a lot of charity events, they employ more women, minorities, and they also support equality. For the reason of support of healthier environment, they try to support the possibility of carpools. Since 2016, they have been dealing with testing autonomous cars, and since 2017 there has been a platform called UberFreight, which is used in cargo transport. At the beginnings of their operation in CZ, the company was an unfair competitor to taxis, as their drivers were not required to have a taxi driver license. This serious imperfection has already been removed, and Uber drivers have to comply with the same conditions as taxi drivers, i.e. they also have to have a taxi driver license and they have to pass a topographical test. What is typical for CZ in the area of transport is sharing bicycles (e.g. Rekola Platform), or sharing scooters (Lime Platform). Scooters can be hired in Prague, bicycles in 10 large cities in CZ (Prague, Brno, Ostrava, Liberec, Olomouc, České Budějovice, Frýdek-Místek, Písek, Kladno, and Mladá Boleslav). The advantage of this way of transport is mainly acceleration of movement inside a city and in its surroundings using an environment-friendly way of transport.

In the area of **accommodation**, people can let out their homes or any other free premises they are not using at the moment. Accommodation is usually for a fee, but it is also possible to make an exchange and visit the guests in their homes next time. The most wide-spread platform making it possible to provide short-time accommodation thanks to sharing real estate with other people is Airbnb. Airbnb is a service interesting not only for real estate owners, as it offers higher appreciation of their real estate than if they rented it on a long-term basis, but the service is also attractive for those staying there, as they usually pay for a short-term real estate rent less than at a classic hotel. Airbnb charges a service fee in % of the price of each mediated accommodation. Airbnb platform was established in 2008. Within a few years, the service has become the second most valuable start-up in the world (behind Uber). This service has been provided in the area of CZ since 2009. The income from accommodation (as well as from passenger transport) acquired through digital platforms of the Airbnb (Uber) type is subject to the income tax. On 1 January 2020, a new amendment to the act on local charges came into effect. It responds to the development of SE and introduces a fee for a stay, which replaces the existing fees for a spa and recreational stay, and the accommodation capacity fee. A specialized platform in CZ in the area of sharing accommodation is a platform called MojeChaty. This company mediates short-term rent of

cottages and weekend houses all around the CZ. Due to its specialization and orientation on the Czech clientele, the growth of this platform is significantly limited. In addition to accommodation, it is also possible to share working premises. For example, there are coworking premises created for the reason of socializing. If independent professionals cannot afford their own office premises or if they need it e.g. only one day per a week, they can use coworking premises. This trend appeared as early as in 2005 in the USA, and now it has spread worldwide. As for CZ, most of these premises are in Prague, but it is also possible to find coworking centres in smaller towns all around the country. One of the most important platforms in this area is PivotDesk; in Prague e.g. InnoCrystal or WorkLounge.

What is breaking through more and more in the **financial area** is crowdfunding, or P2P lending. It is an alternative nonbanking way of funding, where a larger number of individuals contribute to a target amount with a smaller sum. This diversifies the risk in case a debtor fails to pay. We recognize donation-based, reward-based, lending-based, and equity crowdfunding. Kickstarter, operated by an American company established in 2009 is well-known abroad. This platform focuses on creativity, i.e. financing projects in the areas of music, film, technologies, etc. This company operates as reward-based crowdfunding. A Czech equivalent to this platform is a platform called Hithit. A Czech project in the area of donation-based crowdfunding is a platform called Darujme.cz, which helps non-profit organizations to get donations. A platform called Fundlift acts as equity crowdfunding, where investors buy a share in a certain company. However, they do not buy directly a share in a company, but they buy securities that can be later transferred to a share in the company or bonds. The most important representative of crowdfunding in the area of P2P lending in CZ is a company called Zonky, with the investment group of PPF behind. The company was established in 2015. Both the creditor and the debtor have to become members of the online Zonky community. Based on a client's online inquiry, Zonky creates the rating and, depending on it, determines the interest rate. The client then draws up their story, the company displays their inquiry on the online marketplace, and investors have the chance to decide to whom they entrust their money. If there are enough investors to cover the entire required amount, Zonky enters into a contract with the client. People get a loan for cheaper there than at a bank, and people who lend money can increase the value of their savings more advantageously. The service is under the supervision of the Czech National Bank.

Cloud services serve for sharing data or saving hard drive space on your computer. Data are saved to the cloud, so they do not occupy space on your hard drive or on your mobile phone, and they are accessible from different devices. The basic version for storing a limited volume of data is usually free of charge. Data storage is also extended by accessibility of applications on the cloud. An example of a cloud service is Dropbox. The advantages of the cloud include automatic backup, the possibility of recovery of deleted data, and minimal cost of physical storage space. Algo Cloud is a Czech company with very good reputation offering its services since 1997. It is popular particularly for its professional and humane approach to users. The company offers a unique data backup system in three different locations in CZ. It places a large emphasis on security, it has its own data centre, and server administrators are available non-stop and immediately.

Sharing things (equipment, tools, or electronics) is based on letting out and hiring things between users. In the last years, a project called Library of Things has been spreading around the world. In these libraries, people can hire tools, aids for artists, kitchen hardware, electronics, sport and travel equipment, toys, clothes, books, medical aids, etc. They pay a fee for this lending. This makes luxury things accessible also to common people. In CZ, the first library of things was opened at Goethe Institute in 2017. This library has branches in Prague and Brno. Another company called Půjčím.to works on the direct principle of sharing among people. This platform gives people the possibility of advertising their things, and it is possible to borrow from people and from rental shops. The area of sharing things includes not only lending, but also handover of useless things, e.g. in the form of a re-use center. In CZ, there is an application called Nevyhazuj to.cz. Things offered in the application can be acquired at re-use centres in a number of larger CZ cities.

In the area of **work**, it is possible to share housework and a craft. You pay for the work done through an application, or exceptionally in cash after a service has been provided. TaskRabbit is an American Company based in 2008 and operating in the USA and in Great Britain. It connects freelance work with the local demand, and it makes it possible for consumers to find immediate help with everyday tasks, including tidying-up, moving a house, delivery, and maintenance. A tasker has to be registered, and he/she is paid hourly or for an accomplished task, and a service charge is deducted from his/her pay. A portal called Hlídačky.cz was started in CZ in 2012. It offers not only babysitting, but also pet sitting, tidying-up, and a senior care. Sitters have to go through screening. This area also includes employee sharing, where a group of employers jointly hire one worker to cover the needs of different companies. This creates a full-time job for the worker.

In the area of **education**, there are also companies operating worldwide, such as LinkedIn Learning, Coursera, or edX. These platforms provide online courses for free or for a fee. The important platforms in the area of education also include the platforms of Wikipedia and Youtube (see below), which primarily share information at videos, but they are also very often used for education. In CZ, there is a well-known platform called Seduo, which offers education for individuals and companies. Some courses are for free, some for a fee.

The area of **media** mainly shares music, videos, and films. They are widely accessible thanks to platforms. Platforms usually serves not only for acquisition, but also for uploading your own production, which results in the expansion of the offer to huge dimensions. The only condition of accessibility is the Internet connection. The largest Internet server for sharing video files is Youtube. It started in 2005, and it has tens of language versions and with advertisements it is free of charge. Company Netflix, established in 1997, focusses on films, TV programmes, documentaries, etc. It makes it possible to watch films online for a fee. It has been available in CZ since 2016.

4. Discussion about Pros and Cons of SE in the Main Areas

In the area of **transport**, the main advantage is utilization of the capacity of transport means, better accessibility and variability of means of transport, including broader use of

environmentally friendly means of transport. A disadvantage can be found in the danger for pedestrians relating to use of bicycles and scooters in town and their wrong parking outside the designated places. Provision of transport services can be an advantageous form of extra earnings for employees, but there have also been some cases of operating co-transport to the extent of a full-time work capacity without the employee legal protection.

In the area of **accommodation**, SE is presented as a tool that has changed the way of transport and decreased the prices of accommodation and contributed to expansion of tourism. An advantage for owners of a flat or a spare room is in extra earnings from a short-term rent. A disadvantage of this form of accommodation on a massive scale is its impact on the housing market and the number of tourists in attractive locations. The number of rentals through Airbnb in Prague increased threefold between 2016 and 2018. Blocking flats for a short-term rent then limits the supply for ordinary living in the form of a long-term rent or sale and increases prices. A similar problem is being faced by other tourist centres, and they plan some regulation of this activity.

In the area of **finance**, the main advantage is extension of funding sources, particularly for individuals, non-profit organizations, and entities that cannot reach banking sources. An advantage for investors is usually a higher interest rate, but with a higher risk.

In the area of **cloud services**, there is a big disadvantage in inaccessibility of the data if the Internet is not available. This interrupts the access to the server. Transfer of your data to the cloud and operation of cloud applications are also being considered from the point of view of security. On the other hand, the advantages usually include lower costs, transfer of a number of activities to the provider (backup, security, ongoing update), and the possibility of using data spaces or the latest applications without huge investment costs.

The area of **sharing things** is mainly connected with advantages leading to the maximum possible utilization of things, their future use if the owner does not need them any longer. A disadvantage can be seen in the risk relating to the quality, and in the case of lending, also in the takeover of a thing in use.

The most important disadvantages in the area of sharing **work** were mentioned in section 1. However, the above-mentioned platforms bring advantages, rather than disadvantages. In particular, this refers to activities that are harder to cover with ordinary workers (babysitting, pet sitting, etc). The provider can enjoy benefits in the form of extra earnings and flexibility in providing services based on their capacity.

The extension of accessibility of information, videos, and training courses through online platforms in the area of **education** is a clear contribution to this area. Its advantages include worldwide accessibility and a vast range that is available. Its disadvantages are mainly relating to the fact that it is not easy to find your way through the wide range of offerings and to assess the quality of offered courses.

Similar advantages and disadvantages refer to the area of **media**. On the one hand, a huge growth of offerings, increased accessibility, the possibility of becoming creators and, on the other hand, a large variance in the topics and quality in the shared video and audio material.

5. Conclusions

SE is a new economic model, which extends the existing standard possibilities of exchange in the society in a lot of alternatives and forms using technological means. SE affects a lot of areas, it offers sharing tangible and intangible property, and the scope of sharing and its forms are still extending. SE is applied at local, national, and particularly the worldwide levels, it increases competition, increases effectiveness in using available resources, and contributes to sustainable development in a number of cases.

The paper aims to present SE, its concept, areas of operation, benefits, problems, and challenges. The areas of operation, its advantages and disadvantages are demonstrated on examples of platforms existing at both global and national levels, i.e. platforms operating in the CZ. It is desirable to monitor the area of SE and its development, and its impact on the society. In a lot of areas, it significantly affects functioning of the society, both positively (e.g. through its contribution to sustainability), and negatively (e.g. by disadvantaging job providers within SE). It is desirable to continue analysing these phenomena and their impact on the society deeply.

Acknowledgments: This paper is an outcome of research project: “Economic, social and environmental aspects of collaborative economy from the point of view of the Czech Republic”, COST Action No. CA16121 – “From Sharing to Caring: Examining Socio-Technical Aspects of the Collaborative Economy”, funded by the University of Pardubice, led by doc. Ing. Liběna Tetřevová, Ph.D.

References

- Arthurs, H. (2018). The False Promise of the Sharing Economy. In D. McKee, F. Makela, & T. Scassa (Eds.), *Law and the “Sharing Economy”* (pp. 55–72). University of Ottawa Press. <https://doi.org/10.2307/j.ctv5vdczv.6>
- Barancova, H. (2017). Collaborative Economy – Digital Age and Its Reflections for Future Development of the Labour Law. In J. Pichrt, R. Bohac, & J. Moravek (Eds.), *Sharing Economy and Delicts* (pp. 22–38). Praha: Wolters Kluwer ČR.
- Bardhi, F., & Eckhardt, G. M. (2017). Liquid consumption. *Journal of Consumer Research*, 44(3), 582–597. <https://doi.org/10.1093/jcr/ucx050>
- Basselier, R., Langenus, G. & Walravens, L. (2018). The rise of the sharing economy. *Econ. Review*, 57–78.
- Belk, R. W. (2010). Sharing. *Journal of Consumer Research*, 36(5), 715–734. <https://doi.org/10.1086/612649>
- Böcker, L., & Meelen, T. (2017). Sharing for people, planet or profit? Analysing motivations for intended sharing economy participation. *Environmental Innovation and Societal Transition*, 23, 28–39. <https://doi.org/10.1016/j.eist.2016.09.004>
- Botsman, R., & Rogers, R. (2010). *What's mine is Yours: The Rise of Collaborative Consumption*. Glasgow: Harper Collins Publishers.
- Cheng, M. (2016). Sharing economy: a review and agenda for future research. *International Journal of Hospitality Management*, 57, 60–70. <https://doi.org/10.1016/j.ijhm.2016.06.003>
- Darilkova, L. (2019). Social Protection of Workers in Sharing Economy in EU Legislation. In Z. Vrbova (Ed.), *Does the Law Keep up with It?: Society and Science Dynamics at the Beginning of the 21st Century*, (pp. 29–46). Praha: Ústav státu a práva Akademie věd ČR.
- Deloitte. (2017). *Sharing Economy – Wealth without Ownership*. <https://edu.deloitte.cz/m/Content/DownloadPublication/sdilena-ekonomika-2017>
- Demyanenko, S. (2017). Sharing Economy as an Innovative Exchange Tool in the Area of Financial Services in the Context of Persisting Digital Revolution in the Area of the Czech Republic in 2016: *Bachelor Thesis*. Prague University of Economy.
- Dev, N. K., Shankar, R., & Qaiser, F. H. (2019). Industry 4.0 and circular economy: Operational excellence for sustainable reverse supply chain performance. *Resources, Conservation and Recycling*, 153, 104583. <https://doi.org/10.1016/j.resconrec.2019.104583>

- Elischer, D., & Macek, O. (2019). Sharing Economy, or Where is the Burden of Responsibility? In J. Pichrt, R. Bohac, & J. Moravek (Eds.), *Sharing Economy and Delicts* (pp. 73–88). Praha: Wolters Kluwer ČR.
- Frenken K., & Schor, J. (2017). Putting the sharing economy into perspective. *Environmental Innovation and Societal Transitions*, 23, 3–10. <https://doi.org/10.1016/j.eist.2017.01.003>
- Gonzalez-Padron, T. L. (2017). Ethics in the sharing economy: creating a legitimate marketing channel. *Journal of Marketing Channels*, 24(1–2), 84–96. <https://doi.org/10.1080/1046669x.2017.1347005>
- Gregory, A., & Halff, G. (2017). Understanding public relations in the 'sharing economy'. *Public Relations Review*, 43(1), 4–13. <https://doi.org/10.1016/j.pubrev.2016.10.008>
- Gurau, C., & Ranchhod, A. (2020). The sharing economy as a complex dynamic system: Exploring coexisting constituencies, interests and practices. *Journal of Cleaner Production*, 245, 118799. <https://doi.org/10.1016/j.jclepro.2019.118799>
- Hulka, T. (2017). New Forms of Flexible Employment, or Endangering Security? In J. Pichrt, R. Bohac, & J. Moravek (Eds.), *Sharing Economy and Delicts* (pp. 39–49). Praha: Wolters Kluwer ČR.
- Krivosova, M. (2018). *The development of sharing economy in the Czech Republic: Quantitative media analysis*. Master Thesis. Prague University of Economy.
- Marek, M. (2016). *Sharing Economy and Its Place in the Modern Economic System*. Bachelor Thesis. Prague Charles University.
- Matocha, J., & Svoboda, J. (2017). The Undefined Term of Sharing Economy as a Tool for Bypassing Regulation. In J. Pichrt, R. Bohac, & J. Moravek (Eds.), *Sharing Economy and Delicts* (pp. 215–225). Praha: Wolters Kluwer ČR.
- M. Eckhardt, G., & Bardhi, F. (2018). The Sharing Economy Isn't About Sharing at All. *Harvard Business Review*. <https://hbr.org/2015/01/the-sharing-economy-isnt-about-sharing-at-all>
- Netter, S., Pedersen, E. R. G., & Lüdeke-Freund, F. (2019). Sharing economy revisited: Towards a new framework for understanding sharing models. *Journal of Cleaner Production*, 221, 224–233. <https://doi.org/10.1016/j.jclepro.2019.02.225>
- Parente, R. C., Geleilate, J. M. G., & Rong, K. (2018). The Sharing Economy globalization phenomenon: a research agenda. *Journal of International Management*, 24(1), 52–64. <https://doi.org/10.1016/j.intman.2017.10.001>
- Petrijanov, V. (2019). *Industry 4.0 Will Mean Flexibility without Negative Impacts on the Quality and Production Costs...* CFOworld. <https://cfoworld.cz/trendy/prumysl-4-0-bude-znamenat-flexibilitu-bez-negativniho-vlivu-na-kvalitu-a-vyrobni-naklady-4883>
- Pichrt, J. (2018). Memoranda, Accommodation Costs ... and What Else? In J. Pichrt, R. Bohac, & J. Moravek (Eds.), *Sharing Economy and Delicts* (pp. 11–27). Praha: Wolters Kluwer ČR.
- Piletic, P. (2018). 7 Major Disadvantages of the Sharing Economy. *CustomerThink*. <http://customerthink.com/7-major-disadvantages-of-the-sharing-economy/>
- Rehorova, L. (2017). Economy of Online Platforms and Transformation of the Labour Market. In J. Pichrt, R. Bohac, & J. Moravek (Eds.), *Sharing Economy and Delicts* (pp. 50–62). Praha: Wolters Kluwer ČR.
- The Section for European Affairs of the Office of the Government of the Czech Republic. (2017). *Analysis of Sharing Economy and Digital Platforms. The Office of the Government of the Czech Republic*. https://www.vlada.cz/assets/urad-vlady/poskytovani-informaci/poskytnute-informace-na-zadost/Priloha_4_Material_Analyza.pdf
- TNS Political & Social. (2018). *Report The use of the collaborative economy*. <https://publications.europa.eu/en/publication-detail/-/publication/34eb3c1f-cb6f-11e8-9424-01aa75ed71a1>
- Veber, J., Krajcik, V., Hruska, L., & Makovsky, P. (2016). *Sharing Economy*. Praha: VŠPP.
- Valentova, M. (2018). *Sharing Economy – A New Type of Business*. Portal Pohoda. <https://portal.pohoda.cz/pro-podnikatele/uz-podnikam/sdilena-ekonomika-%E2%80%93-novy-druh-podnikani/>
- Zervas, G., Proserpio, D., & Byers, J. W. (2017). The Rise of the Sharing Economy: Estimating the Impact of Airbnb on the Hotel Industry. *Journal of Marketing Research*, 54(5), 687–705. <https://doi.org/10.1509/jmr.15.0204>

Official Authorities and Education in Financial Literacy – the Role of Central Banks in the Czech Republic and Poland

Dorota BEDNARSKA-OLEJNICZAK¹, Libuše SVOBODOVÁ^{2*} and Jaroslava DITTRICHOVÁ²

¹ Wrocław University of Economics and Business, Wrocław, Poland; dorota.bednarska-olejniczak@ue.wroc.pl

² University of Hradec Kralove, Hradec Kralove, Czech Republic; libuse.svobodova@uhk.cz, jaroslava.dittrichova@uhk.cz

* Corresponding author: libuse.svobodova@uhk.cz

Abstract: The objective of this article is to analyse, on the example of Poland and the Czech Republic, actions undertaken by the central banks in the scope of economic and financial education. The study covers an analysis of applied tools and media in the framework of individual target groups. The adjustment of these actions to the long-term context – national strategies shaped by the central banks in accordance with the solutions recommended by OECD was also considered in the study. Undertaking comparative research stemmed, on the one hand, from the neighbouring location of the two countries, a similar level of economic development and a similar role of central banking in their respective economies, whilst on the other hand, from the analysis of study results concerning knowledge and economic awareness and financial competencies of inhabitants of both countries. In both countries, financial literacy is constantly improving. However, it is not possible to determine the direct impact of central bank activities and other educational activities.

Keywords: central bank; Czech Republic; education; financial literacy; Poland

JEL Classification: G20; M50; I22

1. Introduction

Economic and financial education of citizens has been a significant challenge for the governments of most countries for several years. This has resulted in OECD activities which are manifested by successive recommendations concerning possible actions to be taken by countries in this area. In some countries central banks play a special role in financial education. This article aims to analyse the comparative activities of the central banks of the Czech Republic and Poland in recent years to improve financial capability and financial literacy of citizens.

According to World bank definition “financial education is a tool for increasing consumer financial literacy” (World Bank, 2014). OECD (2005) describes the financial education as “the process by which financial consumers and investors improve their understanding of financial products, concepts and risks and, through information, instruction and/or objective advice, develop the skills and confidence to become more aware

of financial risks and opportunities, to make informed choices, to know where to go for help, and to take other effective actions to improve their financial well-being". (OECD, 2005)

The definition of financial literacy used for adults to make it relevant for 15-year-old students is in the PISA assessment. The definition also incorporates students' ability to use financial knowledge and skills to meet challenges in the future. Financial literacy is knowledge and understanding of financial concepts and risks, and the skills, motivation and confidence to apply such knowledge and understanding in order to make effective decisions across a range of financial contexts, to improve the financial well-being of individuals and society, and to enable participation in economic life. (OECD, 2012)

The OECD/INFE for the purpose of measuring financial literacy amongst adults developed the subsequent working definition: "Financial literacy is a combination of the awareness, knowledge, skills, attitudes and behaviours necessary to make sound financial decisions and ultimately achieve individual financial well-being" (Atkinson & Messy, 2012; OECD, 2016). This definition is now globally acknowledged and was also endorsed by G20 leaders in 2012 (G20, 2012).

The Ministry of Finance from the Czech Republic defined financial literacy as "Financial literacy is a set of knowledge, skills and attitudes necessary to achieve financial prosperity through responsible financial decision-making." (Ministry of Finance, 2021)

1.1. OECD – the Financial Literacy Recommendation

The OECD Council adopted the newest Recommendation on Financial literacy during the 2020 OECD Ministerial Council Meeting in October 29th. (OECD, 2020b) It presents a single, comprehensive, instrument on financial literacy to assist governments, other public authorities, and relevant stakeholders in their efforts to design, implement and evaluate financial literacy policies. It is part of a holistic approach to financial-consumer issues, where financial literacy, together with improved financial access, adequate consumer protection, and regulatory frameworks, are expected to support financial resilience and well-being.

The Recommendation covers three main areas:

- National strategies for financial literacy.
- Financial literacy and the various sectors of the financial landscape.
- Effective delivery of financial literacy programmes.

It takes into account the increased digitalisation of finance, it also looks at how to address the needs of vulnerable groups and draws on recent evidence and research.

The four content areas of knowledge and understanding essential issues for financial literacy are: (OECD, 2020a)

- money and transactions,
- planning and managing finances,
- risk and reward,
- the financial landscape.

1.2. Literature Review

Significance of financial literacy, implementation of financial educational programmes, measuring financial literacy of citizens and related issues are frequently discussed in public, professional and academic environment. Financial well-being of individuals makes a large contribution. It is connected with high level of financial literacy, because financially literate individuals perform better their portfolio composition and they are more likely to participate in financial markets (Astuti & Trinugroho, 2016), they are more secured to plan for retirement (Almenberg & Save-Sodergergh, 2011) and rather accumulate higher amounts of wealth (Rooij et. al, 2011; Lusardi & Mitchell, 2011; Lusardi & Tufano, 2009). Developing effective financial educational programmes is essential in understanding financial literacy among young people. (Astuti & Trinugroho, 2016)

The need for study focused specifically on measurement of financial literacy identified Marcolin and Abraham (2006). The need for financial education and to explain variation in financial outcomes such as investing, debt behaviour and savings are used as inputs to model financial knowledge indicators and/or financial literacy. Much fewer studies accent measurement of financial literacy as an objective. To highlight financial literacy tools, current limitations and to assist researchers in establishing standardized and commonly accepted measurement of financial literacy and overview of the importance is solved by Houston (2010).

Lessons learned from almost 25 years long experiences with different form of E-learning presented Gajewski (2016). All experiences were definitely positive. Negative were for example that widely used multimedia materials do not motivate poor students to learn. They prefer to watch the materials in a passive way in the learning process. Hedvičáková (2016) analysed literacy of students and their bank accounts.

In turn „lack of financial literacy was one of the factors contributing to ill-informed financial decisions and that these decisions could, in turn, have tremendous negative spillover” (OECD, 2012). Ciemleja et al. (2014), Kantnerová (2015) also analysed the level of financial literacy in different countries.

2. Methodology

Primary and secondary sources were used in the article. Secondary sources comprise information about education in the financial field and financial literacy in the Czech Republic, Poland and abroad, information collected from professional press, professional literature, discussions with professionals or previous participations in seminars and conferences relating to the aim of the article. The information gained from individual web portals, mainly from the Czech National Bank (CNB, 2021a) and Narodowy Bank Polski (NBP, 2021) are the primary sources. Those websites were gone throw and there have been looking information about financial education that the central banks operate. Then it was necessary to select, classify and up-date accessible relevant information from the numerous published materials that would provide the basic knowledge of the selected topic.

The objective of this article is to analyse, on the example of the Czech Republic and Poland, actions undertaken by the central banks in the scope of economic and financial education.

3. Results

The research part contains analysis that was done in the Czech Republic and in Poland in January and February 2021.

3.1. Solutions for Improving Financial Competencies by Official Authorities in the Czech Republic

The revised Financial Literacy Standard (Standard financial literacy, 2017), which sets the target level of financial literacy for elementary and secondary school pupils was published on 20 July 2017 by the Ministry of Finance. Cashless payments, critical assessment of the supply of services and goods, protection of personal data, budgeting and comparison of liabilities and assets, remuneration, comparison of financial products, short- and long-term planning, age security, risk and emergence of borrowings, the consequences of defaults debt and over-indebtedness have been strengthened compared to financial literacy standards of 2007. The Framework Education Programs include the revised standard of financial literacy. Primary and secondary schools have to according to the National institute of education compare the revised standard of financial literacy with their school curriculum. School education program in the field of financial education during a transitional period have to be edited or completed.

- Web portal "Why Educate in Financial Literacy?"

In 2014, the Ministry of Finance of the Czech Republic launched a pilot version of the PSFV portal entitled "Why Financial Education?" which can be found at (Financial literacy or Why financial education?, 2021). Those websites are actualized and they contain actual information that are important for citizens.

The portal is beneficial electronic textbook for children, parents and also for teachers. Parents could use it themselves to direct in the complicated world of finance or to discuss about issues with children. Basic knowledge, issues from financial world and up-to-date information are provided. Positive is the combination of the theoretical basis with practical and actual information. More about this portal was analysed in (Hedvičáková & Svobodová, 2018a; 2018b). More about financial education of pupils in the Czech Republic is in Hedvičáková et al. (2017) and Hedvičáková and Svobodová (2018c).

- The Czech National Bank

The Czech National Bank also reflects the changes in the financial market. In 2016 they have launched and operated web portal focused on financial literacy (Money on the run). In the previous years they have also informed and educated in the field of financial literacy.

The CNB assumes that:

- the health of the economy also depends on the financial health of the population
- has the necessary information and know-how to contribute to strengthening financial and economic literacy
- it is important for her to have an informed citizen on her side → it facilitates the implementation of her mandate and prevents possible unfair practices in the financial market

The CNB is part of the National Strategy for Financial Education. It participates in creating standards of financial education for primary, secondary and adult schools. The CNB also share experience and information in this area with other institutions such as the Ministry of Finance, the Ministry of Education, Youth and Sports, non-profit organizations, etc.

For high school students, they prepare: Economic Olympiads, experts to schools and students also compete with and essay focused on the financial literacy.

From its position as the "guardian" of fair conditions on the financial market, the CNB wants to take the following steps:

- To prevent unfair practices on financial market.
- To draw consumers' attention to the deliberate conclusion of contracts, be it loans, insurance, investments or savings.

In the last year there have been done changes in the sources presented by the Czech National Bank. Due this fact there are more information focused on the financial literacy divided according to needs of selected groups (see tab. 1). The new webpages (Financial and economic literacy, 2021) were launched in April 2020. There are used those sections on the websites.

- For teachers, pupils and students (teaching materials, useful links) -the main target group are students at age 10-13, but it can be used also for other groups.
- For the public and school groups (exhibitions, outreach groups)
- For the little ones
- For consumers
- Activities supported by the CNB

Table 1. Target groups and tools used for educational actions. (CNB, 2021b)

No.	Target group	Tools
1.	For teachers, pupils and students	Money, Bank and other financial institutions, Personal finances and my budget, Finance triangle
2.	For the public and school groups	Exhibition in Prague and in Brno, Preparation - the new visitor's center, From 2019 - the new outreach agenda
3.	For the little ones	10 coloring pictures that includes the basic information about the Czech National bank, its functions, mission etc.
4.	For consumers	The data, information, videos and statistics about financial market.

- Web portal "Money on the run"

The site Money on the run (CNB, 2021c) was designed by the Czech National Bank for young people aged 18-35. To educate them in a comprehensible form was the main purpose of the websites. Three sections that constitutes important issues are:

- budgeting,
- financial services,
- life events.

The site also included a glossary of terms, quizzes and ten commandments about money. The portal can be used also in school practice. Some issues may be better used for secondary school pupils than elementary ones.

In the last two years the websites were actualized and they have broaden the topics on: insurance, loans, savings, pension, family, housing, car, money and debts.

3.2. Solutions for Improving Financial Competencies by Official Authorities in Poland

Many different institutions are involved in the financial education in Poland, both those strictly educational in nature such as higher education institutions as well as banks, foundations, scientific associations and government institutions (full list available on ZBP, 2020 by Association of Polish Banks (ZBP, 2020)). One of the entities realizing financial education programmes is central bank – the National Bank of Poland (NBP). Within the process of financial education in Poland, a special role is played by the Council for Financial Education which was established in 2019. It comprises the representatives of the Ministry of Finance, the NBP, the Financial Ombudsman and the Polish Financial Supervision Authority. The key goal of the Council for Financial Education is to propagate the knowledge regarding public finance. The Council sets out the directions and paths of realizing the financial tasks under the National Education Fund, among others, educational campaigns and IT campaigns targeted at increasing the financial awareness of the society and elaborating the strategy of financial education as well as monitoring its realization.

To date, no national strategy for financial education has been elaborated the implementation of which is recommended by OECD. Currently, actions are ongoing targeted at elaborating its basic assumptions and directions of actions. The strategy of financial education ought to cover the whole society, with special consideration of individual social groups (such as women, seniors, persons with low income, inhabitants of villages, immigrants etc.). It is thus vital to properly identify those entities and their activities on the financial market, which will permit the identification of the types of financial instruments which might constitute the subject of education and, ultimately, which might impact the choice of educators and the content and the tools of educational programmes. The following basic assumptions referring to the conduct of financial education in Poland, from amongst those formulated by the Financial Ombudsman deserve special attention (Golecki, 2020):

- Applying cognitive results in behavioural psychology in the programmes of financial education and, as a result, combining traditional teaching methods with the new ones, based on studies of behavioural nature.
- There is no single universal approach that would be effective for all target groups in the programme of financial education, both with respect of the clients of financial market entities and, potentially, with respect of the institutions on that market. Initial actions in the scope of shaping the programmes of education will be targeted at regular monitoring of the state of financial awareness of society.

- The Financial Ombudsman will support the forms of financial education that to which the instructors and the participants of trainings will be able to build relations resulting in shaping trust of these participants towards the state and the free-market institutions.
- The programmes of financial education that introduce the techniques of self-control and assertiveness while allowing to avoid excessive expenditure and debts will be supported.
- The programme of financial knowledge will contribute to acquiring practical skills.
- Educational programmes that introduce computer games for children and the youth and contain significant elements in the scope of finance will be promoted. Emphasis will be placed also on the use for educational purposes of mobile applications and websites.
- Actions carried out in the framework of financial education will be inclusive and will not exclude any group on account of any specific limitations – either language-specific, intellectual or age-based.

The educational and information activity is a crucial element of NBP mission. It covers undertaking actions targeted at disseminating knowledge about the principles of functioning of the financial market, encouraging entrepreneurial attitudes, shaping the responsibilities while undertaking financial decisions, increasing the level of knowledge of economic issues, popularizing the knowledge regarding national economic heritage and promoting modern attitudes impacting the shape of social capital (NBP, 2020). As one may notice, the educational activity of NBP overallly refers to the popularization of economic knowledge, however, it largely focuses, particularly on financial education.

Formerly, educational actions carried out by NBP were regulated by the guidelines in “Strategy for economic education of the National Bank of Poland for the years 2010-2012”. Currently, this strategy has not been formulated, nevertheless, actions of NBP reflect to some extent realization of the directions and assumptions provided for by it. The above-specified document indicated three basic types of actions in the scope of realizing by NBP of education *sense stricto* (NBP, 2020): a) deepening and developing economic education on all stages of school and academic education; b) information-training actions targeted at improving economic awareness of the inhabitants, directed at various groups of recipients; c) initiating public debates regarding financial phenomena and conducting courses concerning economic knowledge, activating various social groups (NBP, 2010). Tools of conducting educational activities adjusted to the specificity of target groups have been presented in Table 2.

In the framework of education in the scope of economics and finance, currently NBP:

- announces and realizes cyclical contests,
- organizes trainings,
- supports and realizes educational programmes,
- provides educational resources,
- provides knowledge via Money Centre,
- researches financial knowledge of the Poles (NBP, 2020b).

Table 2. Target groups and tools used for educational actions. (NBP, 2010)

No.	Target group	Tools
1.	Leaders of environments with an impact on shaping economic awareness, Journalists, Teachers of economic subjects and academic lecturers specializing in economic areas	Post-graduate studies and courses, trainings, public debates, contests
2.	Consumers and persons using financial instruments	Educational, promotional actions in the media (press, radio, television, internet)
3.	Persons from environments characterized by a lower level of economic awareness	Training activity (trainings, coaching, mentoring), network of communal libraries as a distribution channel of knowledge and finances as well as economics
4.	Persons using economic knowledge at work	Courses, trainings,
5.	Students (including students of economics)	Meetings with business representatives, business fairs, trainings, online education, conferences, scholarships
6.	Pupils	Lectures, workshops, trainings, courses, contests and other activation methods, shaping teaching programmes

Apart from the discussed actions realized by NBP, one ought to point out a number of initiatives in the scope of economic and financial education that NBP covered with its support. These include, among others: XXXI Economics Olympics organized by the Polish Economic Society, issued by the Foundation of the 100th Anniversary of Poland's Regaining Independence an album "History of money goes on", organization by the Jacek Maziarski Foundation of two issues of trainings in the scope of economic education, prepared in the framework of the "Community Academy" project. Economic education of local society leaders", the project "Modern and safe finances for seniors" organized by the Polish Federation of Third Age University Associations, the programme "Think, decide, act – finances for the youngest" organized by the Association of Shaping Financial Education etc.

3.3. Access Channels and Forms of Conducting Educational Actions in the Czech Republic and Poland

These actions, depending on the type of recipients, were and still are conducted by CNB and by NBP by means of various channels of access and educational policy tools. Both countries have almost the same access channels and forms of conducting educational actions (see Table 3).

Actions conducted by CNB and NBP in the scope of economic education (including financial) are addressed to two main groups of recipients:

- Indirect: leaders of environments having an impact on shaping economic awareness, journalists, teachers of economic subjects and academic lecturers specializing in economic areas.
- Direct: these are consumers and persons using the financial instruments, persons from environments characterized by a lower level of economic awareness (lagging regions in terms of economy – such as village inhabitants), persons using economic knowledge at

work, in particular, persons performing public trust professions (journalists, lawyers, public administration employees), students, pupils (CNB, 2021; NBP, 2010).

Table 3. Access channels and forms of conducting educational actions. (CNB, 2021; NBP, 2010)

No.	Access channel	Forms of conducting educational actions
1.	Media (press, radio, television, internet, external carriers)	Educational-information campaigns: programmes on TV and on the radio, press extras, multimedia materials (presentations, films, games regarding economics), banners, streams, questionnaires - displayed on the internet
2.	Publications	Permanent publications, serial and closed brochures, multimedia publishers
3.	Public debates	Conferences, seminars, debates
4.	Contests	Contests concerning economic knowledge, subject Olympics, competitions for the best academic dissertation
5.	Studies	Academic studies, post-graduate studies
6.	Trainings	Trainings, workshops, lectures, courses, training games, online education – e-learning, coaching and mentoring

4. Discussion and Conclusion

The analysis of financial education activities undertaken by Poland and the Czech Republic's central banks indicates the existence of significant differences in the adopted concepts of activities. In both countries, central banks expanded their activities in broadly understood financial education more than ten years ago. However, it should be noted that in the Czech Republic, the central bank is formally inscribed in successive government strategies for financial education, while in Poland, there are still no such strategies, and the central bank activities are implemented in isolation from the actions of other institutions. Another issue is the preferred forms of educational activities. In the Czech Republic, e-learning plays a vital role in the educational activities of the central bank. As it can be observed, a large part of these activities is of on-line and interactive nature, while in Poland, despite educational portals with non-interactive content, traditional forms of education are preferred.

We should also note that only the covid-19 pandemic increased the number of interactive educational programmes in Poland. Despite the identification of specific target groups (children, students, seniors, digitally excluded people, etc.) in the case of Poland, educational programmes are mainly dedicated to children and young people. In the case of the Czech Republic, it seems that educational activities are dedicated to a wider audience. However, taking into account the compliance of educational activities with the OECD recommendations mentioned in the article, it should be noted that both in the Czech Republic and Poland, most of these recommendations are taken into account in the educational programmes of central banks.

Can we therefore conclude, on the basis of these differences, that the solutions adopted in either country are more advantageous or have better results? The answer is not simple or unequivocal. First of all, central banks in both countries (despite the lack of uniform strategy for financial education in Poland) are elements of the whole system of financial education and it is not possible to indicate the consequences of their actions only. Secondly, the aggregate results of the 2020 Adult Financial Literacy Survey are almost identical for the

Czech Republic and Poland (OECD, 2020a) and are at the level of the G20 average. This is a positive change compared to 2016 (OECD, 2016) when both countries were significantly below the average, with the Czech Republic having a significantly higher level of financial literacy. However, these changes may have been influenced in part by the new structure of the survey instrument in 2020. Thirdly, the analysis of partial results of the OECD survey indicates that there are differences in the levels of financial literacy (here Poles have a higher level), financial behaviour (also a slightly higher level in adult Poles) and attitudes to longer-term financial planning (here Czech adults have a significantly higher level).

A comprehensive view on evaluation of cluster initiatives is presented in Bureš et al. (2012). It is possible to recommend to use clusters to be more effective. The next important issue is also technological readiness of the countries. The situation in the Czech Republic was solved in Svobodová and Hedvičáková (2017) and citizens are prepared to use technologies for education. The central banks of Poland and the Czech Republic acting actively in the field of financial education support growth of financial literacy of the society. However, due to the multitude of entities implementing such activities, it is not possible to indicate the scale of their impact. At the same time, it can be indicated that the implemented educational programmes are part of the CSR concept of banks popular in commercial banks (Bednarska-Olejniczak, 2017). It is all the more understandable that central banks belong to the group of public trust institutions which should influence the improvement of financial security of citizens. Important is also price information asymmetry and financial education solved in Soukal (2015).

COVID-19 has also impact on the financial products and literacy. In the Czech Republic was one of the changes in mortgages, where the credit moratorium allowed ordinary consumer borrowers, self-employed persons and firefighters to defer repayment of loans and mortgages agreed before 26 March 2020, until the end of July or until the end of October (Ministry of Finance, 2020).

Acknowledgments: We would like to thank to project “SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept”, 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic” and to Anna Borkovcová.

References

- Astuti P. H., & Trinugroho, I. (2016). Financial literacy and engagement in banking. *Journal of Economics and Economic Education Research*, 17(1).
- Almenberg, J., & Save-Soderbergh, J. (2011). *Financial Literacy and Retirement Planning in Sweden* (Netspar Discussion Paper 01/2011-018). <http://arno.uvt.nl>.
- Atkinson, A., & Messy, F. (2012). *Measuring Financial Literacy: Results of the OECD / International Network on Financial Education (INFE) Pilot Study* (OECD Working Papers on Finance, Insurance and Private Pensions, No. 15). OECD Publishing. <https://doi.org/10.1787/5k9csfs90fr4-en>
- Bednarska-Olejniczak, D. (2017). Edukacja Finansowa Jako Przejaw Społecznej Odpowiedzialności Banków. *E-Mentor*, 2017, 42–47. <https://doi.org/10.15219/em72.1325>
- Bureš, V., et al. (2012). A Comprehensive View on Evaluation of Cluster Initiatives. In J. Politis (Ed.), *Proceedings of the 8th European conference on management leadership and governance* (pp. 74-79).
- Ciemleja, G., Lace, N., & Titko, J. (2014). Towards the Practical Evaluation of Financial Literacy: Latvian Survey, *Procedia - Social and Behavioral Sciences*, 156(26). <https://doi.org/10.1016/j.sbspro.2014.11.111>
- CNB. (2021a.) CNB. <https://www.cnb.cz/en/>

- CNB. (2021b). *CNB Financial and economic literacy*. https://www.cnb.cz/cs/o_cnb/financni-a-ekonomicka-gramotnost
- CNB. (2021c). *CNB Money on the run*. <https://www.penizenauteku.cz/>
- G20. (2012). *G20 Leaders Declaration*. <http://www.g20.utoronto.ca/2012/2012-0619-loscabos.pdf>
- Gajewski, R. R. (2016). Pitfalls of E-education: from multimedia to digital dementia? In Ganzha, M., Maciaszek, L., & Paprzycki, M. (Eds.), *Federated Conference on Computer Science and Information Systems* (pp. 913-920). <https://doi.org/10.15439/2016F356>
- Golecki, M. (2020). *Kierunki edukacji finansowej Rzecznika Finansowego – Rzecznik Finansowy* (Financial Education Strategy Basic Assumptions, Financial Ombudsman).
- Hedvicakova, M. (2017). Key study of bank accounts for young people with using multi-criteria optimization and fuzzy analysis. *Applied Economics*, 49(17), 3599-3610. <https://doi.org/10.1080/00036846.2016.1265073>
- Hedvičáková, M., Svobodová, L., Dittrichová, J., & Král, M. (2017). Financial literacy and money management of the pupils in the Czech education system. In Novák, P., Jurigová, Z., Kozubíková, L., & Zlámalová, J. (Eds.), *Proceedings of the 8th International Scientific Conference Finance and Performance of Firms in Science, Education and Practice* (pp. 244-259).
- Hedvicakova, M., & Svobodova, L. (2018a). Web portals to support financial literacy in the Czech Republic. *Advanced Science Letters*, 24(4), 2948-2952(5). <https://doi.org/10.1166/asl.2018.11102>
- Hedvicakova, M., & Svobodova, L. (2018b). Web Portals to Support Financial Literacy in Blended Learning in the Czech Republic. *Lecture Notes in Artificial Intelligence* (Vol. 11056, pp. 409-418). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-319-98446-9_38
- Hedvicakova, M., & Svobodova, L. (2018c). Solutions for Higher Competence in Financial Literacy of Pupils at Secondary School in the Czech Republic. *Lecture Notes in Computer Science* (Vol. 11195, pp. 387-396). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-030-02131-3_35
- Huston, S. J. (2010). Measuring Financial Literacy. *The journal of consumer affairs*, 44(2), 296-316. <https://doi.org/10.1111/j.1745-6606.2010.01170.x>
- Kantnerová, L. (2015). The Comparison of Level of Financial Literacy in Four Countries. In E. Pastuszková, Z. Crhová, J. Vychytilová, B. Vytrhlíková, & A. Knápková (Eds.), *Proceedings of the 7th International Scientific Conference Finance and Performance of Firms in Science, Education and Practice* (pp. 559-570).
- Lusardi, A., & Mitchell, O. S. (2011). *Financial Literacy and Planning: Implications for Retirement Wellbeing*. University Press, Oxford.
- Lusardi, A., & Tufano, P. (2009). *Debt Literacy, Financial Experiences, and Overindebtedness* (NBER Working Paper n. 14808). NBER.
- Marcolin, S., & Abraham, A. (2006). *Financial Literacy Research: Current Literature and Future Opportunities*. <http://ro.uow.edu.au/commpapers/223/>
- Ministry of finance. (2017) *Standard financial literacy*. <https://www.mfcr.cz/cs/aktualne/aktuality/2017/standard-financni-gramotnosti-29163>
- Ministry of Finance. (2020). *The general deferral of repayments is ending, lenders will help clients individually*. <https://www.mfcr.cz/cs/aktualne/tiskove-zpravy/2020/plosny-odklad-splatek-konci-poskytovatel-39851>
- Ministry of Finance. (2021). *Financial literacy or Why financial education?* <https://financnigramotnost.mfcr.cz/cs/aktuality>
- NBP. (2021). NBP. <https://www.nbp.pl/>
- NBP. (2010). *Strategy of economic education of the National Bank of Poland for the years 2010-2012*. <http://grafik.rp.pl/grafika2/394296>
- NBP. (2020). About NBP. Educational and information activity. https://www.nbp.pl/home.aspx?f=o_nbp/informacje/dzialalnosc_educacyjna.html
- NBP. 2021. Narodowy Bank Polski (Journal of Laws of 2019, item 1810 and Journal of Laws of 2020, item 568) [WWW Document]. URL https://www.nbp.pl/en/aktyprawne/the_act_on_the_nbp.pdf (accessed 2.1.21).
- OECD. (2005). *Recommendation on Principles and Good Practices for Financial Education and Awareness*, OECD. <https://www.oecd.org/daf/fin/financial-education/35108560.pdf>
- OECD. (2012). *PISA 2012 Financial literacy assessment framework*. <http://www.oecd.org/pisa/pisaproducts/46962580.pdf>
- OECD. (2016). *OECD/INFE International Survey of Adult Financial Literacy Competencies*, OECD. <http://www.oecd.org/daf/fin/financial-education/OECD-INFE-International-Survey-of-Adult-Financial-Literacy-Competencies.pdf>

- OECD. (2020a). *PISA 2018 Results*. <https://www.oecd-ilibrary.org/docserver/48ebd1ba-en.pdf?expires=1613129637&id=id&accname=guest&checksum=C488087B6CA75B53782D4455075FC840>
- OECD. (2020b). *OECD Recommendation on Financial Literacy*. <http://www.oecd.org/finance/OECD-Recommendation-on-Financial-Literacy.htm>
- Rooij van M., Lusardi, A., & Alessie, R. (2011). Financial Literacy and Retirement Planning in the Netherlands. *Journal of Economic Psychology*, 32, 593-608. <https://doi.org/10.1016/j.joep.2011.02.004>
- Soukal, I., & Draessler, J. (2015). Could Financial Literacy Overcome Price Information Asymmetry: Empirical Study. In J. Kraljček, & V. Kajurová (Eds.), *12th International Scientific Conference on European Financial Systems 2015* (pp. 528-535).
- Svobodová, L., & Hedvičáková, M. (2017). Technological Readiness of the Czech Republic and the Use of Technology. *Lecture Notes in Business Information Processing* (Vol. 299, pp. 670-678). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-319-65930-5_53
- World Bank. (2014). *Financial education programs and strategies: Approaches and available resources*. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/901211472719528753/financial-education-programs-and-strategies-approaches-and-available-resources>
- ZBP. (2020). *Mapa edukacji finansowej* (Financial education map). https://www.zbp.pl/getmedia/fab163a0-ed6d-47ef-a434-0dc2c1f115e4/Mapa_6-cz-2-organizatorzy-edu-fin

Social Capital and Innovation in the Countries of the Visegrad Group

Beata BĘDZIK* and Sylwia GOŁĄB

West Pomeranian University of Technology in Szczecin, Szczecin, Poland; beata.bedzik@zut.edu.pl;
sylwia.golab@zut.edu.pl

* Corresponding author: beata.bedzik@zut.edu.pl

Abstract: The aim of the article is to assess social capital and its components in the V4 countries and to indicate their importance for innovativeness. The authors used the statistical data of the V4 and four innovation leaders. A comparative analysis was based on ESS data, Eurostat. The results of social capital reports were cited. The results show the influence of social capital and trust on innovation, while the authors' analysis indicates a large deficit of them in the V4. Their level over the last years has not improved significantly, which may be the reason for the still low innovativeness of the V4, despite an increase of R&D expenditure. It is not only financial resources that are a brake on the growth of innovation in the V4, that there is still some barrier of progress and it could be low social capital, without which effective use of financial resources is impossible. It is an important stage in the search for innovativeness generators. It is necessary to study the interaction of variables, check whether soft determinants have an impact on innovativeness. The subject requires more in-depth analyzes, as it may turn out that strategies will not be effective without building social capital.

Keywords: social capital; innovativeness; trust; Visegrad Group; V4

JEL Classification: O1; O18; O31; R11

1. Introduction

The evolution of economies has recently considerably accelerated, Europe is struggling with many problems that it must face (aging of the population, competition on the global market, financial crises etc.). The driving force behind further development, as stated in the EC report (2012, p. 2), are innovations that are "(...) the best means to put the European economy on the right track and solve social issues in the global economy".

In the Ministry of Economy's document it was stressed that the innovativeness of economic entities creates innovativeness of the economy, contributing to the competitiveness of the economy, which in turn translates into gross domestic product (GDP) growth.

The aim of the article is to assess social capital through the prism of its components in the countries of the Visegrad Group and to indicate the importance of these factors in building and implementing innovation in the V4 countries. Based on the literature of the subject, the article presents relationships between these categories. The assessment of individual V4 countries was made in terms of the social capital resources and development opportunities in the future innovativeness. To this end, the authors used the statistical data of the V4 countries and the statistical data of 4 innovation leaders, i.e. Sweden, Germany,

Denmark, Finland. A comparative analysis was used based on e.g. European Social Survey data, Eurostat statistics. The results of analyzes from reports examining the dependence of innovation on social capital and its components were also cited.

Innovativeness in the literature of the subject is determined by the prism of variously understood novelties, and its boundaries are quite fluid. The term etymology is to be found in the Latin word *innovatio*, meaning renewal or in another Latin word meaning novelty, i.e. *novus*. It is assumed that the concept of innovation was introduced into the literature by Schumpeter (1934), recognizing that the entrepreneur in the search for profit implements innovations by using different, new combinations of factors of production, which changes their current state. Today's understanding of innovation is more liberal than Schumpeter's, because it allows diffusion from other entities. In Eurostat's and OECD's papers an innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or process and that Has been made available to potential users (product) or brought into use by the unit (process).

A wider perspective on innovation and innovativeness allows interpreting it as a social and economic activity, leading to new use of resources, formulating new ideas, new ways of acting and introducing changes, understood as replacing the current state of affairs with others (Gomułka, 1998). Both Drucker (1985) and Schumpeter (1934) were looking for sources of innovation in entrepreneurs' activities. Drucker saw innovations above all as a social and economic phenomenon, not just technological processes.

Similarly, innovativeness as a category located in some space that shapes conditions is perceived in the concept of an innovative environment (innovative milieu), introduced by Aydalot (1986). He sees the source of innovation not in the enterprise, but in the environment in which it operates. According to this concept, the entity is innovative when it interacts with the environment, uses local conditions, which in subsequent stages, based on the specificity of a given environment, will decide on a competitive advantage. All this allows you to effectively use knowledge and information to create new products or new production processes. The model of an innovative environment strongly emphasizes the importance of interaction between business entities, such as mutual learning and a joint search for a solution. Cooperation takes place in a specific geographical space, creating a specific network.

The definitions cited above largely associate innovations with inventions, and hence innovativeness - with technical progress. A contemporary look at innovations extends a bit of a look at innovations and its sources from only its hard aspects, including those soft. The authors of "The Innovative potential ..." report (2016) define innovations through the prism of not only technological improvements, e.g. new products or production techniques, but also in the social dimension. This entails a strong emphasis on the role of social capital in shaping the conditions for innovative activity.

Social capital also falls into the category of ambiguous definitions, because depending on the purpose of the research, its framework is constructed differently, which leads to the blurring of the concept and the application of arbitrarily selected indicators, but the common denominator of all descriptions remains: trust, cooperation and civic activity. Contemporary researchers describing social capital also refer to the category of trust and cooperation within

the community, thanks to which the effectiveness of other growth factors is higher (Będzik, 2015).

The level of general interpersonal trust has a definitely positive effect on economic growth. This is indicated by the results of numerous empirical studies. For example, Knack and Keefer (1997), in a study covering 29 countries, documents the significant positive impact of overall people-to-people trust on Gross Domestic Product (GDP) per capita growth. Similar results were obtained by Akçomak and ter Weel (2009), in a study covering 102 regions in 14 European countries, and Forte et al. (2015) in a study covering 85 regions in 21 European countries.

2. Methodology

Social capital and trust belong to the category of soft factors that are difficult to measure and have been noticed relatively recently, which results in the lack of comparative statistical data. EUROSTAT and European Social Survey (ESS) databases were used to trace the different categories (social capital, trust, innovativeness) in different countries over the course of several years. Thanks to this, different countries can be compared in different years, as the methodology of obtaining data was the same for all countries. The authors made a comparative analysis using secondary data, but thanks to this they ensured the comparability of the analyzed categories.

The source of data describing the innovative capacity selected for the analysis of countries are The Global Competitiveness Reports (GCR), published by World Economic Forum (WEF), from the years 2006-2015. The reports present an assessment of the ability of economies to achieve long-term economic growth based on indicators divided into 12 pillars of competitiveness, while the data from the innovativeness pillar were used for the purposes of the article.

Data on the relationship between social capital and trust and innovation and its individual aspects are presented as correlation coefficients. The values of the t-statistics were also presented. Innovativeness was measured by the summary Innovation Union Scoreboard (IUS), "productivity" was related to the logarithm of labor productivity, measured as GDP per employee. The calculations were taken from the report of the National Bank of Poland. Information on electoral participation, volunteering and the various dimensions of trust came from Eurostat data. Aggregated data on the quality of life, included in OECD reports prepared separately for each country, were also used. A very important source of data used in this publication were the results of surveys from several editions of the European Social Survey (ESS).

3. Results

3.1. The Relationship between Social Capital and Innovativeness

In the National Bank of Poland (NBP) report entitled "The innovative potential of the economy: conditions, determinants, perspectives" the results of comparison of social capital with the level of innovativeness of European countries were presented. The most attention

was paid to the dependence of innovation on the level of social trust for two reasons. First of all, because the literature of the subject assigns to this element of social capital the highest importance in building innovation. Secondly, social capital and its components are relatively difficult to measure, so the availability of data is very limited. However, with regard to social trust, comparability and data availability are satisfactory due to data obtained from the ESS, where social trust is measured systematically, in a uniform manner, for all countries studied and in all waves of the survey. The report also included data from Eurostat and IUS. In the cross-section of EU countries, the average level of social trust is strongly positively correlated with IUS. The societies of the Scandinavian countries ie. Denmark, Sweden, Finland as well as Switzerland, are both the most innovative and the most trusting. On the opposite pole there are countries of Central and Eastern Europe (especially Bulgaria, but also Slovakia and Poland) and Portugal.

A strong positive correlation between social trust and the innovativeness rate is also maintained taking into account country-specific effects that control the level of work productivity or the use of social trust measures delayed by 2 years. It can therefore be concluded that despite relatively better results in terms of productivity and wealth in countries that are at the same time leaders of innovativeness and trust, the data also shows a direct relationship, independent of labor productivity, between social trust and innovativeness. In addition, the discussed effects also appear in the time dimension: within individual countries, the increase in social trust brings about a statistically significant increase in innovativeness (Table 1). Among the most important channels through which social trust favors innovativeness, one can mention the channel of financing and support for innovativeness, investment of companies in R&D, links between companies and support for entrepreneurship.

Table 1. Impact of social trust on innovativeness. Source: own study based on: The innovative potential of the economy: conditions, determinants, perspectives, NBP, Warsaw 2016, p. 276.

Type	1	2	3	4
Method	OLS	RE	OLS	RE
Efficiency _t	<i>0.292 [5.669]</i>	<i>0.237 [5.242]</i>		
Trust _t	<i>0.0515 [3.192]</i>	<i>0.0341 [2.483]</i>		
Efficiency _{t-2}			<i>0.266 [6.101]</i>	<i>0.163 [4.979]</i>
Trust _{t-2}			<i>0.0546 [3.865]</i>	<i>0.0439 [3.503]</i>
Constant	-2.933 [-5.730]	-2.260 [-4.698]	-2.655 [-6.157]	-1.491 [-4.229]
Number of observations	71	71	92	92
Number of countries		26		27
Corrected R-square	0.618	0.627	0.613	0.620
Intra-group R-square		0.196		0.177

¹Note: Innovativeness is measured by a innovation union scoreboard, efficiency concerns the work productivity logarithm, measured as GDP per employee. The values of the statistics t are given in brackets. The italic text in the table means statistically significant variables at a minimum level of 5%.

In turn, Table 2 presents estimates of models that take into account country-specific random effects and trust delayed by 2 years. The results indicate that the level of trust exerts a statistically significant, positive influence on the partial indices of the IUS innovation index related to financing and innovation support (F+S), investments of companies in R&D and corporate connections and entrepreneurship (L+E). Poor positive dependence is characteristic

for innovation indicators in small and medium enterprises (I) and economic effects of innovativeness (EE). The remaining three dimensions of the IUS innovativeness index i.e. dimension of the research systems (RS), human resources (HR) and intellectual assets (IA), do not show dependence from the level of social trust.

Table 2. Impact of trust and frequency of social contacts on innovativeness and its various aspects.

Source: own study based on: The innovative potential of the economy: conditions, determinants, perspectives, NBP, Warsaw 2016, p. 277.

	IUS	HR	RS	F+S	R+D	L+E	IA	I	EE
Method	RE	RE	RE	RE	RE	RE	RE	RE	RE
Efficiency _{t-2}	0.161 [4.60]	0.306 [4.86]	0.561 [7.91]	0.172 [2.06]	-0.122 [-1.39]	0.096 [1.08]	0.367 [5.09]	0.033 [-0.37]	0.156 [3.29]
Trust _{t-2}	0.043 [3.43]	0.017 [0.74]	0.042 [1.62]	0.104 [3.46]	0.111 [3.49]	0.080 [2.48]	0.042 [1.60]	0.057 [1.79]	0.029 [1.65]
Social contacts _{t-2}	-0.001 [-0.05]	-0.102 [-3.27]	0.055 [1.56]	0.027 [0.64]	0.005 [0.12]	0.063 [1.41]	-0.019 [-0.54]	0.097 [2.19]	0.010 [0.41]
Constant	-1.458 [-3.54]	-2.337 [-3.39]	-6.129 [-7.99]	-1.996 [-2.25]	1.171 [1.23]	-1.247 [-1.28]	-3.585 [-4.42]	0.114 [0.12]	-1.397 [-2.55]
Number of observations	92	92	92	92	92	92	92	92	92
Number of countries	27	27	27	27	27	27	27	27	27
Corrected R-square	0.619	0.239	0.752	0.543	0.119	0.454	0.389	0.120	0.391
Intra-group R-square	0.178	0.427	0.261	0.018	0.130	0.008	0.254	0.112	0.057

IUS – Innovation Union Scoreboard; F+S - Finance and Support; R+D - Firm Investments; L+E - Linkages and Entrepreneurship; I - Innovators; EE - Economic effects; RS - Research systems; HR - Human resources; IA - Intellectual assets;

In the above-mentioned studies, social capital revealed by the frequency of social contacts did not show any correlation with the level of innovativeness. The indicator of the average frequency of social contacts according to the ESS data (the question concerned social meetings with friends, relatives or work colleagues) is in the statistical sense uncorrelated with both the summary IUS innovativeness index and its components. The only exception is the human resources index, which is negatively correlated with the frequency of social contacts, as well as the innovation rate of small and medium enterprises, showing moderately positive correlation.

3.2. Results of Innovation and Social Capital in the Countries of the Visegrad Group

All innovativeness rankings place the V4 countries in the group of countries with low rates. In the reports published by the European Commission (EC), the V4 countries are in the group referred to as moderate innovators. For the 28 countries presented in the European Innovation Scoreboard in 2016, Poland took 6th place from the end. It only overtook Romania, Bulgaria, Hungary, Lithuania and Latvia. Slovakia and the Czech Republic were ahead of Poland. Sweden, Denmark and Finland are in the lead. On the other hand, the ranking of innovation in the world is opened by countries such as United States of America, Japan and South Korea.

The conclusions drawn in recent years from reports on innovations change their pronunciation a bit, accentuating the role of soft factors more and more (OECD, 2009). The

importance of the so-called open innovation, innovation based on cooperation between companies (in the form of contracts, joint ventures, outsourcing), eco-innovation, human capital and innovation in the public sector, e.g. in health service, public administration, education, increases.

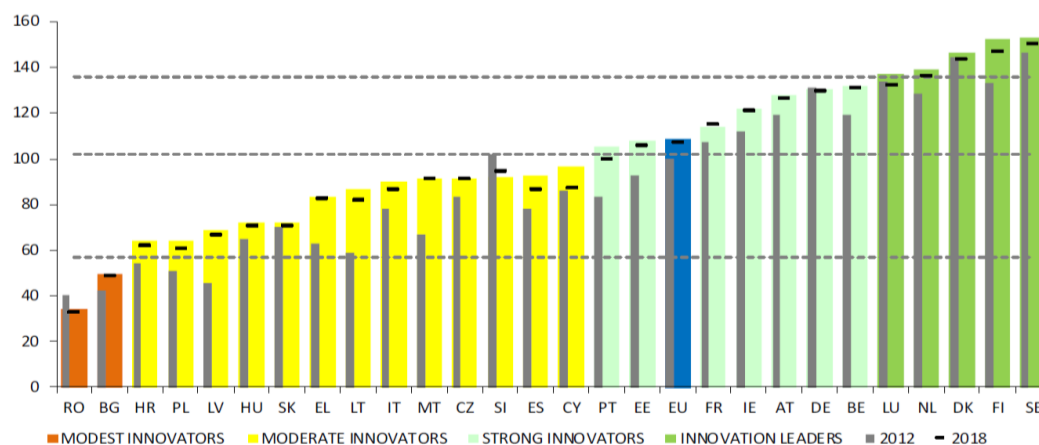


Figure 1. Performance of EU Member States' innovation systems, 2020

Coloured columns show Member States' performance in 2019, using the most recent data for 27 indicators, relative to that of the EU in 2012. The horizontal hyphens show performance in 2015, using the next most recent data for 27 indicators, relative to that of the EU in 2012. Grey columns show Member States' performance in 2012 relative to that of the EU in 2012. For all years the same measurement methodology has been used. The dashed lines show the threshold values between the performance groups in 2019, comparing Member States' performance in 2019 relative to that of the EU in 2019.

Source: European Innovation Scoreboard 2020, European Union 2020, p. 6.

https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_1150

In the ranking prepared by the US agency Bloomberg, the V4 countries are among the 40 most innovative countries in the world. Poland is ranked 24th in terms of Bloomberg's global innovation index, although of the V4 countries it is ahead of only Hungary. However, we can see a gradual improvement in this area, as it ranked 30th last year, while in 2012 it took 34th position. There is no improvement in the 2017 innovativeness report and the only country with V4, in which there was an improvement compared to 2010, is Slovakia, although it was not enough to leave the moderate innovators (MI) group anyway. Figure 1 shows improvement in 2019.

In 2010, Poland held the 50th position, and in 2015 - 67th out of 144 countries. In the Hungarian economy, the changes were even greater, as it fell from the first fifty to the 127th position in 2015. The Czech Republic ranked relatively in the best position in 2015, ranking the 38th position in 2015. In the mentioned reports, the innovativeness of the presented economies is explained by 6 variables: quality of scientific research institutions, R&D expenditure of enterprises, cooperation of science with industry in the field of R&D, government support for technologically advanced products, availability of qualified human capital (scientists) and the number of patent applications. Analysis of data contained in Table 3 shows that Poland in this comparison is very unfavorable. The highest result was achieved in 2015 in terms of government tender procedures for technologically advanced products. Lower results according to the analyzed criteria were achieved by Slovakia, although all

indicators improved during the period considered. A positive phenomenon is the increase in the number of patents in this country in the last analyzed year. The Czech economy has the most favorable situation in the context of the conditions of innovation. The highest values of this country resulted from the highest measures of R&D enterprises' expenditure as well as access to qualified scientists and engineers. In turn, Hungary had the highest number of patents (25 patents per million inhabitants, compared to 7 in Poland), the highest quality indicator for scientific research institutions and cooperation between science and industry in the field of R&D.

Table 3. Innovation measures in the V4 countries in 2010 and 2015

Specification	Czech Republic		Poland		Slovakia		Hungary	
	2010	2015	2010	2015	2010	2015	2010	2015
Capacity for innovation	4.1	4.6	3.3	3.8	2.9	3.5	3.6	3.0
Quality of scientific research institutions	5.1	4.5	4.1	3.0	3.3	3.9	5.2	5.1
Company spending on R&D	4.0	3.7	3.0	2.8	3.0	3.1	3.0	2.9
University-industry collaboration in R&D	4.5	4.0	3.6	3.5	3.3	3.4	4.3	4.3
Government procurement of advanced technology products	4.2	3.0	3.7	3.2	2.7	2.9	3.2	3.2
Availability of scientists and engineers	4.4	4.2	4.2	4.2	4.0	4.0	4.4	4.2
Utility patents per million population	4.2	15.8	0.9	7.1	1.9	9.2	4.6	25

The indexes are in the range from 1 to 7 points; „1” is the smallest and „7” is the most innovative; weighted averages.

Source: own study based on: The Global Competitiveness Report 2010-2011 and 2014-2015. 2011 and 2015. WEF, Geneva, Switzerland p. 488-494 and p. 530-536.

Difficulties in explaining differences in economic development and innovativeness of the country increased, which turned the researchers' attention to soft factors (Będzik & Łoś-Tomiak, 2016; Kaasa et al., 2007; Pérez-Luño et al., 2011; Tura & Harmaakorpi, 2005). In the literature of the subject, innovativeness is combined with the concept of social capital, which level and quality are determined by the processes of creating and disseminating innovations (Casanueva & Gallego, 2010; Wann-Yih et al., 2008; Dakhli & De Clercq, 2003; Florida et al., 2002).

The most important component of social capital, which is the starting point for materializing the benefits of it, is trust. This is the basis for cooperation, participation or involvement in activities. Using a novel panel data on co-owned patents across 29 countries, Brockman et al. (2018) show that “firms in high trust countries are able to produce a higher level of joint output (i.e., co-owned patents). They further show that open innovation is the channel through which societal trust promotes innovative efficiency. Overall, their study establishes societal trust as a key factor in influencing the efficiency of open innovation.” “According to the European Social Survey (ESS), in terms of the general level of trust all V4 countries occupy the last four places among the European countries. V4 respondents think that people in their countries mostly look out for themselves and are not helpful, most people can not be trusted and most people try to get advantage of others rather than to be fair” (Figure 2) (Murphy et al., 2016).

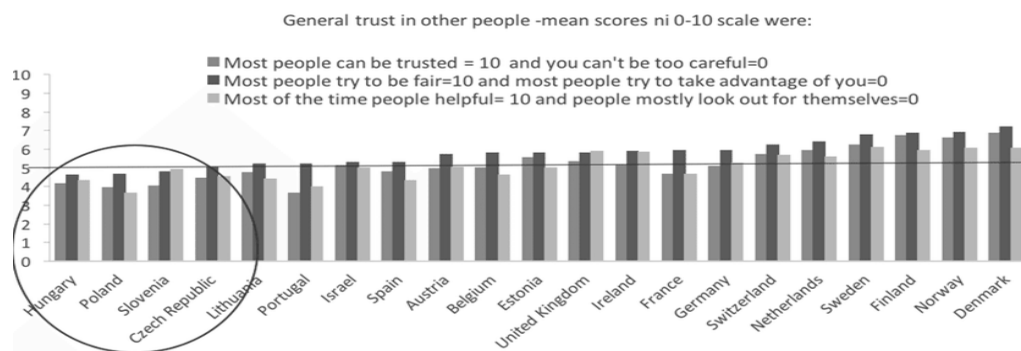


Figure 2. General level of trust, Visegrad Group compared to other EU countries. Source: Koszewska et al. (2015).

„Low levels of trust and social capital (Figure 3), understood as networks of people with similar values, indicate that the societies in V4 countries are not motivated to act in accordance with the idea of common good, including environmental protection, and, in the longer term, to build a sustainable economy. As a result, financial incentives remain most effective.” (Koszewska et al., 2015, p. 27)

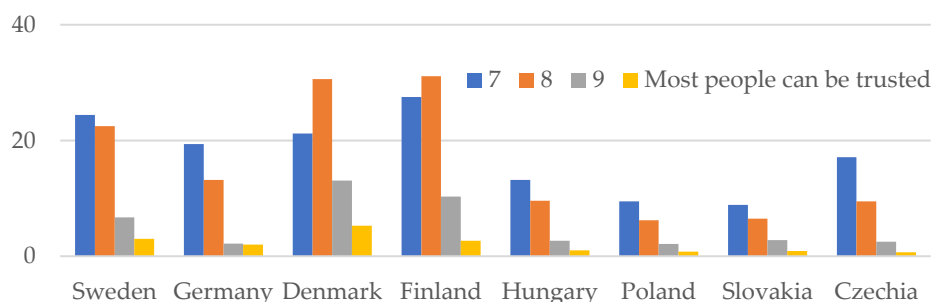


Figure 3. The percentage of people aged 16 and more trusting other people in selected countries in 2018. Source: own calculations based on European Social Survey (ESS) 2018; <http://nesstar.ess.nsd.uib.no>.

Note: The percentage of responses 7-10 on the 0 - scale you can never be too careful; 10 - most people can be trusted.

All V4 countries are characterized by a low level of social capital and its individual components in comparison with other countries of EU. The data presented in Table 4 indicate a relatively high position, i.e. among the countries leading according to this criterion, only in terms of the engagement of government stakeholders. The worst results were obtained by all countries with regard to volunteering. In this analysis, Hungary appears to be the worst, which in all categories belong to the countries with the lowest level of the examined category, in addition to trust in the police, which ranked at the average level among EU countries. This situation remained at a similar level during the period considered, and in the case of voter turnout, despite relatively poor results, it even deteriorated.

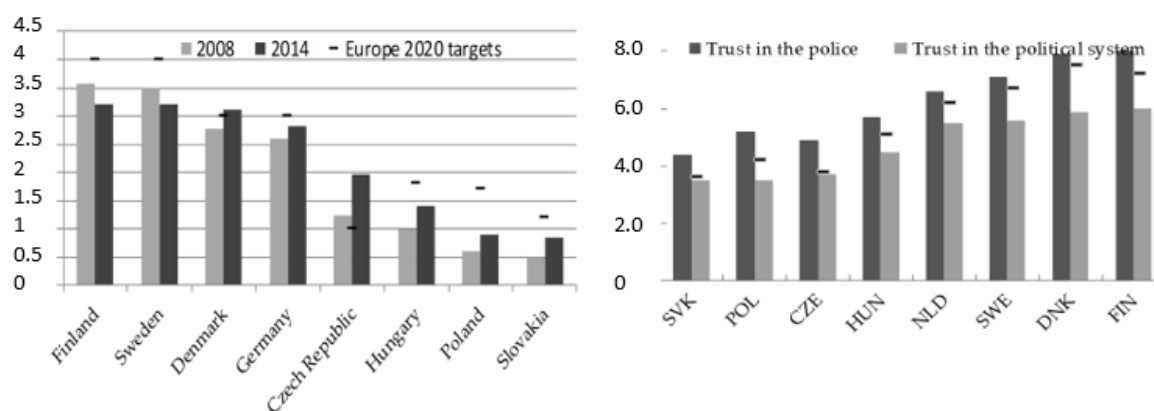
Table 4. Social capital in the V4

Indicator	Czech Republic		Hungary		Poland		Slovakia	
	Tier	Change	Tier	Change	Tier	Change	Tier	Change
Trust in others	3	2013	3	2013	2	2013	2	2013
Trust in the police	3	2013	2	2013	3	2013	3	2013
Trust in the national government	2	↑ 2005-2018	3	↔ 2005-2018	2	↔ 2005-2018	2	↑ 2006-2018
Voter turnout	3	↓ 2006-2013	3	↓ 2006-2014	3	↑ 2005-2015	3	↑ 2006-2018
Government stakeholder engagement	1	2014	3	2014	1	2014	1	2014
Volunteering through organisations	3	2011/2012	No data available		3	2011/2012	3	2011/2012

1 – top-performing OECD tier, latest available year; 2 – middle-performing OECD tier, latest available year; 3 – bottom-performing OECD tier, latest available year; ↑ - improving over time; ↓ - worsening over time; ↔ - no change

Source: own study based on: How's Life? How's life in the Czech Republic; Hungary; Poland; Slovak Republic. 2018. Measuring Well-being, OECD Publishing, Paris. https://read.oecd-ilibrary.org/economics/how-s-life-2017/how-s-life-in-the-czech-republic_how_life-2017-15-en#page225.

Figure 4 presents a rather varied picture of R&D intensity across EU Member States, ranging from 0.38% to 3.17% in 2014. Northern European Member States such as Finland and Sweden not only share a pattern of high expenditure, they have also adopted the most ambitious national targets. In 2014, Denmark achieved its national R&D target of 3% and the Czech Republic reached 1.97%. Other V4 countries have not even approached the target.

**Figure 4.** Gross domestic expenditure on R&D, by country, 2008 and 2014 (% of GDP) (left figure).

Source: own study based on Eurostat; <https://ec.europa.eu/info/statistics>.

Figure 5. Trust in public institutions in European countries, 2018 (right figure)

Note: Response options range from 0 (No trust at all) to 10 (Complete trust) to the question: How much do you trust: The political system in [country]/The legal system in [country]/The police in [country]? The OECD EU average is the population-weighted average of the values included in the chart.

Source: own compilation based on OECD from <https://stats.oecd.org>

The presented research results indicate the dependence of the level of innovation on social trust, and trust in the V4 countries is relatively low compared to the innovation leaders. This is evident in every comparison carried out. The V4 countries are characterized by low

level of trust in the legal system, political system and the police, although among the analyzed institutions, the level of trust in the police is the highest in every country (Figure 5).

The financial crisis and its adverse impact on GDP growth in the following years, along with a rise in nominal government spending on R&D, led to an increase in R&D intensity in most Member States of EU between 2008 and 2014. The exceptions were Finland and Sweden. Growth in R&D expenditure over the same period has been most pronounced among countries with generally low R&D spending such as Slovakia and Czech. The observed trends show that most Member States have put R&D investment high on the policy agenda for combating the effects of the crisis. However, despite these increases the Visegrad Four (except Czech Republic) states would require significant acceleration of R&D intensity growth to meet their respective national target.

The presented research results indicate the dependence of the level of innovation on social trust, and trust in the V4 countries is relatively low compared to the innovation leaders. This is evident in every comparison carried out. The V4 countries are characterized by low level of trust in the legal system, political system and the police, although among the analyzed institutions, the level of trust in the police is the highest in every country (Figure 5).

The growing complexity of technology and the growth of specialization mean that innovation increasingly requires the ability to quickly learn and cooperate within a network of connections. Innovative enterprises rely to a large extent on external networks as an important factor in creating, increasing and seeking new development opportunities and profits. Resource in social capital provides access to a variety of resources and networks, increasing the innovative possibilities of enterprises. Therefore, the new innovativeness model is based on the inclusion of various partners outside the company in the development process of the new product, including customers, users, suppliers and research centers (Alguezali & Filieri, 2010). The level of general interpersonal trust has a statistically significant positive impact on innovation. A higher level of social trust, avoiding costly and time-consuming monitoring, has a positive impact on cooperation and increases time and resources that can be spent on innovation activities. Akçomak and ter Weel (2009) have shown that the impact of public confidence on economic growth results from its statistically significant positive impact on innovation. Similar conclusions on the basis of research were formulated by de Dakhli and Clercq (2004) and Kaasa (2007) proving the significantly positive impact of the level of trust in institutions and the activity in associations on innovativeness.

Social capital, especially in the form of engaging people from the immediate environment in their own entrepreneurship, has a significant impact on the likelihood of engaging in a start-up. Research using microeconomic data shows that social capital is conducive to the likelihood of engaging in a start-up in the form of general entrepreneurship standards in society (Parker, 2011) and the support of loved ones (Davidsson & Honig, 2003). In the Davidsson and Honig (2003) studies, the importance of social capital for the probability of getting involved in the start-up is even higher than the importance of human capital. These authors also show that support for relatives and membership in business organizations (e.g.

chambers of commerce) and other associations have a significant impact on the continuation of activities related to the development of a new enterprise.

Social capital has a significant impact on both progressive and breakthrough innovations, while the impact on incremental innovativeness is slightly higher. Landry et al. (2002), based on research involving companies from the Montreal area, showed that participation and relational capital are the most important factors determining the likelihood of company innovation. At the same time, they distinguished four forms of social capital: 1) the level of trust; 2) networks of connections (business, information, research), which are the source of information; 3) participation capital (frequency of participation in meetings and associations of companies from a given sector); 4) relational capital (personal knowledge with people employed in organizations that support entrepreneurship or universities, as well as with clients and suppliers). At the same time, in their research, the influence of the level of confidence on total innovation and breakthrough innovativeness is not statistically significant, as well as participation. The social capital in the form of a network of connections and relational capital has a significantly positive impact.

In the works of Subramaniam and Youndt (2005), social capital in the surveyed companies is measured by the level of cooperation and knowledge sharing between employees and partners outside the company. The research results identified social capital as a catalyst for the positive impact of human capital on breakthrough innovativeness. Delgado (2011) also distinguishes social capital (knowledge coming from informal and personal relations between employees) and relational capital (benefits related to relations with partners outside the company: customers, suppliers or strategic partners), which impact on breakthrough and progressive innovation turned out to be significantly positive.

4. Discussion

Summarizing the analysis carried out and the research results cited, it should be stated that:

- All V4 countries are characterized by a low level of social capital, compared to other EU countries;
- All V4 countries have the lowest levels of overall confidence among EU countries;
- The V4 countries achieved a relatively high position only in terms of the involvement of government stakeholders, and the worst in the field of volunteering. In this respect, Hungary has the lowest position in the ranking, which achieved the lowest level in all compared categories (trust in others, trust in the national government, etc.). The exception was trust in the police, formed at an average level among EU countries. This situation remained at a similar level in the analyzed period, and in the case of voter turnout, despite relatively poor results, it even worsened;
- Low levels of trust and social capital, understood as networks of people with similar values, indicate that the societies in V4 countries are not motivated to act in accordance with the idea of common good, including environmental protection, and, in the longer term, to build a sustainable economy;

- The V4 countries are characterized by low level of trust in the legal system, political system and the police, although among the analyzed institutions, the level of trust in the police is the highest in every country;
- The years after the financial crisis led to an increase in R&D intensity in most EU countries, except Finland and Sweden. The increase in R&D spending over the same period was also visible in countries such as Slovakia and the Czech Republic. However, despite these increases, the V4 countries (with the exception of the Czech Republic) have not achieved their intended target.

Social capital is conducive to innovativeness and involvement in start-up activities. Based on the results of the research, the most important aspects can be determined. Among them: general interpersonal trust, trust in institutions, social norms and patterns supporting entrepreneurship and creativity, participation capital and relational capital (both related to the intensity of the network of connections). These results are confirmed by the analysis of international innovativeness rankings, in which 10 countries that ranked the highest in terms of various aspects of social capital included in World Values Survey (WVS) and European Social Survey (ESS) surveys are at the same time characterized by the highest innovativeness indicators (National Bank of Poland, 2016).

In the literature of the subject, researchers attribute a key role in creating technical progress indispensable in socio-economic development to various factors. For example, Lucas (1988) focuses on the importance of human capital, while Romer (1986) emphasizes the importance of the research and development sector. Without neglecting the weight of either factor, it should be noted that full and effective use of these factors requires additional conditions. The most important of these is the existence of a cooperation network between actors (Gust-Bardon, 2012). At the same time, it should be remembered that only the fully functional and non-erodible tissue that connects all elements of the system will allow to achieve benefits from the synergy effect. Even the highest quality human capital is not able to stimulate or maintain progress individually. There must be some level of cooperation, and this requires trust, communication and social participation, in other words widely discussed social capital. It is also important that such a conclusion does not apply only to enterprises, because in the era of globalization and integration, they compete and cooperate in search of comparative advantages for entire regions and even countries. And that means that the radius of influence of social capital increases significantly.

In the conditions of globalization and far-advanced integration, innovation is determined by a high level of social capital. It is widely believed that the barrier to the growth of innovation is the low level of funding for creative solutions. This is particularly important in relatively poor economies, which include the V4 countries and which do not have significant resources for R&D. Unfortunately, the problem is much more complicated, because it is not enough to increase expenditures on innovation, because an improperly shaped economy will not be able to absorb them. Therefore, economies with lower R&D funding opportunities should increase their efforts to build social capital, thanks to which even small funds can give greater effects in terms of innovation than large expenditures,

which without an appropriate level of social capital will not bring an increase in innovation. In the area of soft factors from among the V4 countries, relatively the best indicators are reached by Slovakia and the Czech Republic, especially in relation to trust, while the worst in the area of participation. On the basis of this analysis, Hungary obtained the worst results, which in the face of the results of innovation and R&D expenditure suggests the need to intensify efforts to build favorable conditions for future development. Therefore, the level and quality of social capital, which determines effective cooperation and absorption of innovative solutions, is of key importance.

5. Conclusions

It can be assumed that such conclusions bring some optimism for the Visegrad Group, due to the fact that in the face of lack of financial resources, they could use social capital to develop innovativeness. Unfortunately, the analyzes carried out in the article indicate that social capital in these economies is perhaps even a more deficit commodity than financial resources. And that means that o should immediately get involved in its creation, because, as shown by the analysis, the shortcomings of social capital will be a significant barrier to improving the innovation of V4 economies even with financial support. According to the studies of the Srholec (2014) government programmes initiating on innovation have the potential to induce durable changes in the innovative behavior of firms. While without social capital, and therefore without trust and cooperation, no financial means will be able to raise the economy to a higher level of innovative development, and any inflow into the economy will be wasted.

Among the analyzed economies, the Czech Republic has relatively the best results in comparisons, both in terms of innovation and social capital components. Also, in the analyzed decade, an improvement of the analyzed indicators can be seen. The worst results in this ranking were achieved by Poland and Slovakia. Hungary maintains a steady albeit low level of both trust and innovation.

References

- Akçomak, İ. S., & ter Weel, B. (2009). Social capital, innovation and growth: Evidence from Europe. *European Economic Review*, 53(5). <https://doi.org/10.1016/j.euroecorev.2008.10.001>
- Alguezaui, S., & Filieri, R. (2010). Investigating the role of social capital in innovation: sparse versus dense Network. *Journal of Knowledge Management*, 14(6). <https://doi.org/10.1108/13673271011084925>
- Aydalot, P. (1986). *Milieux innovateurs en Europe*.
- Będzik, B., & Łoś-Tomiak, A. (2016). Innovation level in social capital and cooperation aspect. *Scientific Journal Higher Economic–Social School in Ostrołęka*.
- Będzik, B. (2015). (Eds.). *Social capital level as a base for the future of regional development in selected rural municipalities of zachodniopomorskie*. Regional development and its determinants.
- Brockman, P., Khurana, I. K., & Zhong, R. I. (2018). Societal trust and open innovation. *Research Policy*, 47(10), 2048-2065. <https://doi.org/10.1016/j.respol.2018.07.010>
- Casanueva, C., & Gallego, Á. (2010). Social capital and innovation: An intra-departmental perspective. *Management revue*, 21(2), 135-154. https://doi.org/10.1688/1861-9908_mrrev_2010_02_Casanueva
- Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. *Journal of business venturing*, 18(3), 301-331. [https://doi.org/10.1016/S0883-9026\(02\)00097-6](https://doi.org/10.1016/S0883-9026(02)00097-6)
- Dakhli, M., & De Clercq, D. (2004). Human capital, social capital, and innovation: a multi-country study. *Entrepreneurship & regional development*, 16(2), 107-128. <https://doi.org/10.1080/08985620410001677835>

- Delgado, M. (2011). *The role of intellectual capital assets on the radicalness of innovation: direct and moderating effects* (UAM-Accenture working papers, 5). Accenture.
- Drucker, P. (1985). *Innovation and entrepreneurship: Practice and principles*. Harper & Row.
- European Union. (2020). *European Innovation Scoreboard 2020*. Publications Office of the European Union.
- Florida, R., Cushing, R., & Gates, G. (2002). When social capital stifles innovation. *Harvard Business Review*, 80(8).
- Forte, A., Peiró-Palomino, J., & Tortosa-Ausina, E. (2015). Does social capital matter for European regional growth? *European Economic Review*, 77, 47-64. <https://doi.org/10.1016/j.euroecorev.2015.03.013>
- Gomułka, G. (1998). *The theory of innovation and economic growth*. CASE.
- Gust-Bardon, N. I. (2012). Innowacja w myśli ekonomicznej od XVIII do XX wieku: analiza wybranych zagadnień. *Acta Universitatis Nicolai Copernici Oeconomia XLIII nr 1*. https://doi.org/10.12775/AUNC_EKON.2012.008
- Kaasa, A. (2007). *Effects of Different Dimensions of Social Capital on Innovation: Evidence from Europe at the Regional Level* (Working Paper Series, 51). University of Tartu-Faculty of Economics & Business Administration.
- Kaasa, A., Kaldaru, H., & Parts, E. (2007). *Social capital and institutional quality as factors of innovation: evidence from Europe* (Working Paper, 55-2007). University of Tartu Faculty of Economics and Business Administration. <https://doi.org/10.2139/ssrn.1017754>
- Knack, S., & Keefer, P. (1997). Does Social Capital Have an Economic Payoff? A Cross-Country Investigation. *Quarterly Journal of Economics*, 112(4).
- Koszevska, M., Militký, J., Mizsey, P. & Benda-Prokeinova (2015). *Comparative Analysis of The Results Across Countries*. Final Report. Lodz University of Technology. Visegrad Group.
- Landry, R., Amara, N., & Lamari, M. (2002). Does social capital determine innovation? To what extent? *Technological forecasting and social change*, 69(7), 681-701.
- Lucas, R. (1988). On the mechanics of economic development. *Journal of Monetary Economics* 22, 3-42.
- Murphy, L., Huggins, R., & Thompson, P. (2016). Social capital and innovation: A comparative analysis of regional policies. *Environment and Planning C: Government and Policy*, 34(6), 1025-1057. <https://doi.org/10.1177/0263774X15597448>
- National Bank of Poland. (2016). *The innovative potential of the economy: conditions, determinants, perspectives*.
- OECD. (2009). *Interim Report on The OECD Innovation Strategy An Agenda for policy action on innovation*. <https://www.oecd.org/site/innovationstrategy/43381127.pdf>
- OECD. (2017). *How's Life? How's life in the Hungary; Poland; Czech Republic; Slovak Republic*. https://doi.org/10.1787/how_life-2017-37-en
- OECD. (2018). *How's Life? How's life in the Czech Republic; Hungary; Poland; Slovak Republic*. 2018. https://read.oecd-ilibrary.org/economics/how-s-life-2017/how-s-life-in-the-czech-republic_how_life-2017-15-en#page225.
- Parker, S. C. (2011). Intrapreneurship or entrepreneurship? *Journal of Business Venturing*, 26(1), 19-34. <https://doi.org/10.1016/j.jbusvent.2009.07.003>
- Pérez-Luño, A., Medina, C. C., Lavado, A. C., & Rodríguez, G. C. (2011). How social capital and knowledge affect innovation. *Journal of Business Research*, 64(12), 1369-1376. <https://doi.org/10.1016/j.jbusres.2011.01.014>
- Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of political economy*, 94(5), 1002-1037.
- Schumpeter, J. A. (1934). *Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. Oxford University Press.
- Srholec, M. (2014). *Persistence of cooperation on innovation: econometric evidence from panel micro data* (No. 2014/18). Lund University, CIRCLE-Center for Innovation, Research and Competences in the Learning Economy. <https://doi.org/10.18267/j.pep.536>
- Subramaniam, M., & Youndt, M. A. (2005). The influence of intellectual capital on the types of innovative capabilities. *Academy of Management journal*, 48(3), 450-463. <https://doi.org/10.5465/amj.2005.17407911>
- Tura, T., & Harmaakorpi, V. (2005). Social capital in building regional innovative capability. *Regional Studies*, 39(8). <https://doi.org/10.1080/00343400500328255>
- Wann-Yih, W., Man-Ling, C., & Chih-Wei, C. (2008). Promoting innovation through the accumulation of intellectual capital, social capital, and entrepreneurial orientation. *R&D Management*, 38(3). <https://doi.org/10.1111/1467-9914.00120-i1>

Dividend Policy Models and Possibilities of Their Utilization in the Conditions of a Particular Country – Assessment and Proposals

Kristýna BĚLUŠOVÁ and Karel BRYCHTA*

¹ Brno University of Technology, Brno, Czech Republic; kristyna.belusova@fbm.vutbr.cz; brychta@fbm.vutbr.cz

* Corresponding author: brychta@fbm.vutbr.cz

Abstract: The aim of this paper is to describe and compare the existing models of the dividend policy and consequently to present general considerations related to the establishment of a dividend policy model for a particular country (when presenting some specific features for the Czech Republic). The comparison presented in this paper includes 18 existing dividend policy models. Based on the analysis, it may be stated that the models can be divided into two basic groups. The first category of models is aimed at assessing the effect of tax rates on the dividend policy. The second category of models aims at determining the factors affecting the dividend policy. A number of common considered factors may be identified in all the examined models, such as the tax rate on dividends and capital gains, profit/profitability, or debt ratios. Based on the synthesis of the knowledge gained, the authors identified several categories of variables that shall be taken into consideration when creating a dividend policy model for a particular country, namely: general categories aimed at general description of the subject, profitability indicators, indicators of indebtedness, cash and liquidity indicators, assessment of investment opportunities, ownership indicators, tax aspects indicators and relevant category variables.

Keywords: Czech Republic; dividend policy; dividend policy models; establishing dividend policy model

JEL Classification: G32; G38

1. Introduction

The dividend policy has always remained one of the most discussed issues in corporate finance (Sharma, 2018), representing one of the key aspects of managing the company's financial assets (Sakir & Fadli, 2014). Dividend policy can be described as a tool providing the basis for decision-making about profit management – withheld, shared or used for other purposes (Sejkora & Duspiva, 2015). The relevance of the dividend policy for financial management or financial management as such, has been confirmed by many studies, for example by Kumar and Chandrasekar (2014). The objective taken into account should consist in maximizing the company's value (Režňáková, 2012), while financial management must be carried out in such a manner that maximizing the company's value leads to an increase in the shareholders' prosperity (Sakir & Fadli, 2014). This is determined by the market price of the company's shares, and this market price reflects the decision-making of managers in the area

of investment, asset management and financing, and it is the payment of dividends that increases the shareholders' prosperity or wealth (Roy, 2015). A positive correlation between the company's value and the dividend policy has been confirmed, for example, by the study of Budagaga (2017). In an earlier study, however, Miller and Modigliani (1961) concluded that the payment of dividends did not affect the value of the business in the world of perfect capital markets.

There are other relevant aspects related to dividends and dividend policy. According to a study by Berzins, Øyvind, and Stacescu (2017), dividend payments are used to reduce agency conflicts. This conclusion has also been confirmed by the studies by Andres et al. (2019), All-Najjar (2009), Roy (2015), Khalid and Rehman (2015), and Yusof et al. (2019), according to which the ownership structure or the company's ownership determines the dividend policy. However, the dividend policy is also determined, not surprisingly, by accounting and/or tax factors. The studies of Almeida, Pereira and Tavares (2015) dealt with the effect of the final stage of mandatory convergence to IFRS, when the authors concluded that this factor leads to a significant increase in the company's net profit and equity and, consequently, to an increase in dividend payments. In relation to taxation factors, it has been established that by lowering the dividend rate, the share price will increase for high-dividend yield foreign firms in treaty countries (Kenchington, 2019). The dividend policy is also influenced by other factors, such as the company size, growth opportunities and profitability (Fama & French, 2001). It has been shown that, despite the variability of factors determining the dividend policy in individual countries, these factors may be considered as common across six different countries (Denis & Osobov, 2008). The study conducted by Akhtar (2018) also served as a basis to identify the variability of the factors determining the dividend policy across five different countries, whereas it was found that multinationals operating in an imputation tax system and in a common law environment pay comparatively higher dividends relative to firms operating in a classical tax system and civil law regime.

The above conclusions make the issue very current, as it is also necessary to assess the suitability / convenience of using the existing models in the context of their applicability in a particular country which can show a number of particularities.

2. Methodology

The aim of this paper is to identify, describe and classify the existing models of the dividend policy and subsequently to present general starting points for establishment a dividend policy model. A partial aim was to make a critical assessment of the application of existing models in the conditions of the Czech Republic.

The paper is based on a qualitative research the primary purpose of which is to better understand the social phenomenon/issue (Disman, 2011). Application of the qualitative research and using secondary data is necessary when taking account of the following research aim which is to establish a dividend model complying with the conditions of a particular country. Thus, starting with the qualitative research fits perfectly for this research task, since, as aptly pointed by Becker (2009), within the qualitative research, "... researchers

discover in the field what they can gather and count that will be useful for testing ideas generated empirically in the course of the work.”

The research method applied consists in a multiple case study and grounded theory (Hendl, 2016), whereas the content analysis of the text served as the data collection technique. The research dealt with the existing studies focused on dividend policy models. Namely, they include 18 dividend policy models from 11 different countries. The source of the secondary data includes professional databases, namely the Proquest Central, Scopus, Science Direct, and Web of Science databases. The basic key words used for searching were as follows: dividend policy, model of dividend policy, determinants of dividend policy. Based on the update as of 01 February 2021, the databases showed following results for the key words dividend policy: 15,985 results of the Proquest Central database (Proquest, 2021); 3,427 records for the Scopus database (Elsevier, 2021a); 27,391 records for the Science Direct database (Elsevier, 2021b) and 3,240 records of the Web of Science database (Clarivate, 2021). To focus on papers strictly dealing with the topic of the research, continuous selections were realized while using other key words within searching, taking account of the content of the abstracts and texts of the papers themselves. Regarding the papers selected for this study, the papers have been included in more databases at the same time.

The dividend policy models have been examined in order to identify the following:

1. The substance / nature of the dividend policy model;
2. The explained variables;
3. The explanatory variables;
4. The timeline of the input data;
5. The environment for which the model was created (territory/location);
6. The number of entities included in the model;
7. The factors determining the dividend policy.

The models were subsequently described from the perspective of the above criteria. This was followed by an evaluation of the possibility of using individual models in terms of possibilities and limits in the conditions of a particular country, paying a special attention for the transfer of existing models in the conditions of the Czech Republic.

3. Results

The analysis of the dividend policy models evaluated and the subsequent synthesis of the results achieved showed the existence of two basic categories of models. The first one represents valuation models which target the assessment of a company's value (6 out of 18 examined models). The second category focuses on identifying the factors determining the dividend policy as such (12 out of 18 examined models). The results of the classification are provided in Table 1 below.

Table 2 summarizes the number of independent variables, an overview of individual dependent variables, timeline covered and the environment for which the model was created. It is worth mentioning that established models exhibit high level of differences.

Table 1. Categorization of dividend policy models – model type.

Category of the dividend policy model	Author/s of the study
Dividend policy models based on valuation	Ince and Owers (2012), Gourio and Miao (2010), Kari, Karikallio and Pirttilä (2008), Papaioannou and Savarese (1994), Ricketts and Wilkinson (2008), and Gropp (2002).
Dividend policy models based on identifying the determinants	Bushra and Mirza (2015), Hardin, Huang and Liano (2012), Al-Najjar (2009), Roy (2015), Dereeper and Turki (2016), Baker and Powell (2012), Khalid and Rehman (2015), Deslandes, Landry and Fortin (2015), Yusof and Ismail (2016), Trabelsi, Aziz and Lilti (2019), Andres et al. (2019), and Andres et al. (2008).

Table 2. Description of investigated models by means of set criteria.

Study by	Number of independent variables considered	Individual dependent variables	Timeline covered	Environment
Baker and Powell (2012)	22	Decision-making on dividend payout to shareholders	2006-2009	Indonesia, 163 listed companies
Roy (2015)	11	Dividend payout ratio Dividend payout ratio	2007-2008 and 2011-2012	Indie, 68 listed companies
Yusof and Ismail (2016)	11	Dividend per share	2006-2010	Malaysia, 200 listed companies
Deslandes, Landry and Fortin (2015)	9	Annual total amount of common shares repurchased at time. Annual total cash dividends paid on common shares to all shareholders at time	2003-2008	Canada, 494 companies subject to the same taxation regime
Trabelsi, Aziz and Lilti (2019)	9	Dividend premium	1992-2010	France, 358 companies operating in various sectors and listed in the SBF 250 index.
Gourio and Miao (2010)	8	Dividend payment	1988-2002	USA, 11,945 companies
All-Najjar (2009)	8	Dividend payout ratio	1994-2003	Jordan, 86 companies
Dereeper and Turki (2016)	8	Dummy variable of dividend status	1989-2009	USA, listed companies with a share price exceeding USD 1 million and a share percentage greater than 50%

Study by	Number of independent variables considered	Individual dependent variables	Timeline covered	Environment
Kari, Karikallio and Pirttilä (2008)	7	Dividend distribution at time	1999-2004	Finland and companies operating in the industrial sector (both listed and unlisted)
Bushra and Mirza (2015)	7	Dividend yield Dividend payout ratio	2005-2010	Pakistan, 75 listed companies; KSE 100 index
Gropp (2002)	7	Change in financing the fixed assets by long-term and short-term debt	1985-1990	Germany, 375 companies operating in 7 different sectors and listed on the stock exchange
Ricketts and Wilkinson (2008)	6	Share price / registered capital	1975-1985 and 1990-2000	Australia, 500 companies
Hardin, Huang and Liano (2012)	5	Dividend size Dividend yield	1964-1994	USA, companies labelled as investment funds listed on the New York or US Stock Exchange, paying dividends quarterly
Ince and Owers (2012)	4	Dividend payout ratio	1979-2002	USA, 1,500 companies representing 75% of the capital market
Papaioannou and Saverse (1994)	3	Dividend payout ratio	1983-1991	USA, 243 industrial and 40 utility companies listed on the stock exchange
Khalid and Rehman (2015)	3	Dividend payout ratio	2004-2009	Pakistan, 50 listed companies; KSE-100 index, operating in 7 different sectors
Andres et al. (2019)	2	Dividend payout ratio	1984-2005	Germany, 220 companies listed on the German stock exchange
Andres et al. (2008)	2	Dividend per share	1984-2005	220 German listed companies

On the basis of the comparison, it may be concluded that the existing models are designed mainly for non-European environments, yet three out of 18 models were designed for the conditions of Germany, whose capital market may be considered as highly developed. The examined time period acquired the values from 4 to 30 years. The number of companies for which data was obtained and used within the model ranged from 50 to 11,945, which

represents huge disproportion regarding this variable. Furthermore, these companies were those operating in various sectors. The dominant feature of these companies was their listing on the stock exchange.

3.1. Factors Determining the Dividend Policy

Ince and Owers (2012), who examined the effect of tax rates on the business value as defined through the perspective of the Dividend payout ratio criterion, confirmed in their research that both the dividend tax rate and the capital gains tax rate affected the dividend policy. The authors Kari, Karikallio, and Pirttilä (2008), who focused on assessing the impact of the tax reform on the business value, concluded that the tax rates and the Dividends/Assets, Profit/Assets, Investments/Assets, Equity/Debt, and Debt/Assets ratios affected the Dividend distribution at time. Gourio and Miao (2010), who addressed a similar issue – specifically the impact of the tax reform on changes in long-term company financing – conclude their research by the amount of the dividend paid is impacted by the investment levels, new capital/investment, Dividends/Revenues and Cobb-Douglas production function in relation to the change in the tax rate on dividends and capital gains. The impact of the tax reform was also confirmed by Ricketts and Wilkinson (2008), who found its impact on the company's retained earnings and share price on the market.

A positive effect of the tax rates on the Dividend payout ratio was confirmed by the research carried out by Papaioannou and Savarese (1994). In the study by Bushra and Mirza (2015), it was revealed that the total assets and revenue growth was affected by the Dividend yield and Dividend payout ratio. Among other things, the study by Hardin et al. (2012) confirmed the high mutual correlation between the Dividend yield and Dividend size indicators. All-Najjar (2009) notes that the dividend policy is determined by the following factors: total debt/total assets, share of the institutional ownership in the company, return on equity, and total assets. Roy (2015) identified, as the factors determining the Dividend payment ratio, the company's management system and the ratio of financial assets to total assets. In the model created by Khalid and Rehman (2015), the determining factor of the Dividend payout ratio is the company's ownership structure. According to Yusof and Ismail (2016), the Dividend per share is determined by these variables: profit, debt, company size, shareholder size, and investment opportunities. The study conducted by Baker and Powell (2012), based on the questionnaire survey, implied that the managers of the examined companies considered the most important factors affecting the dividend policy to be the stability of profits, the level of the current profits, the level of expected profits, liquidity, and the economic forecast. According to the study by Deslandes, Landry, and Fortin (2015), the dividend policy is determined by the percentage of shares held by investors, the annual amount of the cash dividend, profit, the company's market value, total assets, profit volatility, and the total debt. According to the study by Dereeper and Turki (2016), the dividend status is affected by the revenue and the dividend payout ratio.

Gropp (2002), who examined the impact of tax rates on the financial decision-making of a company in his study, found that the current tax environment leads to debt financing of the company. Trabelsi, Aziz, and Lilti (2019) found that the total amount of assets, profitability,

systematic and specific risk, total debt of the company and lagged dividend affect the dividend policy. Andres et al. (2019) confirmed the effect of concentration of ownership in their study, and in an earlier study, these authors confirmed the effect of cash flow per share (Andres et al. 2008). Table 3 below shows a summary of the underlying key factors determining the dividend policy in each study/model.

Table 3. Key factors determining dividend policy.

Variable	Study by
Tax rates on dividends and capital gains	Ince and Owers (2012), Gropp (2002), Gourio and Miao (2010), Kari, Karikallio and Pirttilä (2008), and Papaioannou and Saverse (1994)
Debt	Trabelsi, Aziz and Lilti (2019), All-Najjar (2009), Deslandes, Landry and Fortin (2015), Yusof and Ismail (2016), and Kari, Karikallio and Pirttilä (2008)
Investment	Kari, Karikallio and Pirttilä (2008), Yusof and Ismail (2016), and Gourio and Miao (2010)
Company size (headcount and total assets)	Kari, Karikallio and Pirttilä (2008), Trabelsi, Aziz and Lilti (2019), Roy (2015), Deslandes et al. (2015), All-Najar (2009), and Yusof and Ismail (2016)
Profit / profitability and sales	Kari, Karikallio and Pirttilä (2008), Trabelsi, Aziz and Lilti (2019), Deslandes, Landry and Fortin (2015), Ricketts and Wilkinson (2015), Baker and Powell (2012), Yusof and Ismail (2016), and Gourio and Miao (2010)
Ownership	Andres et al. (2019), All-Najjar (2009), Roy (2015), and Khalid and Rehman (2015)
Dividend factors	Kari, Karikallio and Pirttilä (2008), Gourio and Miao (2010), Trabelsi, Aziz and Lilti (2019), Deslandes, Landry and Fortin (2015), Dereeper and Turki (2016), and Andres et al. (2008)

4. Discussion and Conclusions

The existing dividend policy models show a high degree of variability: when it comes merely to the number of entities included in the models, it varies widely (ranging from 50 to 11,945 entities), while it must also be noted that they were companies operating across different industries. In this respect, i.e. according to the industry criterion, the existing models could not be stratified. In relation to the assessment of the applicability (transferability) of the existing models in the context of a particular country, it is worth noting that:

- The existing dividend policy models have been mainly developed for non-European environments (the models developed for European conditions represent a minority);
- Some models have been developed to assess (reflect) the selected social phenomenon (e.g. the impact of legislative changes on the company's value or the dividends paid), which reduces their general applicability – for instance, in the conditions of the Czech Republic which show stable legal regulations regarding taxation of dividend incomes);
- The companies in the models include those traded on a developed securities market, which obviously means the availability of certain indicators which companies not traded on a regulated market simply do not have.

Taking into account the above, it may be concluded that the adoption of models based on different rates before and after the tax reform (see e.g. Ince & Owers, 2012; Gourio & Miao,

2010; Kari et al., 2008) lacks any justification without further modification in the context of the country with minor or now changes in the legal regulations (which is, for instance, the case of the Czech Republic). On the other hand, there is an interesting factor worthy of further examination and evaluation in the framework of the dividend policy models, represented by the possible maximum rate enshrined in the relevant Double Tax Treaty (for general tax aspects see OECD, 2017; for the situation regarding the Czech Republic see Bělušová and Brychta (2017); for the rules governing taxation of dividend in the EU see Bělušová (2018) or the use of the conditions foreseen in Directive 2011/96/EU of 30 November 2011 on the common system of taxation applicable in the case of parent companies and subsidiaries of different Member States for tax exemption. This international tax factors seem to be more or less omitted in the existing models. Other, very serious obstacle, when speaking about the adoption (transfer) of the existing models for a particular country, is a lack of available data and the level of development Stock Exchange market.

For instance, in the Czech Republic, on the Prague Stock Exchange, there were currently 11 companies traded on the Prime market, 6 companies on the Standard Market, 32 foreign companies on the Free market, and 5 companies on the Start Market (Prague Stock Exchange, 2020). Simply for the purposes of general comparison, for example, there are 318 companies traded on the Prime standard market and 151 companies on the General Standard on the Frankfurt Stock Exchange (Deutsche Börse Group, 2020). In summary, it may be stated that, based on the fundamental comparison of the above data and reflecting the requirements imposed on the minimum research sample size, it is clear that the use of some factors / indicators is not possible in the context of some countries (including the Czech Republic) due to the absence of relevant data or due to the absence of the sufficient amount of relevant data. In other words, models developed on the basis of indicators available for publicly traded companies are not generally suitable for the application in a particular country thanks to relatively small number of companies traded in this manner. Based on the research and evaluation of conditions in the Czech Republic, it is possible to state that none of the models can be adopted and applied in the context of this transformation economy without any further modification. There are several reasons for this. The primary reasons include the underdeveloped financial market in the Czech Republic (Meluzín, 2009; Skalická et al., 2018) (in the Czech Republic, there is a very small number of entities the shares of which are traded on the Prague Stock Exchange) and the relative stability in terms of corporate income tax and dividend withholding tax. In relation to developing the dividend policy in the context of the Czech Republic, the authors also point out the need to define the dividend more broadly as a share of profits paid to capital companies. As confirmed in the study by Yusof and Ismail (2016), large companies have a higher tendency to pay the share of profits to their owners. Taking into account the very limited availability of data for small and medium-sized enterprises, it seems appropriate to focus the attention in the Czech Republic on large to very large companies, with the following indicators will serve to identify this category of companies:

- The size of operating income;
- The size of total assets;
- Number of employees.

The examined sample then will automatically include the companies listed on the Prague Stock Exchange. In the context of the Czech Republic, the company may deal with the after-tax profit as follows:

- Increase in the registered capital;
- Settlement of accumulated losses from previous years;
- Transfer to retained profits from previous years;
- Transfer to a reserve fund or other company's funds; and/or
- Payment of shares to shareholders (for a number of related aspects, see Act No. 90/2012 Coll., on Business Corporations, as amended).

Naturally, when quantifying the amount of dividends paid, it will not be possible to identify the profit with the profit-sharing amount. It will be necessary to make adjustments following the above transactions, which, with respect to the structure of the financial statements, makes the issue much more complex, both in terms of data collection and the calculation itself.

4.1. Potential Variables and Their Stratification when Establishing Dividend Policy Model

Table 4 below summarizes the potential variables and their stratification, as it emerged from the synthesis of the findings of the literature research. The appropriateness (necessity) of incorporating the specific variables will be the subject of further examination in the process of addressing a partial research task, i.e. when developing the dividend model. Currently, it is worth mentioning to need to include aspects related to COVID-19 pandemic. As the situation in the secondary financial markets suggest, the influence of this vis maior aspect has far-going impacts.

Table 4. Independent (explanatory) variables – the first stage of developing the model.

General Category	Indicators
General indicators	Number of employees; Company's age; Total assets; Fixed assets; Changes in fixed assets; Current assets; Working capital; Change in current assets; Registered capital; Retained profits; Operating income; Growth in total revenue; Pre-tax profit; After-tax profit
Profitability indicators	ROE [%]; ROA [%]
Indebtedness	Long-term debt; Change in long-term debt; Short-term debt; Change in short-term debt; Total debt; Change in total debt; Equity/Total debt; Total debt [%]; Self-financing coefficient [%]
Cash and liquidity indicators	Current liquidity; Available liquidity; Instant liquidity; Financial assets to total assets; Free cash flow
Investment opportunities	Retained profit/total assets
Ownership	Ownership size; Structure of the ownership
Tax aspects	Tax rate on dividend income; Corporate income tax rate
Category variables	Legal form of business; Predominant domestic/foreign direct ownership

Taking account of the results of the research made, for the purposes of developing a dividend model in the context of a particular country, it seems appropriate to use a general linear regression model with a fixed effect and interactions. The Hausman test (see Hausman, 1978; Yusof and Ismail, 2016) shall be used to determine the appropriate selection method, i.e. to determine whether a random effect form is more appropriate for a specific model or not. A correlation coefficient shall be used to eliminate redundant variables. The subsequent extraction of variables shall perform using the step regression or the analysis of the main components.

Acknowledgement: The project presented in this article is supported by Internal Grant Agency of the Brno University of Technology, Grant No. FP-S-20-6466 (Predicting Models in Finances – specifics of SMEs).

References

- Akhtar, S. (2018). Dividend policies across multinational and domestic corporations – an international study. *Accounting and Finance*, 58, 669–695. <https://doi.org/10.1111/acfi.12179>
- All-Najjar, B. (2009). Dividend behaviour and smoothing new evidence from Jordanian panel data. *Studies in Economics and Finance*, 26(3), 182–197. <https://doi.org/10.1108/10867370910974017>
- Almeida, L. A. G., Pereira, E. T., & Tavares, F. O. (2015). Determinants of dividend policy: evidence from Portugal. *Review of Business Management*, 17(54), 701–719. <https://doi.org/10.7819/rbgn.v17i54.1943>
- Andres, C. (2008). Dividend policy of German firms: A panel data analysis of partial adjustment models. *Journal of Empirical Finance*, 16(2), 175–187. <https://doi.org/10.1016/j.jempfin.2008.08.002>
- Andres, C. (2019). Dividend policy, corporate control, and the tax status of the controlling shareholder. *Journal of Industrial and Business Economics*, 46(2), 157–189. <https://doi.org/10.1007/s40812-018-0100-6>
- Baker, K. H. & Powell, G. (2012). Dividend policy in Indonesia: survey evidence from executives. *Journal of Asia Business Studies*, 6(1), 79–92. <https://doi.org/10.1108/15587891211191399>
- Becker, H. S. (2009). How to Find Out How to Do Qualitative Research. *International Journal of Communication*, 3, 545–553. <https://ijoc.org/index.php/ijoc/article/view/550/329>
- Bělušová, K. (2018). Taxation of dividend in the European Union – A comparative study. *Acta Sting*, 7(3), 6–22. https://www.sting.cz/acta_sting/archiv/3-2018/
- Berzins J., Bøhren, Ø., & Stacescu, B. (2017). Shareholder Conflicts and Dividends. *Review of Finance*, 22(5), 1807–1840. <https://doi.org/10.1093/rof/rfx046>
- Brychta, K., & Bělušová, K. (2017). International Taxation of Dividends as Regulated in Double Tax Treaties – a Case of the Czech Republic. In M. Čulík (Ed.), *Financial Management of Firms and Financial Institution: 11th International Scientific Conference: Proceedings (I part)* (pp. 122–130). VŠB – Technical University Ostrava. https://www.ekf.vsb.cz/share/static/ekf/www.ekf.vsb.cz/export/sites/ekf/frpfi/.content/galerie-souboru/2017/proceedings/Part_I_final.pdf
- Budagaga, A. (2017). Dividend Payment and its Impact on the Value of Firms Listed on Istanbul Stock Exchange: A Residual Income Approach. *International Journal of Economics and Financial Issues*, 7(2), 370–376. <https://www.econjournals.com/index.php/ijefi/article/view/4088/pdf>
- Bushra, A., & Mirza, N. (2015). The determinants of corporate dividend policy in Pakistan. *The Lahore Journal of Economic*, 20(2), 77–98. <https://doi.org/10.35536/lje.2015.v20.i2.a4>
- Clarivate. (2021). Web of Science database. [online]. <http://apps.webofknowledge.com/>
- Denis, D. J., & Osobov, I. (2008). Why do firms pay dividends? International evidence on the determinants of dividend policy". *Journal of Financial Economics*, 89(1), 62–82. <https://doi.org/10.2139/ssrn.887643>
- Dereeper, S., & Turki, A. (2016). Dividend policy following mergers and acquisitions: US evidence. *Managerial Finance*, 42(11), 1073–1090. <https://doi.org/10.1108/MF-10-2015-0293>
- Deslandes, M., Landry, S., & Fortin, A. (2015). The effects of a tax dividend cut on payout policies: Canadian evidence. *International Journal of Managerial Finance*, 11(1), 2–22. <https://doi.org/10.1108/IJMF-05-2014-0081>
- Deutsche Börse Group. (2020, January 15). Deutsche-boerse.com [online]. [https://deutsche-boerse.com/dbg-de/Directive 2011/96/EU. On the common system of taxation applicable in the case of parent companies and subsidiaries of different Member States. European Union, The European Parliament and the Council of the European Union. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:345:0008:0016:EN:PDF](https://deutsche-boerse.com/dbg-de/Directive%202011%2F96%2FEU.%20On%20the%20common%20system%20of%20taxation%20applicable%20in%20the%20case%20of%20parent%20companies%20and%20subsidiaries%20of%20different%20Member%20States.%20European%20Union,%20The%20European%20Parliament%20and%20the%20Council%20of%20the%20European%20Union.%20https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:345:0008:0016:EN:PDF)

- Disman, M. (2011). *Jak se vyrábí sociologická znalost: příručka pro uživatele* [How Sociological knowledge is Produced: a User Guidebook]. Karolinum.
- Elsevier (2021a). Scopus database. [online]. <https://www.scopus.com/>
- Elsevier (2021b). Science Direct database. [online]. <https://www.sciencedirect.com/>
- Fama, E. F., & French, K. R. (2001). Disappearing dividends: changing firm characteristics or lower propensity to pay? *Journal of Financial Economics*, 60(1), 3–43. [https://doi.org/10.1016/S0304-405X\(01\)00038-1](https://doi.org/10.1016/S0304-405X(01)00038-1)
- Gourio, F., & Miao, J. (2010). Firm Heterogeneity and the Long-run Effects of Dividend Tax Reform. *American Economic Journal: Macroeconomics*, 2(1), 131–168. <https://doi.org/10.1257/mac.2.1.131>
- Gropp, R. E. (2002). Local taxes and capital structure choice. *International Tax and Public Finance*, 9(1), 51–71. <https://doi.org/10.1023/A:1014413724596>
- Hardin, W. G., Huang, G., & Liano, K. (2012). Dividend Size, Yield, Clienteles and REITs. *The Journal of Real Estate Finance and Economics*, 45(2), 435–449. <https://doi.org/10.1007/s11146-010-9276-x>
- Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, 46(6), 1251–1271. <https://doi.org/10.2307/1913827>
- Hendl, J. (2016). *Kvalitativní výzkum* [Qualitative Research]. Portál.
- Ince, U., & Owers, J. E. (2012). The interaction of corporate dividend policy and capital structure decisions under differential tax regimes. *Journal of Economics and Finance*, 36(1), 33–57. <https://doi.org/10.1007/s12197-009-9101-7>
- Kari, S., Karikallio, H., & Pirttilä, J. (2008). Anticipating Tax Changes: Evidence from the Finnish Corporate Income Tax Reform of 2005. *Fiscal Studies*, 29(2), 167–196. <https://doi.org/10.1111/j.1475-5890.2008.00072.x>
- Kenchington, D. G. (2019). Does a change in dividend tax rates in U.S. affect equity prices of non-U.S. stocks? *Review of Accounting Studies*, (24), 593–628. <https://doi.org/10.1007/s11142-019-9489-z>
- Khalid, S., & Rehman, U. M. (2015). Determination of Factors effecting the Dividend policy of Organizations. *International Journal of Information, Business and Management*, 7(3), 319–333.
- Kumar, D. N. S., & Chandrasekar, V. (2014). Financial management analysis of dividend policy pursued by selected Indian manufacturing companies. *Journal of Financial management and Analysis*, 27(1), 20–32.
- Meluzín, T. (2009). Výzkum prvotních veřejných nabídek akcií realizovaných na českém kapitálovém trhu [Research of Initial Public Offerings of Shares on the Czech Capital Market], *E&M Ekonomie a Management*, 12(2), 108–121.
- Miller, M. H., & Modigliani F. (1961). Dividend policy, growth and the valuation of shares. *The Journal of Business*, 34(4), 411–433. <https://www.jstor.org/stable/2351143>
- OECD. (2017, January 18). *Model Tax Convention on Income and on Capital 2017* (Full Version). <https://doi.org/10.1787/g2g972ee-en>
- Papaioannou, G., & Savarese, M. C. (1994). Corporate dividend policy response to the tax reform act of 1986. *Financial Management*, 23(1), 56–63. <https://doi.org/10.2307/3666056>
- Prague Stock Exchange. (2020, January 15). PSE.cz. <https://www.pse.cz/>
- Proquest. (2021). ProQuest Central database. [online]. <https://search.proquest.com/>
- Režňáková, M. (2012). *Efektivní financování rozvoje podnikání* [Effective Financing of Business Development]. Grada Publishing House.
- Ricketts, R. C., & Wilkinson, B. R. (2008). The effects of shareholder dividend taxes: Evidence from the Australian tax integration environment. *Journal of International Accounting Research*, 7(1), 77–96. <https://doi.org/10.2308/jiar.2008.7.1.77>
- Roy, A. (2015). Dividend Policy, Ownership Structure and Corporate Governance: An Empirical Analysis of Indian Firms. *Indian Journal of Corporate Governance*, 8(1), 1–33. <https://doi.org/10.1177/0974686215574422>
- Sakir, A., & Fadli, M. (2014). Influence of managerial ownership, debt policy, profitability, firm size and free cash flow on divided policy: A study in Indonesian manufacturing industries. *Delhi Business Review*, 15(1), 15–22. https://www.delhibusinessreview.org/V15n1/dbr_v15nb_pg15_22.pdf
- Sejkora, F., & Duspiva, P. (2015). The position of management of Czech joint-stock companies on dividend policy. *E&M Ekonomie a management*, 18(2), 73–88. <https://doi.org/10.15240/tul/001/2015-2-006>
- Sharma, K. (2018). Impact of Dividend Policy on the Value of Indian Banks. *SCMS Journal of Indian Management*, 15(4), 14–19. <https://www.scms.edu.in/uploads/journal/SCMS%20Journal%20July-September%202018.pdf>
- Skalická, M., Zinecker, M., Balcerzak, A., & Meluzín, T. (2018). Why do companies go public? Evidence from the Prague Stock Exchange. *Entrepreneurial Business and Economics Review*, 7(1), 181–199. <https://doi.org/10.15678/EBER.2019.070110>

- Trabelsi, D., Aziz, S., & Lilti, J. (2019). A behavioural perspective on corporate dividend policy: evidence from France. *Corporate Governance*, 19(1), 102–119. <https://doi.org/10.1108/CG-02-2018-0077>
- Yusof, Y., & Ismail, S. (2016). Determinants of dividend policy of public listed companies in Malaysia. *Review of International Business and Strategy*, 26(1), 88–99. <https://doi.org/10.1108/RIBS-02-2014-0030>
- Zákon č. 90/2012 Sb., o obchodních korporacích. Parlament České republiky.
<https://www.zakonyprolidi.cz/cs/2012-90?text=90%2F2012>

Rate of Wage Levelling or Diversification of OECD Member Countries: In Which Countries Are Wage More Inequality?

Diana BÍLKOVÁ

University of Economics, Prague, Czechia; bilkova@vse.cz

Abstract: The main objective of this research is to capture wage inequality in OECD member countries and to find out in which countries wages are the most levelled and in which countries wages are the most diversified. The Gini coefficient and index were used for this purpose. The highest values of the Gini index were found in two Latin American OECD member countries, namely in Chile and Mexico, values exceeding 45 percent indicate strong wage diversification. On the contrary, Slovenia, Slovakia, the Czechia show a strong levelling of wages, the values of the Gini index are around 25 percent. The data for this research come from the official OECD statistical database and International Labour Organization Database (ILOSTAT). Gross annual wage after its conversion to purchasing power parity (PPP) in 2018 constant prices at USD is the main research variable. The data for this research includes employees in both business and non-business spheres. The wage is paid to the employee for the work done in the private (business) sphere, salary in the budget (state, public, non-business) sector.

Keywords: wage levelling; wage diversification; wage inequality; Gini coefficient of diversification; Gini index of diversification; Lorenz curve of diversification

JEL Classification: D31; J31; E24

1. Introduction

In the developed countries of the world, wage shears are constantly opening up. Wages and salaries of employees with the highest incomes are rising the most. For example, wage differences are evidenced by the difference between the average wage and the median wage, too. Most employees in the developed countries in the world do not reach the average wage. Real wages of experts are currently rising in the developed countries of the world, so it can be expected that this disparity will continue to increase.

Rising wage and income inequality is also a major problem in Organization for Economic Cooperation and Development (OECD) countries, especially in view of the recent coronary crisis and the fact that the prospects for a slowdown in this growth is currently very low, especially for more developed countries. In this context, many researchers, and scholarly articles around the world are published on topic of wage and income diversifications and inequality.

Marjit, Beladi, and Chakrabarti (2004) provide a theoretical analysis of the possible impact of trade and fragmentation on the skilled–unskilled wage gap in a small developing

economy. In particular, they illustrate the possibility of a decline in the relative wage of the unskilled labour following an improvement in the terms of trade. Analysing data from the Current Population Survey for 1963 to 2005, Autor, Katz and Kearney (2008) find that the slowing of the growth of wage inequality in the 1990s hides a divergence in the paths of upper-tail (quantiles 90/50) inequality, which has increased steadily since 1980, even adjusting for changes in labour force composition, and lower-tail (quantiles 50/10) inequality, which rose sharply in the first half of the 1980s and plateaued or contracted thereafter. Fluctuations in the real minimum wage are not a plausible explanation for these trends since the bulk of inequality growth occurs above the median of the wage distribution. Western and Rosenfeld (2011) observe that from 1973 to 2007, private sector union membership in the United States declined from 34 to 8 percent for men and from 16 to 6 percent for women. During this period, inequality in hourly wages increased by over 40 percent. The authors report a decomposition, relating rising inequality to the union wage distribution's shrinking weight and they argue that unions helped institutionalize norms of equity, reducing the dispersion of nonunion wages in highly unionized regions and industries. Acosta and Gasparini (2007) present evidence of the hypothesis that capital accumulation can modify the relative productivity between skilled and unskilled workers, leading to changes in the wage structure, taking advantage of the variability in wage premia and capital investment across industries in Argentina's manufacturing sector. The authors conclude that the wage premium for skilled workers increased more in those industries with higher investment in machinery and equipment.

This paper deals with the analysis of the development of wage diversification in OECD member countries in the period just after the global economic crisis, specifically 2013–2018. The main aim of the current research is to quantify the development of wage diversification using the Gini diversification coefficient and then the Gini diversification index with the intention of comparing this development in individual countries or their groups. The following scientific hypotheses follow from the set research objectives:

- H1: In all OECD member countries, the wage diversification expressed by the Gini index does not exceed 50 percent.
- H2: Wage diversification in post-communist countries is lower than in other countries due to the past almost egalitarian system.
- H3: Central and South American OECD countries show the highest degree of wage diversification within OECD member countries.
- H4: Non-European OECD member countries are characterized by a higher degree of wage diversification than European countries.

2. Database

The data for this research come from the official OECD statistical database and International Labour Organization Database (ILOSTAT). Gross annual wage after its conversion to purchasing power parity (PPP) in 2018 constant prices at USD is the main research variable. Then, average gross annual wage after its conversion to PPP in 2018 constant prices at USD is the main research wage indicator – hereinafter in the text referred

to as average wage. All 36 OECD member countries are statistical units of research. These states are divided into seven blocks according to their geographical location, historical development, culture, social systems, and level of advancement of the country, see Table 1.

Table 1. Country blocks of the OECD member states, country names and their international codes.

Source: www.mvcr.cz

Group of countries	Country	Code	Group of countries	Country	Code
Western European developed countries	Austria	AUT	Central European post-communist countries	Czechia	CZE
	Belgium	BEL		Hungary	HUN
	France	FRA		Poland	POL
	Germany	DEU		Slovakia	SVK
	Luxembourg	LUX		Slovenia	SVN
	Netherlands	NLD	Baltic countries	Estonia	EST
	Switzerland	CHE		Latvia	LVA
Scandinavian countries	Denmark	DNK		Lithuania	LTU
	Finland	FIN	Non-European countries	Australia	AUS
	Iceland	ISL		Canada	CAN
	Norway	NOR		Chile	CHL
	Sweden	SWE		Israel	ISR
Anglo-Saxon countries	Ireland	IRL		Japan	JPN
	United Kingdom	GBR		Mexico	MEX
South European countries	Greece	GRC		New Zealand	NZL
	Italy	ITA		South Korea	KOR
	Portugal	PRT		Turkey	TUR
	Spain	ESP		United States	USA

The data for this research includes employees in both business and non-business spheres. The wage is paid to the employee for the work done in the private (business) sphere, salary in the budget (state, public, non-business) sector. From the point of view of the analysed data from the OECD statistical database, both wages in the business sphere and salaries in the non-business sector are included under the wage term.

The data was processed using the SAS, SPSS and Statgraphics statistical packets and the Microsoft Excel spreadsheet.

3. Theory and Methodology

Gini coefficient is related to the popular Lorenz curve, see Figure 1. In this figure, the Lorenz curve represents the arc indicated by the arrow. The two extreme Lorenz curve shape options for full levelling and full diversification are shown here, too.

Lorenz curve is plotted in a rectangular chart with two scales from zero percent to a hundred percent. The cumulative relative frequencies (in percentages) of the statistical units that carry the variable of interest are on the horizontal axis. On the contrary, the cumulative totals (in percentages) of the concentrated variable are on the vertical axis. Thus, the coordinates of the points on the Lorenz curve are the cumulative relative frequencies (in percentages) of the statistical units that carry the variable under consideration, and the corresponding cumulative totals (in percentages) of the concentrated variable. In the case of full levelling, the Lorenz curve coincides with the indicated diagonal of the square, which

means that each statistical unit obtains the equal part from the total sum of the values of the researched variable. The more the Lorenz curve bends, the greater is the diversification of the variable under investigation, i.e. the concentration of a relatively large part of the total sum of the values of the monitored variable into a small number of statistical units. In the case of full diversification, the Lorenz curve turns into two each other perpendicular lines, i.e. it merges with the horizontal axis and the right edge of the graph. This means that the total sum of the values of the variable being examined is concentrated into only one statistical unit.

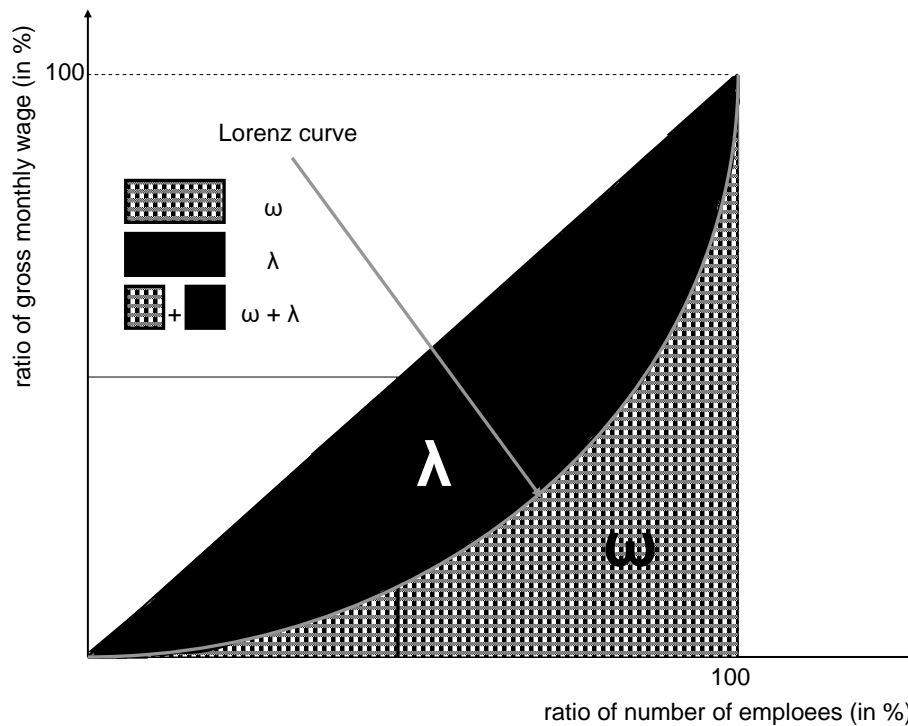


Figure 1. Lorenz curve

The characteristic of diversification is then the ratio of the area content between the square diagonal and the Lorenz curve to the area content of the whole triangle below the diagonal of the square. This characteristic is called the Gini coefficient of diversification

$$GC = \frac{\lambda}{\lambda + \omega}. \quad (1)$$

The Gini coefficient takes values in the range from zero to one, where it gets value zero at extreme levelling, when each statistical unit obtains the equal part from the total sum of the values of the researched variable, and it gets value one at extreme differentiation, when the total sum of the values of the variable being examined is concentrated into only one statistical unit. The Gini coefficient is considered to be one of the most suitable indicators of measuring wage and income inequalities. The Gini coefficient multiplied by a hundred is called the Gini index. This is the same statistic, expressed only as a percentage.

We calculate the Gini coefficient from the interval frequency distribution as

$$GC = \frac{\sum_{i=1}^l [M_i(h) - M_i(d)] \times (p_i) \times [1 - k(p_i)]}{\sum_{i=1}^l [M_i(h) - M_i(d)] \times [1 - k(p_i)]} \quad (2)$$

where: $M_i(h)$ is upper limit of the i^{th} interval, $i = 1, 2, \dots, l$,
 $M_i(d)$ is lower limit of the i^{th} interval, $i = 1, 2, \dots, l$,
 p_i is relative frequency in the i^{th} interval, $i = 1, 2, \dots, l$,
 $k(p_i)$ is cumulative relative frequency in up to the i^{th} interval, $i = 1, 2, \dots, l$,
 l is number of intervals,

or, if we know the averages at each interval, using the formula

$$GC = \frac{\sum_{i=1}^l [\bar{M}_{i+1} - \bar{M}_i] \times (p_i) \times [1 - k(p_i)]}{\bar{M}} \quad (3)$$

where: $\bar{M}_{i+1} - \bar{M}_i$ is the difference of the $i+1$ -th and i^{th} interval averages, $i = 1, 2, \dots, l$,
 \bar{M} is the total average over all intervals,
 p_i is relative frequency in the i^{th} interval, $i = 1, 2, \dots, l$,
 $k(p_i)$ is cumulative relative frequency in up to the i^{th} interval, $i = 1, 2, \dots, l$,
 l is number of intervals.

Gini coefficient can be also calculated using the mathematical formula as an average of differences in wages between all possible pairs of individuals

$$GC = \frac{\sum_{i=1}^n \sum_{j=1}^n |x_i - x_j|}{2 n^2 \bar{x}} \quad (4)$$

where: x_i, x_j are wages of two randomly chosen individuals, $i, j = 1, 2, \dots, n$,
 n is number of individuals,
 \bar{x} is an average.

The advantage of this calculation procedure is that it is not necessary to sort individuals or groups according to monitored variable. However, the so-called Brownian formula is more often used to calculate the Gini coefficient

$$GC = \left| 1 - \sum_{i=1}^n (x_i - x_{i-1}) \times (y_i + y_{i-1}) \right| \quad (5)$$

where: x_i is the cumulative ratio of beneficiaries of monitored variable, $i = 1, 2, \dots, n$,
 y_i is the cumulative ratio of monitored variable, $i = 1, 2, \dots, n$.

4. Results

Figures 2–6 quantify the development of diversification of OECD member countries in the period 2013–2018. Specifically, Figure 2 refers to Western European developed countries, Figure 3 represents Scandinavian countries, Figure 4 represents Anglo-Saxon and South European countries (too small blocs of countries from Table 1 were plotted with another small bloc), Figure 5 refers to Central European post-communist and Baltic post-communist countries, and finally Figure 6 includes Non-European countries.

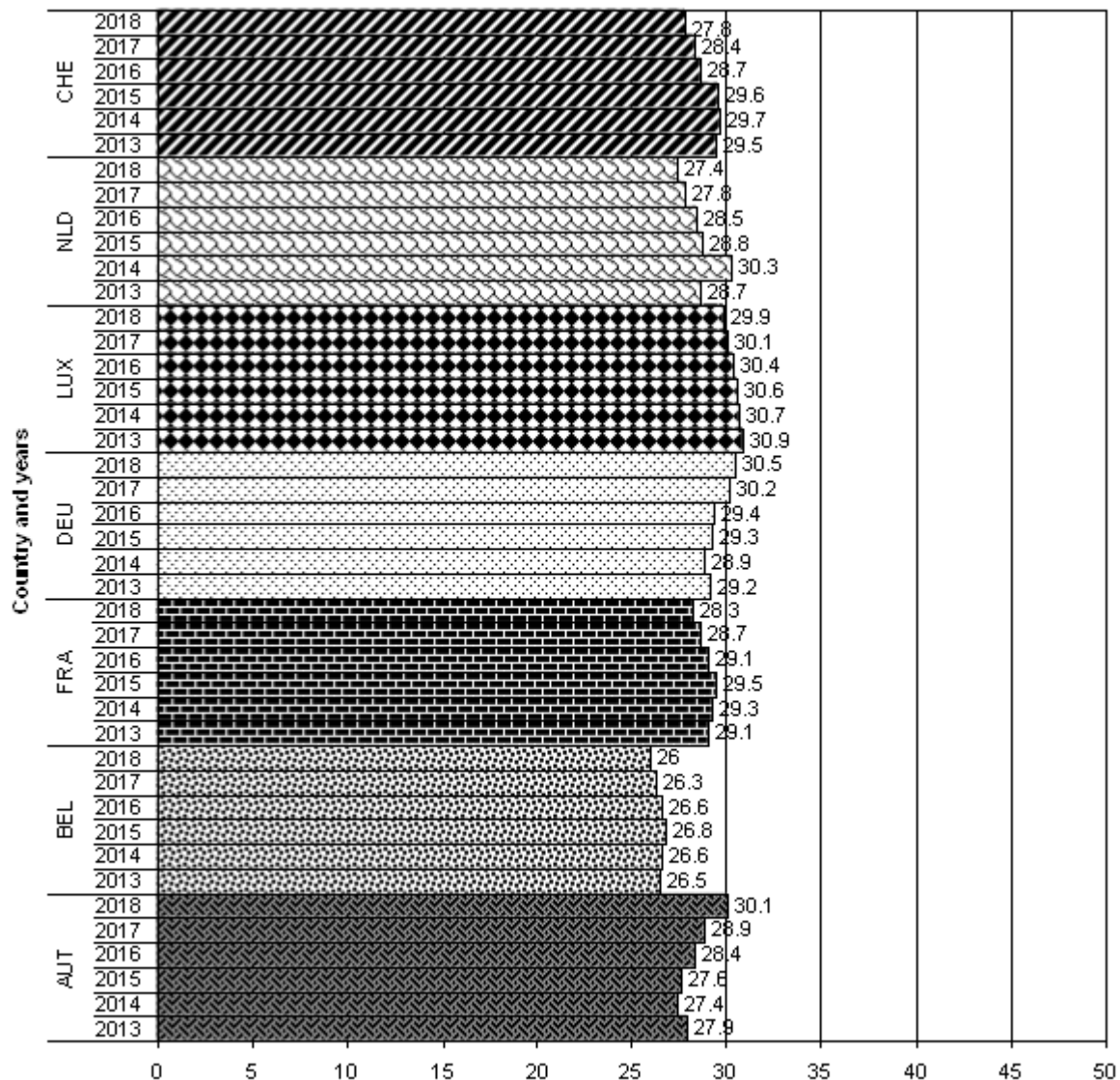


Figure 2. Gini index (in %) of wage of Western European developed countries

The Gini index takes values in the range from zero to one hundred, where it gets value zero at extreme levelling, when all employees have the same wage, and it gets value one hundred at extreme differentiation, when all wage belongs to one employee. The closer the Gini index is to one hundred, the higher inequality is in wage distribution. The closer the Gini index is to zero, the higher levelling is in wage distribution.

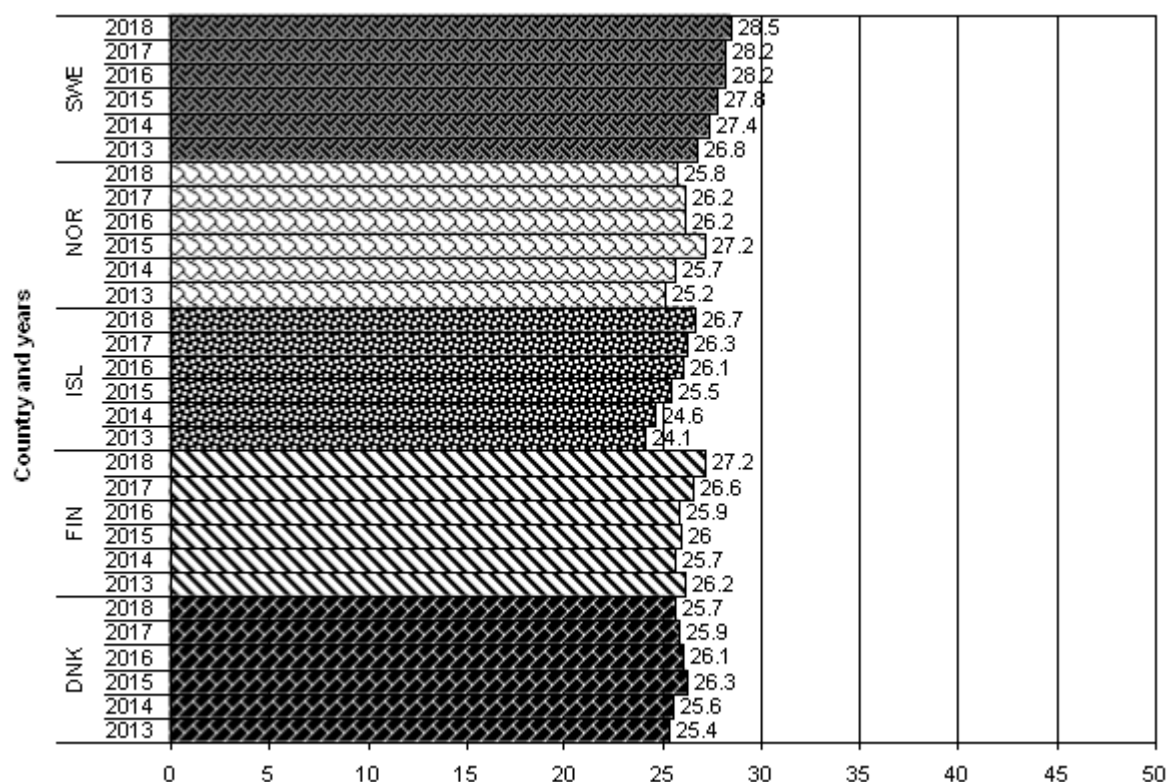


Figure 3. Gini index (in %) of wage of Scandinavian countries

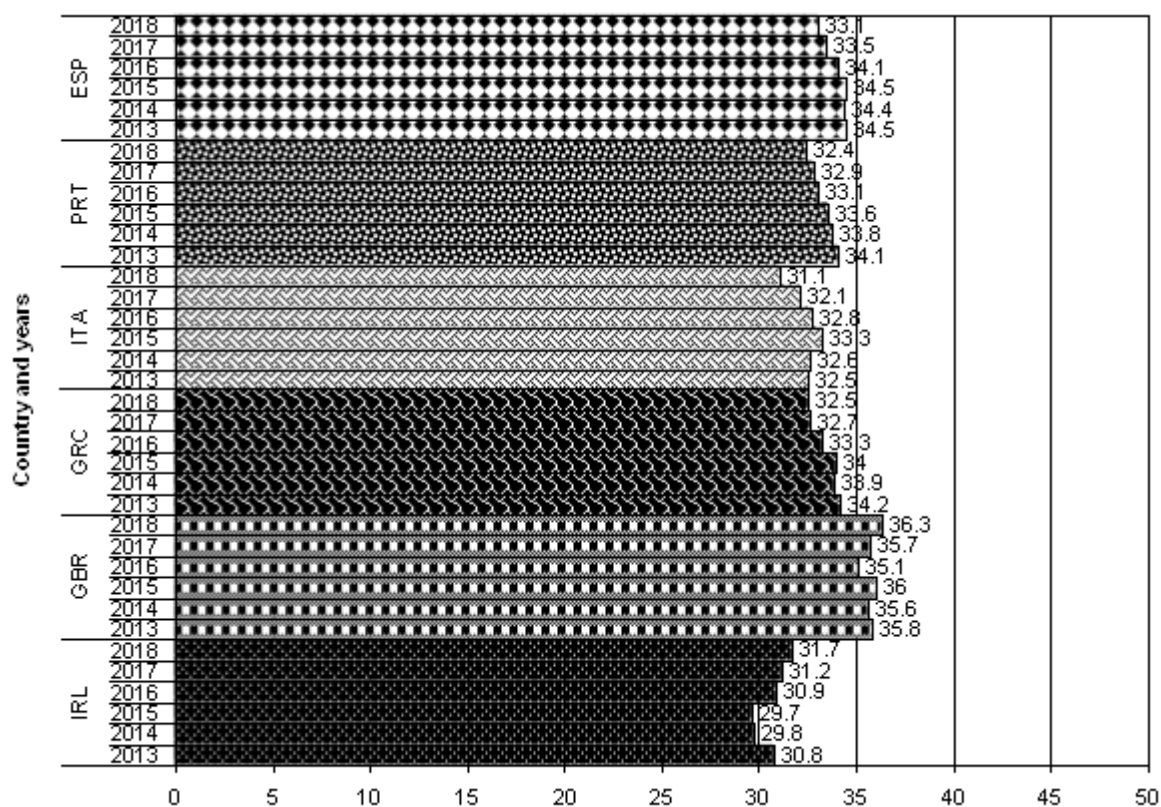


Figure 4. Gini index (in %) of wage of Anglo-Saxon and South European countries

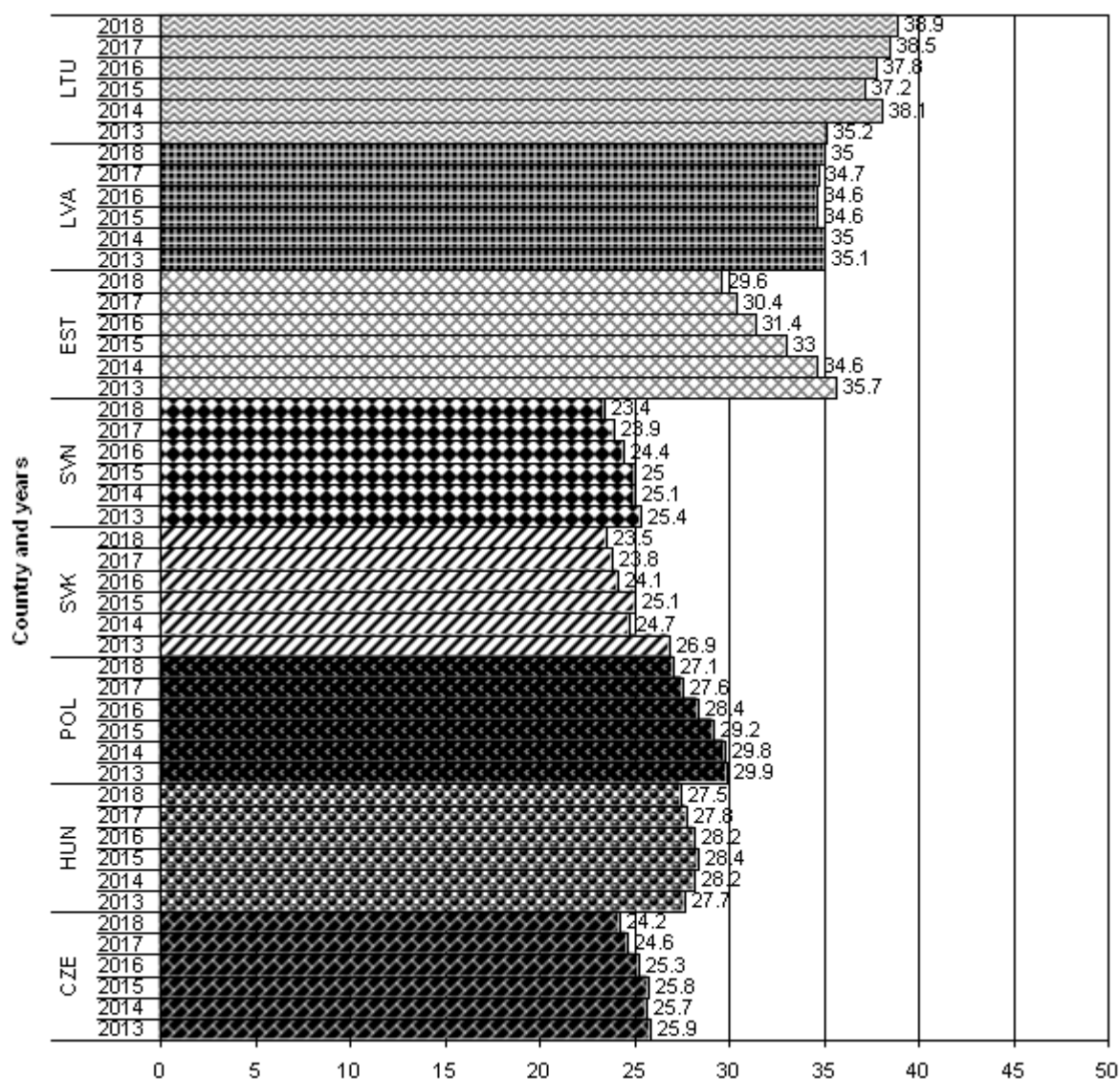


Figure 5. Gini index (in %) of wage of Central European post-communist and Baltic post-communist countries

Figures 2–6 show that the highest values of the Gini index were found in two Latin American OECD member countries, namely in Chile and Mexico, with values in excess 45 percent indicating strong wage diversification. Chile and Mexico are the only Latin American countries to be members of the OECD. Low taxes are typical for both countries. Employers' wage costs in both countries are the lowest among OECD member countries. When comparing average net wages, the differences between Western European countries and the two Latin American countries are much lower than when comparing gross wages.

On the contrary, post-communist countries, namely Slovenia, Slovakia, and the Czechia, show the lowest wage diversification, which does not exceed 27 percent. As the people of post-communist countries switched from the original egalitarian systems to capitalism from the early 1990s, they encountered a new phenomenon, such as the rise of social inequality. The original Yugoslavia had a looser regime even before the collapse of the communist bloc, which also affected the economy, and since some time it was even possible to do business freely. The Slovenian economy benefits from its advantageous location, which in a small

state connects the eastern part of the Alps, which is important for tourists in all seasons, several tens of meters long coast of Adriatic Sea and it is a transit country for travel to the Balkans, especially to neighbouring Croatia. The country has a high level of banking, a very good infrastructure, a dense and high-quality motorway and road network and high-quality tourist centers.

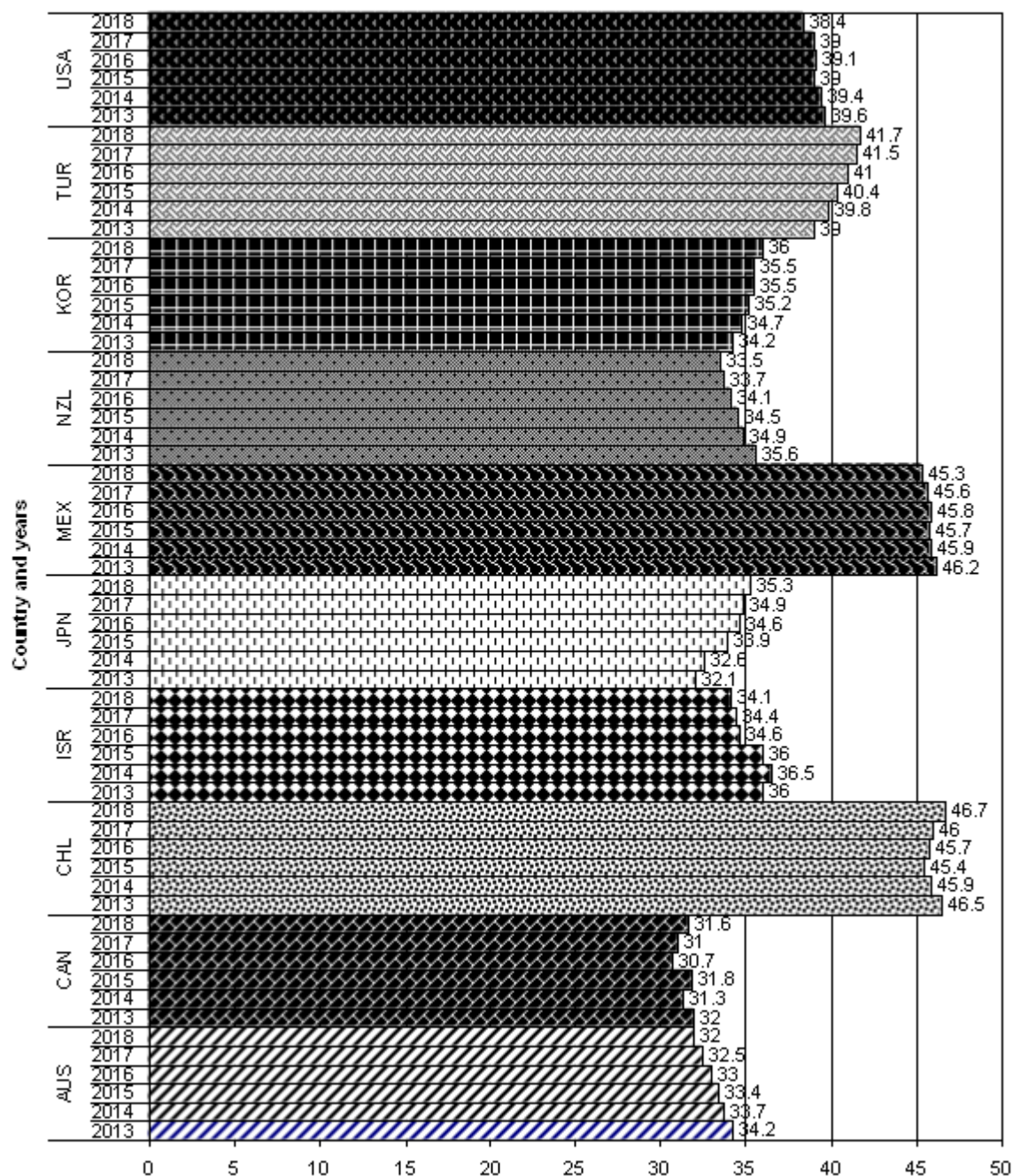


Figure 6. Gini index (in %) of wage of Non-European countries.

When independent Czechia and Slovakia emerged from the original Czechoslovakia on the 1st January 1993, these were countries in which the process of economic transformation was already underway. Both countries were affected by an unsuitable and completely unsustainable structure of industry, focused mainly on heavy industry, with Slovakia

accounting for about 30 percent and the Czechia for about 70 percent of the industrial production of the entire federation. In Slovakia, however, in the first years of independence, reforms slowed down and mainly corruption appeared. However, at the beginning of the third millennium, some economic reforms, which triggered very sharp GDP growth and falling unemployment, were sharply criticized by the left parties, especially for lower living standards, mostly poorer. Slovakia is the third strongest economy of the post-communist countries after the Czech Republic and Slovenia. The Czechia has the most stable and prosperous economy of all the countries of the former Council of Mutual Economic Assistance (CMEA). The basis of the Czech economy is industry and services, agriculture and other primary production are underrepresented. The Czechia has the largest number of self-employed persons per capita in Europe. Unemployment and government debt in the Czech Republic remain among the lowest in Europe.

Overall, it can be stated that wage diversification is higher in non-European countries rather than in European countries. From European countries, the United Kingdom shows a relatively large wage diversification, which does not fall below 35 percent throughout the period under review. All four southern European countries also show a relatively high degree of wage diversification, which does not fall below 31 percent over the entire period. On the contrary, all Central European post-communist countries are characterized by low wage diversification not exceeding 30 percent in any of these countries throughout the period under review, only Poland approached 30 percent in the period immediately after the global economic crisis. The situation is different in the post-communist Baltic countries, where we record relatively strong wage diversification, especially in Lithuania, where it has reached almost 39 percent in the last years of the period under review. All Scandinavian countries and all Western European developed countries are characterized by relatively low wage diversification, which does not exceed 31 percent in any country throughout the research period.

5. Conclusions

According to the results obtained, Slovenia, Slovakia and the Czechia show the lowest wage diversification of all OECD member countries. For example, in the Czechia, when comparing one-fifth of the highest-paid employees and one-fifth of the lowest-paid employees, this group of the richest has about 3.5 times more than the group of the poorest. There are several reasons why wages are so balanced in these countries. One of them is the historical heritage from the communist era, when in a non-free environment, the wages of employees were limited and distorted. However, this would not be enough for the first place in the ranking, because other countries have communist experience, too. One of the reasons why wage diversification is so low in these countries is the relatively successful transformation of the economies of these countries. If we look at the opposite end of the scale, we see some Eastern bloc countries where the transformation of the economy after the end of communism was much wilder than in the three countries.

Now, we evaluate the defined scientific hypotheses based on the obtained research results:

- H1: Proven. The two OECD member countries of Latin America show the highest wage diversification within the OECD member countries in the period 2013–2018. There are Chile and Mexico, the wage diversification expressed by the Gini index does not exceed 47 percent in either of these two countries in that period.
- H2: Proven in terms of the Central European post-communist country bloc, with the exception of Poland. The Baltic post-communist countries bloc shows relatively high wage diversification, probably due to quite dramatic demographic effects.
- H3: Proven, Chile and Mexico are the only two OECD member countries in Latin America to show the highest level of wage diversification within OECD member countries in 2013–2018 due to the fact that the government does not make any major interventions in the economy here. During this period, the Gini index ranged 45.4–46.7 percent in Chile and 45.3–46.2 percent in Mexico.
- H4: Proven in part. Wage diversification in non-European OECD member countries is in the range of 30.7–46.7 percent, which is completely outside the wage diversification of the Scandinavian countries, the Central European post-communist and essentially Western European developed countries. However, the wage diversification of non-European OECD member countries partly overlaps with the Anglo-Saxon countries, the Southern European countries and the Baltic post-communist countries.

In OECD member countries, the average wage increased even during the economic crisis, although the wage demands of many jobseekers decreased, mainly to have a job. Employees performing ancillary work in particular had a difficult situation on the labour market, while the wages of professionals who are key for employers, have risen in recent years. In all developed OECD countries, therefore, the best investment for citizens is spending on education and increasing their own know-how. Professionals in all fields have the best starting position on the labour market. Which is why lifelong learning is a way to secure not only an average and higher wage, but also the easiest way to find a suitable job.

The direct relationship between employees' wages and their purchasing power supports monitoring not only the level of wages, their structure, but also examining the development of wage diversification while monitoring sales opportunities for long-term and short-term consumer products. Therefore, the distribution of employees' wages should be also taken into account by entrepreneurs when considering their sale areas. The estimation of wage distributions based on data on their diversification makes possible to determine approximately the total volume of wage resources in various enterprises. Knowledge of the distribution of employees' wages accompanied by data on their diversification should be also taken into account by politicians at various steps within the state budget, such as at various considerations regarding the level of the tax burden.

In the following research, it is possible to focus on estimates of the future development of wage distributions, which would enable to combine considerations of wage diversification with socio-political considerations, for which it is usually not enough to estimate future wage level developments, but to estimate the future shares of low, medium and high wages, too.

Acknowledgments: This paper was subsidized by the funds of institutional support of a long-term conceptual advancement of science and research number IP400040 at the Faculty of Informatics and Statistics, University of Economics, Prague, Czech Republic.

References

- Acosta, P., & Gasparini, L. (2007). Capital Accumulation, Trade Liberalization, and Rising Wage Inequality: The Case of Argentina. *Economic Development and Cultural Change*, 55(4), 793–812. <https://doi.org/10.1086/516764>
- Autor, D. H., Katz, L. F., & Kearney, M. S. (2008). Trends in U.S. Wage Inequality: Revising the Revisionists. *The Review of Economics and Statistics*, 90(2), 300–323. <https://doi.org/10.1162/rest.90.2.300>
- Marjit, S., Beladi, H., & Chakrabarti, A. (2004). Trade and Wage Inequality in Developing Countries. *Economic Inquiry*, 42(2), 295–303. <https://doi.org/10.1093/ei/cbh061>
- Western, B., & Rosenfeld, J. (2011). Unions, Norms, and the Rise in U.S. Wage Inequality. *American Sociological Review*, 76(4), 513–537. <https://doi.org/10.1177/0003122411414817>

Sales of Consumer Chemicals in Zero-packaging Stores - a Challenge for Small and Medium-sized Chemical Companies

Lenka BRANSKA^{1*}, Michal PATAK¹, Katerina HROMADNIKOVA¹ and Zuzana PECINOVA¹

¹ University of Pardubice, Pardubice, Czech Republic; lenka.branska@upce.cz; michal.patak@upce.cz; katerina.hromadnikova@student.upce.cz; zuzana.pecinova@upce.cz

* Correspondence: lenka.branska@upce.cz

Abstract: One of the innovations in the area of increasing the sustainability of packaging may be the introduction of zero-packaging sales. The paper deals with the advantages and disadvantages of zero-packaging sales, in relation to consumer chemicals. It presents the results of primary quantitative research carried out with 100 final consumers through electronic surveys using a structured questionnaire. Content analysis and multiple response analysis were used to identify the most significant advantages and disadvantages of purchasing consumer chemicals in zero-packaging stores. The biggest advantages are the reduction of waste from packaging materials, being able to buy the exact quantity required, and environmental protection. The biggest disadvantages include the insufficient expansion of the stores, the necessity to carry their own containers and the higher price of products sold. The advantage of "selling quality products" and the disadvantages of "uncertainty in terms of composition and quality" and "hard-to-observe hygiene requirements" are perceived differently depending on whether or not customers actually buy consumer chemicals in zero-packaging stores. The conclusions are important in terms of the possibility of creating a competitive advantage of small and medium-sized companies.

Keywords: sustainable supply chain; retail; zero-packaging; chemical product

JEL Classification: Q01; M31; L81

1. Introduction

Population growth and rate of consumption increase the volume of packaging used throughout the supply chain. A larger volume of packaging is needed not only in all stages of the gradual creation of the final product, but also for the final products (Meherishi et al., 2019). The need for packaging material is enormous indeed, with 100,000 products packed in the world every second (Vörös, 2019).

As a result, the demands on packaging and the constant increase thereof pose a challenge for companies and academia to find solutions ensuring packaging sustainability. The idea is becoming prevalent that the design of sustainable packaging should include both the design of technical parameters and logistical and environmental parameters (Dominic et al., 2015). Packaging materials should be made from renewable sources, recyclable, composable. They

should also be cheap and with such physical and chemical properties as to allow easy adaptation to different uses (Farooque et al., 2019).

Companies are currently looking for a way to more environmentally friendly packaging. One of their main drivers is the effort to achieve economic benefits as a result of gaining a more valuable product or new customers (Civancik-Uslu et al., 2019). However, environmentally oriented packaging innovations are not implemented in the same way in all industries. According to Meherishi et al. (2019), these innovations are mainly introduced by food companies, however, companies in the chemical and pharmaceutical industries as well as retail businesses (especially electronic) have also implemented sustainable packaging.

In order to increase the sustainability of packaging, chemical and pharmaceutical companies usually seek to reduce the volume of plastics used in connection with packaging. For example, Dow Chemicals Company has begun to develop sustainable solutions for all of its plastic-packed products. It endeavours to use less material, with less weight, creating less waste (Dow, 2020). Another option for innovations in order to reduce plastic is to use new materials or change the size or type. As for the size of the package, it is appropriate to increase it if customers buy more than one package at a time, while reducing it is appropriate if the product is often not consumed before the expiration date (Gustavo et al., 2018).

However, the above-mentioned options for increasing sustainability do not represent the only directions of implemented packaging innovations in general, not even in companies in the chemical and pharmaceutical industries. Other possibilities are also mentioned in the literature, in particular 'reuse/recycle/remanufacture/return of packaging' (Meherishi et al., 2019).

A fundamentally different way to increase the sustainability of packaging is the introduction of zero-packaging sales. From the point of view of traditional retail sales, this is a relatively new variant, however, in the last 10 years, a large number of these stores have been opened worldwide and in the European context (Istas, 2019; Beitzen-Heineke et al. 2017). For example, the first zero-packaging store in Belgium was opened in 2014 and it is currently estimated that there are 45 such stores. In the Czech Republic, the first projects of this kind appeared at about the same time. Consumer chemicals belong to the assortment sold in these stores as standard.

Zero-packaging stores are based on the concept of zero-packaging. This means that consumers bring their own packaging to these stores, which they fill and pay according to the weight of the product purchased. Zero-packaging stores sell fruit and vegetables, dry products (wheat, pasta, rice, lentils, etc.) and products in liquid or semi-liquid form, such as milk, yoghurt or jam. From the point of view of consumer chemicals, cleaning products and products for personal hygiene (e.g. soap and shampoo) are offered. Zero-packaging sale mainly removes primary packaging, secondary and tertiary packaging cannot be removed completely. However, secondary and tertiary packaging is usually replenished by the supplier or the empty ones are replaced with full ones. If the store cooperates with a supplier who does not use the packaging repeatedly, it often endeavours to use it internally or find another use for it and thus extend the period of its use (Beitzen-Heineke et al., 2017).

Zero-packaging stores represent an opportunity to radically reduce the volume of packaging, however, in contrast to traditional sales, they are far from being used as much, neither when buying food nor consumer chemicals. The main reason is probably mainly related to the customer. According to Ma et al. (2020) customer is the best driver and the second most common barrier to packaging innovation in the FMCG sector. Zero-packaging stores will be expanded if their operation is possible in terms of technical and organizational barriers and if customers use them. They will do so if their perception of advantages exceeds the perception of disadvantages. So far, only a few researches on the advantages and disadvantages of purchasing in zero-packaging stores have been carried out, none of them focused on the purchase of consumer chemicals.

Previous research in this area shows that the main reasons for customers to do the shopping in zero-packaging stores are not only waste elimination, reducing the environmental impact (Price, Waterhouse & Co, 2015; Salkova & Regnerova, 2020) and quality of products sold, but also reducing the need for waste collection, non-collection of things and the use of reusable packaging instead of disposable packaging (Salkova & Regnerova, 2020). According to previous research, the main disadvantages are: limited range of products, higher demands on the shopping (especially the necessity to prepare for the shopping) (Beitzen-Heineke et al., 2017; Salkova & Regnerova, 2020), unavailability and a small number of stores (Salkova & Regnerova, 2020), greater time expenditure of the purchase and all-day transfer of packaging, if the shopping is done only after leaving work) (Beitzen-Heineke et al., 2017).

The literature also deals with the risks associated with shopping in zero-packaging stores. The identified risks mainly include the threat of contamination of purchased products due to poorly cleaned packaging brought by the customer (Beitzen-Heineke et al. 2017; LEAD Innovation Blog, 2020), safety of transport, durability or labelling (LEAD Innovation Blog, 2020). These problems are more pronounced in cosmetic, pharmaceutical and hygienic products (LEAD Innovation Blog, 2020).

A study (Price, Waterhouse & Co, 2015) also reveals another problem that may affect the development of zero-packaging stores. Zero-packaging stores are positively perceived by most consumers, but only a minority would be willing to pay higher prices.

Primary quantitative research has been carried out in order to be able to develop knowledge in the area of advantages and disadvantages of purchasing in zero-packaging stores, especially in connection with consumer chemicals. Its purpose was to reveal the share of consumers who purchase consumer chemicals in zero-packaging stores and the perception of the advantages and disadvantages of this method of purchase from the customer's point of view. The research has contributed to the development of theoretical knowledge in the field of zero-packaging sales, both in general and in relation to consumer chemicals. Therefore, its conclusions can be used by both academia and businesses, including those outside the chemical industry. They can be used especially by small and medium-sized companies, for which, by understanding the perceived advantages and disadvantages, zero-packaging sale can become an opportunity to gain a competitive advantage.

2. Methodology

The aim of the primary research was to specify the attitudes of Czech consumers to the zero-packaging sale of consumer chemicals (for laundry, cleaning and hygiene purposes). The partial goals were intended to identify:

- the frequency of purchasing consumer chemicals in zero-packaging stores,
- willingness to recommend the purchase of consumer chemicals in zero-packaging stores,
- perceived advantages and disadvantages of purchasing consumer chemicals in zero-packaging stores and
- differences in perceived advantages and disadvantages depending on whether the consumer does the shopping in zero-packaging stores.

The research was organized as quantitative in a group of economically active inhabitants in the Czech Republic (15–64 years). Data collection was carried out using the quota selection method with quotas linked to the age and sex of the respondent, according to data from the Czech Statistical Office as at December 31, 2019 (Czech Statistical Office, 2020). Data collection took place in the period April – May 2020 via an electronic survey using a structured questionnaire, which was piloted on 10 respondents before the start of the research. The survey included 100 respondents in the required structure (see Table 1).

Table 1. Structure of respondents by sex and age

Sex	Age					Total
	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years	
Men	7%	12%	12%	11%	8%	50%
Women	7%	9%	12%	15%	7%	50%
Total	14%	21%	24%	26%	15%	100%

At the beginning of the survey, the respondents were asked about the frequency of shopping in zero-packaging stores and their willingness to recommend these stores for purchasing consumer chemicals. Subsequently, the respondents were asked to specify 3 advantages and 3 disadvantages of purchasing in zero-packaging stores. At the end of the survey, selected classification features of the respondents (gender, age, education and income) were identified.

The obtained data were processed by content analysis of advantages and disadvantages, resulting in the identification of 8 categories of advantages and 9 categories of disadvantages (advantages or disadvantages with a frequency of less than 5% were included in the category "Other"). Subsequent statistical analysis focused on comparing the importance of advantages and disadvantages in zero-packaging stores using frequency analysis and multiple response analysis. Statistical analysis identified main advantages and disadvantages from the perspective of all respondents and the differences between respondents who do the shopping in zero-packaging stores and those who do not. The statistical significance of these differences was verified by chi-square test (with continuity correction) at the 5% level of significance.

3. Results of the Primary Research

The primary research helped to reveal a number of interesting facts concerning the purchase of consumer chemicals in zero-packaging stores.

3.1. Frequency of Purchasing Consumer Chemicals in Zero-packaging Stores

The research has shown that a relatively small number of respondents do the shopping in zero-packaging stores. Most respondents (70%) do not shop in a zero-packaging store at all (see Figure 1).

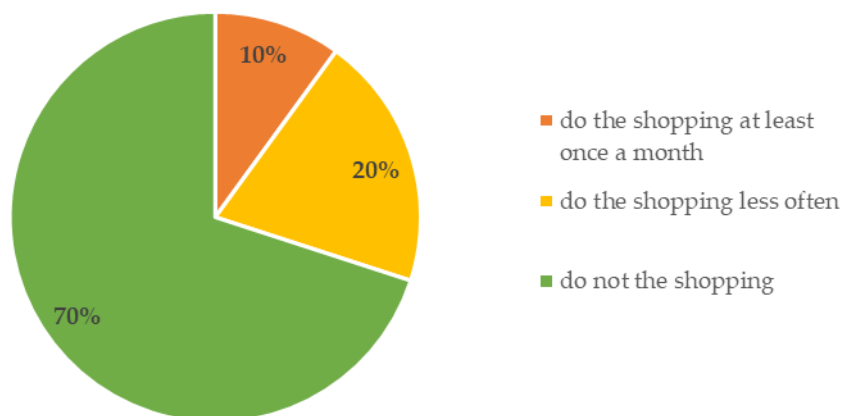


Figure 1. Frequency of shopping in zero-packaging stores

Interestingly, however, virtually all respondents (29 out of 30) who buy consumer chemicals in zero-packaging stores also recommend this kind of shopping.

3.2. Advantages of Purchasing Consumer Chemicals in Zero-packaging Stores

The primary research made it possible to identify the perceived advantages of purchasing consumer chemicals in zero-packaging stores. The most frequently mentioned advantage is the reduction of waste from packaging materials (this advantage was mentioned by more than half of all respondents). Other often-mentioned advantages were being able to buy the exact quantity required and environmental protection. More than a third of respondents mentioned these three advantages (see Figure 2).

The sale of quality products at lower prices and the possibility of reusing your own packaging can be considered to be the minor advantages of purchasing consumer chemicals in zero-packaging stores. The 'Other' category covers a wide portfolio of advantages, such as personal contact with the seller, the freshness of the goods sold, a good feeling from the purchase and purchase of products mainly from local producers.

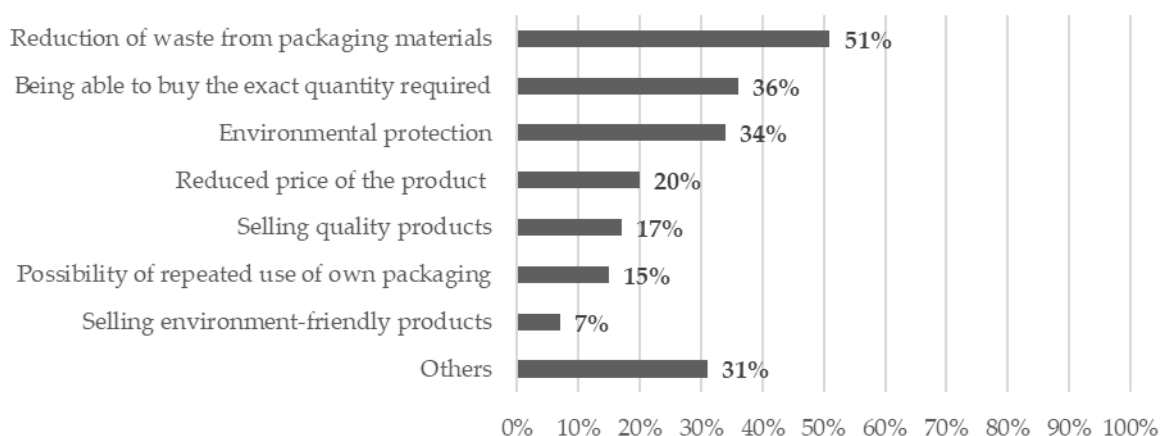


Figure 2. Advantages of shopping in zero-packaging stores

It was interesting to examine whether opinions differ on the advantages of doing the shopping in zero-packaging stores depending on whether respondents actually do the shopping in zero-packaging stores (see Table 2).

Table 2. Differences in views on the advantages of shopping in zero-packaging stores depending on whether the purchases are actually made

Advantage	Percent of Customers		Chi-square Test	
	Regular Customers	Customers of zero-packaging stores	Chi-square	P-value
Possibility of repeated use of own packaging	13%	20%	0.373	0.541
Selling quality products	10%	33%	6.534	0.011
Reduction of waste from packaging materials	53%	47%	0.122	0.727
Being able to buy the exact quantity required	33%	43%	1.123	0.289
Environmental protection	30%	43%	1.123	0.289
Reduced price of the product	26%	7%	3.646	0.056
Selling environment-friendly products	4%	13%	1.434	0.231
Possibility of repeated use of own packaging	13%	20%	0.373	0.541

The analysis showed that the difference is statistically significant only in the advantage of selling quality products. The real customers perceive the selling of quality products to be an advantage much more often than those who do not do their shopping in zero-packaging stores. This advantage is cited by 33% of respondents shopping in zero-packaging stores, while respondents who do not do their shopping in zero-packaging stores cite this advantage in only 10% of cases.

3.2. Disadvantages of Purchasing Consumer Chemicals in Zero-packaging Stores

Regarding the disadvantages of purchasing consumer chemicals in zero-packaging stores, "insufficient expansion of stores" was most often mentioned (it was mentioned by more than a third of respondents). Other significant disadvantages are the "necessity to bring own containers" and the "higher price of the products sold". These three most significant disadvantages were mentioned by more than a quarter of respondents (see Figure 3). Some respondents also perceive "limited product selection", "necessity to plan the shopping", "time-

consuming shopping", "hard-to-observe hygiene requirements" and "uncertainty of composition and quality of products" as disadvantages. The 'Other' category includes a number of disadvantages, such as shorter product shelf life, reluctance to change habits and more complex product handling.



Figure 3. Disadvantages of shopping in zero-packaging stores

As with the advantages, it was interesting to examine to whether the opinion on the disadvantages of shopping in zero-packaging stores differs depending on whether the respondents actually do the shopping in zero-packaging stores (see Table 3).

Table 3. Differences in views on the disadvantages of shopping in zero-packaging stores depending on whether the purchases are actually made

Disadvantage	Percent of Customers		Chi-square Test	
	Regular Customers	Customers of zero-packaging stores	Chi-square	P-value
Insufficient expansion of stores	33%	47%	1.177	0.278
Limited product selection	9%	30%	5.976	0.015
Higher price	13%	50%	13.912	0.000
Necessity to bring own containers	31%	23%	0.333	0.564
Hard-to-observe hygiene requirements	9%	3%	0.263	0.608
Time-consuming shopping	9%	10%	0.000	1.000
Uncertainty of product composition and quality	4%	10%	0.414	0.520
Necessity to plan the shopping	9%	17%	0.700	0.403

It was found that there is a statistically significant difference in two disadvantages, namely "limited product selection" and "higher price". Customers who purchase consumer chemicals in zero-packaging stores perceive these disadvantages to a much greater extent than those who do not do the shopping in these stores.

4. Discussion

The primary research found that a relatively small number of customers shop in zero-packaging stores. However, customers who prefer shopping in a zero-packaging store then recommend it to their friends.

Regarding the identified advantages, the research is in line with previous research (Price, Waterhouse & Co, 2015; Salkova & Regnerova, 2020) in the advantages of waste elimination, reduction of environmental impact, quality of products sold and reuse of packaging. In addition, however, it revealed the advantage of "being able to buy the exact quantity required". This is a relatively often perceived advantage - it was cited by more than a third of all respondents and more than 40% of respondents who are also customers of zero-packaging stores. We consider this finding to be an addition to the advantages already revealed. It is likely that this advantage cannot be considered specific to the purchase of consumer chemicals in zero-packaging stores. The composition of the 'Other' category is interesting. The advantages cited therein indicate the individual benefits that customers get when shopping.

Research into the disadvantages of shopping in zero-packaging stores confirmed the conclusions come to by Beitzel-Heineke et al. (2017) and Salkova and Regnerova (2020), that the main disadvantages are the limited range of products, unavailability and a small number of stores and higher demands on the preparation of the shopping. In addition, it revealed other relatively important disadvantages, in particular the "necessity to bring your own containers", "higher price of products sold", "hard-to-observe hygiene requirements" and "uncertainty of the composition and quality of products". We consider the first two additional disadvantages revealed to be particularly important (cited by a quarter of respondents or more). Disadvantages "limited product selection" and "higher price" indicate the biggest differences in perception depending on whether the customers actually do the shopping in zero-packaging stores. Especially those who do consider them to be disadvantages. The 'Other' category indicates the existence of a number of problems that reduce the individual value to customers or small customer segments. At any rate, even in the case of disadvantages, the disadvantages revealed cannot be considered specific to the purchase of consumer chemicals. This leads us to the conclusion that the advantages and disadvantages of shopping in zero-packaging stores are perceived regardless of the products that are purchased. These are thus the advantages and disadvantages of the form of purchase.

5. Conclusions

The findings and conclusions of the research can be used to develop zero-packaging product sales. The advantages perceived by respondents shopping in zero-packaging stores are the reasons why the respondents shop in those stores. They make purchases here mainly for environmental reasons, but also partly for economic reasons (when they buy the exact quantity required). By contrast, perceived disadvantages are barriers to the wider expansion of this form of sale. Therefore, it is more important for companies to focus on the disadvantages perceived by customers who buy consumer chemicals in the traditional way (and do not use zero-packaging stores). Overcoming these barriers brings an opportunity to attract this segment of customers. This could be an opportunity especially for small and medium-sized businesses. However, it would also mean overcoming a number of internal corporate barriers. We assume these internal barriers to zero-packaging sales, but the professional literature does not yet offer their specific form. Therefore, we consider it

appropriate to develop this research through follow-up research in companies (of various sizes) in order to identify the barriers preventing companies from implementing this form of sales. Research performed in companies not only of different sizes, but also of different industries (especially the food industry) would then make it possible not only to describe these barriers, but also to possible specifics, if any, according to the size of the company and individual industries.

Acknowledgments: This study was supported by a grant from the Fund for Bilateral Relations within the framework of the EEA and Norway Grants 2014-2021 (EHP-BFNU-OVNKM-3-134-01-2020).

References

- Beitzen-Heineke, E. F., Balta-Ozkan, N., & Reefke, H. (2017). The prospects of zero-packaging grocery stores to improve the social and environmental impacts of the food supply chain, *Journal of Cleaner Production*, 140(3), 1528-1541. <https://doi.org/10.1016/j.jclepro.2016.09.227>
- Civancik-Uslu, D., Puig, R., Voigt, S., Walter, D., & Fullana-i-Palmer P. (2019). Improving the production chain with LCA and eco-design: application to cosmetic packaging. *Resources, Conservation & Recycling*, 151, 104475.
- Czech Statistical Office. (2020). *Population composition by sex and age units as of 31.12.* [Data set]. Retrieved February 20, 2020, from <https://vdb.czso.cz/vdbvo2/faces/cs/index.jsf?page=vystup-objekt-parametry&pvo=DEMD001&sp=A&pvokc=&katalog=30845&z=T>
- Dominic, C. A. S., Östlund, S., Buffington, J., & Masoud, M. M. (2015). Towards a Conceptual Sustainable Packaging Development Model: A Corrugated Box Case Study, *Packaging Technology and Science. An International Journal*, 28(5), 397-413. <https://doi.org/10.1002/PTS.2113>
- Dow. (1995-2020). *We will deliver circular economy solutions.* Dow. <https://corporate.dow.com/en-us/science-and-sustainability/plastic-waste/economy.html>
- Farooque, M., Zhang, A., Thürer, M., Qu, T., & Huisingh, D. (2019). Circular supply chain management: A definition and structured literature review. *Journal of Cleaner Production*, 228, 882-900. <https://doi.org/10.1016/j.jclepro.2019.04.303>
- Gustavo, J. U., Pereira, G. M., Bond, A. J., Viegas, C. V., & Borchardt, M. (2018). Drivers, opportunities and barriers for a retailer in the pursuit of more sustainable packaging redesign. *Journal of Cleaner Production*, 187, 18-28.
- Istas, D. *Expansion of the local, organic and zero-packaging food concept in three contexts: zero-packaging grocery stores, conventional supermarkets, and eco stores.* Master thesis. Maastricht University.
- LEAD Innovation Blog. (2020). *The packaging-free supermarket - trend or future?* <https://www.lead-innovation.com/english-blog/packaging-free-supermarket>
- Ma, X., Park, C., & Moultrie, J. (2020). Factors for eliminating plastic in packaging: The European FMCG experts' view. *Journal of Cleaner Production*, 256, 120492. <https://doi.org/10.1016/j.jclepro.2020.120492>
- Meherishi, L., Narayana, S. A., & Ranjani K. S. (2019). Sustainable packaging for supply chain management in the circular economy: A review. *Journal of Cleaner Production*, 237, 117582. <https://doi.org/10.1016/j.jclepro.2019.07.057>
- Price, Waterhouse & Co (2015). *Verpackungsfreie Lebensmittel – Nische oder Trend?* <https://www.pwc.de/de/handel-und-konsumguter/assets/pwc-verpackungsfreie-lebensmittel.pdf>
- Salkova, D., & Regnerova, O. (2020). Methods of eliminating waste from food packaging as a globalization tool. In T. Klietk (Ed.), *The 19th International Scientific Conference Globalization and its Socio-Economic Consequences 2019 – Sustainability in the Global-Knowledge Economy (04025)*. <https://doi.org/10.1051/shsconf/20207404025>
- Vörös, F. (2019). *Plasty: Situace v Evropě je neradostná.* Průmyslová ekologie. <https://www.prumyslovaekologie.cz/info/plasty-situace-v-evrope-je-neradostna>

Export of Czech Animal Production to Selected Countries of European Union

David BROŽ*, Miroslava NAVRÁTILOVÁ and Markéta BERANOVÁ

Czech University of Life Sciences, Prague, Czech Republic; brozd@pef.czu.cz; navratilovam@pef.czu.cz, mberanova@pef.czu.cz

* Corresponding author: brozd@pef.czu.cz

Abstract: The aim of this article is to explore volume (in US dollars) of foreign trade of animals and animal products classified under SITC codes 00 live animals, 01 meat and meat products and 02 milk products and eggs in context of distance between states. Eight states of the European Union were analysed according to the number of inhabitants relatively equal to the Czech Republic. Ordinary Least Squares model was performed for variables distance, gross domestic product per capita, dummy variable border, and dummy variable history. Gravity model showed that significant variable distance is negatively affecting agrarian export. Significant variable gross domestic product per capita of exported country impacted agrarian export positively also significant variable history impacted agrarian trade positively. Variables borders and gross domestic product per capita of the Czech Republic were both nonsignificant and with negative effect. This article used panel data for analysis of agrarian trade with animal products. For future research will be used more types of model for evaluation and more states from Europe. New variables will be possibly added appropriately to selected countries.

Keywords: gravity model; foreign trade; animal production; export

JEL Classification: C33; Q17; Q18

1. Introduction

The agricultural sector, together with industry and services, is naturally part of the national economies of all countries in the world (Tanentzap et al., 2015). The position of agriculture and the entire agricultural sector within the national economy is the result of long-term tendencies of economic development, political situations of the state of society (Marunelu, 2020). The trade with agricultural products expands choice, stable demand, and supply (Stieglitz & Charleton, 2007). Agriculture is one of the traditional human activities and trade in agricultural commodities through countertrade is one of the oldest trade activities in history.

At present, the agricultural sector, agrarian trade and agriculture itself face many challenges such as increasing crop productivity, expanding organic farming, strengthening ties with other sectors, but also maintaining the competitiveness of the sector itself and many others (Smutka et al. 2019). From a long-term point of view, the current global agri-food sector is exposed to climate change (Huang et al., 2011). In recent years, there have been growing concerns around the world about the undesirable combined consequences that accompany

rapid economic growth, which is based on the free market and the development of science and technology. The issue of sustainability thus becomes a topic (Mangee & Elmslie, 2010) that is discussed in relation to individual economic sectors (Rehber & Grega, 2008).

The study of the economics of international trade in agricultural and food products is a relatively new specialization in the field of agricultural economics (Josling et al., 2010). One of the methods how is possible examine international trade are gravitational models (Ugurlu & Jindřichovská, 2019). Anderson (1979) considers gravitational models to be one of the most successful empirical tools of research and notes that gravitational equations can be applied to a wide range of goods and factors that move across regional and national borders.

The coronavirus pandemic (COVID-19) will certainly affect the future of the world, including trade and agriculture. Within the agri-food complex, self-sufficiency at the level of individual countries and regions (Fontan Sers & Mughal, 2020) will be probably priority. The growing interest of consumers in local production could be seen in previous years. One possible explanation for this situation is that it is a possible reaction of the inhabitants of individual countries to a certain unification of the market in the international context of (Schjøll, 2017).

The aim of this article is to explore (in US dollars) of foreign trade in animals and animal products classified under SITC codes 00 live animals, 01 meat and meat products and 02 milk products and eggs in context of distance between states.

The article consists of several parts, which follow each other logically. In the Introduction is the elaboration of the theoretical framework of the solved problem. The chapter Methodology describes the methodological procedure of own calculations and sources of information. Subsequently, the resulting findings are presented in the Results. These are further discussed. Finally, the conclusion summarized all findings in article.

2. Methodology

The theoretical framework of the presented paper was elaborated on the basis of scientific articles and literature. Secondary data for the research were obtained from official databases.

The analysis of trade will be evaluated using a gravitational model of foreign trade. The software used for the analysis is SPSS Statistic 24 for data matrix modification. All calculations are performed in the econometric program Gretl.

Data from year 2004 to 2019 were taken. Eight states of the European Union were analysed according to the number of inhabitants relatively equal to the Czech Republic. Among the selected were originally countries with an average population of 7 million to 13 million. To improve the explanatory power of the model, the list of countries was extended by Netherlands. Selected countries are Bulgaria, Austria, Hungary, Sweden, Portugal, Greece, Belgium, and the Netherlands. The population of country was chosen as factor to narrow selection sample of EU countries.

Portugal's data lacked a calculation for 2016 for livestock, which was interpolated according to the average of the surrounding values. Furthermore, the flow was not known in financial terms for meat and meat products for the years 2004 and 2005. With respect to the

low surrounding values, the data were supplemented by a minimum value of 1,000 US dollars.

The input data for analyses were determined as follows for the individual variables:

Table 1. Sources of data for analyses. Own elaboration, 2020

Variable	Source of data
GDP per capita of countries	World Bank: World Development Indicators
Distance between countries	CEPI II gravity database
Export of CZ to j countries	Czech statistical office- Foreign trade database
Borders	own research
History	own research

The basic idea of the gravity model is to use the distance between the capitals of the observed countries. In our case, the CEPI II database was used, which provides data on distances between capitals. In Figure 1 are distances taken from CEPI II database. The disadvantage of this method is that agrarian foreign trade is not directed from the capital of the Czech Republic to the capital. Márquez – Ramos et al. (2006) states that distance variable is commonly used to define transport costs.

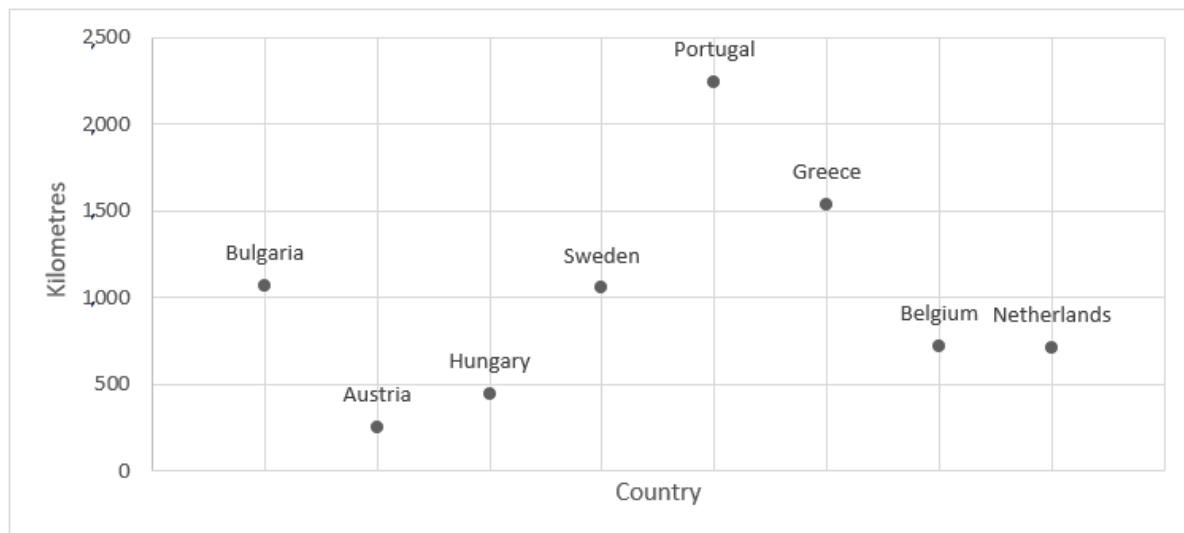


Figure 1. Distance between Prague and capital of selected countries in kilometers, own elaboration according to CEPI II (2020)

Tinbergen (1962) and Poyhonen (1963) can be included among the most important pioneers of gravitational models in the field of international trade. According to these authors, the volume of trade is affected by the gravitational attraction between objects. Thus, it is directly dependent on their size and indirectly on the distances between them, depending on the proportionality factor G .

Tinbergen (1962) defined his model using the following relationship.

$$F_{ij} = G \frac{Y_i^{a_1} Y_j^{a_2}}{D_{ij}^{a_3}} \quad (1)$$

Where:

F_{ij} flow trade flow between economies i and j

Y_i and Y_j Represent economic distance between countries i and j

D_{ij} Geographic distance between countries

G Gravity constant

Many years have passed since the definition of the basic model, and Deardorff's (1998) research was groundbreaking, showing that the relational equations of the gravitational model can be explained using standard business theory. Subsequently, Evenett and Keller (1998) defined a model from the Heckscher-Ohlin model and a theory of increasing returns to scale. Cuenca García et al. (2013) used for model variable comcol which was variable for countries colonized by same colonizer, due to history of Czech Republic Austria – Hungary Monarchy was selected as relationship between colonized countries. Bubáková (2013) mentioned using of gross domestic product per capita for model.

For the purposes of this article, the gravitational model will be used in following logarithmic form:

$$\ln X_i = \beta_0 + \beta_1 \ln GDPPC_i + \beta_2 \ln GDPPC_j + \beta_3 \ln DIST_{ij} + \beta_4 BORDER_{ij} + \beta_5 HISTORY_{ij} + \varepsilon_{ij} \quad (2)$$

Where:

$GDPPC_i$ – gross domestic product per capita of i country

$GDPPC_j$ – gross domestic product per capita of j country

$DIST_{ij}$ – geographical distance between countries

$BORDER_{ij}$ – dummy variable indicating if country i and j share common land border

$HISTORY_{ij}$ - Dummy variable indicating historical relationships between country i and j (Austria-Hungary)

ε_{ij} – random error

For selecting most suitable model were used F – test, Breusch – Pagan test and Hausman test. The selection was from the following model types - Ordinary Least Squares model, Fixed Effects Model and Random Effects Model. White test was performed on the model to determine the heteroscedasticity. Autocorrelation was investigated by Wooldridge test in panel data.

The following abbreviations were used in the article: EFTA = European Free Trade Association, EU = European Union, GDP = Gross domestic product, SITC = Standard International Trade Classification. OLS = Ordinary Least Squares, PQRM = Poisson quasi maximum likelihood

3. Results

The basic idea of the gravitational model is to use the distance between the capitals of the observed countries. In our case, the CEPI II database was used, which provides data on distances between capitals. The disadvantage of this method is that agrarian foreign trade is

not directed from the capital of the Czech Republic to the capital. Márquez-Ramos et al. (2006) states that distance variable is commonly used to define transport costs.

Problems with heteroscedasticity were identified for SITC 00 and SITC 01 and after major modifications it would be possible to use a gravitational model (lagging of variables, dynamization of models). On the contrary, a good result was investigated for SITC 02. Multicollinearity was not found between the variables. Descriptive statistics are presented in Table 2.

Table 2. Summary statistics for agregation SITC 02, source own calculation and elaboration

Variable	Mean	Median	Minimum	Maximum
Milk products and eggs (thousands of US\$)	9,833	6,815.5	3	4,9856
Distance (km)	1,003.6	886	252	2245
GDPPCi (US\$)	19,203	19,881	11,750	23,495
GDPPCj (US\$)	32,327	33,681	3,389.7	61,127

The model was tested by F-test. Breusch-Pagan test and Hausman test. After testing of heteroscedasticity and autocorrelation. Ordinary Least Squares model was chosen as suitable for describing relationship between variables. McCallum (1995) used Ordinary least squares model as estimation method for his model with dummy variables borders. Null hypotheses for white test for heteroscedasticity and Wooldridge test for autocorrelation were not rejected.

Table 3. Results for SITC 02 – milk and milk products, source own calculation and elaboration

Variable	Coefficient	P-value	Significance
Constant	6.09383	0.3965	
GDPPCi	-0.144352	0.7973	
GDPPCj	1.38122	0.0041	***
Distance	-1.60406	0.0005	***
Borders	-0.979803	0.1452	
History	2.24083	0.0136	**

Note: ***statistically significant at 1% level, **significant at 5%

Table 3 Shows that SITC 02 milk products and eggs are influenced by significant variable distance, GDPPCj and History. Variable distance is possible to interpret that with every 1% grow is amount of exported agrarian products lower for 1.60%. Variable Gross domestic product per capita is significant and the interpretation is that with every 1% grow of GDPPCj will also raise export for 1.38%. Third Significance variable is history. Variable history in relationship to Czech Republic was represent by Austria-Hungary monarchy. For this variable is possible to do extension of model by other countries which were in monarchy. Variable border is not significant this could be caused by representation by only one state Austria. In Figure 2 are volumes of agrarian trade for selected states for years 2004, 2008, 2012, 2016 and 2019. There is possible to recognize in compare with other states that export to Austria is not in long term period significant. For future research will be added other states which are neighboring the Czech Republic. Variable GDPPCi is not significant.

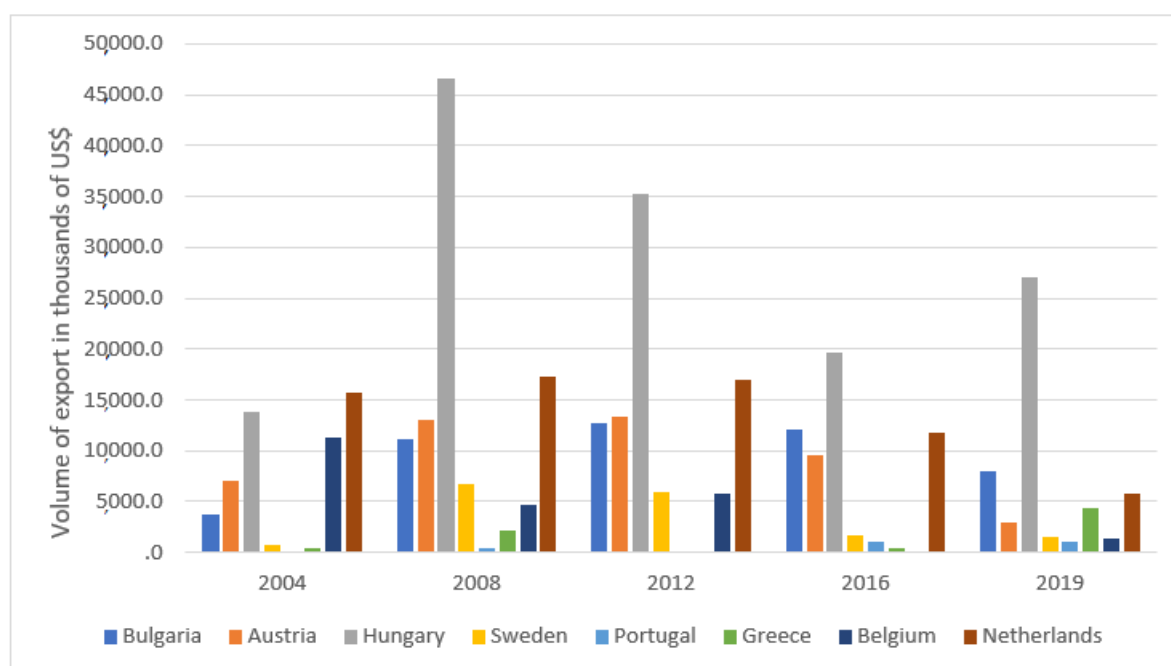


Figure 2. Export of milk products and eggs to selected countries. own elaboration according to Czech Statistical Office (2020)

Variable border is not significant this could be caused by representation by only one state Austria. For future research will be added other states which are neighboring the Czech Republic. In Figure 2 are volumes of export of milk products and eggs from Czech Republic to selected states for years 2004, 2008, 2012, 2016 and 2019. There is possible to recognize fluctuation and degressivity for all states. The most important partners for year 2019 of foreign trade of SITC 02 – milk products and eggs are Germany with 283,792 thousand of dollars, Slovakia with 208,060 thousand of dollars, Italy with 125,809 thousand of dollars and Poland with 69,398 thousand of dollars.

4. Discussion

Ševela (2002) developed a static model based on cross-sectional data. The significant variables with positive effect were gross national income and GDP. The negative factor was investigated for the distance between business partners. On the contrary, the influence of customs duties (the paper was prepared before the accession of the Czech Republic to the EU) and the real effective exchange rate and dummy variables expressing membership in the EU or EFTA has not been proven.

Balogh and Leitão (2019) created a comprehensive model of agrarian trade, which included a major trading partner of the country. In this paper authors included dummy variables such as landlocked countries, similar religions, and possible trade agreements. All variables in model were significant.

Morland et al. (2020) extended his model by a common language and variables GDP per capita were used. The model also includes the forest rents variable, which is not relevant for this research.

Braha et al. (2017) add to variable list of econometric models also effect of exchange rate. The assumption of adding this variable is that increasing in exchange rate would devalue home currency (in case of our article Czech crown), hence export would be cheaper. Assumption are with positive sign because of export should grow.

Ugurlu and Jindřichovská (2019) in his research add dummy variable Visegrad Fourth which could be also interesting to analyze. Compared to our study, there is a similarity between the variable of Visegrad Fourth and history. The author of article worked with importance of International Financial Reporting Standards which by his finding should positively affect the export.

Findings of Cuenca García et al. (2013) correspond with our results. Distance as factor play role. This fact author verifies on 160950 observation in panel data. Author for his work used variables border and history too.

Bergstrand et al. (2015) assembled model with Poisson quasi maximum likelihood (PQML) which he prefers as estimator over he admits that results are qualitatively the same using OLS.

Key topic for future research will be extension of data matrix. In research will be chosen all countries from EU and Europe.

5. Conclusions

The aim of this article was to analyse volume (in US dollars) of foreign trade in animals and animal products classified under standard international trade classification (SITC) codes 00 live animals, 01 meat and meat products and 02 milk products and eggs in context of distance between states including variables Gross domestic product per capita, dummy variable borders which indicates if country is bordering with Czech Republic and history. Negative impact of significant variable distance was identified. Positive impact of variable history and gross domestic product per capita of country where is product exported was significant and verified. The topic of gravity model is still very important in context of foreign trade. Future research will take into account more states from Europe and other models as Poisson quasi maximum likelihood will be examined.

Acknowledgments: This work was also supported by the Internal Grant Agency of Faculty of Economics and Management, Czech University of Life Sciences Prague - grant number 2020B0002 – “The impact of climate change on the economic performance of the viticulture and wine-making sector in the Czech Republic”.

References

- Anderson, J. (1979). A Theoretical Foundation for the Gravity Equation. *The American Economic Review*, 69(1), 106-116. <https://www.jstor.org/stable/pdf/1802501.pdf>
- Balogh, J. M., & Leitão, N. C. (2019). A gravity approach of agricultural trade: The nexus of the EU and African, Caribbean and Pacific countries. *Agricultural Economics – Czech*, 65, 509-519. <https://doi.org/10.17221/131/2019-AGRICECON>
- Bergstrand, J. H., Larch, M., & Yotov, Y. V. (2015). Economic integration agreements, border effects, and distance elasticities in the gravity equation. *European Economic Review*, 78, 307-327. <https://doi.org/10.1016/j.euroecorev.2015.06.003>

- Braha, K., Qineti, A., Cupák, A., & Lazorčáková, E. (2017). Determinants of Albanian Agricultural Export: The Gravity Model Approach. *Agris on-line Papers in Economics and Informatics*, 8(2), 3-21. <https://doi.org/10.7160/aol.2017.090201>
- Bubáková, P. (2013). Gravity Model of International Trade, Its Variables, Assumptions, Problems and Applications. *Acta Oeconomica Pragensia*, 21(2), 3-24. <https://doi.org/10.18267/j.aop.396>
- CEPII Research and Expertise on the World Economy. (2020). *Databases and Models* [Data set]. Retrieved December 18, 2020, from http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele.asp
- Cuenca García, E., Navarro Pabsdorf, M., & Gómez Herrera, E. (2013). The gravity model analysis: an application on MERCOSUR trade flows. *Journal of Economic Policy Reform*, 16(4), 336-348. <https://doi.org/10.1080/17487870.2013.846857>
- Czech Statistical Office. (2020). *Pohyb zboží přes hranice* [Data set]. Retrieved December 20, 2020, from <https://apl.czso.cz/pll/stazo/STAZO.STAZO>
- Deardorff, A. (1998). Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? In J. A. Frankel (Ed.), *The Regionalization of the World Economy* (pp. 7-32). University of Chicago Press.
- Evenett, S. J., & Keller, W. (1998). *On Theories Explaining the Success of the Gravity Equation* (Working Paper 6529). National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w6529/w6529.pdf
- Fontan Sers, C., & Mughal, M. (2020). Covid-19 outbreak and the need for rice self-sufficiency in West Africa. *World Development*, 135. <https://doi.org/10.1016/j.worlddev.2020.105071>
- Huang, H., von Lampe, M., & van Tongeren, F. (2011). Climate change and trade in agriculture. *Food Policy*, 36, S9-S13. <https://doi.org/10.1016/j.foodpol.2010.10.008>
- Josling, T., Anderson, K., Schmitz, A., & Tangermann, S. (2010). Understanding International Trade in Agricultural Products: One Hundred Years of Contributions by Agricultural Economists. *American Journal of Agricultural Economics*, 92(2), 424-446. <https://doi.org/10.1093/ajae/aaq011>
- Mangee, N., & Elmslie, B. (2010). Environmental Standards and Trade Volume. *Modern Economy*, 1(2), 100-111. <https://doi.org/10.4236/me.2010.12010>
- Márquez-Ramos, L., Martínez-Zarzoso, I., & Suárez-Burguet, C. (2007). The Role of Distance in Gravity Regressions: Is There Really a Missing Globalisation Puzzle? *The B.E. Journal of Economic Analysis & Policy*, 7(1). <https://doi.org/10.2202/1935-1682.1557>
- Marunelu, I. (2020). Research on the Small Peasant Individual Households in Romania within the Framework of Sustainable Agriculture. *Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development*, 20(1), 341-346.
- McCallum, J. (1995). National Borders Matter: Canada-U.S. Regional Trade Patterns. *The American Economic Review*, 85(3), 615-623. <https://www.jstor.org/stable/pdf/2118191.pdf>
- Morland, C., Schier, F., & Weimar, H. (2020). The Structural Gravity Model and Its Implications on Global Forest Product Trade. *Forests*, 11(2), 178. <https://doi.org/10.3390/f11020178>
- Poyhonen, P. (1963). A Tentative Model for the Volume of Trade between Countries. *Weltwirtschaftliches Archiv*, 90, 93-100.
- Rehber, E., & Grega, L. (2008). Agriculture, Trade and Sustainability. *The European Legacy*, 13(4), 463-479. <https://doi.org/10.1080/10848770802180755>
- Schjøll, A. (2017). Country-of-origin preferences for organic food. *Organic Agriculture*, 7, 315-327.
- Ševela, M. (2002). Gravity-type Model of Czech Agricultural Export. *Agricultural Economics*, 48(10), 463-466.
- Smutka, L., Maitah, M., & Svatoš, M. (2019). The Czech Agrarian Trade Comparative Advantages Distribution Based on Value and Volume Approach. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 67(6), 1613-1625. <https://doi.org/10.11118/actaun201967061613>
- Stiglitz, J. E., & Charlton, E. (2007). *Fair trade for all: How trade can promote development*. Oxford University Press.
- Tanentzap, A. J., Lamb, A., Walker, S., & Farmer, A. (2015). Resolving Conflicts between Agriculture and the Natural Environment. *PLOS Biology*, 13(9). <https://doi.org/10.1371/journal.pbio.1002242>
- The World Bank. (2020). *Databank – World Development Indicators* [Data set]. Retrieved December 20, 2020, from <https://databank.worldbank.org/source/world-development-indicators>
- Tinbergen, J. (1962). *Shaping the World Economy: Suggestions for an International Economic Policy*. The Twentieth Century Fund.
- Ugurlu, E., & Jindřichovská, I. (2019). Estimating Gravity Model in the Czech Republic: Empirical Study of Impact of IFRS on Czech International Trade. *European Research Studies Journal*, 22(2), 265-281.

Is the Slovak Pension System Prepared for the Next Decades?

Jakub BUČEK* and Michal TOMČO

Masaryk University, Brno, Czechia; jakubbucek@mail.muni.com; 455799@mail.muni.cz

* Corresponding author: jakubbucek@mail.muni.com

Abstract: This paper compares the financial stability of two alternative pension systems in Slovakia – the first one with gradually increasing retirement age and the second one with fixed retirement age. To achieve this goal, we have created a population projection based on the cohort-component model and the financial flows model working with the income and expenditure of the pension fund. We have found that the overall population will face a gradual decline in the size, however the post-productive population will increase until 2060s, which will increase the pressure on the public finance. While the pension system with fixed retirement age will cause higher burden on the pension fund, the costs of the pension system with flexible retirement age are passed on to other areas of the social security system. It is necessary to employ other policies that will increase the productivity, support natality to reverse the negative population projection, or liberate the labour migration to stabilize the public finance in the long run.

Keywords: pension system; financial stability; minimum retirement age

JEL Classification: H55; J11; J18

1. Introduction

Many European countries are facing the challenge of aging population. The main reasons are the increasing number of older people along with prolonging of a life expectancy due to improved medical care. Additionally, the number of children born per woman is decreasing for the last decades. This will put a pressure on the public finance in the upcoming decades because the imbalance in pension systems between incomes and expenses will grow even larger and national governments may be forced to implement major reforms to keep the public finance sustainable.

Slovakia is no exception to the phenomenon and the first significant attempt to reform of pension system in Slovakia appeared in the year 2019. The new regulation of the social security system came into effect at the beginning of the July 2019. It replaced the old way of determining retirement age which took into account development of the life expectancy and set a fixed retirement age to 64 years for all citizens. Because the new retirement age is significantly lower than the old retirement age, this will put even higher pressure on the public finance in Slovakia.

The regulation has become a source of discussions in which some argue in favor of the government's decision while others argue against it. Proponents argue with decreased ability of the older people to provide the same work performance. Opponents emphasize an

expected demographic development which may lead to pension fund deficit due to continuing decrease in a productive part of the society and increase in number of retired. Another argument against this act of parliament relates to its form. The act was enrolled as a constitutional law which makes it more difficult to be change.

Although everyone agrees on the importance of sustainability of the pension system, no academic papers comparing these two pension systems in Slovakia has been published to the authors' best knowledge. The main goal of this paper is to compare the two pension systems in Slovakia. The current one with fixed minimum retirement age and the old one with gradually increasing retirement age that reflects increasing of life expectancy. The comparison focuses on financial sustainability of both pension systems and their impact on public finance in the long-term.

2. Methodology

As a first step we construct our own population projection for Slovakia, because available Slovak population projections includes rather aggregated information about age groups than information for each age, i.e. a single number for age group 60-64 is available while our approach requires number for each age from 60 to 64. The need of own estimation emerged mainly for the reason to distinguished between people who do and do not reach minimum retirement age in the pension system with gradually increasing retirement age.

The selected population model is a variation of cohort-component model (for example O'Neill et al. (2001) and Štědroň (2012)). The model is based on the current age distribution of population and it assumes that each year part of population in a given age cohort survive till the next time period and the rest die. The model is also populated with women that can give a birth with a given probability that corresponds to current fertility statistics in Slovakia. These births represent newborn people in the model.

The method can be summarized by Equation 1 which is computed separately for men and women as their survival rates differ. The principle of the population development can be referred as a natural growth increment.

$$\begin{aligned}
 \textit{Total Population} &= \textit{Newborn} \\
 &+ \sum_{t=1}^{100} (\textit{Population at the age } t \cdot \textit{Survival rate at the age } t)
 \end{aligned} \tag{1}$$

On the other hand, it is important to mention a major restriction of the selected population model. It is constructed as a model of a closed economy which means that the migration of people is not considered. This decision was made because of low migration to and from Slovakia compared to the total population. The ratio of difference between people migrating to and from Slovakia to the total population ranged from 0.03% to 0.07% in the current decade. For the reason, we omit the effect of migration in our population model.

Despite this limitation, the selected population model can be considered as reliable although its prediction power is naturally decreasing in the long run. According to the

backward projection of the population growth, it is following the same trend as the real observed data. We also compared the population projection from the estimated cohort-component model with population projections from other authors (Department of Economic and Social Affairs, Population Division, 2019; Batog et al., 2019) and they follow the same trends.

As a next step we construct the pension fund financial flows model. It is based on simple principle of the contributions and expenditures of the pension fund. It is described by Equation 2.

$$\begin{aligned} \text{Pension fund balance} \\ &= (\text{Labours} \cdot \text{Yearly contribution}) \\ &- (\text{Pensioners} \cdot \text{Yearly pension}) \end{aligned} \quad (2)$$

The contributions to the system are determined by the number of labours, the average yearly salary, and the social security tax rate. The number of labours is determined by the number of people in a particular age and the employment rate for a given age. Please note that as people are approaching the retirement age, their employment rate is slowly decreasing and eventually the employment rate for Slovaks between 60 and 64 years old is only around 33% according to the current statistics. It is expected that this figure will increase along with the increasing retirement age and improvement of general life conditions, however we have fixed this parameter to the current value in the model.

The pension fund expenditures are product of the number of the old-age pensioners and the average monthly pension. All people older than the legislative retirement age are considered as the old-age pensioners and this number differs in both systems. In case of the system with fixed minimum retirement age, all people above 64 years are old-age pensioners. In the system with gradually increasing retirement age, the minimum retirement age is recalculated every year and for simplicity it is rounded down to the whole years. This creates the characteristic zig-zag shape of the lines in graphs for the pension system with increasing retirement age.

Both revenues and expenditures of the pension fund are influenced by a share of people that are members of the second pillar of the pension system. The contributions to the pension fund are proportionally reduced according to the valid legislation for the members of the second pillar, however they also get reduced pensions from the public pension system when they reach the pension age. For the paper, we assume that the share of people that are members of the second pillar is stable for the whole period and it is set to 50%.

In this paper, three scenarios of the financial flows of the pension funds are considered. A negative scenario characterizes a situation in which the growth of average yearly salaries is lower than the growth of the average yearly pension. A neutral scenario is projecting the same growth for the average yearly salary as well as for the average yearly pension and their growth is set to value 2%. This value is a minimum guaranteed growth rate of pensions in Slovakia. If the annual inflation rate is higher than 2%, the growth of pensions is same as the inflation rate. A positive scenario is considered as a growth of the yearly salary higher than 2%. All considered scenarios are summarized in Table 1.

Table 1. The summary of the considered scenarios of the pension fund financial flows

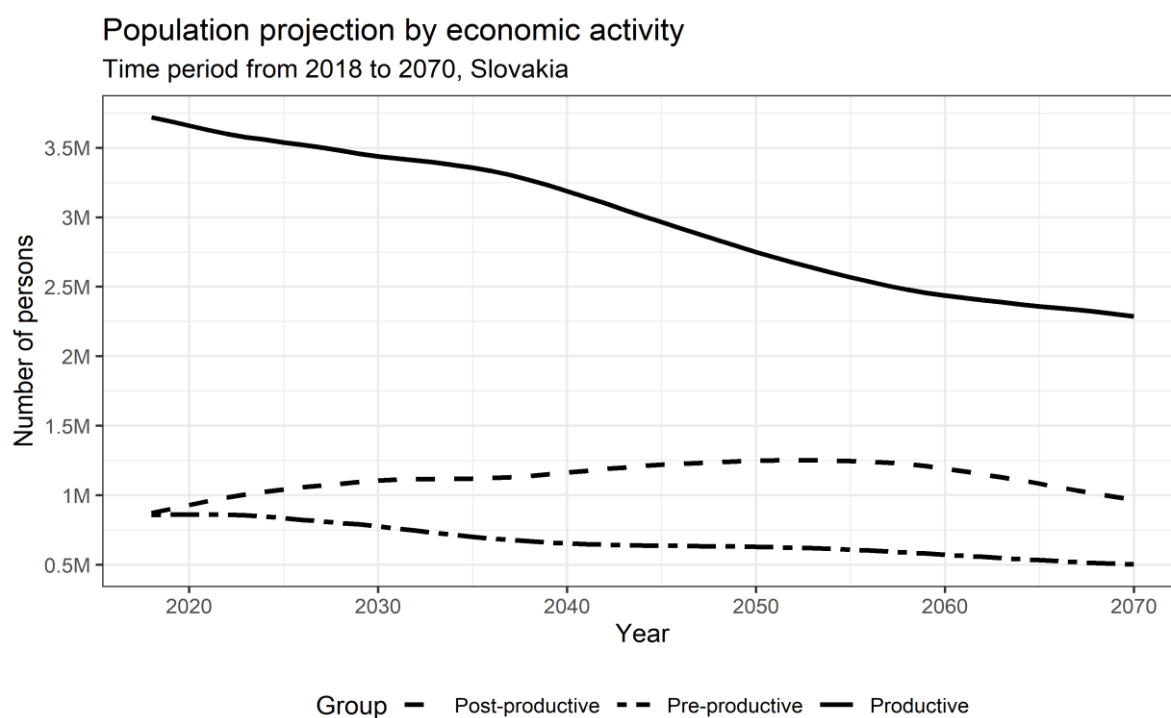
	Positive scenario	Neutral scenario	Negative scenario
Average yearly salary growth	3%	2%	1%
Average yearly pension growth	3%	2%	2%

Measured values of the pension fund balance are expressed proportionally to the GDP of the current year. Its value in the next years is gained from 2018 GDP which is constantly increased by the same yearly growth rate as the yearly salary growth.

3. Results

3.1. Population projection for Slovakia

The results from the population projection follow our expectations and they are also in line with other available population projections for Slovakia (Department of Economic and Social Affairs, Population Division, 2019; Batog et al., 2019). Figure 1 shows a significant decrease of the overall population during the next 50 years. The whole Slovak population will be reduced to one third of its current size during the observed period. This is caused mainly by the low natality which will lead to halving the pre-productive population and this will afterwards result in decrease of the productive group. In contrast, the size of the post-productive population will reach its peak around the year 2055 and it will get back to the level of the year 2020 in the following 20 years.

**Figure 1.** Population development by economic activity in time period between 2018 and 2070, Slovakia

The decrease of the productive population might have a serious impact on the number of labours that corresponds to a single old-age pensioner. Figure 2 displays development of the labours and old-age pensioners under both alternatives, the fixed minimum retirement age and the gradually increasing retirement age.

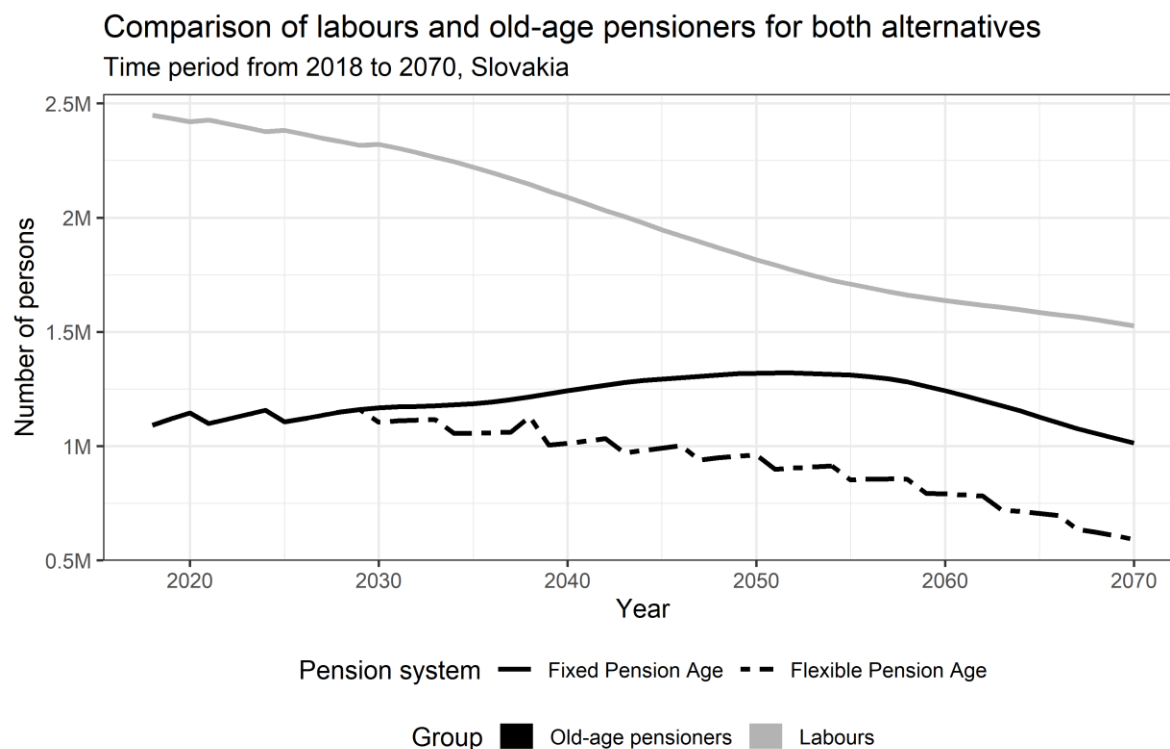


Figure 2. Comparison of labours and old-age pensioners for both alternatives in time period between 2018 and 2070, Slovakia

The development of the labours is almost identical in both systems, while the development of old-age pensioners differs significantly. The number of labours is gradually decreasing in both systems. It starts on 2.5 million labours at the beginning of the time period and it will eventually drop to 1.5 million labours in the year 2070. Although there are almost no differences in the number of labours between these two pension systems, there is a hidden important phenomenon which is related to the gradually increasing retirement age system. The system with flexible retirement age is source of the high old-aged people unemployment due to low employment rates in the higher age groups. Their existence is not present in the figure.

On the hand, the difference in the number of old-age pensioners is clearly visible. The pension system with fixed retirement age will generally generate more old-age pensioners. The increase in the number of pensioners in the system with fixed retirement age will be driven by a strong population wave born in the 1970s. The peak will be reached around the year 2055 and then the number of pensioners will start to decrease. Related to this development, the pension fund balance is expected to see the most critical period between 2050 and 2060.

We have run a several scenarios of the possible pension fund development in Slovakia. Figure 3 shows financial flows of the pension fund in both pension systems for all scenarios.

We can notice a better performance of the gradually increasing retirement age system (solid lines) compared with the pension system with fixed retirement age (dashed lines) in all considered scenarios. The only exception is the period of the first decade when both alternatives provide the same results. This is caused by gradual approaching of the retirement age to the guaranteed minimum age and therefore retirement age in both scenarios are similar for the first couple of years.

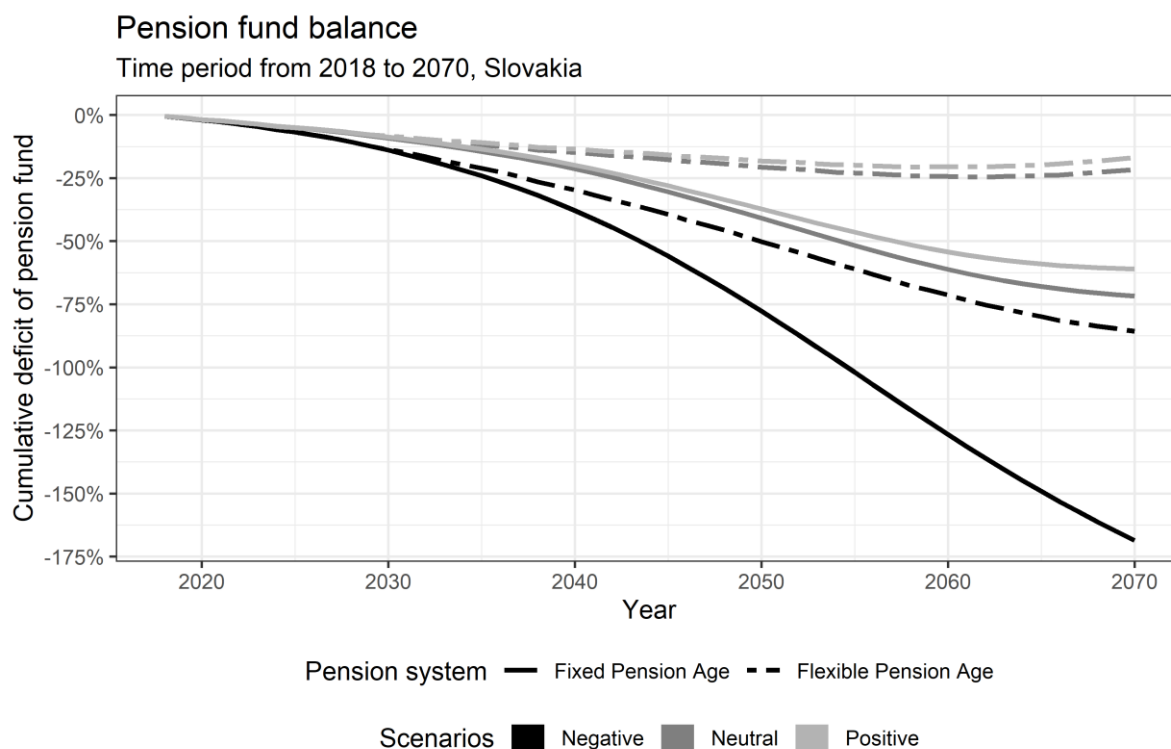


Figure 3. Pension fund balance in time period between 2018 and 2070, Slovakia

The gradually increasing retirement age system is characterized by lower deficits of the pension fund deficit compared to system with fixed retirement age during the whole selected time period. The worst scenario will generate cumulative deficit of nearly 90% of GDP at current prices by the end of the selected period with the highest increments in 2060s. Both neutral and positive scenarios will reach much lower cumulative deficit 25% of GDP at current prices around the year 2060 and the debt will slowly decrease in the following years. The critical decade in 2060s can be accounted to the strong population wave born in the 1970s.

The pension system with fixed retirement age is performing much worse and in the case of the worst scenario, it will generate cumulative deficit of pension fund of nearly 175% of GDP at current prices. The cumulative deficit in this alternative is almost doubled compared to the other pension system. The other two scenarios will generate cumulative deficits that are comparable with the worst scenario for the alternative. This is caused by the difference in the number of old-age pensioners at the end of the selected time period. The system with fixed retirement age will have around 1 million old-age pensioners versus around 600 thousand old-age pensioners in the system with flexible retirement age.

Similar research on the pension fund sustainability was conducted by Slovak Institute for Financial Policy (Institute for Financial Policy, 2020). The researchers are expecting

continuous deepening of the pension fund deficit due to increasing expenditures of the pension fund. Urbaníková and Papcunová (2016) also present negative tendencies of the future development of the pension fund balance. As main determinants of this development are mentioned retirement age and high of the pension fund contributions.

However, results of two above mentioned papers differ, in compare to our paper, in absolute values, tendencies of the future development of the pension fund balance are following similar tendencies.

To sum up the results, we can confirm the expected results from the very first chapter of this paper. The Slovak population is expected to face a significant decrease in the population lead mainly by the fall of the productive one. On the other hand, number of the old-age pensioners can follow different values according to the established pension system regulation.

In the comparison of the two selected alternatives, the fix minimum retirement age system performed worse in all considered variants. The deficits achieved significantly higher values which culminate during the critical period around 2060 and in the following decade.

On the other hand, the gradually increasing retirement age systems seems to provide better results in case of pension fund deficits. Its biggest disadvantage relates to the high old-age labours unemployment rate which shifts the burden of the pressure on the public system to different components of the social security system.

4. Conclusions

The correct setting of the social security system and its components is always a difficult task for the national government. This is even harder and yet more important when the population projection predicts significant increase in the number of old-age pensioners and simultaneously decrease in the number of people in the productive age. The incorrect pension system policy may negatively threaten not only the pension fund balance but even the whole public finance.

The new pension system changes in Slovakia will lead to higher pension fund deficits compared to the alternative system with gradually increasing retirement age. In that case, the government will be obligated to service any deficit by rearrangement of the national budget, increasing payroll taxes or reducing old-age pension.

The previous pension system with gradually increasing retirement age follows similar gradual decrease in the number of labour and old-age pensioners, but the effect of the increasing number of old-age pensioners will be suppressed by the increasing minimum pension age. Generally, this setting of the pension system will achieve lower deficits of the pension fund. On the other hand, this setting will probably generate high unemployment for people that would reach the minimum retirement age in the system with fixed minimum retirement age but not in the system with gradually increasing retirement age. Therefore, this setting will put under a pressure other component of the social security system.

Keep in mind that the results of the paper are limited by used models for population projection and pension fund financial flows. The former model is limited to closed economy

that cannot attract new worker from foreign countries and it relies on parameters like natality, survival rates or unemployment that are fixed for the whole period. Any exogenous changes in these parameters may significantly change the population projection in both ways. The latter model is just a simple balance model that is based on stable growth paths of relevant variables and does not take into account any dynamic caused by economic cycle.

To conclude, none of the compared scenarios can be announced as a winner. Both systems have their positive and negative consequences on the pension fund balance and public finance sustainability. The national government should increase the productivity, support natality to reverse the negative population projection, or liberate the labour migration to stabilize the public finance in the long run.

Acknowledgments: This work was supported by funding of specific research at Faculty of Economics and Administration project MUNI/A/0906/2019. This support is gratefully acknowledged.

References

- Batog, C., Crivelli, E., Ilyina, A., Jakab, Z., Lee, J., Musayev, A., Petrova, I., Scott, A., Shabunina, A., Tudyka, A., Xu, X. C., & Zhang, R. (2019). *Demographic Headwinds in Central and Eastern Europe* (Departmental Paper No. 19/12). IMF Policy Papers. <https://www.imf.org/en/Publications/Departmental-Papers-Policy-Papers/Issues/2019/07/11/Demographic-Headwinds-in-Central-and-Eastern-Europe-46992>
- Department of Economic and Social Affairs, Population Division. (2019). *World Population Prospects 2019, Volume II: Demographic Profiles* (ST/ESA/SER.A/427). United Nations. https://population.un.org/wpp/Publications/Files/WPP2019_Volume-II-Demographic-Profiles.pdf
- Ministry of Finance of the Slovak Republic, Institute for Financial Policy. (2020). *Pension projections of Slovakia - 2020 update*. <https://www.mfsr.sk/sk/financie/institut-financnej-politiky/seminare-prezentacie/prezentacie/25-pension-projections-slovakia-2020-update.html>
- O'Neill, B., Balk, D., Brickman M., & Ezra, M. (2001). A Guide to Global Population Projections. *Demographic Research*, 4(8), 203-288. <https://doi.org/10.4054/DemRes.2001.4.8>
- Statistic Office of the Slovak republic. (2019). *DataCUBE* [Data set]. Retrieved April 20, 2019 from <http://datacube.statistics.sk>
- Štědroň, B. (2012). *Prognostické metody a jejich aplikace*. C.H. Beck.
- Urbanikova, M., & Papcunová, V. (2016). Pension Systems in Slovakia and Its Sustainability. *Geographical Information*, 20(2), 341-351. <https://doi.org/10.17846/GI.2016.20.2.341-351>

Causal Loop Diagrams and Automated Identification of Feedbacks in Economic Systems

Vladimír BUREŠ

University of Hradec Kralove, Hradec Kralove, Czech Republic; vladimir.bures@uhk.cz

Abstract: Systems dynamics is a universal and widely used discipline that examines systems' behaviour over time. The casual loop diagram represents one of the commonly applied tools during the analysis of various economic problems. This paper presents a tool facilitating the work of managers who are forced to work with different perspectives on one shared issue. The created application enables mechanical analysis of a diagram created in the Vensim Pro application. The program is used for fast validation of models and checking the correctness of the structure. Based on the similarity of the structure, shared or different loops can be highlighted. The results can serve as a basis for developing strategies, policies or group discussions directed at analysing existing economic systems.

Keywords: economic systems; model comparison; causal loop diagram; system dynamics; automated identification

JEL Classification: C61; C63

1. Introduction

System dynamics deals with understanding how the system behaviour changes over time and is gaining popularity due to its flexibility and structural focus (Kelly et al., 2013). It has already been applied to support decision-making in many disciplines ranging from medicine and health care (Clarke et al., 2021; Loyo et al., 2013; Sahin et al., 2020) to urban coastal systems (Mavrommati et al., 2013). Although system dynamics has its intellectual origins in control engineering, management science, and digital computing, it currently shapes the frontier of better-understanding the behaviour of social and economic systems (Forrester, 2003). System dynamics models often generate counterintuitive behaviour and are at odds with traditional economic theory (Radzicki, 2009; Režný & Bureš, 2018). However, models represent essential tools for generating new knowledge as they help us uncover dominant feedback, unintended consequences, synergic effects, or emergent attributes (Bureš & Tučník, 2014). We look for patterns within the details without losing sight of the big picture. Analysis of economic systems is widely associated with the presentation of mental models in which economic systems are captured. Development of ability of collection and organisation of data, interdisciplinary model development, transparency of models, and visualisation of the results represent the main issue. System dynamics helps to cope with complexity and acquire better insights, which is the primary assumption of better understanding and meaningful decision making. This need constitutes the main rationale and motivation of this study.

This paper is based on the analysis of models of economic systems represented by causal loop diagrams (CLD). CLD represent the notation of the bounded system structure which is composed of variables and their relationships that interact with each other. This work aims to present a software application that reads a model created in the Vensim Pro software application and verifies the correctness of the CLD stored in this model. The manuscript is structured as follows. After this introductory section, the applied methodology focused on the CLD structure and associated MDL file details created in the Vensim Pro application is presented. Next section introduces acquired results. It focuses on the validation of diagrams, the process of loop identification, and how outcomes are provided. The last section concludes the paper.

2. Methodology

This study's main assumption is based on the conviction that economic systems, as an instance of soft systems, are not mostly associated with an exact description of structures and behaviours. However, the notation of CLD is rigorous and can be analysed. Binder et al. (2004) describe CLD as an oriented graph. Since we need to go through the graph, it is recommended to use an adjacency matrix and determine each link's polarity. It is also possible to successfully detect multiple relationships and record the absolute number of relationships without polarity (two relationships with opposite polarity would be subtracted from each other). We do not know if they are variables without a relationship, or with one either positive or negative polarity). The algorithm continues with depth-first and breadth-first search. Because we are looking for all the loops in the graph and do not know if there will be more loops, this algorithm is not suitable as a stand-alone method. For instance, the search can be applied to each variable where a loop would be found. However, it is possible that in a variable, which belongs to more than one loop, the algorithm chooses the wrong one, and we do not get all loops even in multiple runs in the graph.

There are various methods for dealing with feedbacks in system dynamics models. The Loops that Matter method can serve as an example (Schoenberg et al., 2020). When determining the algorithm for finding loops, it is interesting to be inspired by Oliva's work (2004), in which an adjacency matrix capturing variables and relationships is used. It further enriches it by using a distance matrix, showing how far variables along the link path are from each other. This approach ensures finding loops consecutively from small to larger ones and always tests when inserting a new loop into the list if it differs by at least one link from the previous one.

The solution presented in this study is based on the adjacency matrix analysis, where for each variable, the output link is inserted into the list of potential loops. At the same time, the algorithm goes through all links already inserted into the list. If any of these links starts with the end node or ends with the starting node of the processed binding, the previous link is extended by the processed link.

For the practical implementation, Visual FoxPro 9.0 programming language was used as it has a set of functions for reading and writing files, as well as an extensive set of functions for working with two-dimensional arrays. The MDL file format is proprietary and well-

Figure 1. Sketch information about the graphical representation of the diagram.

The following main components and functions are used when programming the code for work with the contents of the MDL file:

The program reads the entire contents of the file into the memory, where the contents can be further processed and searched.

125

The text box is searched for the occurrence of a specific character set that identifies a new line in the file. From such a position, we read further to the end of the line and such a sequence of characters is for us one element in the diagram.

```
FOR lncount = 1 TO lnCountRows
  ** check if this is variable
  IF LEFT(lcTmpRows[lncount,1],3) = "10,"
    lcTmpVars[lncountVar,1] = lncountVar
```

A cycle by which individual diagram objects are inserted into a two-dimensional array, for each element (row) we distinguish different attributes of the element (identifier, name, coordinates) and we write them into individual columns of the array.

```
LEFT(lcTmpRows[lncount,1],3) = "10,"
```

If a line starts with the sequence “10” it is a “node” in the diagram. For a line starting with “1” it is a link:

```
LEFT(lcTmpRows[lncount,1],3) = "1,"
```

We go through all the relationships and for each we write in the adjacency matrix of the polarity of the individual relationships.

```
DO CASE
  CASE INLIST(lcTmpCausL[lncount,8],"+","s","S")
    lnMatrixVal = 1
  CASE INLIST(lcTmpCausL[lncount,8],"-","o","O")
    lnMatrixVal = -1
```

3. Results

When constructing the algorithm, we proceed from nodes in the diagram by developing their list. We find the internal number in the original diagram (unique) for each node, assign a unique internal number for our processing, and save the name and coordinates. We also examine relationships. As with nodes, we find out the number of links and their output and input nodes. In the list, we store the link’s original identifier and the indication from where and to where the link leads. We only store our internal node identifiers here. We will also find out whether the links are reinforcing (the relationship designation is “S / s / +”) or balancing “O / o / -” and if the designation is missing or out of the permitted values. If so, we mark the link as incorrect. From the list of links, we process the adjacency matrix.

The link in Figure 2 leads from the node with internal number 2 to the node with internal number 1. In the adjacency matrix, there is a value of -1 in column 1 (where the link leads to) which indicates a negative link.

List of causal links (InternalID, OriginalID, VariableIDFrom, VariableNameFrom, VariableIDTo, VariableNameTo, coordinates)									
1	3	2	A - Available workfo	1	B - Work backlog	CIRCLE	-	1 (401,84)	
2	6	4	E - Consumption of r	1	B - Work backlog	CIRCLE	+	1 (631,91)	
3	8	3	C - Project tasks co	5	F - Other projects r	CIRCLE	+	1 (382,230)	
4	9	5	F - Other projects r	4	E - Consumption of r	CIRCLE	+	1 (603,252)	
5	11	6	D - Work efficiency	3	C - Project tasks co	CIRCLE	+	1 (425,185)	
6	12	1	B - Work backlog	6	D - Work efficiency	CIRCLE	+	1 (517,119)	
7	14	3	C - Project tasks co	2	A - Available workfo	CIRCLE	+	1 (311,175)	

Matrix of causal links						
0	0	0	0	0	0	1
-1	0	0	0	0	0	0
0	1	0	0	1	0	0
1	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	1	0	0	0	0

Figure 2. Link and its position in the matrix.

Furthermore, it can also be seen that in the matrix in row 1 and column 2 there is 0. If the relationship also leads back from point 1 to point 2, which is allowed, then there will also be a non-zero number at this point [1,2], expressing the link in the opposite direction.

If there is more than one link leading from one node to another, Vensim signals this state of the diagram with a warning, but such writing is not allowed in causal loop diagrams. The algorithm evaluates the number of links greater than 1 between two nodes as an error and records the absolute values of each constraint in the matrix so that the values of 1 and -1 cannot be used for information whether each relationship has a different strength. This situation would lead to a final sum of 0 and the target state could not be distinguished from the state where there is no link between the nodes. For better visual differentiation of erroneous or missing polarity of the coupling, *the algorithm uses* the value 100 instead of +/- 1.

3.1. Identification of Loops

The loops are drawn in the diagram by a circular arrow symbol, the designation R or B and a serial number. The loops are not tied to the links in the diagram in the same way as for nodes and links. The “comment” element is used to draw the loop and it has no connection to other objects in the diagram. The drawing of the loop only corresponds graphically that it is surrounded by the relationships forming the loop. We want to check that the drawn loops correspond to the relationships surrounding them and find out if a loop is missing. Therefore, we find all the loops that can exist in the diagram, regardless of whether they are drawn in the diagram or not. Then, we examine according to the position of the links and the drawn loops, whether found loops correspond to the drawn ones.

We can expect two results of this procedure, either “no difference” or an error in the diagram (a loop is completely missing or inaccurately drawn with respect to its position or polarity indication).

When looking for an algorithm, we must first choose a suitable method of searching. Let's assume that if we examine all the relationships in the diagram, we cannot omit any of the existing loops. Thus, we can proceed by considering each relationship as a starting point of the loop, and as we go through the relationships, we will gradually form groups of

relationships that follow each other in the nodes. If we go through all the relationships in this way, we get some loops. Figure 3 presents the CLD associated with a project management system. A few steps are outlined.

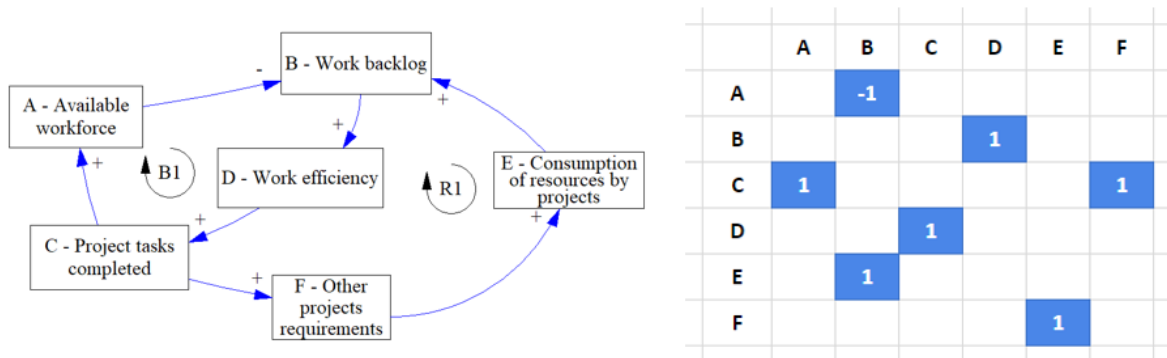


Figure 3. Initial state of the procedure.

STEP	Sequence of links			
1	A	B		
2	A	B		
	B	D		
	A	B	D	
3	C	A	B	
	B	D		
	C	A	B	D
	C	A		

Figure 4. Loops after the third step.

We start the path of the matrix line by line. They show us the direction of the relationships. We place each link we process on a new line in our list of “future loops”. The first relationship leads from A to B, so we write A-B in the resulting field as the first loop’s starting point. We continue through the second line, where we have another starting point of the B-D loop. We can’t go to the third step at the moment, because we have found so far that we have two potential beginnings of loops A-B and B-D. We see that we can extend the relationship A-B by B-D as there is a match in the nodes, and after the connection from A-B and B-D it becomes A-B-D. At the end of the second step, we have three potential loops: A-B, B-D and A-B-D. We can proceed to the next steps which can be summarised as follows:

1. Take a new link and make it a separate line.
2. Find out whether the link can be connected via the same node name to the end or beginning of another line.
3. Check it out in this way for all rows already identified.
4. Repeat this sequence for all non-zero elements in the matrix.

In the end, we obtain a list of existing loops. From the perspective of feedback verification, there is a complication we need to deal with. Relationships are not represented by lines, but by parts of a circle or a curved line. Since the loops are drawn to the centre of

the polygon defined by the individual nodes in the CLD, it is not very likely that the drawn loops would be at the edge of one of the circles that encircle the loop. Thus, we can approximate when calculating a circular segment forming a loop by lines between two nodes. The program evaluates the found loop as correct if it occurs inside the polygon (see Figure 5). There are several algorithms to determine whether a point is inside a polygon. For implementation, Jordan Curve Theorem method (Kline, 1942) is applied. It states that if a ray projected from the point of investigation intersects the investigated polygon horizontally in an odd number of places, the investigated point lies inside the polygon. An even number of intersections means that the point lies outside the polygon (Haines, 2001). Therefore, we proceed by obtaining the equations of all edges of the polygon. We use the drawn point coordinates with the loop symbol and test whether such a line formed by two adjacent vertices intersects the Y coordinate of the point under investigation. If so, we are interested in whether such a point of intersection lies to the left or to the right of the point under investigation. We apply this procedure on all lines, and if we have an even number of intersections on one side (right or left), then the examined point is outside the polygon, in other cases, it is inside the polygon. In Figure 5, we can see that the ray from loop B1 intersects the polygon twice and is thus outside the polygon and the ray R1 intersects the polygon once (in one direction) and thus lies inside the polygon. Thus, for each loop found in the diagram, it is determined, in which detected loops, represented by the corresponding polygons, the indicators of loops are located.

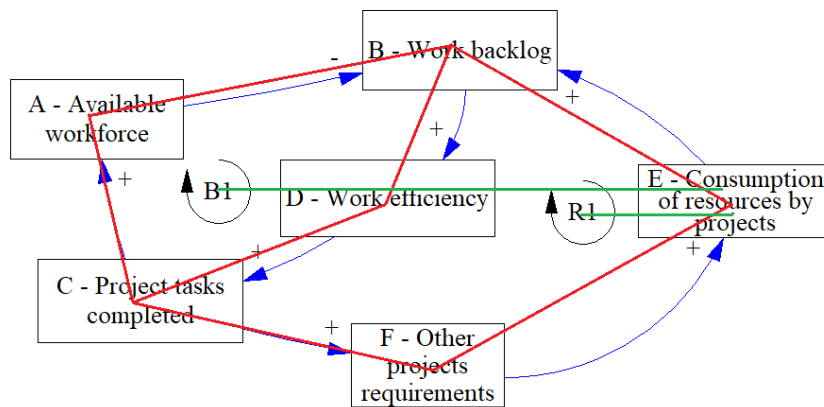


Figure 5. Matching feedback identifications with existing polygons.

3.2. Outcome Presentation

Suppose the program evaluates, based on the found loops and the polarity of the relationships that make them up, that a loop is incorrectly determined (R instead of B or vice versa). In that case, the incorrectly identified loop is marked in red, and the correct loop type is indicated (see Figure 6). If the loop is drawn with its centre outside the polygon formed by the identified loop's individual nodes, it is evaluated as missing and shown in the correct place. The method of calculating the centroid of the polygon is used in the calculation. Therefore, the original loop is marked as unpaired and is also marked in red as incorrect (see Figure 7). To fix it, move the loop to the right place.

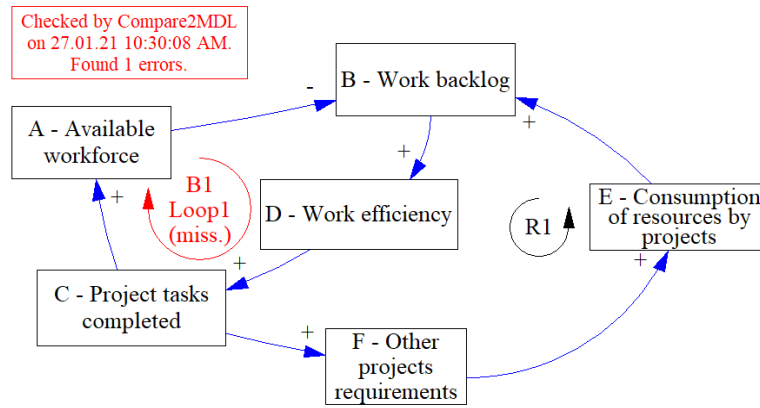


Figure 6. Missing feedback indicator.

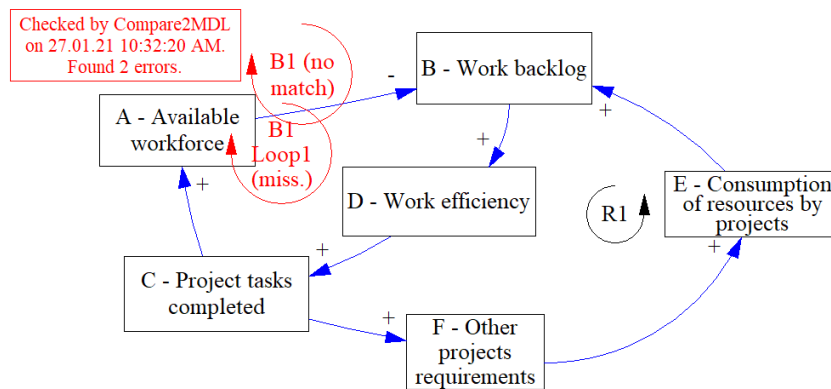


Figure 7. Incorrect position of the feedback indicator.

4. Discussion and Conclusion

Approaches to CLD analysis can be divided into two categories. The first category can be labelled as “mechanical”. We are not familiar with the CLD content or topic of interest. We can consider variables as objects associated with textual strings and located somewhere in the diagram. Links connect these variables and we consider loops as comments with round arrows. The second category can be titled as “contextual” as we understand the diagram’s content and the analysis is based on working with this content. The presented method is based on the mechanical analysis as we deal with verifying whether the diagram meets all the rules necessary for its construction. These rules can be transformed into an algorithm to create a tool to check the correctness of the diagram. Vensim Software, in which the method is developed, contains interactive tools for checking the diagram. The user can mark a specific variable in the model and run the “Loops” tool to check which loops pass through the variable. This tool is suitable for continuous checking or finding the cause of a specific error in a diagram during the modelling process. The marked loops R1 and B1 are marked with the help of the element “comment” and are not connected with the loops in the diagram. In Vensim, it is impossible to check whether the marked loops correspond to those that currently exist in the diagram. The presented method provides the added value for this technical perspective as it extends the software functionality.

Implications of applying this method during the analysis of economic systems are apparent. Vague and ambiguous relationships between variables characterise economic systems. Bureš (2006) provides an example in the case of knowledge management and associated endeavour if its implementation in organisations. The issue with economic systems is also supported by the fact that, unlike variables and relationships that can be easily read from CLD, loops are more complex. Although CLD is associated with several weak points (Richardson, 1986), they can be used as a tool for a better understanding of structures and behaviour in areas such as industrial-technological innovation (Guo et al., 2021), value chain analysis (Muflikh et al., 2021), investment analysis (Nasirzadeh et al., 2021), productivity in manufacturing industries (Kamble & Wankhade, 2021), sustainability factors (Bureš & Racz, 2017), ambient intelligence (Mikulecký et al., 2011), or the industry growth (Eshaghpour et al., 2021). In the current form, the method provides an outcome that can be used as a valuable mean of introduction and presentation of the modelled system to specific target groups such as modelling workshop newcomers, new team members or decision- or policy-makers that need some kind of initial insight. System modellers can use it to clarify the story itself. In this way, the complexity of an analysed economic system is presented to the same target group, which enables to tame complexity as well. Hence, more appropriate and precise system comprehension can be anticipated. Hence, approved version can serve as a material for development of corresponding scenarios (Mohelská & Sokolová, 2010) or publication at social networks (Černá & Svobodová, 2017).

Not only can the method serve as a control mechanism for CLD construction for individuals, i.e. reassurance that decision making is based on realistic assumptions, but also at the corporate and inter-corporate level. It can serve as a tool for the unification of mental models in case of group modelling and decision making. Mostly, the final product of the group diagram development is a complex model with many variables and even more links included (see for instance work of Allender et al. (2014)). Not only at the corporate level, but also in multi-corporate institutions such as economic clusters where different perspectives are common, and a consensus has to be found. Evaluation of cluster effectiveness, productivity or efficiency can serve as an example when CLD can be successfully deployed (Bureš et al., 2012). Moreover, subjectivity represents a significant issue here (Jung, 2017).

There are limitations associated with the developed method. First, the method was tested by analysis of relatively simple CLDs. The question is whether the method would be able to provide outcomes of more complex CLDs in a reasonable time. Current testing reveals that the speed of the algorithm for large CLD (20+ variables) is quite unsatisfactory when the finding of all loops requires tens of minutes. However, there are methods which can be used for CLD simplification (Bureš, 2017). Reduction of complexity enables the application of the method without this type of limitation. Moreover, the development of CLD with tens of variables can be counterproductive and support confusion. Second, the application is developed in an environment which is not mainstream in the current computer science technologies. Thus, the conversion to more appropriate and robust environments is recommended. However, the method and software application can reach the target in any CLD and can identify the loops. The program can intervene in the native MDL format and

highlight errors in it. The modified file can be reopened and further processed by Vensim. The developed algorithm is finite and always reaches the goal, which represents one of the strong points.

Acknowledgments: This manuscript is based on the work and many thanks go to Tomáš Petržilka, who designed, developed and tested the Compare2MDL application. His innovative approach and assistance are gratefully acknowledged.

References

- Allender, S., Owen, B., Kuhlberg, J., Lowe, J., Nagorcka-Smith, P., Whelan, J., & Bell, C. (2015). A Community Based Systems Diagram of Obesity Causes. *Plos One*, 10, e0129683. <https://doi.org/10.1371/journal.pone.0129683>.
- Binder, T., Vox, A., Belyazid, S, Haraldsson, H., & Svensson, M. (2004). Developing system dynamics models from causal loop diagrams. *Proceedings of the 22nd International Conference of the System Dynamics Society 2004* (pp. 1-21). Oxford, England.
- Bureš, V. & Tučník, P. (2014). Complex agent-based models: Application of a constructivism in the economic research. *E+M Ekonomie a management*, 17(3), 152-168. <https://doi.org/10.15240/tul/001/2014-3-012>.
- Bureš, V. (2006). Knowledge management and its implementation. In *Proceedings of the 2nd International Conference on Web Information Systems and Technologies Location (WEBIST) 2006* (pp. 115-118). INSTICC.
- Bureš, V. (2017). A Method for Simplification of Complex Group Causal Loop Diagrams Based on Endogenisation, Encapsulation and Order-Oriented Reduction. *Systems*, 5(3), 46. <https://doi.org/10.3390/systems5030046>.
- Bureš, V., & Racz, F. (2017). Identification of Sustainability Key Factors Based on Capturing Dominant Feedbacks of Behavioural Stereotypes in Socio-Economic Systems. *Systems*, 5(2), 42. <https://doi.org/10.3390/systems5020042>.
- Bureš, V., Jašiková, V., Otčenášková, T., Kolerová, K., Zubr, V., & Marešová, P. (2012). A Comprehensive View on Evaluation of Cluster Initiatives. In J. Politis (Ed.), *Proceedings of the 8th European Conference on Management Leadership and Governance (ECMLG) 2012* (pp. 74-79), Neapolis University Pafos.
- Carlin, B. I. (2009). Strategic price complexity in retail financial markets. *Journal of Financial Economics*, 91(3), 278–287. <https://doi.org/10.1016/j.jfineco.2008.05.002>.
- Clarke, B., Kwon, J., Swinburn, B., & Sacks, G. (2021). Understanding the dynamics of obesity prevention policy decision-making using a systems perspective: A case study of Healthy Together Victoria. *Plos One*, 16(1), e0245535. <https://doi.org/10.1371/journal.pone.0245535>.
- Černá, S., & Svobodová, L. (2017). Internet and social networks as a support for communication in the business environment - Pilot study. In P. Jedlička, P. Marešová & I. Soukal (Eds.), *15th International Scientific Conference on Hradec Economic Days 2017* (pp. 120-126), Hradec Králové, Czech Republic.
- Eshaghpour, S., Hosseini, S.H., Aghaei, S.A., & Seif, M.S. (2021). A hybrid systems approach to determine effective factors on the growth of marine industries in developing countries. *International Journal of Business and Systems Research*, 15(1), 124-142. <https://doi.org/10.1504/IJBSR.2021.11175>.
- Forrester, J.W. (2003). Economic theory for the new millennium. *System Dynamics Review*, 29(1), 26–41.
- Guo, J., Chen, M., Sun, X., Wang, Z., & Xue, J. (2021). Leveraging industrial-technological innovation to achieve sustainable development: A systems thinking perspective. *Plos One*, 15, e0242981. <https://doi.org/10.1371/journal.pone.0242981>.
- Haines, E. (2001). Point in Polygon Strategies. In P.S. Heckbert (Ed.), *Graphics Gems* (pp. 24-46). Academic Press.
- Jung, J. U. (2017). Reducing Subjectivity in the System Dynamics Modeling Process: An Interdisciplinary Approach. *Lecture Notes in Computer Science*, 10585, 365–375.
- Kamble, R., & Wankhade, L. (2021). System dynamics model to improve productivity in manufacturing industries. *International Journal of Productivity and Quality Management*, 32(1), 23-52. <https://doi.org/10.1504/IJPQM.2021.112018>.
- Kelly, R.A., Jakeman, A.J., Barreteau, O., Borsuk, M.E., ElSawah, S., Hamilton, S.H. et al. (2013). Selecting among five common modelling approaches for integrated environmental assessment and management. *Environmental Modelling & Software*, 47, 159–181. <http://doi.org/10.1016/j.envsoft.2013.05.005>.
- Kline, J.R. (1942). What is the Jordan Curve Theorem? *The American Mathematical Monthly*, 49(5), 281-286.

- Loyo, H.K., Batchner, C., Wile, K., Huang, P., Orenstein, D., & Milstein, B. (2013). From model to action: Using a system dynamics model of chronic disease risks to align community action. *Health Promotion Practice*, 14(1), 53–61. <https://doi.org/10.1177/1524839910390305>.
- Mavrommati, G., Bithas, K., & Panayiotidis, P. (2013). Operationalising sustainability in urban coastal systems: A system dynamics analysis. *Water Research*, 47(20), 7235–7250. <https://doi.org/10.1016/j.watres.2013.10.041>
- Mikulecký, P., Olševičová, K., Bureš, V., & Mls, K. (2011). Possibilities of Ambient Intelligence and Smart Environments in Educational Institutions. In N.Y. Chong, & F. Mastrogiovanni (Eds.), *Handbook of research on ambient intelligence and smart environments: Trends and perspectives* (pp. 620-639). IGI Global. <https://doi.org/10.4018/978-1-61692-857-5.ch029>.
- Mohelská, H., & Sokolová, M. (2010). The Creation of the qualitative scenarios in the virtual three-dimensional environment Second Life. In A. Karahoca, & S. Kanbul (Eds.), *Proceedings of the 1st World Conference on Information Technology (WCIT) 2010*. Istanbul, Turkey. <https://doi.org/10.1016/j.procs.2010.12.053>.
- Muflikh, Y.N., Smith, C., & Aziz, A.A. (2021). A systematic review of the contribution of system dynamics to value chain analysis in agricultural development. *Agricultural Systems*, 189, 103044. <https://doi.org/10.1016/j.agsy.2020.103044>.
- Nasirzadeh, H., Amin-Tahmasbi, H., & Amoozad Khalili, H. (2021). Investment analysis in privatisation of National Iranian Drilling Company using systems dynamics and BWM technique. *Energy Policy*, 148, 111963. <https://doi.org/10.1016/j.enpol.2020.111963>.
- Oliva, R. (2004). Model structure analysis through graph theory: partition heuristics and feedback structure decomposition. *System Dynamics Review*, 20, 313-336. <https://doi.org/10.1002/sdr.298>.
- Radzicki M.J. (2009). System Dynamics and Its Contribution to Economics and Economic Modeling. In R. Meyers (Ed.), *Encyclopedia of Complexity and Systems Science*. Springer. https://doi.org/10.1007/978-0-387-30440-3_539
- Režný, L., & Bureš, V. (2018). Adding Feedbacks and Non-Linearity to the Neoclassical Growth Model: A New Realm for System Dynamics Applications. *Systems*, 6(2), 8. <https://doi.org/10.3390/systems6020008>.
- Richardson, G. (1986). Problems with causal-loop diagrams. *System Dynamics Review*, 2, 158-170.
- Sahin, O., Salim, H., Suprun, E., Richards, R., MacAskill, S., Heilgeist, S., Rutherford, S., Stewart, R.A., & Beal, C.D. (2020). Developing a Preliminary Causal Loop Diagram for Understanding the Wicked Complexity of the COVID-19 Pandemic. *Systems*, 8, 20. <https://doi.org/10.3390/systems8020020>.
- Schoenberg, W., Davidsen, P., & Eberlein, R. (2020). Understanding model behavior using the Loops that Matter method. *System Dynamics Review*, 36(2), 158-190. <https://doi.org/10.1002/sdr.1658>.

Contextualisation of the Current Knowledge and Technology Transfer-Related Literature: The Text Analysis

Vladimír BUREŠ* and Tereza OTČENÁŠKOVÁ

University of Hradec Kralove, Hradec Kralove, Czech Republic; vladimir.bures@uhk.cz;
tereza.otcenaskova@uhk.cz

* Corresponding author: vladimir.bures@uhk.cz

Abstract: The importance and relevancy of technology and knowledge transfer has been growing together with the interest and attractiveness for the organisations and institutions from both public and private sector. As a result, various literature focus on different aspects of this topic. Therefore, this paper focuses on the analysis of the current knowledge and technology transfer-related literature. It aims to identify the most mentioned keywords and topics to understand and contextualise the research field. The research methodology is based on the text analyses using the open access KH coder software. The correspondence analysis, co-occurrence network analysis, hierarchical cluster analysis and Self-Organising Map are used to reveal the results and the main topics of the discussed area. Crucial keywords strategy, policy and mission are identified. Furthermore, the technology and knowledge transfer are closely related to the learning and networking processes. The outputs also imply the three main word clusters including the academic environment, the organisational processes and projects supported by the software, and the information and knowledge management. Obviously, the discussed issues might provide the topical framework for reaching excellency as well as long-term competitive advantage.

Keywords: applied research; knowledge transfer; technology transfer; text analysis

JEL Classification: I23; O31; O32

1. Introduction

Science represents the activity with far-reaching implications for modern society. Researchers who appear as authors in a research article are a visible and easily quantifiable manifestation of an organisational scientific effort. The importance of knowledge and technology transfer is crucial for both the commercial and public areas (Marešová et al., 2020). Research institutions and universities are an important basis for unique intellectual property. These are dependent on the effective development of human resources and the management of related processes. In addition, the interaction with the commercial world has been becoming increasingly important as one of the tools for competitiveness increase. Apparently, there is a need to address the area at both levels, individual institutions and relevant social disciplines. Basic issues of support and management of related types of knowledge as a basis for subsequent possible improvement of efficiency need to be addressed as well. At the regional or national level, grants are offered to provide top researchers full

service from practical matters such as accommodation, transport and food, to social ones such as the integration of other family members into society, children into schools, interest groups etc. It is not just the desire to work closely with colleagues that leads to the growth of extensive scientific collaboration and teams. Thanks to changes in the approach to scientific activity that attract the attention of scientists, the cooperation is essential. And that is not limited to the world of science. There are several examples of the huge impact that successful collaboration can have, such as the discovery of the causative agent of severe acute respiratory distress syndrome (Abraham, 2004). Research organisations are increasingly enthusiastic about the collaborative approaches and are encouraging their teachers and staff to work in a more integrative way, recognising that teams are likely to have a faster and fuller impact than individuals can achieve on their own. Institutions and financial agencies are setting up the infrastructure to encourage greater interaction, such as building large open laboratories where more researchers with the same interests can work in close proximity. Sharing ideas through the creation of interdisciplinary working groups and joint ownership of research projects is now also feasible thanks to the possibility to apply for the international grants. It is noteworthy that voluntary cooperation can be seen among institutions that would otherwise be considered competitive (Shrum et al., 2007). The aim of this paper is to analyse the main topics in the current research literature focused on knowledge and technology transfer. The article is structured as follows. After the introductory section, the methodology with a brief description of applied tools is introduced. Consequently, the results acquired from the analysis of available abstracts and keywords are presented. They are discussed in the next section with the emphasis put on the main topics and related perspectives. The final section concludes the paper.

2. Methodology

Analysis of research studies is based on the selection of appropriate, topical and high-quality papers published and indexed in the Scopus database. The basic set of studies is selected by using Knowledge and Technology Transfer as the main search keyword. Moreover, eligibility criteria are established in order to include only relevant information resources. Their application reduces the number of analysable papers (see Table 1). The main eligibility criteria with their justification are:

- publication of the paper during the last ten years (the reason is to include only up-to-date and topical issues),
- records marked as articles or conference papers,
- authors' keywords contain "technology transfer" or "knowledge transfer" concepts (various papers are connected with the domain-specific topics such as analytical chemistry or pharmacology and technology and knowledge transfer is considered in a different way when compared to this study),
- the paper is written in English (the text-mining analysis and associated tools are prepared for English language only).

Consequent analysis is executed in the KH Coder application, an open access text-mining and text-analysis software tool available at: <https://kncoder.net/en/>.

Table 1. Selection criteria

Criterion	Number of research papers
Topic: knowledge and technology transfer	9,586
Time limitation: 2012-2021	5,346
Document type: article, conference paper	4,354
Keywords: "technology transfer", "knowledge transfer"	1,127
Language: English	1,091

The following paragraphs briefly introduce methods used for the research papers analysis. The correspondence analysis is a multivariate statistical analysis applicable to the qualitative data. In this type of analysis, factor scores are reckoned from a frequency distribution to maximise their correlation (Petrovic et al., 2009). It is an effective technique which captures the correlations between features and classes and has been extensively used in different data mining tasks such as classification (Yang et al., 2017), feature selection (Zhu et al., 2010), and discretisation (Zhu et al., 2011).

The Co-occurrence network analysis helps to acquire a graphic visualisation of potential ties among concepts. The co-occurrence networks represent the collective interconnection of concepts grounded in their paired presence. Networks are generated by connecting pairs of concepts applying a set of criteria defining co-occurrence. For instance, concepts X and Y are considered to co-occur if they appear in a specific block of text. Another block of text may contain concepts Y and Z. Linking X to Y and Y to Z develops a co-occurrence network of these three concepts. The co-occurrence patterns are significant for understanding structures, offering new insights into potential interaction networks, and revealing niche spaces shared by community members (Ma et al., 2016). For instance, in the case of co-word networks, Milojević et al. (2011) apply Jaccard coefficient to execute hierarchical clustering, for the same purpose, Yan et al. (2015) use Ward's methods. Delecroix and Epstein (2004) utilise an Ascendant Hierarchical Clustering algorithm based on the strength of association with cluster keywords; and Williams et al. (2016) define clusters with the Louvain community detection method. De la Hoz-Correa et al. (2018) use the community detection algorithm.

Generally, in the cluster analysis, it is not known which elements fit into which clusters. The data is reviewed to define the grouping or clusters (Zolfaghari et al., 2019). The cluster analysis is a technique for classifying a "body" of information into manageable, meaningful fragments. It represents a tool for data reduction which enables to develop subgroups which are manageable in more appropriate way. This technique examines the full complement of inter-relationship between variables. Derived from the general cluster analysis, the hierarchical cluster analysis is the major statistical method for finding homogeneous groups of cases based on the measured characteristics (Zhang et al., 2017). The clustering method uses the dissimilarities or distances between objects when forming the clusters.

Self-Organising Map (SOM) represents a dimensionality reduction algorithm generally used to represent a high-dimensional dataset as two-dimensional discretised pattern.

Reduction in dimensionality is performed while retaining the topology of data present in the original feature space (Misra et al., 2020). It converts complex, non-linear statistical relationships among high-dimensional data into simple geometric relationships on a low-dimensional display (Leonard et al., 1999). Details related to the tool settings are presented in Table 2.

Table 2. Settings of the applied analytical tools

Analytical Tool	Correspondence analysis	Co-occurrence network	Hierarchical cluster analysis	Self-Organising Map
Minimum Term Frequency (TF)	15, 25	15, 25	15, 25	15, 25
Distance	N/A	Jaccard, Cosine, Euclid	Jaccard, Cosine, Euclid	N/A
Methods	N/A	N/A	Ward, Average, Complete	N/A
Type of edges (words – words)	N/A	X	N/A	N/A

3. Results

Although analysis of available resources is performed on all combinations of available settings presented in Table 2, only selection of outcomes is presented in this section. The reason is that the application of different methods and various types of distance calculations provide similar results. The detailed analysis of these is not necessary for the purpose of this study.

Figure 1 presents the results of the correspondence analysis executed on the set of both, available abstracts and associated keywords. Provided graphs seem to be hard to read, however organisation of concepts is one of the interesting outcomes. One can also zoom in to find out the details. It is apparent that while increasing the term frequency reduces significantly the number of concepts included in abstracts, keywords still provide insight into the word correspondence. The reason is that while abstracts comprise a higher amount of words and thus potentially interesting word associations, word frequency lists, keywords in context, co-occurrences of concepts or terms, abstract-associated keywords are more precise on providing results in which general statements and empty phrases are not included. There are several clusters of concepts which can be identified. Abstracts contain words which are more or less associated with the same intensity. There are only a few exceptions. Three of them are connected with application domains, engineering, health and energy. Another three terms represent the managerial perspective which emphasises the necessity of long-term approach to knowledge and technology transfer, policy, strategy and mission. Moreover, keywords also stress the role of learning. There are also several clusters of topics identifiable. The first one is connected with the academic environment and universities, the second one focuses on managerial issues including support of related processes by software applications and the third one is associated with the information and knowledge management.

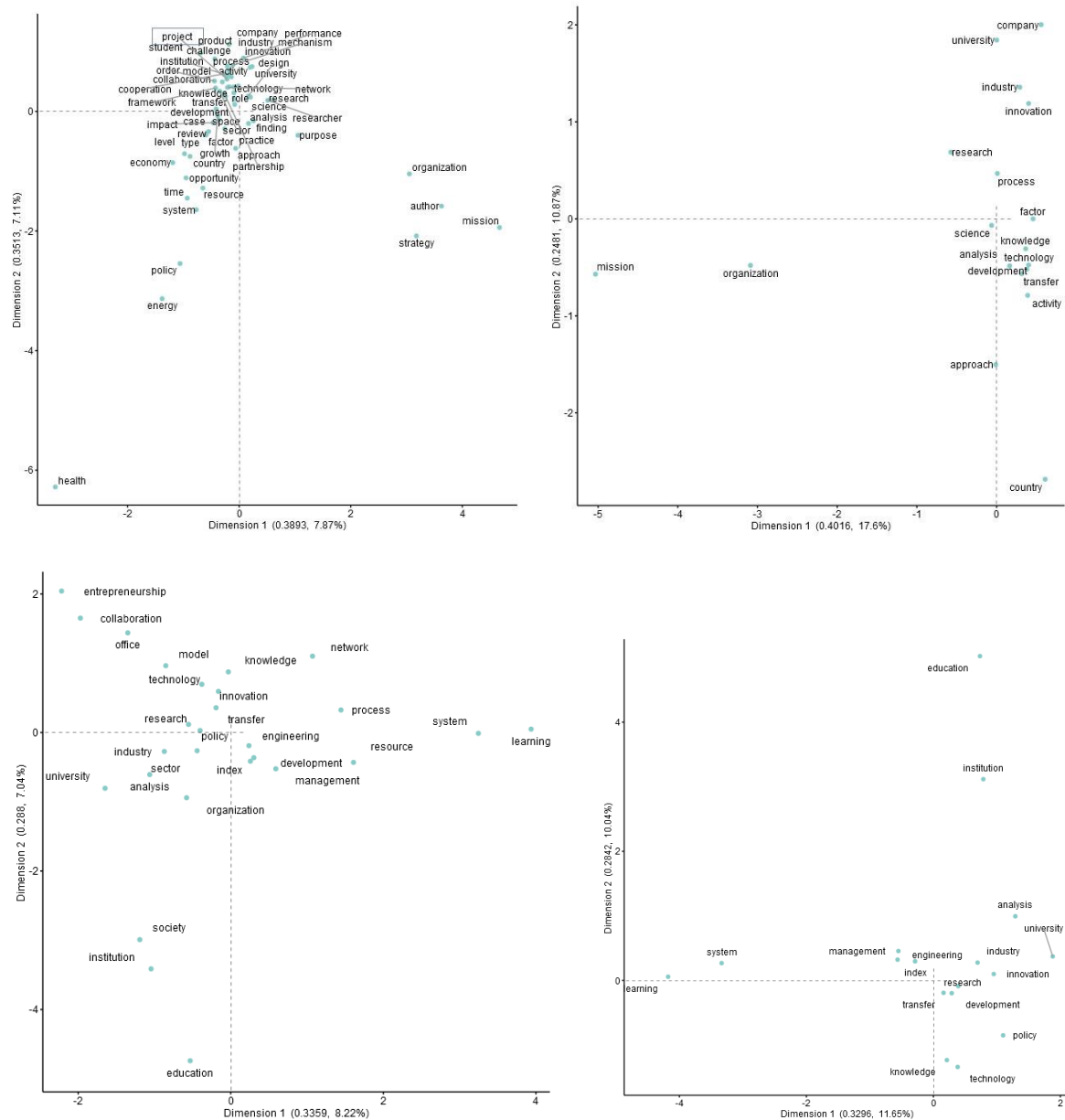


Figure 1. Correspondence analysis results: a) minimum TF 15, abstracts; b) minimum TF 25, abstracts; c) minimum TF 15, keywords; d) minimum TF 25, keywords. (Authors' research).

Results of the co-occurrence network analysis presented in Figure 2 partially support the outcome of the correspondence analysis. However, they bring quite less information as identified clusters are rather general than dealing with specific topics or issues. Especially when the term frequency is increased to 25, the figures' content becomes too vague and associated with common terms from the knowledge and technology transfer domain.

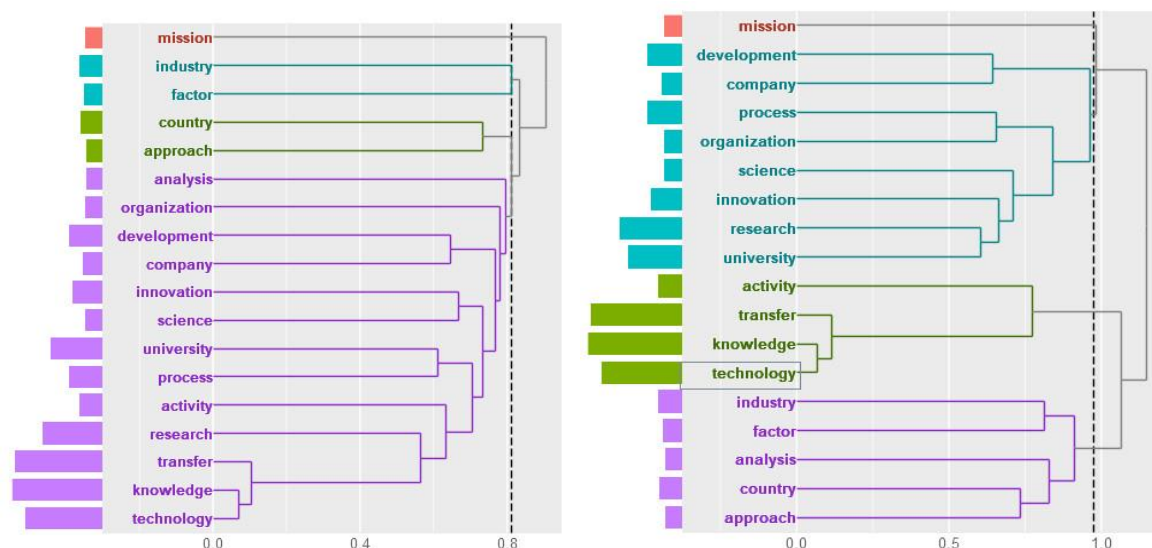


Figure 3. Hierarchical cluster analysis of abstracts: a) F25_average_Jaccard; b) F25_Ward_Jaccard. (Authors' research).

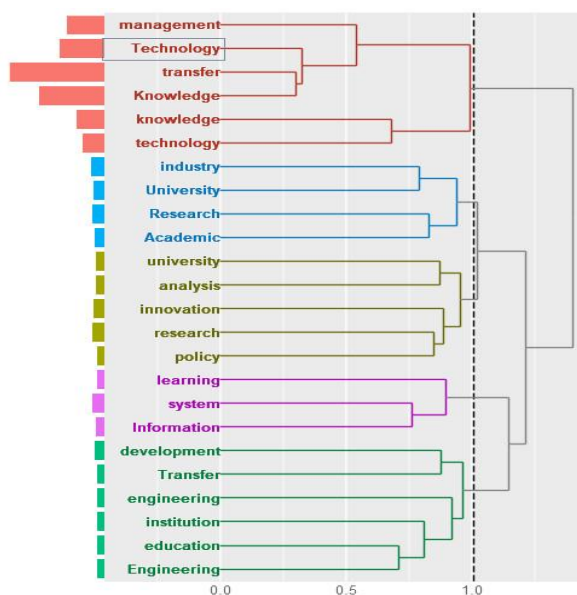


Figure 4. Hierarchical cluster analysis of keywords (F25_Ward_Jaccard). (Authors' research).

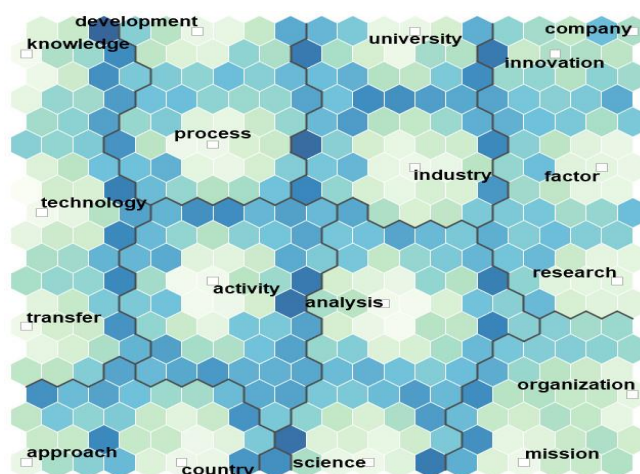


Figure 5. Self-Organising Map of abstracts. (Authors' research).

4. Discussion

Currently, the organisations from both public and private sector care about their business potential and the possibilities how to commercialise their research, innovations, production outputs and other activities. The provided analysis proved that the topics related to necessity of conceptual, properly planned and long-termly focused approach are crucial. The policy, strategy and mission represent the important prerequisites in the successful implementation of the systematic approach to the continuously rising number of transferred technologies. Campbell et al. (2020) claims that the policy-makers represent one group of the important users of research outputs. This directly corresponds with the results. Moreover, the impact of knowledge transfer outputs is connected with the new policies and innovations. Except from these, the keywords society is mentioned proving that there is particular overlap to the societal aspects and scientific benefits which correspond to the benefits of technology and knowledge transfer in general.

Hand in hand, the abovementioned results reveal the importance of learning and education. These keywords indicate the significant impact of these. No matter whether at the academic level or at the business level, the learning should be ideally continuous and efficient in terms of the value added. The teaching, learning, training or sharing lead to awareness increase followed by better knowledge exchange in pursuit to support the transfer and innovation in particular.

Obviously, the networking plays an essential role (OECD, 2013). This is closely related to the fact that keywords like partnership, collaboration or cooperation occur frequently. Apparently, this implies the need to cooperate and coordinate the knowledge and technology transfer activities. The interconnections and relations might lead to synergies, higher participation of the stakeholders and their interaction. Therefore, the linkage between university and organisation, university and industry, organisation and industry or various other connections might be identified. The keyword entrepreneurship is frequent specifying the essential role of businesses. Furthermore, the keyword country occurs as well which implies the relevance of the implemented activities at the national level.

The results show that the important areas - within which the technology and knowledge transfer is discussed among the literature analysed - comprise for example health sector or the engineering. Healthcare is considered as one best captured area connected with the evidence-based case studies (Campbell et al., 2020). Within this field, various methods of knowledge transfer such as Knowledge Maps, Ontologies, Process Modelling, Lessons Learned, Best Practice Sharing, Story Telling, Job Rotation or Communities of Practice might be applied and implemented (Kruse et al., 2015). Engineering sciences are even called like “transfer sciences” (OECD, 2013) which prove their role in that field. Nevertheless, there are interdisciplinary differences in the transfer intensity as well as tools and channels used occur (OECD, 2013).

Among the word clusters, three main areas were identified. These keywords were repeating relatively often and therefore show the close relation to as well as importance of these for the technology and knowledge transfer. The first area is represented by the *academic*

environment/universities. As mentioned above, the universities are an important part of the stakeholders as well as know-how holders. They provide particular knowledge, innovative ideas, theoretical support, technical background or resources needed. These might include the human, time, technological, space or another types. The value added for both parties is significant. For the company, the mentioned advantages might be attractive as they can reach relatively cheap workforce, interesting inputs and irreplaceable solutions thanks to the unbiased and 'fresh' academic perspective. For the academic institution, the possibility to solve 'real-world' problems and to be useful represent the crucial motivational aspects.

The second cluster of results prove that the *process*, *project* and *software* are present relatively frequently. These are relatively obvious as everything within organisations is related with particular processes. These can be just internal, external or both (see the networking discussion above). Currently, in a lot of organisations and institutions, the word project is used nearly for whatever. This fact explains its occurrence. Nevertheless, the technology and knowledge transfer itself usually represents a particular project involving various stakeholders, processes, tools and other components. The last element, software, is nearly ubiquitous for various purposes within a lot of daily activities and processes within the organisations.

The third cluster identifies the *information and knowledge management*. As these fields tackle with the information and knowledge which result in the technology and knowledge transfer, their presence is not surprising. No matter whether these are fully incorporated within the organisations or not, they represent importance supportive framework for smoother and more efficient technology and knowledge transfer. In case that the information and knowledge management is not managed well within the organisation, the problems might occur. This situation can be considered as a long-term issue in this domain (Bureš & Brunet-Thornton, 2009). The latter might include the confusing roles of employees, their unclear responsibilities, the uncaptured or not well managed knowledge, the unused potential of intellectual capital of the organisation (Bureš, 2006).

Generally speaking, there are various tools for technology and knowledge transfer support. These comprise for example various R&D and innovation grants, tax incentives, financial support to academic spin-offs, public-private partnerships or funding infrastructures (Campbell et al., 2020). Obviously, these tools for and channels of knowledge and technology transfer are not mentioned among the literature analysed. Also, the keywords identified miss doubtless the types of intellectual property or the aspects connected with the marketing of the technology and knowledge transfer. This was revealed even though the abovementioned issues represent important parts of the whole commercialisation process.

5. Conclusions

A lot of international, national and regional strategies, documents and reports emphasise the importance of research and the application of new knowledge in practice. The importance of innovation in promoting competitiveness and the further development of social, cultural and economic benefits followed by the overall progress is also highlighted (OECD, 2013). The responsible institutions and bodies focus on the appropriate supportive tools and

improvement of the real results of publicly funded research and development and their implementation including the practical application more effectively.

Scientific and academic staff represent key stakeholders in the process of intellectual property protection at universities as they are originators of achieved results. However, the whole process will not be possible without professional support at the institutional level in a form of individuals helping with realisation of transfer in practice or specialised technology transfer office. Such experts should not only assess the current state of the art of the planned results from the available databases, but also assess the applicability of these results within the process of commercialisation. There is an important role of collaboration among the scientists, academicians and the supporting staff who guides others during all stages of the commercialisation process.

From the future development perspective, it is necessary to significantly and purposefully strengthen the motivation of employees in this area, optimise and continue to support their individual development and further education with regard to the constantly changing legislative and economic conditions. Furthermore, it is necessary to define the conditions and alternatives of commercialisation options, facilitate administration and show and bring examples of good practice of mutual coexistence of academic and business sector. Technology and knowledge transfer will then significantly contribute to intensive social interaction and communication between the two sectors, as well as to the effective sharing of information and knowledge between the academic environment and the commercial world. For these purposes, there should be ideally established and implemented the strategy at the national level. The availability of consultancy services and centres of the intellectual property protection and technology transfer is beneficial. These can also support the start-ups and spin-off companies as well as provide the targeted networking and consultancy services.

The aim of knowledge transfer is to identify the business potential of particular invention, exploit and commercialise it. This corresponds with the paper results including the significant connection of the knowledge transfer with the continuous, complex and systematic approach to the research and development activities. These might comprise the mission and policy statement, followed by the setting of the strategy and the fulfilment of the aforementioned. These are researched and discussed within both the knowledge and technology transfer-related literature, and all levels of the organisational and institutional framework of the technology and knowledge transfer in practice.

Acknowledgments: The research has been partially supported by the Faculty of Informatics and Management UHK specific research project n. 2107 "Integration of Departmental Research Activities and Students' Research Activities Support". Authors also thank Marek Zanker for his assistance.

References

- Abraham T. (2004). *Twenty-First Century Plague: The Story of SARS*. Baltimore: The Johns Hopkins University Press.
- Bureš, V. (2006). Knowledge management and its implementation. In J. Cordeiro, V. Pedrosa, B. Encarnação, & J. Filipe (Eds.), *Proceedings of the 2nd International Conference on Web Information Systems and Technologies (WEBIST 2006)* (pp. 115-118). Setubal, Portugal.

- Bureš, V., & Brunet-Thornton, R. (2009). Knowledge Management: the Czech Situation, Possible Solutions and the Necessity for Further Research, In K. Dalkir (Ed.), *Proceedings of the 6th International Conference on Intellectual Capital, Knowledge Management and Organisational Learning* (pp. 95-102). Montreal, Canada.
- Campbell, A., Cavalade, C., Haunold, C., Karanikic, P., & Piccaluga, A. (2020). *Knowledge Transfer Metrics. Towards a European-wide set of harmonised indicators*. In M. Karlsson Dinnetz (Ed.), EUR 30218 EN, Publications Office of the European Union. Luxembourg. <https://doi.org/10.2760/907762>
- de la Hoz-Correa, A., Muñoz-Leiva, F., & Bakucz, M. (2018). Past themes and future trends in medical tourism research: A co-word analysis. *Tourism Management*, 65, 200–211. <https://doi.org/10.1016/j.tourman.2017.10.001>
- Delecroix, B., & Epstein, R. (2004). Co-word analysis for the non-scientific information example of Reuters Business Briefings. *Data Science Journal*, 3(15), 80–87. <https://doi.org/10.2481/dsj.3.80>
- Kruse, P., Kummer, C. & Jannack, A. (2015). Empowering Knowledge Transfer in Healthcare: A Framework of Knowledge Transfer Methods. In *Challenges and Opportunities in Health Care Management* (pp. 319-328). https://doi.org/10.1007/978-3-319-12178-9_25.
- Leonard, J. G., Pietrzyk, M., & Cser, L. (1999). *Mathematical and Physical Simulation of the Properties of Hot Rolled Products*. Oxford, United Kingdom: Elsevier.
- Ma, B., Wang, H., & Dsouza, M. et al. (2016). Geographic patterns of co-occurrence network topological features for soil microbiota at continental scale in eastern China. *ISME*, 10, 1891–1901. <https://doi.org/10.1038/ismej.2015.261>
- Marešová, P., Bureš, V., Štemberková, R., Matulová, P., Krejcar, O., Toman, J., & Škodová Parmová, D. (2020). *Od výzkumu po využívání v praxi: Vše kolem transferu znalostí a technologií*. Gaudeamus.
- Milojević, S., Sugimoto, C. S., Yan, E., & Ding, Y. (2011). The cognitive structure of library and information science: Analysis of article title words. *Journal of the American Society for Information Science and Technology*, 62(10), 1933–1953. <https://doi.org/10.1002/asi.21602>
- OECD. (2013). Knowledge transfer channels and the commercialisation of public research. In *Commercialising Public Research: New Trends and Strategies*. OECD Publishing. <https://doi.org/10.1787/9789264193321-5-en>
- Petrovic, S., Basic, B. D., Morin, A., Zupan, B., & Chauchat, J. H. (2009). Textual Features for Corpus Visualization Using Correspondence Analysis. *Intelligent Data Analysis*, 13(5), 795-813. <https://doi.org/10.3233/IDA-2009-0393>
- Shrum, W., & Genuth, J. et al. (2007). *Structures of Scientific Collaboration*. Boston: The MIT Press.
- Misra, S., Li, H., & He, J. (2020). *Machine Learning for Subsurface Characterization*. Gulf Professional Publishing.
- Williams, R., Runco, M. A., & Berlow, E. (2016). Mapping the themes, impact, and cohesion of creativity research over the Last 25 years. *Creativity Research Journal*, 28(4), 385–394. <https://doi.org/10.1080/10400419.2016.1230358>
- Yan, B. N., Lee, T. S., & Lee, T. P. (2015). Mapping the intellectual structure of the Internet of Things (IoT) field (2000–2014): A co-word analysis. *Scientometrics*, 105(2), 1285–1300. <https://doi.org/10.1007/s11192-015-1740-1>
- Yang, Y., Pouyanfar, S., Tian, H., Chen, M., Chen, S. C., & Shyu, M. L. (2017). IF-MCA: Importance factor-based multiple correspondence analysis for multimedia data analytics. *IEEE Transactions on Multimedia*, 20(4), 1024–1032. <https://doi.org/10.1109/TMM.2017.2760623>
- Zhang, Z., Murtagh, F., Van Poucke, S., Lin, S., & Lan, P. (2017). Hierarchical cluster analysis in clinical research with heterogeneous study population: highlighting its visualization with R. *Annals of Translational Medicine*, 5(4), 75. <https://doi.org/10.21037/atm.2017.02.05>
- Zhu, Q., Lin, L., Shyu, M. L., & Chen, S. C. (2010). Feature selection using correlation and reliability-based scoring metric for video semantic detection. In J. E. Guerrero (Ed.), *Proceedings of IEEE international conference on semantic computing* (pp. 462–469). Palo Alto, CA, USA.
- Zhu, Q., Lin, L., Shyu, M. L., & Chen, S. C. (2011). Effective supervised discretization for classification based on correlation maximization. In R. Alhajj, J. Joshi, & M. L. Shyu (Eds.), *Proceedings of IEEE international conference on information reuse and integration* (pp. 390–395). Las Vegas, NV, USA
- Zolfaghari, F., Khosravi, H., Shahriyari, A., Jabbari, M., & Abolhasani, A. (2019). Hierarchical cluster analysis to identify the homogeneous desertification management units. *PLoS ONE*, 14(12), e0226355. <https://doi.org/10.1371/journal.pone.0226355>

Forecasting of the Stock Price Using Recurrent Neural Network – Long Short-term Memory

Michal DOBROVOLNY¹, Ivan SOUKAL^{1*}, Ali SALAMAT², Anna CIERNIAK-EMERYCH³ and Ondrej KREJCAR¹

¹ University of Hradec Kralove, Hradec Kralove, Czech Republic; michal.dobrovolny@uhk.cz; ivan.soukal@uhk.cz; ondrej.krejcar@uhk.cz

² Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia; aselamat@utm.my

³ University of Economics in Wroclaw, Wroclaw, Poland; aemerych@wp.pl

* Corresponding author: ivan.soukal@uhk.cz

Abstract: We employ a recurrent neural network with Long short-term memory for the task of stock price forecasting. We chose three stocks from the same sub-industry: Visa, Mastercard, and PayPal. This paper aims to test the LSTM network's prediction on stock prices and propose the best settings for selected stock price forecasting. The secondary goal is to assess how the settings differed in the case of two highly correlated stocks (Visa-Mastercard year correlation coefficient average: 0.97) and the case of only weak correlated stock (Visa-PayPal correlation coefficient average: 0.39). We tested 117 different settings of LSTM neural networks. The settings differed by the number of epochs/splits (from ten to fifty-eight by the step of four) and the range (minute, hour, and day). Our dataset was the stock price from 1.6.2020 to 15.1.2021. The best performing network has been trained on a 10-day period for Visa and 10-minute for Mastercard and PYPL. However, the differences were negligible, so we did not find the number of epochs as a key setting, unlike in the case of FOREX.

Keywords: neural networks; stock price; forecasting; long short-term memory

JEL Classification: C53; C58

1. Introduction

Machine learning is a very promising and topical field. It counts among awards winning technology in many fields. Researchers are successfully finding more and more fields where Artificial intelligence (AI) can apply. Also, there are already proven fields — for instance, natural language processing, time series or image data (Abdel-Nasser & Mahmoud, n.d.; Peña-Barragán et al., 2011). In image data processing can be found examples about fixing an image (Wolterink et al., 2017; Yang et al., 2018), compression (Sun et al., 2020), super-resolution (Dobrovolny, Mls et al., 2020), image classification (Mambou et al., 2018) or forecasting (Abbasimehr et al., 2020; Chalvatzis & Hristu-Varsakelis, 2020; Dobrovolny, Soukal et al., 2020; Li et al., 2020; Zhang et al., 2021). Regardless of the field, researchers constantly try to improve their models with many variations and settings.

The aim of this paper is to determine what time period and the number of epochs is the best for the prediction of selected stock prices. We focused on three stocks – VISA,

MasterCard and PayPal with NYSE tickers V, MA, and PYPL. Such stocks were deliberately chosen to test how Recurrent neural network (RNN) will handle the titles from the same sub-industry (Financials – Credit/Payment Services) where moreover, two of them are expected to be strongly correlated and the remaining one is close to the role of disrupting competitor/innovator for more than two business cycles. Therefore, we summarize the research questions related to the main goal. Firstly, will the prediction result in the same time splits and overall quality for V and MA stocks? Secondly, will the prediction result in the same time splits and overall quality for V and PYPL from the same sub-industry?

This paper is divided into several parts. In the first chapter, we described areas of using neural networks for forecasting time series. In the second chapter, we described the basic RNN concept and LSTM network architecture. In the third section we presented our experiment and results. In the last chapter, we discuss our results and future work.

2. Methodology

2.1. Topic Overview

Regarding the Web of Science database, the topic of forecasting stock prices is increasing. We used a query ALL=(FORECAST AND STOCK AND PRICE AND NEURAL). Since 2014 there is more than double number of published articles; see Figure 1.

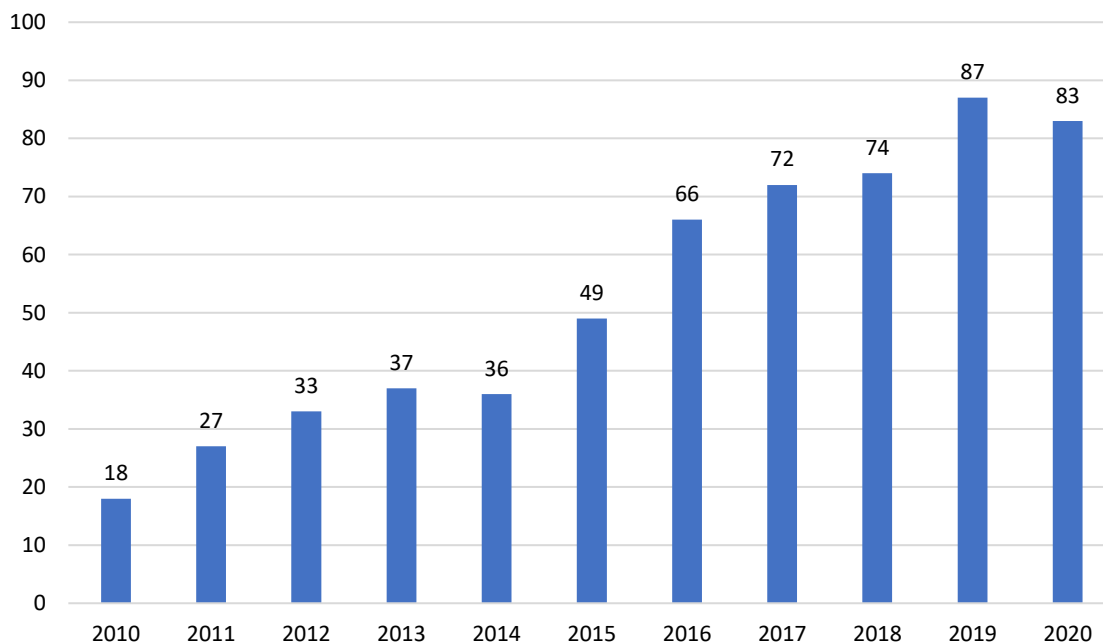


Figure 1. Yearly count of articles published on the Web of Science.

Keyword analysis in Figure 2 shows the connection between neural networks and keywords such as forecasting, stock-market, prediction in a total of the top 50 keywords in 4 clusters. The minimum occurrence of keywords was five times. The amount of all used keywords is 2182 from 757 articles. This analysis suggested the suitability of using RNN for stock price prediction. We also found out there are not many research papers using long short-term memory (LSTM).

LSTM's core concept is the cell state, and there are different gates. The cell state acts as a transport highway that transmits relative data all the way down the sequence chain. You can think of it as the network's "memory". In theory, the cell state will hold relevant information during the sequence's processing. So even data from the earlier time steps will lead to later time steps, decreasing the short-term memory impact. Data is added or removed to the cell state through gates as the cell state goes on its journey. The gates are various neural networks that determine which cell state data is enabled. Finally, as Hochreiter and Schmidhuber (1997) mentioned, during a training, the gates will learn what data is necessary to retain or forget. An alternative to LSTM is Gated Recurrent Units (GRU).

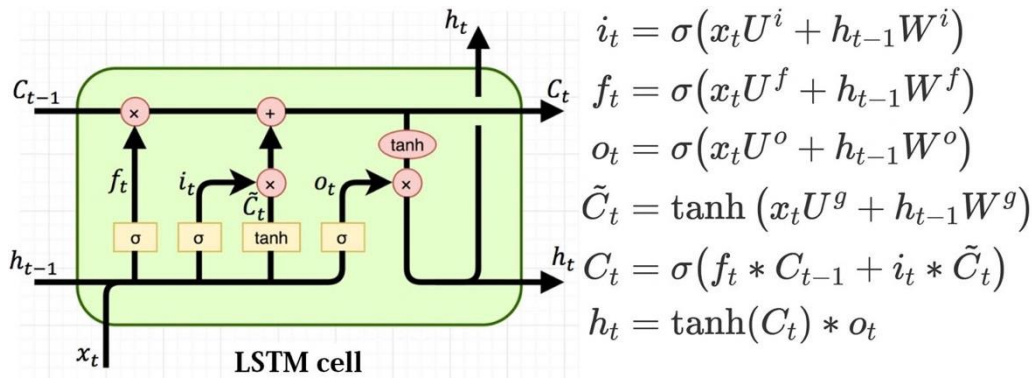


Figure 3. An illustration of LSTM cell with memory pipe (Varsamopoulos et al., 2020).

2.3. Dataset, HW and Data Treatment

As a programming language, we decided to use Python and its packages. Available packages were the main reason to choose the Python as a programming language. For data, we used package yfinance. This package provides a powerful API to download stock data on any point of history when they were available. It also provides a possibility to choose a time interval the value of a particular stock is aggregated into. For instance, the minute, hour or day period. This great opportunity we did use in our work to determine the best time period to make predictions which was the main purpose of this paper.

Data we used were stock values from 1.6.2020 until 15.01.2021. We tested intervals of 1 minute, 1 hour and 1 day. This dataset contained various values – Date as an index, Open, High, Low, Close, Adj Close, and Volume. In every phase of training and evaluation, we used only the High value.

LSTM, RNN, and NN generally are very performance demanding. Our computation computer has two dedicated cards with a total of 7,934 CUDA cores. These cards are one of the top-performing gaming cards of current NVIDIA cards. Because of framework support, we decided to use NVIDIA cards only. One of our cards is 1080TI with 11,176 MB graphic memory and 1.607 MHz max clock rate. Another one is 2080TI with 11,019 MB of graphics memory and 1,545 max clock rates. The used processor is i7-8700 with a 3.20 GHz clock.

Prediction validation was calculated by MSE and mean absolute error (MAE). Both methods are commonly used for neural network loss calculation. In our case, the used loss function was MSE

$$MSE = \sum_{t=1}^N e_t^2 / N \quad (1)$$

where e_t is the difference between the predicted and the actual value, N is a number of observations.

3. Results

Stock prediction is a very exciting field of study. Firstly, we focused on the correlation between the stocks. All are from the same industry providing substitutional services at a similar range. The daily data from the last five year timespan showed an extremely tight relation of price quotes between V and MA, see Figure 4. This relation became almost perfect in 2017 and 2019, reaching a correlation of 0.985. The correlation coefficient average was 0.97. The difference between V-MA open and close prices correlation was less than 1 %. A very tight relation was also present in the daily volume correlation analysis showing a correlation of 0.71. The price of PYPL is correlated to V, hence to MA as well, nevertheless the relation of a moderate to low strength for open prices for which the correlation coefficient average reached 0.39. A much stronger relation showed close prices with a correlation coefficient ranging from moderate to high positive relation strength values. The difference between V-PYPL open and close prices correlation was ranging from 18% to 66%.

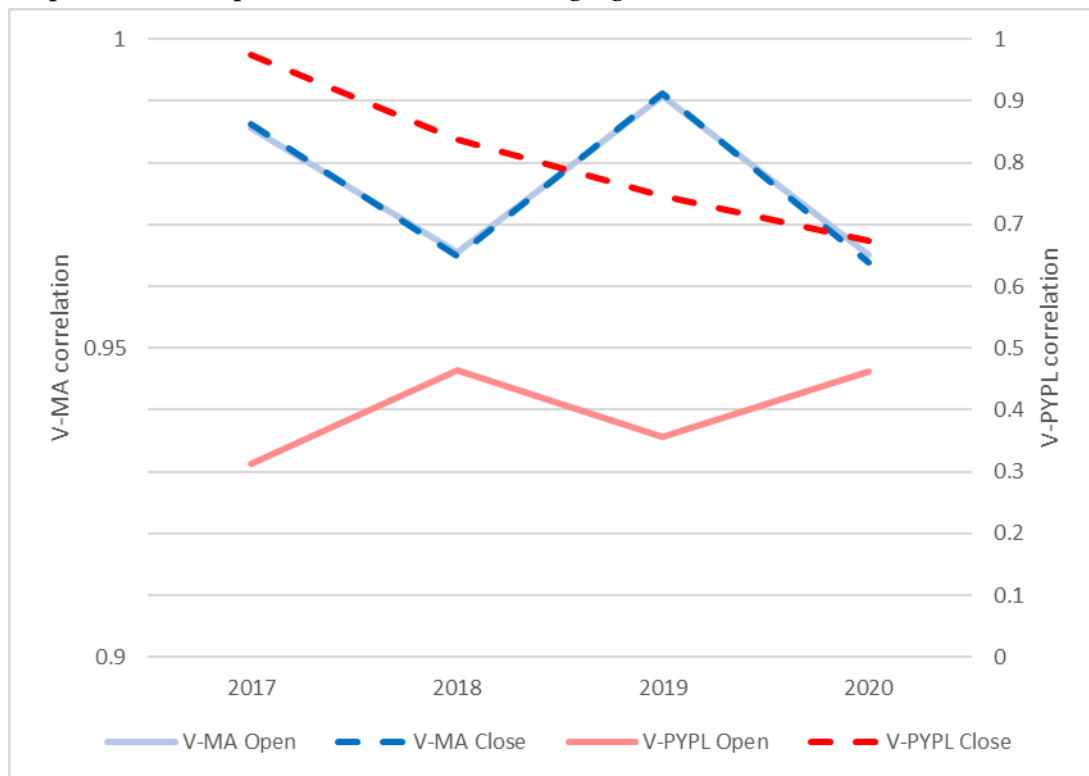


Figure 4. Correlation coefficients per year for V-MA (left axis) and V-PYPL (right axis) stock price quotes.

The weakest relation was found in the daily traded volume analysis. V-PYPL correlation coefficient of 0.37 indicated only a weak positive relation.

Our simple model with only one LSTM layer shows excellent performance on this dataset. The architecture we tested was constructed on top of LSTM layer. Our model

contains three LSTM units and one dense layer. The used optimizer was RMSprop, and the measured loss was MSE. We tested different time splits/epochs ranging from 10 to 58 by the step of four periods to test the impact of different time periods. In total, we have done 117 tests. All our experiments had batch size 32. We tested all stock for time periods 1 minute, 1 hour and 1-day range.

Figure 5 shows MSE values results for all three stocks based on minute range. We performed minute, hour, and day range-based prediction; however, for the demonstration, we chose only the minute range variant because it contained minimal MSE value for two out of three stocks.

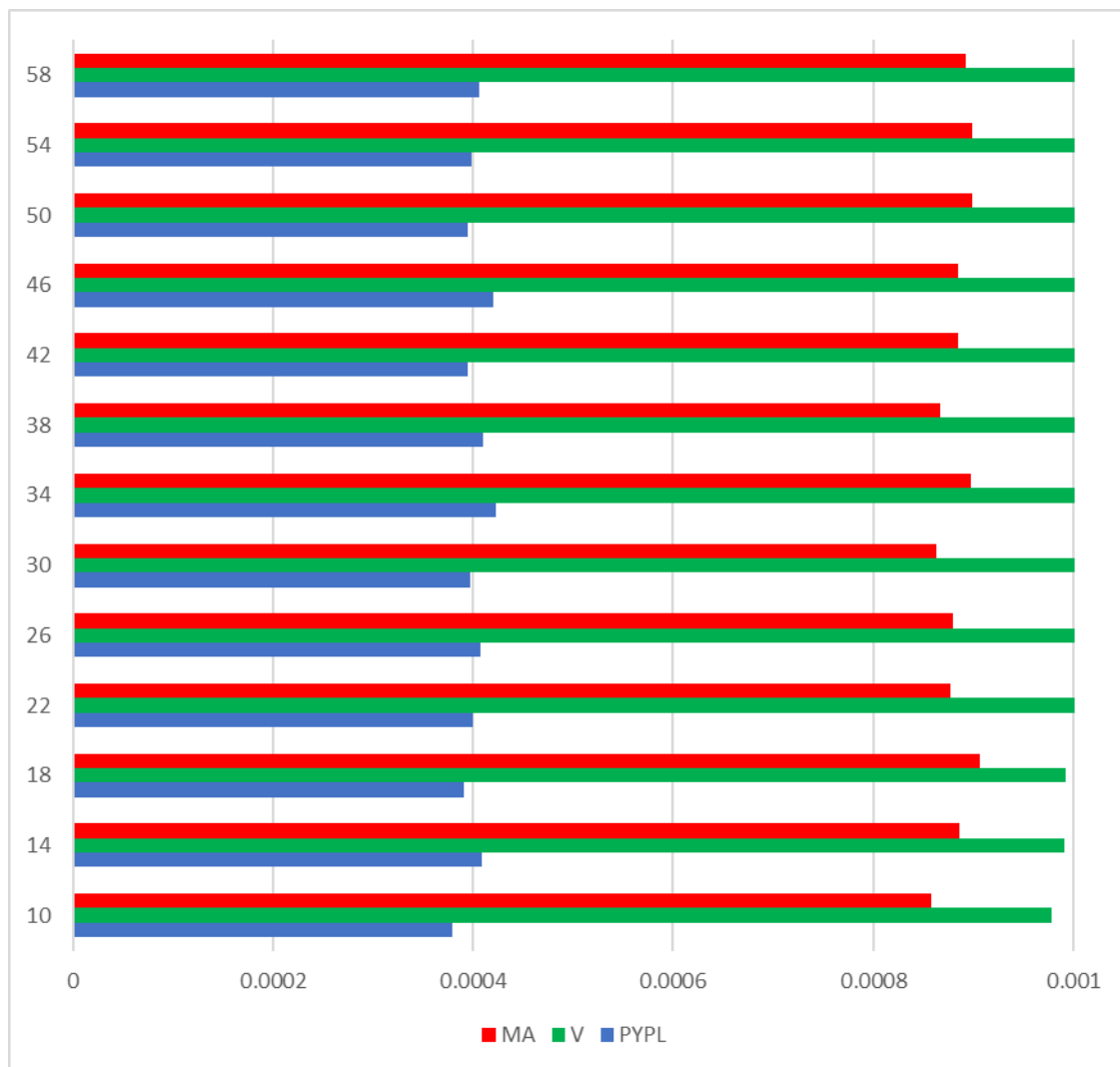


Figure 5. MSE values for MA, V, and PYPL stocks based on minute range and different epochs.

Firstly, the best quality showed prediction for the PYPL stock across the time split periods or epochs. Secondly, the lowest MSE values were calculated at 10 splits regardless of a stock. Thirdly, the difference between V and MA MSEs was less than 0.002. This is three-times lower than the average MSE difference of 0.006 between V and PYPL. Fourthly, the difference between MSE minimum and maximum was as small as $6.65\text{E-}5$ for V, $8.99\text{E-}5$ for MA, and $5.64\text{E-}5$ for PYPL.

As mentioned before, we also tested the impact of different time ranges on the predicted value. We tested minute, hour, and day ranges. The optimal time range was minute one for PYPL and MA, and day one for V. The optimal number of epochs/splits was, regardless of the range, ten. Figure 5. presents MSE minimal results for different ranges.

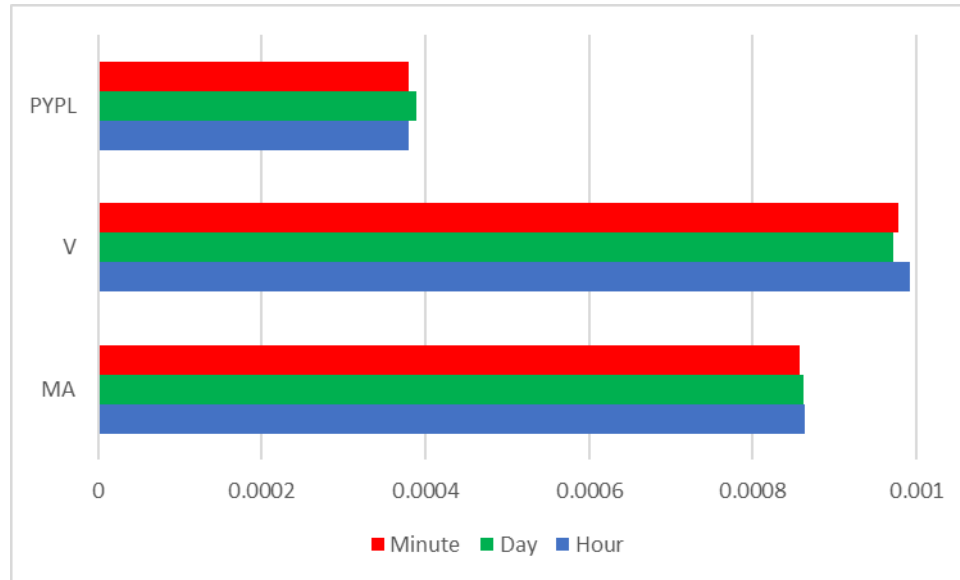


Figure 5. Comparison of MSE on different time period per stock.

Figure 5 shows that the difference in MSE minimal values were almost the same regardless of the range. To finish the presentation of the results, we provide a demonstration of the price chart with a prediction so there can be assessed how successfully our prediction matched the real price move for ten epoch and 1-minute range settings, see Figure 6.

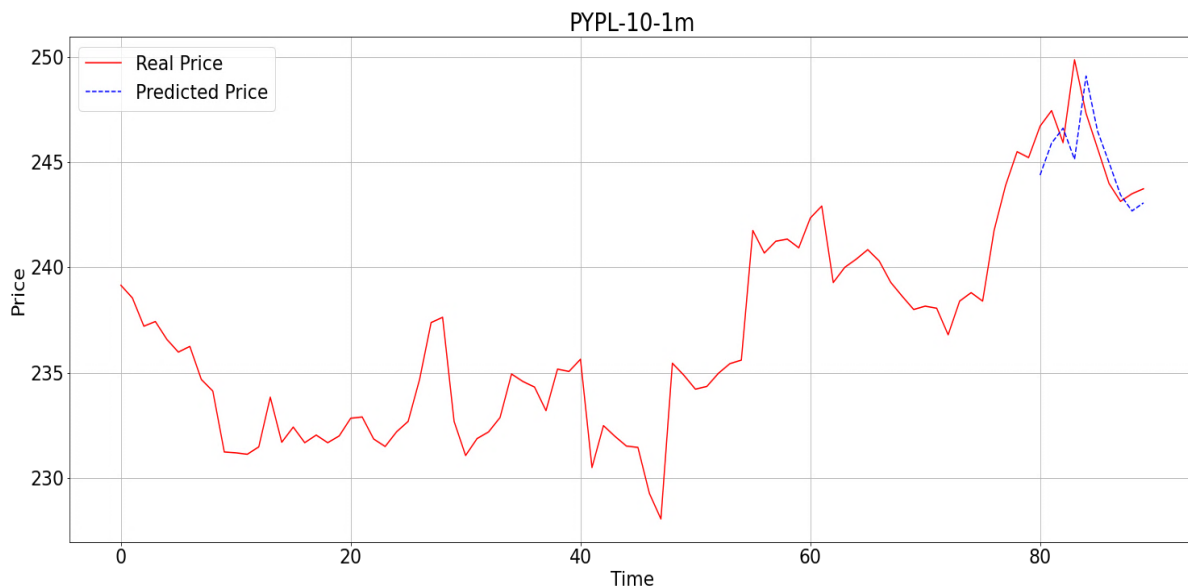


Figure 6. Predicted price for next 10 minutes of PYPL stock with input size of 10 minutes.

4. Discussion

Firstly, we interpret the correlation analysis. Correlation coefficients prove an extremely tight relation in V-MA stock price quotes and trading volumes since 2017. That is more than

two years before our own testing timespan starts. To reach the main goal of finding optimal time splits, we indeed managed to pick two separate, yet almost identical, companies from the stock price point of view. In the case of V-PYPL or due to a tight V-MA relation any V-PYPL can be considered to be almost identical to MA-PYPL, we found a positive however, much weaker relationship. Unlike V-MA the price quotes showed not only moderate relationship in price quotes but the traded volume analysis resulted in only weak positive relationship. Mainly open price quotes correlation manifested weaker bond which even decreased over time. We claim that in the case of PYPL we selected a company from the same sub-industry providing a similar range of services; however, its price changes had only weak relation to V or MA and so we managed to select the stock that differs from V or MA in terms of price shifts.

Secondly, our analysis of different ranges, as well as different epochs/splits, resulted into very little prediction quality variation. The difference between MSE minimum and maximum was extremely low. This applied to both in the same range and even when comparing ranges altogether. So yes, the best results were achieved with ten splits/epochs in a month range for PYPL and MA, and ten splits in day range for V. Nevertheless, it was almost as if it does not matter, from a practical point of view, which time split/how many epochs or range we used in settings. From this particular result, we can see that there is a great difference between predicting a stock value and FOREX value, where choosing the best settings had a significant impact (Dobrovolny, Soukal, et al., 2020).

Thirdly, we compare our finding of a low number of epochs but, in general, very little impact on the result quality/efficiency measured by MSE, to other authors. Other authors chose LSTM NN for stock price prediction with varying results. Chalvatzis and Hristu-Varsakelis (2020) employed structurally simple LSTM NN for price prediction generation based on price observations over a similar number of trading days and employed, among other metrics, the same prediction quality assessment by MSE. Their epoch settings were 11, 22, and 44. Although the focus was different, the interesting point is that they also found the shortest epoch as the optimal one, in our case 10, is the case of (Chalvatzis & Hristu-Varsakelis, 2020) it was 11.

Much higher number of splits/epochs were utilized in (Zhang et al., 2021). They tested two settings of 100 and 200 epochs. They assessed quality/efficiency by rootMSE. The best prediction results were found by a feature set (trading, liquidity, traditional attention, and new attention proxies) as model input, with no regard to a number of epochs. The state when the difference between lower and higher was negligible is in accord with our findings.

Study (Li et al., 2020) set the number of training epochs up to 500. Nevertheless, such a high number was never reached. Loss curves in the training set and the validation set reached the minimum at about the 50th epoch and sharply increased in the subsequent training iterations. Six different epoch settings were employed by (Abbasimehr et al., 2020) from 50 to 500. The hyperparameters for the best-resulted LSTM model included 500 epochs by rootMSE.

As mentioned before, the number of epochs choices for LSTM NN stock price prediction models showed varying results. We conclude the discussion section by the claim that our results were in accord with several.

In connection with our current work, we would like to continue in the field of applications such as a stock index prediction, cryptoassets, or commodities, especially gold for which (Král & Olszanska, 2020) claimed that regardless of a period, gold investment was profitable.. At the same time, over the current results, we would like to program a robot for automatic trading, which would be used to verify our results over real-time data in operation.

5. Conclusions

We studied a highly topical issue of machine learning application for stock price prediction. We employed LSTM NN, for which we tested different settings of epochs to find the optimal one assessed by the MSE criterion. We chose for our model three stocks listed in the NYSE: V, MA, and PYPL. All three were selected on purpose to investigate our secondary objective. That was a comparison of prediction for two highly, almost perfectly, correlated stock versus much less, but still making business in the same sub-industry, stock. We confirmed that the relation between V-MA prices is an extremely tight, almost perfect positive correlation. Their close relationship in the three-year timespan was confirmed by also traded volume correlation above 0.7. The relation between V-PYPL was much less strong, mainly regarding open prices showing only a weak positive correlation coefficient. Similarly, the correlation in traded volumes was weak.

The price prediction by LSTM NN results was evaluated by MSE values. We tested different time splits/epochs ranging from 10 to 58 by the step of four periods to test the impact of different time periods. The best results were achieved with ten splits/epochs in a month range for PYPL and MA, and ten splits in day range for V. Nevertheless, it was almost as if it does not matter, from a practical point of view, which time split/how many epochs or range we used in settings. From this particular result, we can see a great difference between predicting stock value and FOREX value, where choosing the best settings had a significant impact. This result was in accord with another study (Zhang et al., 2021) and low number of epochs was in accord with (Chalvatzis & Hristu-Varsakelis, 2020). The rest of the applications utilized significantly more epochs to reach optimal MSE or rootMSE values.

References

- Abbasimehr, H., Shabani, M., & Yousefi, M. (2020). An optimized model using LSTM network for demand forecasting. *Computers & Industrial Engineering*, 143, 106435. <https://doi.org/10.1016/j.cie.2020.106435>
- Abdel-Nasser, M., & Mahmoud, K. (n.d.). Accurate photovoltaic power forecasting models using deep LSTM-RNN. In *Neural Computing and Applications* (pp. 2727–2740).
- Chalvatzis, C., & Hristu-Varsakelis, D. (2020). High-performance stock index trading via neural networks and trees. *Applied Soft Computing*, 96, 106567. <https://doi.org/10.1016/j.asoc.2020.106567>
- Dobrovolsky, M., Mls, K., Krejcar, O., Mambou, S., & Selamat, A. (2020). Medical Image Data Upscaling with Generative Adversarial Networks. In I. Rojas, O. Valenzuela, F. Rojas, L. J. Herrera, & F. Ortuño (Eds.), *Bioinformatics and Biomedical Engineering* (Vol. 12108, pp. 739–749). Springer International Publishing. https://doi.org/10.1007/978-3-030-45385-5_66

- Dobrovolny, M., Soukal, I., Lim, K. C., Selamat, A., & Krejcar, O. (2020). Forecasting of FOREX Price Trend using Recurrent Neural Network - Long short-term memory. In P. Maresova, P. Jedlicka, K. Firlej, & I. Soukal (Eds.), *Hradec Economic Days 2020* (pp. 95–103). <https://doi.org/10.36689/uhk/hed/2020-01-011>
- Hochreiter, S., & Schmidhuber, J. (1997). Long Short-Term Memory. *Neural Computation*, 9(8), 1735–1780. <https://doi.org/10.1162/neco.1997.9.8.1735>
- Král, M., & Olszanska, A. (2020). Investing in Gold: Good or Bad Choice? 20-Year History. In P. Maresova, P. Jedlicka, K. Firlej, & I. Soukal (Eds.), *Hradec Economic Days 2020* (pp. 382–389). <https://doi.org/10.36689/uhk/hed/2020-01-044>
- Li, X., Wu, P., & Wang, W. (2020). Incorporating stock prices and news sentiments for stock market prediction: A case of Hong Kong. *Information Processing & Management*, 57(5), 102212. <https://doi.org/10.1016/j.ipm.2020.102212>
- Mambou, S., Maresova, P., Krejcar, O., Selamat, A., & Kuca, K. (2018). Breast Cancer Detection Using Infrared Thermal Imaging and a Deep Learning Model. *Sensors*, 18(9), 2799. <https://doi.org/10.3390/s18092799>
- Peña-Barragán, J. M., Ngugi, M. K., Plant, R. E., & Six, J. (2011). Object-based crop identification using multiple vegetation indices, textural features and crop phenology. *Remote Sensing of Environment*, 115(6), 1301–1316. <https://doi.org/10.1016/j.rse.2011.01.009>
- Sun, Y., Chen, J., Liu, Q., & Liu, G. (2020). Learning image compressed sensing with sub-pixel convolutional generative adversarial network. *Pattern Recognition*, 98, 107051. <https://doi.org/10.1016/j.patcog.2019.107051>
- Varsamopoulos, S., Bertels, K., & Almudever, C. G. (2020). Comparing neural network based decoders for the surface code. *IEEE Transactions on Computers*, 69(2), 300–311. <https://doi.org/10.1109/TC.2019.2948612>
- Wolterink, J. M., Leiner, T., Viergever, M. A., & Isgum, I. (2017). Generative Adversarial Networks for Noise Reduction in Low-Dose CT. *IEEE Transactions on Medical Imaging*, 36(12), 2536–2545. <https://doi.org/10.1109/TMI.2017.2708987>
- Yang, Q., Hou, X., & Zhang, L. (2018). Measurement of natural and cyclical excess capacity in China's coal industry. *Energy Policy*, 118, 270–278. <https://doi.org/10.1016/j.enpol.2018.03.052>
- Zhang, Y., Chu, G., & Shen, D. (2021). The role of investor attention in predicting stock prices: The long short-term memory networks perspective. *Finance Research Letters*, 38, 101484. <https://doi.org/10.1016/j.frl.2020.101484>

The Potential of Low-Carbon Development of the Polish Economy

Maria DZIKUĆ¹, Szymon SZUFA², Janusz ADAMCZYK¹, Maciej DZIKUĆ^{1*} and Piotr KUŁYK¹

1 University of Zielona Góra, Zielona Góra, Poland; ma.dzikuc@wez.uz.zgora.pl; m.dzikuc@wez.uz.zgora.pl
j.adamczyk@wez.uz.zgora.pl; p.kulyk@wez.uz.zgora.pl

2 Lodz University of Technology, Łódź, Poland; szymon.szufa@p.lodz.pl

* Correspondence: m.dzikuc@wez.uz.zgora.pl

Abstract: Poland is currently a dynamically developing country belonging to the European Union. However, the economic development does not go hand in hand with improving the quality of the environment. The air quality in Poland is one of the worst in the entire European Union. Although industry generally meets current ecological standards (especially large enterprises), the air quality is negatively affected by heating buildings, road transport, agriculture and small enterprises. It should be emphasized that heating single-family houses using old, energy-inefficient boilers, in which low-quality fuel is burned, has the greatest impact on poor air quality in Poland. Despite actions taken to reduce emission in Poland, concentrations of harmful substances in the air are still exceeded. Poor air quality contributes to the additional costs associated with the absence of sick workers in the workplace. The aim of the article is to present the conditions related to the low-carbon development in Poland. The article indicates the potential of the LCA technique, which can effectively support activities for low-carbon development.

Keywords: economy; low-carbon development; energy; Poland

JEL Classification: O11; Q53; Q56

1. Introduction

The economic development that has taken place in Poland over the last three decades has translated into the quality of infrastructure and the standard of living of Poles. However, the economic development has too little impact on reducing the amount of pollution that gets into the air (Truong et al., 2019). It is important that in Poland the problem is not only the excessive amount of CO₂ emitted into the air, but also other substances that directly affect human health and the environment (Yang and Liu, 2018). The excessive CO₂ emission has a negative impact on the environment, but from the social point of view it is not felt in the short term (Dzikuc et al., 2020). Changes caused by the excessive CO₂ emission are spread over time and it is more difficult to attribute a specific number of illnesses or premature deaths to people (Wattanakuljarus, 2019; Bedir & Yilmaz, 2016; Stewart et al., 2019). From the residents' point of view, harmful substances such as suspended particulates or benzo(a)pyrene – B(a)P, which directly affect human health, may seem more important (Balmes, 2019). Pollutants contained in the air, such as particulate matter PM_{2.5} and PM₁₀ are not only the cause of malaise, but also contribute to the occurrence of serious respiratory and cardiovascular diseases. Furthermore, air pollution can affect the formation and strengthening of mental disorders. Various air pollutants, in particular particulate matter and nitrogen oxides, may be associated with poor

mental health. Long exposure to PM_{2.5} may increase the risk of depressive symptoms (Sass et al., 2017). However, increased levels of nitrogen dioxide can lead to worsening of existing depressive conditions (Buoli et al., 2018). The aim of the article is to present the conditions related to the low-carbon development in Poland. The article indicates the potential of the LCA technique, which can effectively support activities for low-carbon development.

2. The Sources of Air Pollution

Many factors affect the air quality. The most important of them include: the amount and type of raw materials used for energy production, the share of ecological installations, including those based on renewable sources (Figure 1). Poland uses a large amount of solid fuels, which often contribute to air pollution during combustion (Ciupek et al., 2019; Zaporozhets and Khaidurov, 2020). In 2016, almost 20% less solid fuels were burned in Poland than in Germany, where more than twice as many people live as in Poland (Cutz et al., 2019). In addition, Germany is the fourth economy in the world that produces much more products than Poland. In Poland, gas fuels are used to a much lesser extent than in other EU countries of similar size, whose combustion pollutes the environment to a lesser extent (Bitat, 2018).

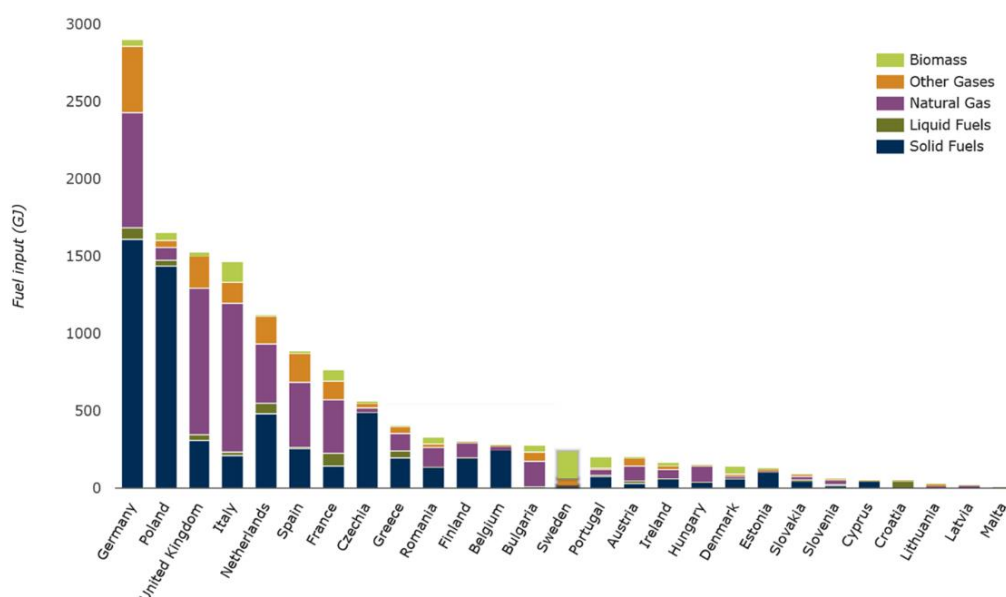


Figure 1. Fuel inputs used in 2017 by country and fuel type. European Environment Agency (2019)

An important factor affecting the air quality is also the technology used for generating energy. This is especially important when burning fossil fuels, because old technologies are characterized by much lower energy efficiency and contribute to the emission of much more harmful gases and dust into the air. Another factor is the use of filters that allow the retention of the vast majority of harmful substances that do not get into the air. However, it should be emphasized that mainly large industrial plants and power plants are equipped with this type of installations. Smaller installations, such as home boiler rooms, are not equipped with any filters, which is particularly noticeable during the heating season (Dzikuć et al., 2017). An additional problem is the fact that a large proportion of single-family houses in Poland do not have adequate thermal insulation, which increases the consumption of thermal

energy, which is often produced using energy-inefficient boilers. It is estimated that approximately 3.5 million flats, mainly single-family buildings, require thermal modernization in Poland (Piwowar, 2019; Junga et al., 2020).

The last three decades have been a period in which excessive emission of harmful substances has been largely reduced, the source of which was industry and the energy sector (Leisen et al., 2019; Garba et al., 2020). Although the CO₂ emission has still not been reduced. However, this will not be done in the coming years because the energy sector in Poland is based on coal and it will be possible to switch it to other sources only in the long run (Szufa et al., 2020b; Romanowska-Duda et al., 2020; Piwowar & Dzikuć, 2019). Currently, industry in Poland meets ecological standards (especially large enterprises). However, the air quality is greatly affected by heating buildings, road transport (Dzikuć et al., 2017; Laskowski et al., 2019; Bielaczyc & Woodburn, 2019), agriculture and small businesses. It should be emphasized that heating single-family houses using old, energy-inefficient boilers, in which low-quality fuel is burned, has the greatest impact on poor air quality in Poland.

According to the report of the European Environment Agency (EEA) entitled "Air quality in Europe – 2018", Poland is one of the countries with the most polluted air in the EU. According to EEA, there are 19 out of 20 cities most polluted by B(a)P in Poland. EEA analysed data on air pollution in 2016 in over 2.5 thousand cities from 41 European countries (including all EU countries). The concentration of suspended dusts (PM_{2.5} and PM₁₀), carcinogenic B(a)P, nitrogen oxides as well as sulfur and ozone compounds were tested. Unfortunately, Polish cities are among the most polluted in the EU. According to the guidelines, WHO indicates that the average annual B(a)P concentration should not exceed 1 ng/m³. However, in many cities in Poland this level is exceeded many times during the heating season, e.g. in Nowa Ruda, the B(a)P level is almost 18 ng/m³. Unfortunately, Nowa Ruda is not the only city in Poland where the level of B(a)P is exceeded several times. Moreover, the excessive concentration of particulate matter in the air, PM_{2.5} and PM₁₀, means that Polish cities are also among the infamous leaders in the EU's most polluted.

It should be emphasized that in recent years in Poland the level of B(a)P emission has been at a similar level (Table 1). Poland is not the only country in the EU where the B(a)P concentration in the air has not been reduced in recent years (Czyżewski et al., 2020). However, in Poland, B (a) P emissions are the highest in the entire EU. The problem of excessive concentrations of B(a)P in the air does not only apply to highly industrialized and densely populated areas. Also, less industrialized regions (Kopczyński et al., 2017), where the population density is lower than in other parts of the country, may be excessively contaminated by B(a)P.

Analyzing the distribution of the average annual normative value of the concentration of B(a)P contained in PM₁₀ in Poland in 2017, it should be noted that the problem concerns almost every major town in the country. The results of B(a)P concentration in the air obtained in 2017 indicate a significant exceeding of the target level specified for this substance in all zones where measurements were carried out (Dzikuć, 2013). Due to significant exceeding of permissible concentrations of B(a)P in the air in Poland, almost all zones were included in class C, which creates the obligation to develop air protection programs. Only 3 zones out of

Table 1. Member State contributions to EU emissions of B(a)P. European Environment Agency (2019)

Member State	Benzo(a)pyrene (Mg)													Change (%)		Share in EU-28 (%)	
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	1990-2018	2017-2018	1990	2018
Austria														-83	-0.9	2.3	0.9
Belgium	15	12	9.6	7.7	5.3	4.7	4.0	3.9	2.6	2.7	2.8	2.6	2.6	-83	-0.9	2.3	0.9
Bulgaria	83	77	1,900	3,429	20	31	39	43	100	106	101	71	4.9	-94	-93.0	12.2	1.8
Croatia	7.0	5.7	5.1	6.3	6.0	5.7	5.6	5.5	4.8	5.4	5.2	5.0	4.8	-32	-3.7	1.0	1.7
Cyprus	2.4	1.9	1.1	0.7	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	-95	10.1	0.3	0.0
Czechia	91	60	17	14	17	17	17	17	16	16	16	16	16	-83	-2.6	13.5	5.7
Denmark	3.5	3.6	3.0	3.1	2.5	2.2	2.2	2.2	2.0	2.2	2.3	2.3	2.2	-36	-1.1	0.5	0.8
Estonia	2.4	2.8	2.4	2.1	2.4	2.0	2.0	2.1	2.0	2.0	2.0	2.2	2.2	-5	0.1	0.4	0.8
Finland	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	21	-0.4	0.0	0.1
France	13	13	9.8	7.3	6.0	5.1	5.5	5.8	5.0	5.0	5.1	5.0	4.7	-63	-4.7	1.9	1.7
Germany	139	48	31	23	35	31	35	37	29	30	28	29	28	-80	-2.9	20.6	10.3
Greece	37	40	39	39	35	36	36	36	32	31	30	31	31	-16	0.9	5.4	11.3
Hungary	26	9.9	8.5	7.8	9.6	11	12	12	9.4	9.9	10	9.8	8.0	-69	-18.4	3.9	2.9
Ireland	14	8.6	6.1	5.6	5.2	4.9	4.7	5.1	4.4	4.3	4.0	3.6	3.7	-73	3.9	2.0	1.4
Italy	10	11	11	12	21	14	19	19	17	18	17	19	17	67	-10.2	1.5	6.1
Latvia	6.3	6.0	6.1	4.8	3.6	3.7	3.6	3.2	3.1	2.6	2.5	2.8	2.9	-54	3.8	0.9	1.1
Lithuania	6.4	3.1	3.2	3.6	3.8	3.8	3.8	3.7	3.4	3.1	3.2	3.2	3.2	-51	-0.9	0.9	1.2
Luxembourg	1.2	0.6	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.2	-85	10.2	0.2	0.1
Malta	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	-96	-93.8	0.0	0.0
Netherlands	4.9	2.9	1.8	1.9	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	-68	-2.2	0.7	0.6
Poland	101	123	73	93	101	87	87	82	72	72	75	75	73	-27	-2.1	14.9	26.6
Portugal	8	7	6	5	4	4	4	4	4	4	4	4	5	-39	9.1	1.1	1.7
Romania	17	10	16	18	20	18	19	18	18	18	18	17	17	5	-0.2	2.5	6.4
Slovakia	15	8.3	7.7	9.4	8.8	8.4	8.7	8.1	6.6	7.1	7.3	7.1	6.2	-59	-12.8	2.2	2.3
Slovenia	2.8	2.2	2.0	2.4	2.5	2.5	2.4	2.5	2.0	2.2	2.2	2.1	1.9	-31	-8.9	0.4	0.7
Spain	30	25	27	26	30	30	26	31	26	29	32	28	28	-8	-1.0	4.5	10.1
Sweden	6.2	6.3	4.9	5.3	3.4	3.3	3.1	3.0	2.8	2.7	2.7	2.6	2.3	-64	-13.6	0.9	0.8
United Kingdom	35	23	6.9	6.0	7.8	6.8	7.8	8.2	7.2	7.8	7.9	7.7	8.1	-77	4.7	5.1	2.9
EU-28 ^(a)	676	511	2,199	3,735	351	334	350	354	374	382	381	348	275	-59	-21.1	100	100
EU-28 ^(b)	676	511	2,199	3,735	351	334	350	354	374	382	381	348	275				

^(a) Sum of national totals, as reported by EU Member States and the United Kingdom. ^(b) Sum of sectors.

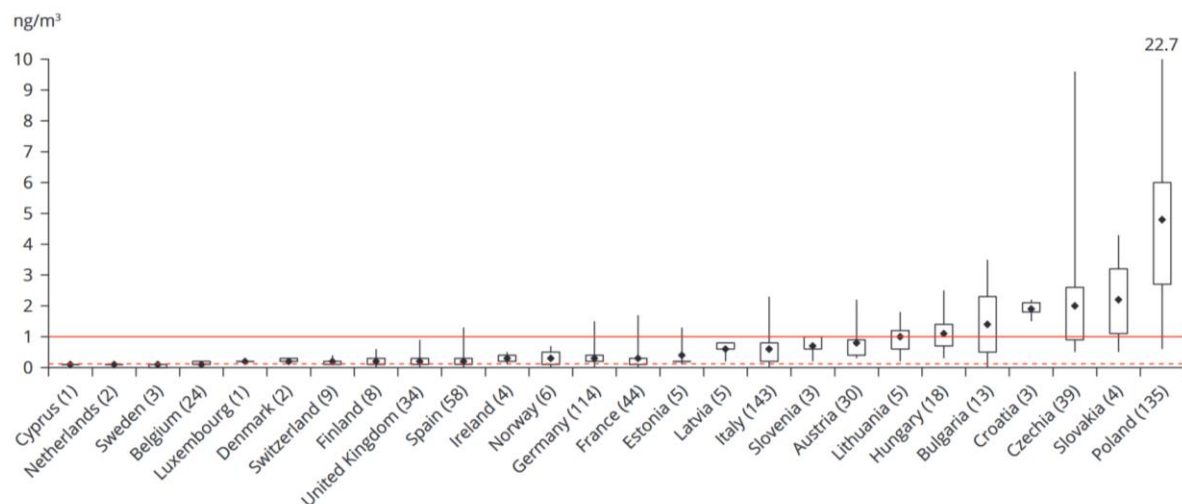


Figure 2. B(a)P concentrations in 2017 and number of stations considered for each country. World Health Organization (2020)

46 examined, i.e. the city of Koszalin, the city of Olsztyn and the Tri-City Agglomeration were qualified to zone A, which means that only these 3 locations are characterized by no exceedances of B(a)P concentrations in the air (Inspectorate of Environmental Protection 2018). The scale of excessive concentrations of B(a)P in the air that occur in Poland is clearly illustrated in Figure 2.

Figure 2. is based on the annual mean concentration values. For each country, the number of stations considered (in brackets), and the lowest, highest and average values (in ng/m³) recorded at its stations are given. The rectangles mark the 25th and 75th percentiles. At 25% of the stations, levels are below the lower percentile; at 25% of the stations, concentrations are above the upper percentile. The upper horizontal line marks the concentration of 1.0 ng/m³. The lower horizontal line marks the estimated air quality RL. The graph should be read in relation to Map 6.1, as a country's situation depends on the number of stations considered. The highest value for Poland, 22.7 ng/m³, is out of the graph for representation purposes.

When analysing air pollution in Poland, the CO₂ emission should not be neglected, although from the point of view of residents, excessive CO₂ may seem like a smaller problem, because this greenhouse gas does not directly affect the quality of the environment and human health in a short period of time. In the long run, however, the excessive CO₂ emission can be harmful to humans due to the deterioration of the quality of life through global warming, which in turn can cause more frequent rapid atmospheric phenomena (Dai et al., 2015). However, the effects of global warming can be observed more and more often not only in the world, but also in Poland. These include violent atmospheric phenomena and melting of glaciers (Szufa et al., 2020a).

According to Eurostat estimates, the level of CO₂ emission from energy consumption in 2018 fell by 2.5% in the EU compared to 2017. CO₂ emissions are an important factor affecting global warming and account for around 80% of all EU greenhouse gas emissions. It should be emphasized that, according to Eurostat estimates, while CO₂ emissions fall across the EU, in Poland it has increased. The increase in the share of CO₂ emissions in Poland results from economic growth and the fact that the energy sector is based in 80% on coal, whose combustion is the main reason for the increase in CO₂ emissions (Woźniak & Pactwa, 2018).

Poland will be forced to reduce CO₂ emissions in the future not only because of the EU policy, but also for economic reasons, as prices of CO₂ emission allowances have increased several times over the past several months. The Polish economy, which is dominated by coal, will be less competitive compared to countries whose energy systems are based more on renewable energy or nuclear energy. High prices of CO₂ emission allowances in the long run will force greater activity in Poland in the implementation of low-carbon solutions that have not been economically justified until now (Costantini et al., 2019).

3. The Impact of Air Pollution on Life Quality

Excessive amounts of harmful substances in the air affect many aspects of human life and the environment. Regardless of whether the analysis will include substances that are felt by people in a short period of time, e.g. B(a)P. Also important are gases that affect the environment and, consequently, people's quality of life, such as CO₂, whose impact is spread over time, but changes caused by rising average temperatures on the earth are noticeable and can be very severe for the inhabitants of most regions of the world. Repeated heat waves during the summer, which are especially dangerous for older people, can increasingly lead to tens of thousands of deaths.

Despite actions taken to reduce emission in Poland, concentrations of harmful substances in the air are still often exceeded and the air quality in Poland is one of the worst in the entire EU. Poor air quality not only contributes to the deterioration of living conditions of residents, but also affects the need to incur additional costs associated with the absence of sick employees in the workplace. Moreover, it is estimated that about 47.5 thousand people die every year in Poland due to poor air quality (Table 2) (World Health Organization, 2020). Which significantly exceeds the EU average. This result is mainly affected by air pollution with PM_{2.5} suspended dust, which is characterized by almost the highest annual average. Only Bulgaria is more polluted with 2.5 dust. Poor air quality, caused by excessive emission of particulate matter, is not a new problem in Poland and has been recorded in principle since the beginning of measurements of airborne concentrations of this harmful substance. In contrast, Poland has slightly lower NO₂ pollution than the EU average and close to the average ozone concentration.

Extreme weather events can, as a consequence, lead to the loss of health or lives of many people and paralyze the conduct of business. The resources needed to rebuild damaged infrastructure are often calculated in millions of euros. Much of the damage is conditioned by extreme weather phenomena. In addition, higher air temperatures affect the length of the growing season, not only in Poland and the EU, but in many places around the world. The flowering and harvesting season for cereals is accelerating, which may bring some positive changes in regions that have hitherto had a cooler climate, e.g. northern Europe (Kibria et al., 2018). However, a more serious problem is the increase in temperature, which may lead to a decrease in the amount of rainfall, thereby reducing crop yields in central and southern Europe, including Poland.

Another effect of excessive human interference in the environment through excessive emission of gases and dust into the air is the melting of glaciers and rising sea and ocean

levels, which will flood the areas previously inhabited by people and used by them for the purposes of agriculture or running business activities. The oceans' temperature rise accelerates the metabolism of organisms and increases their oxygen consumption. This reduces the oxygen concentration in the water and, as a consequence, can lead to a situation where some of the marine waters begin to die.

Table 2. Premature deaths attributable to PM_{2.5} and NO₂ exposure in the EU-28, 2015. European Environment Agency (2019)

Country	Population (1,000)	PM _{2.5}		NO ₂	
		Annual mean (^a)	Premature deaths (^b)	Annual mean (^a)	Premature deaths (^b)
Austria	8,576	13.3	5,900	19.8	1,200
Belgium	11,237	13.0	7,400	20.9	1,500
Bulgaria	7,202	24.1	14,200	16.1	640
Croatia	4,225	17.4	4,500	17.3	430
Cyprus	1,173	16.9	750	14.1	30
Czechia	10,538	17.0	10,100	16.6	490
Denmark	5,660	9.7	2,800	10.5	80
Estonia	1,315	6.7	560	8.2	<5
Finland	5,472	5.3	1,500	8.8	40
France	66,488	11.9	35,800	17.9	9,700
Germany	81,198	12.3	62,300	20.0	13,100
Greece	10,858	19.1	12,000	18.1	2,300
Hungary	9,856	18.9	12,800	18.0	1,300
Ireland	4,629	6.5	1,100	7.6	30
Italy	60,796	18.5	60,600	24.9	20,500
Latvia	1,986	10.6	1,600	12.1	130
Lithuania	2,921	11.7	2,600	12.2	70
Luxembourg	563	12.0	240	19.9	50
Malta	429	12.8	240	16.5	20
Netherlands	16,901	12.3	9,800	20.5	1,900
Poland	38,006	21.6	44,500	15.6	1,700
Portugal	9,870	9.8	5,500	15.7	890
Romania	19,871	18.1	25,400	14.9	1,300
Slovakia	5,421	19.1	5,200	16.9	240
Slovenia	2,063	17.4	1,800	16.7	160
Spain	44,154	12.7	27,900	21.2	8,900
Sweden	9,747	5.9	3,000	10.8	110
United Kingdom	64,875	9.4	31,300	19.7	9,600
EU-28	506,030	13.9	391,000	18.9	76,000

4. Potential for Low-Carbon Development Activities

The implementation and maintenance of sustainable low-carbon development in Poland will require the involvement of significant financial resources. Although low-carbon solutions are considered expensive and they are often perceived as an additional burden for the economy, these expenses should be combined with the costs of developing coal energy, the costs of which will grow in the future, including due to the rising costs of coal extraction, which must be extracted from less accessible places, and the rising costs associated with the CO₂ emission charges. A completely different problem is the fact that this raw material is running out. EU member states, including Poland, allocate significant funds to low-carbon development. However, in some countries CO₂ emissions are rising and emissions of harmful substances such as particulate matter remain at a similar level.

National governments are already aware that in the future it will be necessary to completely abandon fossil fuels. Of course, this raises many problems, such as the loss of jobs for people employed in the energy sector. It should be emphasized that people will need energy and that, along with reducing energy production by burning coal, it will be necessary to develop renewable energy sources, in which employees will also be needed (Leseure et al., 2019). Moving to an economy that will be more based on renewable energy requires time and resources, especially in a country like Poland, whose energy sector is 80% coal-based. It should be emphasized that, in line with the Europe 2020 strategy, the EU allocates in its 2014-2020 budget almost 1 trillion euros for sustainable growth, jobs and competitiveness. At least one-fifth of the EU budget for 2014-2020 will be allocated to the transition to a low-carbon European economy. Giving up the use of fossil fuels for renewable energy is very difficult and will require a change in the entire energy system (Mikielewicz et al., 2019).

Limiting the burning of fossil fuels is currently one of the most important conditions for reducing greenhouse gas emissions to the atmosphere. Solid fuels are among the most important elements of the global energy system and meet the demand for electricity and heat (Tucki et al., 2019b; Szatyłowicz & Skoczko, 2019).

The implementation of low-carbon development in Poland is conditioned by many factors. The economic factor is particularly important. The excessive amount of gas and dust emitted into the air is due to many reasons. One of them is long-term neglect, which is associated with the lack of regulations limiting the emission of harmful substances into the air from home boiler rooms. It is only in recent years that solutions have begun to be implemented whose effects are not yet visible. While industrial emissions have been significantly reduced, no solutions have been introduced that would significantly reduce a diffuse emission. The problem is possible to solve because most EU countries with a similar climate are doing much better than Poland. In Poland, there have been no legal solutions explicitly prohibiting the use of certain fuels and technologies for energy production.

In addition to do's and don'ts, solutions that support the implementation of low-carbon technologies should be expanded (Adamczyk et al., 2017) The Clean Air program, launched in September 2018, aimed at reducing harmful gas and dust emissions to the air, has not yet led to a noticeable reduction in emissions. The Clean Air Program assumes the granting of

subsidies and loans aimed at the organic emission of gases and dust to the air from existing single-family residential buildings or to avoid the emission of air pollution from newly built residential buildings (Adamczyk & Dylewski, 2017). The budget of The Clean Air program is 103 billion zlotys. The implementation of the program is expected to last until 2029. Unfortunately, for The Clean Air program to achieve and lead to thermal modernization of about 3.5 million residential buildings, it would be necessary to sign three hundred and several dozen thousand contracts each year. However, during the first 10 months of operation of this program, about 30,000 applications were considered positively. Despite the considerable financial resources provided for limiting the emission of harmful substances into the air, the effectiveness of the solutions introduced in 2018 can be assessed only in a few years (Poór et al., 2015).

To effectively reduce gas and dust emissions to the air, various solutions should be implemented in parallel. Considering that in Poland, heating of single-family buildings has a large share in gas and dust emissions to the air, the possibilities of reducing pollution caused by burning fossil fuels in home boiler rooms should be analysed. For this purpose, the LCA technique is helpful, which indicates how to identify more environmentally friendly ways to generate energy needed for heating buildings (Zarębska & Dzikuć, 2013; Barros et al., 2020).

LCA is a technique that allows comparing different types of boilers for heating apartments and indicate a solution that will burden the environment the least. The LCA assessment takes into account the entire life cycle of a product, from raw material extraction and processing, through product manufacturing, distribution, use, reuse, maintenance, recycling and final disposal, and transport. The International Organization for ISO Standardization defines LCA as a technique for assessing environmental aspects and potential impacts associated with a product (Burchart-Korol et al., 2018, Adamczyk & Dzikuć, 2014).

The road transport sector has a significant, untapped potential for the development of a low-carbon economy (Tucki et al., 2019a; Bogacki and Bździuch, 2019). The growing number of cars in Poland significantly contributes to increasing greenhouse gas emissions. In Poland, cars that do not meet current environmental standards dominate, because they were often manufactured several years ago. The average age of a car registered in Poland is 13 years. It is necessary to look for solutions that reduce the number of old cars traveling on Polish roads. This can be achieved by supporting users when buying cars that will be less harmful to the environment and improve the functioning of public transport, which can contribute to giving up the frequent use of their own car.

5. Conclusions

The article indicates the aspects of low-carbon development and indicates some of the actions that can effectively reduce emissions to the air. It should be emphasized that the implementation of the indicated solutions will be easier with the growing social acceptance, which is the result of the need to live in a clean environment and the use of products that

have been produced using low-carbon technologies. However, to increase social acceptance for implementing low-carbon solutions, educational activities will be necessary.

In order to ensure low-carbon development, it will be indispensable to implement solutions that will not be approved of by everyone, such as various orders and bans. An example of such a solution successfully used in many European cities is the introduction of a ban on entering city centers for cars that do not meet current ecological standards. It will also be necessary to enforce existing legal solutions more effectively. These activities must be carried out in a wide range. On the one hand, it is vital to give up several million old type boilers that are used to heat single-family buildings. These boilers can be replaced by more ecological solutions such as heat pumps, however, to be implemented on a large scale, financial support from the state is necessary.

It is urgent to accelerate the reduction of electricity generation in hard coal and lignite power plants. For this purpose, it is crucial to create to a greater extent more opportunities for renewable energy development. The growing energy needs of a developing country require new production capacity. Low-carbon solutions should be promoted, which due to, among others EU climate policy, may turn out to be much more economical in the next few years. Micro installations that can be located near almost every single-family building may prove to be particularly beneficial. The development of distributed energy will also reduce the need to transmit energy over long distances, which is necessary in the case of dominance of large coal power plants.

Acknowledgments: This study was conducted and financed in the framework of the research project “Economic aspects of low carbon development in the countries of the Visegrad Group”, granted by the National Science Centre, Poland. Program OPUS, grant No. 2018/31/B/HS4/00485.

References

- Adamczyk, J., & Dylewski, R. (2017). Analysis of the sensitivity of the ecological effects for the investment based on the thermal insulation of the building: A Polish case study. *Journal of Cleaner Production*, 162, 856-864. <https://doi.org/10.1016/j.jclepro.2017.06.123>
- Adamczyk, J., & Dzikuć, M. (2014). The analysis of suppositions included in the Polish Energetic Policy using the LCA technique - Poland case study. *Renewable and Sustainable Energy Reviews*, 39, 42-50. <https://doi.org/10.1016/j.rser.2014.07.083>
- Adamczyk, J., Piwowar, A., & Dzikuć, M. (2017). Air protection programmes in Poland in the context of the low emission. *Environmental Science and Pollution Research*, 24(19), 16316-16327. <https://doi.org/10.1007/s11356-017-9233-9>
- Assessment of air quality in zones in Poland for 2017. (2018). Chief Inspectorate of Environmental Protection, Warszawa (in Polish).
- Balmes, J. R. (2019). Household air pollution from domestic combustion of solid fuels and health. *Journal of Allergy and Clinical Immunology*, 143(6), 1979-1987. <https://doi.org/10.1016/j.jaci.2019.04.016>
- Barros, M. V., Salvador, R., Piekarski, C. M., de Francisco, A. C., & Freire, F. M. C. S. (2020). Life cycle assessment of electricity generation: a review of the characteristics of existing literature. *The International Journal of Life Cycle Assessment*, 25(1), 36-54. <https://doi.org/10.1007/s11367-019-01652-4>
- Bedir, S., & Yilmaz, V. M. (2016). CO₂ emissions and human development in OECD countries: granger causality analysis with a panel data approach. *Eurasian Economic Review*, 6(1), 97-110. <https://doi.org/10.1007/s40822-015-0037-2>
- Bielaczyc, P., & Woodburn, J. (2019). Trends in Automotive Emission Legislation: Impact on LD Engine Development, Fuels, Lubricants and Test Methods: a Global View, with a Focus on WLTP and RDE Regulations. *Emission Control Science and Technology*, 5, 86-98. <https://doi.org/10.1007/s40825-019-0112-3>

- Bitat, A. (2018). Environmental regulation and eco-innovation: the Porter hypothesis refined. *Eurasian Business Review*, 8(3), 299-321. <https://doi.org/10.1007/s40821-017-0084-6>
- Bogacki, M., & Bzdziuch, P. (2019). Predicting the spatial distribution of emissions from urban buses based on previously measured data and scenarios for their modernization in the future. Case study: Krakow, Poland. *Atmospheric Environment*, 199, 1-14. <https://doi.org/10.1016/j.atmosenv.2018.11.009>
- Buoli, M., Grassi, S., Caldiroli, A., Carnevali, G. S., Iodice, F. S., Cantone, L., Pergoli, L., & Bollat, V. (2018). Is there a link between air pollution and mental disorders? *Environment International*, 118, 154-168. <https://doi.org/10.1016/j.envint.2018.05.044>
- Burchart-Korol, D., Pustejovska, P., Blau, A., Jursova S., & Korol, J. (2018). Comparative life cycle assessment of current and future electricity generation systems in the Czech Republic and Poland. *International Journal of Life Cycle Assessment*, 23, 2165–2177. <https://doi.org/10.1007/s11367-018-1450-z>
- Ciuppek, B., Janeba-Bartoszewicz, E., & Urbaniak, R. (2019). Effect of fineness and increased humidity of carbonaceous fuels on the chemical composition of exhaust gases. *Przemysł Chemiczny*, 98(8), 1283-1285. <https://doi.org/10.15199/62.2019.8.15>
- Costantini, V., Crespi, F., & Paglialunga, E. (2019). Capital–energy substitutability in manufacturing sectors: methodological and policy implications. *Eurasian Business Review*, 9(2), 157-182. <https://doi.org/10.1007/s40821-018-0114-z>
- Cutz, L., Berndes, G., & Johnsson, F. (2019). A techno-economic assessment of biomass co-firing in Czech Republic, France, Germany and Poland. *Biofuels, Bioproducts and Biorefining*, <https://doi.org/10.1002/bbb.2034>
- Czyżewski, B., Trojanek, R., Dzikuc, M., & Czyżewski, A. (2020). Cost effectiveness of the common agricultural policy and environmental policy in country districts: spatial spillovers of pollution, bio-uniformity and green schemes in Poland. *Science of the Total Environment*, 726, 138254. <https://doi.org/10.1016/j.scitotenv.2020.138254>
- Dai, J., Kesternich, M., Löschel, A., & Ziegler, A. (2015). Extreme weather experiences and climate change beliefs in China: An econometric analysis. *Ecological Economics*, 116, 310-321. <https://doi.org/10.1016/j.ecolecon.2015.05.001>
- Dzikuc, M. (2013). Energy security of urban and rural Lubuskie Land = Bezpieczeństwo energetyczne miast i wsi województwa lubuskiego. *Rynek Energii*, 104(1), 56-61.
- Dzikuc, M., Dzikuc, M., & Łasiński, K. (2017). Technical and Economic Aspects of Low Emission Reduction in Poland. *International Journal of Applied Mechanics and Engineering*, 22(4), 1107-1112. <https://doi.org/10.1515/ijame-2017-0072>
- Dzikuc, M., Dzikuc, M., & Siničáková, M. (2017). The social aspects of low emission management in the Nowa Sól district. *Management*, 21(1), 237-249. <https://doi.org/10.1515/manment-2015-0091>
- Dzikuc, M., Kuryło, P., Dudziak, R., Dzikuc, M., & Godzisz, K. (2020). Selected Aspects of Combustion Optimization of Coal in Power Plants. *Energies*, 13(9), 2208. <https://doi.org/10.3390/en13092208>
- European Environment Agency. (2020). Retrieved November 28, 2020, from <https://www.eea.europa.eu>.
- European Environment Agency. (2020). *European Union emission inventory report 1990-2018 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)* (Report No 05/2020). Luxembourg: Publications Office of the European Union.
- Garba, A., Tama, U. A., & Ammani, A. I. (2020). Deforestation, sectoral CO₂ emissions and climate change nexus: Fresh evidence from Nigeria. *International Journal of Multidisciplinary Research and Growth Evaluation*, 1, 16-27. <http://www.allmultidisciplinaryjournal.com/archivesarticle/2020.v1.i3.38.pdf>
- Junga, R., Pospolita, J., Niemiec, P., Dudek, M., & Szleper, R. (2020). Improvement of coal boiler's efficiency after application of liquid fuel additive. *Applied Thermal Engineering*, 179, 115663. <https://doi.org/10.1016/j.applthermaleng.2020.115663>
- Kibria, G., Haroon, A. K. Y., & Nugegoda, D. (2018). Low-carbon development (LCD) pathways in Australia, Bangladesh, China and India—a review. *Journal of Climate Change*, 4, 49-61. <https://doi.org/10.3233/jcc-180006>
- Kopczyński, M., Lasek, J., Iluk, A., & Zuwała, J. (2017). The co-combustion of hard coal with raw and torrefied biomasses (willow (*Salix viminalis*), olive oil residue and waste wood from furniture manufacturing). *Energy*, 140(1), 1316-1325. <https://doi.org/10.1016/j.energy.2017.04.036>
- Laskowski, P., Zasina, D., Zimakowska-Laskowska, M., Zawadzki, J., & Warchałowski, A. (2019). Vehicle Hydrocarbons' Emission Characteristics Determined Using the Monte Carlo Method. *Environmental Modeling & Assessment*, 24(3), 311-318. <https://doi.org/10.1007/s10666-018-9640-4>

- Leisen, R., Steffen, B., & Weber, C. (2019). Regulatory risk and the resilience of new sustainable business models in the energy sector. *Journal of Cleaner Production*, 219(10), 865-878. <https://doi.org/10.1016/j.jclepro.2019.01.330>
- Leseure, M., Robins, D., Wall, G., & Jones, D. (2019). Making the most out of renewable energy opportunities: Lessons learned from a regional strategic mapping approach. *International Journal of Energy Sector Management*, 13(1), 212-228. <https://doi.org/10.1108/IJESM-02-2017-0011>
- Mikielewicz, D., Kosowski, K., Tucki, K., Piwowski, M., Stępień, R., Orynycz, O., & Włodarski, W. (2019). Influence of Different Biofuels on the Efficiency of Gas Turbine Cycles for Prosumer and Distributed Energy Power Plants. *Energies*, 12(16), 3173. <https://doi.org/10.3390/en12163173>
- Piwowar, A. (2019). Buildings in agricultural holdings in the context of low-carbon development of the agriculture and rural areas in Poland. In *Education Excellence and Innovation Management through Vision 2020. 33rd IBIMA Conference Proceedings* (pp. 322-331). <https://ibima.org/accepted-paper/buildings-in-agricultural-holdings-in-the-context-of-low-carbon-development-of-the-agriculture-and-rural-areas-in-poland>
- Piwowar, A., & Dzikuć, M. (2019). Development of renewable energy sources in the context of threats resulting from low-altitude emissions in rural areas in Poland: A review. *Energies*, 12(18), 3558. <https://doi.org/10.3390/en12183558>
- Poór, P., Šimo, M., & Karkov, M. (2015). CMMS as an effective solution for company maintenance costs reduction. In *Production Management and Engineering Sciences* (pp. 241-246).
- Romanowska-Duda, Z., Piotrowski, K., Wolska, B., Dębowski, M., Zieliński, M., Dziugan, P., & Szufa, S. (2020). Stimulating effect of ash from Sorghum on the growth of Lemnaceae A New Source of Energy Biomass. In: M. Wróbel, M. Jewiarz, & A. Szłęk (Eds), *Renewable Energy Sources: Engineering, Technology, Innovation, Springer Proceedings in Energy* (pp. 341-349). Springer, Cham. https://doi.org/10.1007/978-3-030-13888-2_34
- Sass, V., Kravitz-Wirtz, N., Karceski, S. M., Hajat, A., Crowder, K., & Takeuchid, D. (2017). The effects of air pollution on individual psychological distress. *Health & Place*, 48, 72-79. <https://doi.org/10.1016/j.healthplace.2017.09.006>
- Stewart, J., Anda, M., & Harper, R. J. (2019). Low-carbon development in remote Indigenous communities: Applying a community-directed model to support endogenous assets and aspirations. *Environmental Science & Policy*, 95, 11-19. <https://doi.org/10.1016/j.envsci.2019.01.003>
- Szatylowicz, E., & Skoczko, I. (2019). Evaluation of the PAH Content in Soot from Solid Fuels Combustion in Low Power Boilers. *Energies*, 12(22), 4254. <https://doi.org/10.20944/preprints201910.0317.v1>
- Szufa, S., Dzikuć, M., Adrian, Ł., Piersa, P., Romanowska-Duda, Z., Lewandowska, W., Marczak, M., Błaszczuk, A., & Piwowski, A. (2020a). Torrefaction of oat straw to use as solid biofuel, an additive to organic fertilizers for agriculture purposes and activated carbon—TGA analysis, kinetics. *E3S Web of Conferences*, 154, 02004. <https://doi.org/10.1051/e3sconf/202015402004>
- Szufa, S., Wielgosinski, G., Piersa, P., Czerwińska, J., Dzikuć, M., Adrian, Ł., Lewandowska, W., & Marczak, M., (2020b). Torrefaction of Straw from Oats and Maize for Use as a Fuel and Additive to Organic Fertilizers — TGA Analysis, Kinetics as Products for Agricultural Purposes. *Energies*, 13(8), 2064. <https://doi.org/10.3390/en13082064>
- Truong, A. H., Patrizio, P., Leduc, S., Kraxner, F., & Ha-Duong, M. (2019). Reducing emissions of the fast growing Vietnamese coal sector: The chances offered by biomass co-firing. *Journal of Cleaner Production*, 215, 1301-1311. <https://doi.org/10.1016/j.jclepro.2019.01.065>
- Tucki, K., Mruk, R., Orynycz, O., Wasiak, A., Botwińska, K., & Gola, A. (2019a) Simulation of the Operation of a Spark Ignition Engine Fueled with Various Biofuels and Its Contribution to Technology Management. *Sustainability*, 11(10), 2799. <https://doi.org/10.3390/su11102799>
- Tucki, K., Orynycz, O., Wasiak, A., Świć, A., & Dybaś, W. (2019b). Capacity Market Implementation in Poland: Analysis of a Survey on Consequences for the Electricity Market and for Energy Management. *Energies*, 12(5), 839. <https://doi.org/10.3390/en12050839>
- Wattanakuljarus, A. (2019). Effects and burdens of a carbon tax scheme in Thailand. *Eurasian Economic Review*, 9(2), 173-219. <https://doi.org/10.1007/s40822-018-0100-x>
- World Health Organization. (2020). *European detailed mortality database*. Regional Office for Europe, Copenhagen. Retrieved November 13, 2020, from https://www.who.int/healthinfo/statistics/mortality_rawdata/en
- Woźniak, J., & Pactwa K. (2018). Responsible Mining-The Impact of the Mining Industry in Poland on the Quality of Atmospheric Air. *Sustainability*, 10(4), 1184-1200. <https://doi.org/10.3390/su10041184>
- Yang, T., & Liu, W. (2018). Does air pollution affect public health and health inequality? Empirical evidence from China. *Journal of Cleaner Production*, 203(1), 43-52. <https://doi.org/10.1016/j.jclepro.2018.08.242>

- Zaporozhets, A. O., & Khaidurov, V. V. (2020). Mathematical Models of Inverse Problems for Finding the Main Characteristics of Air Pollution Sources. *Water, Air, and Soil Pollution*, 231, 563. <https://doi.org/10.1007/s11270-020-04933-z>
- Zarębska, J, & Dzikuć, M. (2013). Determining the environmental benefits of life cycle assessment (LCA) on example of the power industry. *Scientific Journals Maritime University of Szczecin*, 34(163), 97-102.

Is There a Future for Carbon Capture and Storage?

Anders EKELAND¹, Rong KANG², Jaroslav KOVÁRNÍK^{3*} and Eva HAMPLOVÁ⁴

¹ Statistics Norway, Oslo, Norway; anders.ekeland@ssb.no

² Northwest University, Xi'an, China; rong_k@yahoo.com

³ University of Pardubice, Pardubice, Czech Republic; jaroslav.kovarnik@upce.cz

⁴ University of Hradec Kralove, Hradec Kralove, Czech Republic; eva.hamplova@uhk.cz

* Corresponding author: jaroslav.kovarnik@upce.cz

Abstract: The article discusses the political economy of CCS. The IPCC reports gives CCS a significant role in keeping global warming somewhere between 1.5 and 2 degrees Celsius, but still there is very few installations in operations and very few in the pipeline. This raises the question of why the diffusion of CCS has been slow and seem to slow down rather than speed up. First the paper discusses the question: When there is consensus the take-off of CCS depends on a high CO₂ price, why is the price so low? Secondly discusses: What would happen if the CO₂ price was 100 USD or higher? Would CCS then be the preferred way to reduce emissions or would other technologies be not only cheaper, but also faster and easier to implement? The paper concludes that the question the role of CCS in mitigating climate change also must be formulated as *political* problem, where the political/electoral effects of a high CO₂ price plays a key role and needs to be taken much more *explicitly* into consideration than has been done so far. The paper uses primarily the fate of CCS in Norway as a case study of the political economy of CCS.

Keywords: CCS; Carbon Capture and Storage; carbon pricing; emission trading income distribution; just transition

JEL Classification: Q54; Q58; Q52

1. Introduction

The purpose of this article is to discuss the political economy of CCS. CCS is of course not the only technology that is needed in order to reach a near total reduction in CO₂ emissions by 2015, but it has been and is given a significant role, not only in the IPCC reports, but also in the national climate policy in many countries. in IPCC reports gives CCS a significant role in keeping global warming somewhere between 1.5 and 2 degrees Celsius, but still there is very few installations in operations and few in the pipeline. This raises the question of why the diffusion of CCS has been so slow, and seems to slow down rather than speed up. The obvious answer is that that investing in CCS is not profitable. There is a general consensus that to make it profitable the price of carbon needs to be at significantly higher level than today. That raises the question: When there is consensus the take-off of CCS depends on a high CO₂ price, why is the price so low? Secondly the paper discusses: What would happen if the CO₂ price was at a level sufficient to make CCS profitable, let's say 100 USD or higher? Would CCS then be the preferred way to reduce emissions or would other technologies be not only cheaper, but also faster and easier to implement? The paper

concludes that the question the role of CCS in mitigating climate change also must be formulated as *political* problem, where the political/electoral effects of a high CO₂ price plays a key role and needs to be taken much more *explicitly* into consideration than has been done so far. The paper is based primarily on the experiences and the fate of CCS so far in Norway as an empirical background of the political economy of CCS, (Jakobsen et al., 2017; Karimi & Komendantova, 2017; Rottereng, 2018; Anker, 2018; Tjernshaugen, 2008, 2011), but we will not discuss the Norwegian case in particular, since the Norwegian experiences just shows the importance of the key factors influencing the diffusion of CCS, which are the cost of CCS and the price of carbon.

2. Methodology and Structure of the Paper

This paper aims to answer the question: Why CCS is not taking off, despite being in operation for many decades? CCS is basically a mature technology, while there is of course still room for improvement existing methods. There are also introduced new methods, like the Allam-Fetvedt oxy-fuel method, for an overview of the state of the art of various CCS technologies, see (Sifat & Haseli, 2019). The methodology of this paper is a brief descriptive analysis, pointing to some well-known stylized facts as a starting point for an analytical discussion of the future of CCS. Since this article is primarily a discussion of the political economy of CCS and objective and due to space limitations, we will start out by very briefly describing the most important stylized facts without a lot of references to the literature. In our opinion a lot of references is not necessary. The stylized facts of CCS that are important for our discussion are not controversial. They are summarized in a handful of reports. The key report is of course the yearly report from The Global CCS Institute. The “Global Status of CCS 2020” is a very informative and readable publication with many nice and graphs, (Institute, 2020). To our knowledge nobody claims that the information provided by the institute it is not facts based, on the contrary, it is the common starting point for all analysis of CCS as a mitigation policy. The same goes for The World Bank Group report on “State and Trends of Carbon Pricing 2020”, (World Bank, 2020). Actually, the data in these two reports do not change very much from year to year. This slow progress of both CCS and carbon pricing is closely related for reasons that we think is essential to understand in order to understand “what must be done” to borrow a famous phrase from Lenin. Then there are the IPCC reports, with an increasing “alarmistic” message. In this paper will use the IPCC report on 1.5 degrees, where both CCS and carbon pricing is mentioned many times, 375 and 57 respectively. One can of course discuss of the report gets all the uncertainties right, if the reports are too afraid of being even more alarmistic, but for our present purpose that is absolutely not an issue. What is the issue is that although carbon price and CCS is mentioned all the way through the report, there is in our opinion not any real discussion of the relation between carbon price and diffusion of CCS, even less about what can be done to increase the price of carbon. From a more methodological point of view, we think it us fruitful to look at getting to the target of zero emissions in 2050 as an optimal control problem, where the price of carbon is they key control variable which can be used to get the quantum of CO₂-emissions to the desired level, that is to zero as soon as possible, in 2050 the latest.

Finally, there are many articles and books on CCS. Regarding sources for information about CCS policy formulations, our impression is that it is reports like the three reports mentioned above mentioned, that policy makers and climate policy NGOs reads. These mostly from consultancy firms or various types of contract research, which is by policy makers, trade unions and NGOs. These are generally of good quality, mostly based on either academic or own research. When we in this paper will give relatively few references to this vast literature, it is because the key points we want to discuss is described and mentioned in the report on the status of CCS, status of carbon pricing and in the IPCC report on the need for CCS.

The paper is structured as follows. In section 3 we show that CCS is spreading slowly. In section 4 we discuss why carbon, as a way to price CO₂ emissions, is not higher, pointing to the effects on the income distribution and the political effects of the changes in the income distribution.

3. The Problem – CCS Spreading at Snail's Pace

The figure below shows the development of CCS capture capacity in various stages of the facilities development.

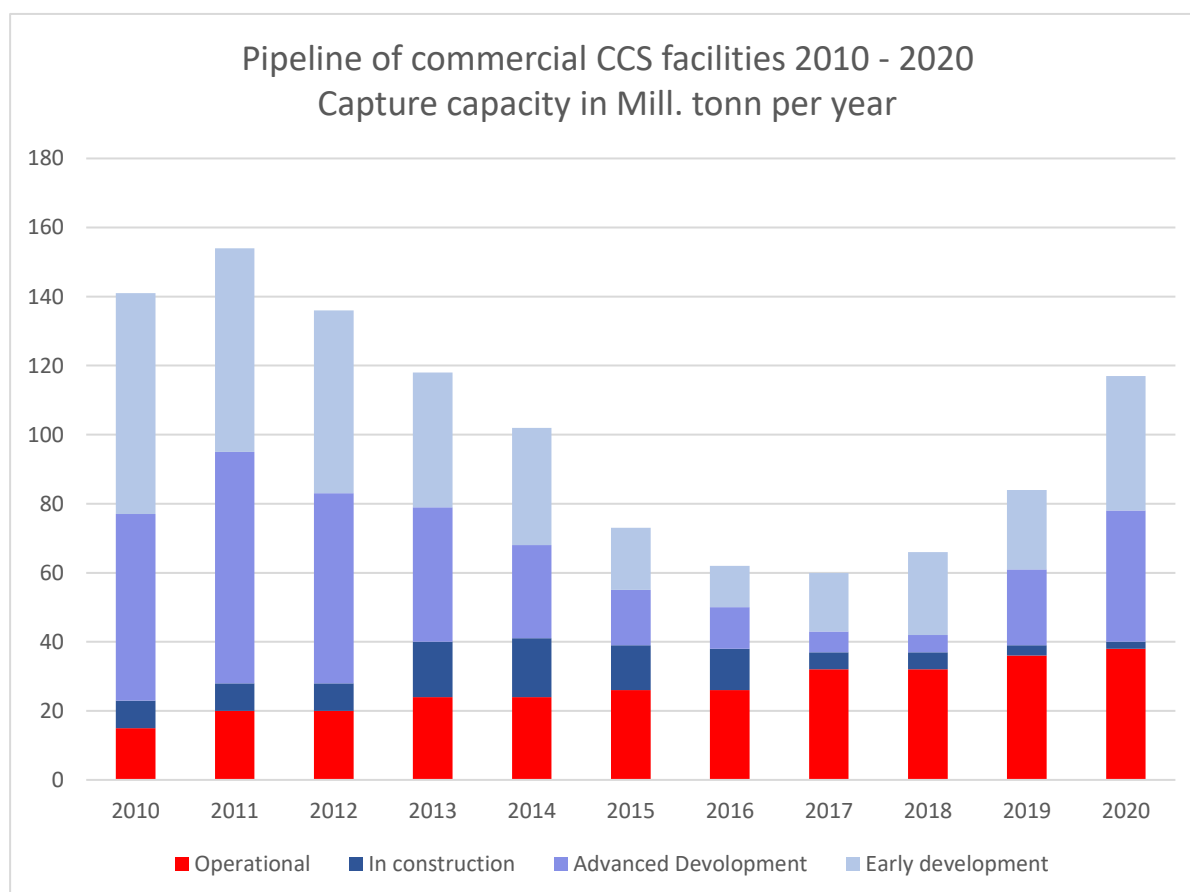


Figure 1. Overview of CCS installations (Institute, 2020, p.17)

The figure shows that the actual capture and storage capacity in 2020 is higher (red color) than 10 years ago but growing very slowly. When it comes to future capacity it does not look very good either, (Oei & Mendelevitch, 2016). This would of course not be a problem if

today's capacity was anywhere near what is stated in the Global CCS report as needed. The quantum must increase "from around 40 Mt of CO₂ per annum today to around 5.6 gigatons (Gt) in 2050 – a more than hundredfold increase" according to the report. Just to make it clear, the number of 5.6 gigatons can of course be discussed, but for our present purpose it is not important at all if that number is 4 Gt or 7 Gt. The point we want to make is that CCS capacity is not in the near future anywhere near the need, that is anywhere near fulfilling the role assigned to it in the last IPCC report. This in our opinion makes it imperative to discuss what can be done to speed up the diffusion – or alternatively, realize that CCS is not going to make it, and that one must immediately start looking for other solutions.

The reason why it is spreading so slowly is of course no mystery, it is the low price of carbon. From the World Bank Group's yearly reports on carbon pricing it is clear that the primary reason is that in most countries carbon is not priced at all, only about 16 percent of the world's emissions are taxed (World Bank, 2020). Even in those countries, regions where it is taxed, the carbon price is low. Since the EU ETS (emission trading system) is the most important carbon pricing area, we will use the current price in the EU ETS as a reference price, for simplicity 30 Euro. The average the last ten years has been much lower, but for our discussion, making it 20 or 40 Euro does not matter substantially. What is clear – and mentioned by everybody is that a 30 Euro carbon price is way too low to make CCS worth investing in. Consequently, it is only when CO₂ is used for enhanced oil recovery (EOR) or supported by very generous government subsidies, that it is profitable for the individual firm.

The low carbon price is not a problem for CCS only, as IPCC puts it: "The available literature indicates that mitigation pathways in line with 1.5°C pathways would require stringent and integrated policy interventions (very high confidence). Higher policy ambition often takes the form of stringent economy-wide emission targets (and resulting peak-and-decline of emissions), larger coverage of NDCs to more gases and sectors (e.g., land-use, international aviation), much lower energy and carbon intensity rates than historically seen, **carbon prices much higher than the ones observed in real markets**, increased climate finance, global coordinated policy action, and implementation of additional initiatives" (IPCC, 2018), p. 148, our emphasis).

While the concept "income distribution" is occurs only once in the IPCC report, the report is clearly aware of the distributional effect of a carbon tax on income distribution: "First, in the absence of countervailing policies, *higher energy costs have an adverse effect on the distribution of welfare*. (p. 375, our emphasis).

3.1. CCS, the Carbon Price and the Yellow Vests

The 1.5 degree IPCC report came out in 2018, before "yellow vests" came onto the streets in Paris. In a nutshell the yellow vest movement showed clearly why the carbon price is so low worldwide. If governments try to tax carbon without taking the "adverse effect of the distribution of welfare" into consideration, that price increase will be met with more or less massive and/or militant protests. In our opinion, and our first conclusion is that those who faith in CCS must deal with this income distribution problem, that the only way to get the

carbon price that CCS needs is to increase the carbon price in a socially just way. That is in a way making the yellow vests benefit from a higher carbon price. There are many ways to do that, but one of the simplest is the “Carbon Fee and Dividend” (CFD) system proposed by climate researcher, James Hansen. The principle is very simple, (Foster, 2013). You put a tax on fossil fuel at the “source”, that is collecting it from producers and/or importers of fossil fuel. They will then include the increased cost in the prices they charge their customers, and that way price increases will spread in the economy until the final customers, mostly households will “pay the bill”. If the government at the same time redistributes the collected carbon tax revenue with an equal share to all legal citizens, the CFD will be a “Robin Hood” redistribution system. The system will be taking tax revenue from the rich with a large (above average) carbon footprint and giving to the “poor” that statistically have a lower than average carbon footprint, since there is a close correlation between the size of the normal consumption basket and carbon content, so the total price of a person’s consumption is a very good indicator of the carbon footprint. There is a lot more to be said about carbon tax and distribution, how to deal with exports and imports of goods, but that is not important in this context. A very good general introduction to carbon pricing is the so-called Stiglitz-Stern report, (*Report of the High-Level Commission on Carbon Prices*, 2017). A Robin Hood carbon tax might sound like left wing Keynesian policies, but that is not necessarily the case. In the US a group of former high level republicans have endorsed the idea, (Council, 2017). We will not discuss in this article the very interesting question why both left-wingers and Reagan-republicans can support the same policy. The point we want to make is that anyone who is serious about CCS has to be even more serious about how to find a solution to the problem of how to make it possible in a democracy to rise the carbon price and win elections. A CFD policy might be one way to do it. When the Global CCS Institute report just in one sentence express the obvious fact that the carbon price is way too low, writing that: “Stronger policy to incentivize rapid CCS investment is overdue”, this is a very clear understatement, when the distributional effects of a higher carbon price is the main reason why it is still way too low to “incentivize” rapid investment in CCS.

There is actually more written on the key question of income distribution, that is social justice in the latest IPCC report. A lot of good points and good references are given in chapter 4.4.5.2 “Carbon pricing: necessity and constraints”, but it speaks volumes that the question of the carbon price is not even mentioned, not to speak of brought to the forefront as “what must be done” in the “Summary for policy makers” The word “price” does not appear even once in this “Summary for policy makers”. There is a short paragraph in the “Technical summary” (p. 33).

3.2. The Question of the Level of the Carbon Price

There are very many estimates of the carbon price needed in order to keep augmentation of the global temperature below 1.5 degrees or 2.0 degrees, and for CCS to take off. This is reflected in the estimates in the IPCC report. From the chapter “2.5.2.1 Price of carbon emissions”, starting on page 152, we have extracted the following table:

Table 1. IPCC overview over estimates for the price of a ton of CO₂, in 2010 USD

	2030	2050	2070
1.5 degrees	135–6,050	245–14,300	420–19,300
2.0 degrees	15–220	45–1,050	175–2,340

The report has just a brief remark regarding the estimates: “The wide range of values depends on numerous aspects, including methodologies, projected energy service demands, mitigation targets, fuel prices and technology availability...” (p 152). One might argue that given such a great variation it would have been better to round the numbers more to indicate the uncertainty and variation of the estimates. Use 150–6,000 for the first interval, 250–14,000, but this not important, because the James Hansen CFD proposal has as it’s “driving force” an *ever-rising* carbon price. One has to start with a certain price and have rule for how much the carbon price should increase each year. If one started in the EU ETS for example with 40 Euro, up roughly 10 Euro from the highest level the last year (2020) and increased it by 10 Euros every year, this would then reach 80 Euro in four years. Since the tax is collected at the “source” the whole economy will be affected. Today the EU ETS only covers 40% of the economy and does not include transport. The political motivation for excluding transport was and is fairly obviously, because if transport was included, then the gasoline price would rise as the EU ETS carbon price kept rising. An economy wide (socially just) carbon tax would of course have a bigger effect, not only due to coverage, but also due to predictability. All actors in the economy can calculate in a rational, “deterministic” way. After 3–4 years the effects of the ever-rising carbon prices would be clearly felt. The effects could be using various indicators, not the least the sale of fossil. One could observe the effects in different markets and for different social group. Based on such data, the democratic process could consider in/decreasing rise of the carbon price. The carbon price would then become a “force” one could use to get a dynamic system like an economy in the direction one wants and at hopefully at the desired speed.

4. Carbon Price and Substitution

In this section we will in typical economist way “assume” that the carbon price by some policy (miracle) has reached a level where CCS could be profitable. If that is 100 Euro or 200 does not matter. If it is an ever-rising carbon prices, it will reach the “take-off” level sooner or later – and all market actors will know that. Since CCS is profitable when used to extract more oil, we think that the 100–200 Euro range is not order of magnitude wrong. What we want to discuss briefly is the substitution effect of such a high price, because this question which is discussed very little, practically not at all in the literature as far as we can see. In Norway there has been a public debate in relation to the CCS project capturing CO₂ from cement production (Norcem) and from burning the household waste produced in the wider Oslo area (Fortum Oslo). Both projects are related to the Northern Light project, (Institute, 2020, p. 22).

When it comes to cement, the emissions are both from using fossil fuel to get the required heat and from the chemical reaction that creates cement. It is the latter that really needs CCS.

Fossil fuel can be substituted for producing heat. The recent discussion is if actually will use cement as much as we do today when the price of cement is significantly much higher caused by either only a tax on fossil fuel and/or a tax on CO₂-emissions. In Norway glue wood has been used for decades, for example in the construction of the Oslo airport. Recently an 84-meter-high glue wood building was built (Mjøstårnet), so clearly glue wood could easily become cheaper when cement becomes significantly more expensive. In China it would probably be glue bamboo that could be used. The great advantage of using wood and especially bamboo is that wood and bamboo stores carbon and using it to a much larger extent would be an example of “negative emissions”. Concrete is used for a lot of construction purposes, like bridges where wood and bamboo might not have the strength etc. needed (Hassan & Johansson, 2018), but production of steel for example does not necessarily create emissions,. There are substitutes for the fossil input to the steel production process, (Greenbiz, 2020).

When it comes to household waste the question is if it would not be better to “get rid of the problem” that is to reduce the amount of waste that needs to be burned by increased recirculation, refilling etc. If there was a way to make the consumer to be able to choose between a product with a “need-to-be-burned” packaging with a higher price than the “substitute” recyclable product that could be more rational to invest in getting into place than billions of Euro for an end of pipeline solution. A solution which might be replaced by recirculation because we need to reduce the extraction of finite resources or protecting the oceans from plastic waste.

In a way there has been a major substitution already because there are very few coal and gas power plants with CCS in operation. The reason is that electricity based on wind and solar has become much cheaper over the last decade. Of the CCS projects in early or advance development there are more intended to be used in power production, but if the price of electricity produced by solar and wind continues to fall, even when the cost of storage is included, they can “crowd out” power plants with CCS. This is a story we already know from Norway. The original argument for building CCS at Mongstad (on the West coast of Norway) was to “clean” a natural gas power plant. This power plant (Kårstø) never became economically viable, because it could not compete with Norwegian hydro-power and there was an increasing amount of wind-power being build. The company could not see any possibility for profitable operation then next 10 to 15 years. In 2017 the gas power station was taken apart, the valuable parts like the turbine was sold.

5. Conclusions

There is a gap between the emissions reductions needed to keep global temperature between 1.5 to 2.0 degrees. CCS has been assigned an important role in reducing emissions for decades. The capacity to do so have grown very slowly the last 10 years and needs to be increased at least hundredfold. The reason for this slow growth is the low price of carbon, which gives no incentive to invest in CCS. A global carbon price does not exist, and even in EU where it is well established, it has only recently reached 30 Euros, which is still only half of the price needed by the most optimistic estimates of the carbon price needed for CCS to be

profitable. In our opinion the reason why the carbon price is so low is that any attempt to increase the carbon price without simultaneous and very “visible” compensation for below-median incomes are politically impossible. The yellow vest movement in France against Macrons modest increase in the price of petrol indicates that very clearly. Even if there was implemented policies that were able to get the carbon price to at least 100 Euros in a socially just way, it might not lead to the take off-of CCS. The main reason is that wind and solar power, even with the extra costs incurred by the need to build storage would be significantly cheaper. When it comes to emissions not resulting from burning of fossil fuels, like the production of cement, burning of household waste etc. a high carbon price might lead to substitution. Glue wood and bamboo, fossil free steel, composite materials could become cheaper substitutes for concrete as building materials. If a price is put on products that result in emissions from household waste being burned recycling might increase to a degree that eliminated any massive emissions from household waste. If this prognosis is correct, CCS might never take off and should not any longer be a part of “the solution” to the climate crisis.

References

- Anker, P. (2018). A pioneer country? A history of Norwegian climate politics. *Climatic Change*, 151(1), 29-41. <https://doi.org/10.1007/s10584-016-1653-x>
- Council, C. L. (2017). *The Conservative Case for Carbon Dividends*. Retrieved from <https://www.clcouncil.org/media/2017/03/The-Conservative-Case-for-Carbon-Dividends.pdf>
- Foster, J. B. (2013). James Hansen and the Climate-Change Exit Strategy. *Monthly Review*, 64(9).
- Greenbiz. (2020). *Is it possible to make steel without fossil fuels?* Retrieved from <https://www.greenbiz.com/article/it-possible-make-steel-without-fossil-fuels>
- Hassan, O. A. B., & Johansson, C. (2018). Glued laminated timber and steel beams: A comparative study of structural design, economic and environmental consequences. *Journal of Engineering Design and Technology*, 16(3), 398-417. <https://doi.org/10.1108/Jedt-12-2017-0130>
- Institute, G. C. (2020). *Global Status of CCS 2020*. Retrieved from globalccsinstitute.com/resources/global-status-report/
- IPCC. (2018). *Global warming of 1.5°C*. Retrieved from <https://www.ipcc.ch/sr15/>
- Jakobsen, J., Roussanally, S., & Anantharaman, R. (2017). A techno-economic case study of CO₂ capture, transport and storage chain from a cement plant in Norway. *Journal of Cleaner Production*, 144, 523-539. <https://doi.org/10.1016/j.jclepro.2016.12.120>
- Karimi, F., & Komendantova, N. (2017). Understanding experts' views and risk perceptions on carbon capture and storage in three European countries. *Geojournal*, 82(1), 185-200. <https://doi.org/10.1007/s10708-015-9677-8>
- Oei, P. Y., & Mendelevitch, R. (2016). European Scenarios of CO₂ Infrastructure Investment. *Energy Journal*, 37, 171-194. <https://doi.org/10.5547/01956574.37.SI3.poei>
- Report of the High-Level Commission on Carbon Prices*. (2017). Retrieved from Washington DC: <https://www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices>
- Rottereng, J. K. S. (2018). When climate policy meets foreign policy: Pioneering and national interest in Norway's mitigation strategy. *Energy Research & Social Science*, 39, 216-225. <https://doi.org/10.1016/j.erss.2017.11.024>
- Sifat, N. S., & Haseli, Y. (2019). A Critical Review of CO₂ Capture Technologies and Prospects for Clean Power Generation. *Energies*, 12(21). <https://doi.org/10.3390/en12214143>
- Tjernshaugen, A. (2008). Political commitment to CO₂ capture and storage: evidence from government RD&D budgets. *Mitigation and Adaptation Strategies for Global Change*, 13(1), 1-21. <https://doi.org/10.1007/s11027-006-9077-y>
- Tjernshaugen, A. (2011). The growth of political support for CO₂ capture and storage in Norway. *Environmental Politics*, 20(2), 227-245. <https://doi.org/10.1080/09644016.2011.551029>
- World Bank. (2020). *State and Trends of Carbon Pricing 2020*. The World Bank. Retrieved from <https://openknowledge.worldbank.org/handle/10986/33809>

Functional Data Analysis in Econometrics

Kateřina FRONČKOVÁ* and Pavel PRAŽÁK

University of Hradec Králové, Hradec Králové, Czech Republic; katerina.fronckova@uhk.cz;
pavel.prazak@uhk.cz

* Corresponding author: katerina.fronckova@uhk.cz

Abstract: Functional data analysis is a modern and dynamically developing field of statistics, which finds its application in many different areas. It can also be used in econometrics. The paper explains the main ideas of functional data analysis and presents its fundamental theoretical background. It also shows an overview of the possibilities of using a functional approach in the analysis of economic and financial data through a search and review of scientific articles. Out of the total number of 1,492 articles dealing with the topic of functional data analysis and meeting the search criteria, 55 articles focusing on the solution of econometric problems are identified. Subsequently, the use of functional data analysis in the exploratory analysis of the industrial production index of the Czech Republic is demonstrated. The so-called phase plane plots are used for the analysis, which make it possible to better examine the dynamics of the development of industrial production. The analysis studies the development of production in individual years and examines the impact of various economic shocks. Using a functional approach, it is possible to answer questions that are difficult to answer using classical statistical methods.

Keywords: functional data analysis; econometrics; phase plane plot; industrial production index

JEL Classification: C19

1. Introduction

Functional data analysis is a modern and dynamically developing field of statistics. It has been booming over the last twenty years, so it is a relatively new approach compared to classical statistical methods known for centuries.

The subject of interest of functional data analysis is data that can naturally be perceived as functions. Although these data are available in practice in the form of sequences of individual observed values, the basic idea of functional data analysis is to approach these sequences as entire entities – functions (it is usually assumed that functions are continuous and smooth, and their value exists for all points of a certain domain on which they are defined, but they are observed only at specific individual points). The function is then the basic unit of analysis. The most common type of functions are functions with a one-dimensional continuous argument, which is typically time, but the argument can also be multidimensional, such as position in space, etc.

Functional data analysis combines the ideas and approaches of classical statistics and mathematical functional analysis. The goals of functional analysis are similar to that of other

areas of statistics, for example, to discover, describe and explain various important data characteristics, examine relationships between variables, create statistical models, perform inference, etc. The advantage of functional data analysis over classical statistics is the more natural perception of functional data, which makes it possible to use more information in analyzes concerning the behavior of a function or work with derivatives of a function. Moreover, functional data can be problematic from the point of view of classical statistics.

Functional data analysis finds its application in various natural and social sciences and applied domains. Its importance is closely related to the development of computer technology, which allows the acquisition, storage, and processing of large amounts of data of a functional nature.

The paper deals with the presentation of the fundamental ideas of functional data analysis and discussion of the possibilities of its use in econometrics. Section 2 is devoted to a review of scientific articles focused on the functional analysis of economic and financial data. Section 3 provides an overview of the main theoretical basis of functional data analysis. In section 4, the functional approach is used to analyze the dynamics of the industrial production index. Section 5 is the concluding summary.

2. Review of the Possibilities of Using Functional Data Analysis in Econometrics

To explore the possibilities of using functional data analysis in econometrics, a review of scientific articles was performed.

Articles were searched in the Web of Science and Scopus databases using the query string "functional data analysis", the occurrence of which was searched in article titles, abstracts, and keywords. Only articles from peer-reviewed journals and written in the English language were selected. The search was conducted in December 2020, so all articles published (and indexed in the database) up to that time were included. A total of 2,929 articles matching the search criteria were found in both databases. Of these, 1,437 records were duplicates. After their removal, 1,492 articles remained, the focus of which was studied.

The result was the identification of 55 articles describing the practical application of functional data analysis in the field of economics. The articles came from the years 2002–2020, in recent years the number of articles has been higher. The usual type of problem solved was an exploratory analysis, regression analysis, or time series analysis; in the tasks of creating various models, besides describing the relationships between variables, the most common goal was to predict future behavior.

The articles focused on the description and modeling of the behavior of various economic or financial variables and the examination of the influence of various factors on their behavior. Specifically, the subject of analyzes was, for example, the behavior of exchange rates (Kearney et al., 2018, 2019; Kim & Jung, 2018b), interest rates (Caldeira et al., 2020), price formation in online auctions and e-commerce (Bapna et al., 2008; Oomen, 2019; Reddy & Dass, 2006; Reithinger et al., 2008; S. Wang et al., 2008), prices of strategic commodities such as oil (Kearney et al., 2015; Kearney & Shang, 2020; Kim & Jung, 2018a), real estate prices (Peng et al., 2014; Seya et al., 2016), wages and wage inequality (Scott & Handcock, 2005; D. Wang et al., 2018), behavior of stock indices (Kokoszka et al., 2017; Müller et al., 2011; Z. Wang et al.,

2014), modeling and forecasting stock or bonds returns (Brockhaus et al., 2018; Caldeira & Torrent, 2017; Cao et al., 2020; Das et al., 2019; Hays et al., 2012), including the related quantification of investment risk and portfolio optimization (Cai, 2018; Kokoszka et al., 2019). The dynamics of supply and demand in various markets was also examined (Canale & Vantini, 2016).

3. Theoretical Fundamentals of Functional Data Analysis

Some basic theoretical aspects of functional data analysis are presented, more detailed information can be found, for example, in (Hsing & Eubank, 2015; Kokoszka & Reimherr, 2017; Ramsay & Silverman, 2005).

3.1. Functional Random Variable

A functional random variable can be formally defined as a variable that takes values in an infinite dimensional space (functional space), $X = \{X(t) : t \in T\}$. In functional analyzes, we work with observations of the functional variable resp. functional data, $\{x_i(t) : t \in T, i = 1, 2, \dots, N\}$. The function x_i is the basic object (unit) of analyzes, it is assumed that its value $x_i(t)$ exists for all $t \in T$, but in practice it is observed only in specific discrete points $t_{ij} \in T, j = 1, 2, \dots, n$. The argument t is often one-dimensional (it is then a function of one variable, typically for example time), but it can also be two-dimensional or generally multidimensional. Further in the text, it will be assumed that $t \in T \subset \mathbb{R}$.

3.2. Creating a Functional Representation of Data

Since functional data are available in practice only in the form of individual discrete observations, it is first necessary to create their functional representation. If it is assumed that these observations are not loaded with noise, it is an interpolation problem. On the other hand, if noise, such as measurement errors or various random perturbations, is present in the observations, it is a smoothing problem. In general, the following model can be considered

$$y_{ij} = x_i(t_{ij}) + \epsilon_{ij}, \quad (1)$$

where $x_i(t_{ij})$ is the actual value of the function x_i at the point t_{ij} , y_{ij} is the corresponding observed value and ϵ_{ij} denotes possible (additive) noise.

The most common way of representing a function is to express it in the form of a linear combination of certain basis functions

$$x_i(t) \approx \sum_{k=1}^m c_{ik} \phi_k(t), \quad (2)$$

where ϕ_k is a certain standard collection of basis functions (e.g., splines, sine and cosine functions, wavelets, etc.) and c_{ik} are the corresponding coefficients of the linear combination.

The representation is chosen so that the function x_i suitably corresponds to the observed data, is continuous and usually also smooth; everything depends on the requirements of the practical problem that is solved.

3.3. *Characteristics of Functional Data, Derivatives of Functions, Functional Models*

As in classical statistics, it is possible to define basic descriptive characteristics (such as mean, variance, covariance, correlation) also for functional data, with the only difference that they have the form of functions.

As already mentioned, the usual requirement is the smoothness of functions, which is also associated with the existence of their derivatives. Depending on the required number of derivatives, the basis for representing the functions, etc. is then chosen.

The functional approach can be useful in exploratory analysis, but functional variables can also appear in various models, purely functional or in combination with classical scalar variables, and the derivatives of functions can also appear in the models.

4. **Demonstration of the Application of the Functional Approach in the Analysis of the Industrial Production Index**

The use of functional data analysis in economics will be shown on the exploratory analysis of the industrial production index. A functional representation of the data will be created, and the derivatives of the function will be used in the subsequent analysis.

4.1. *Industrial Production Index and Data Source*

The industrial production index measures the output of the industrial sector adjusted for price effects. It is a basic indicator of industrial short-term statistics. Its calculation is given according to the Statistical classification of economic activities in the European Community, (NACE Rev. 2, Eurostat). Data on the industrial production index of the Czech Republic in the years 2000–2020, which was obtained from the website of the Czech Statistical Office, were used for the analyzes. The data took the form of monthly indices calculated against the base index, which is the average index of the year 2015 (index 2015 = 100). A total of 252 values were involved, the values were adjusted for the effect of calendar variations, the logarithms of the indices were used in subsequent analyzes. The whole time series can be seen in Figure 1, a growing trend and seasonal variation are evident. The implementation of analyzes was performed in R.

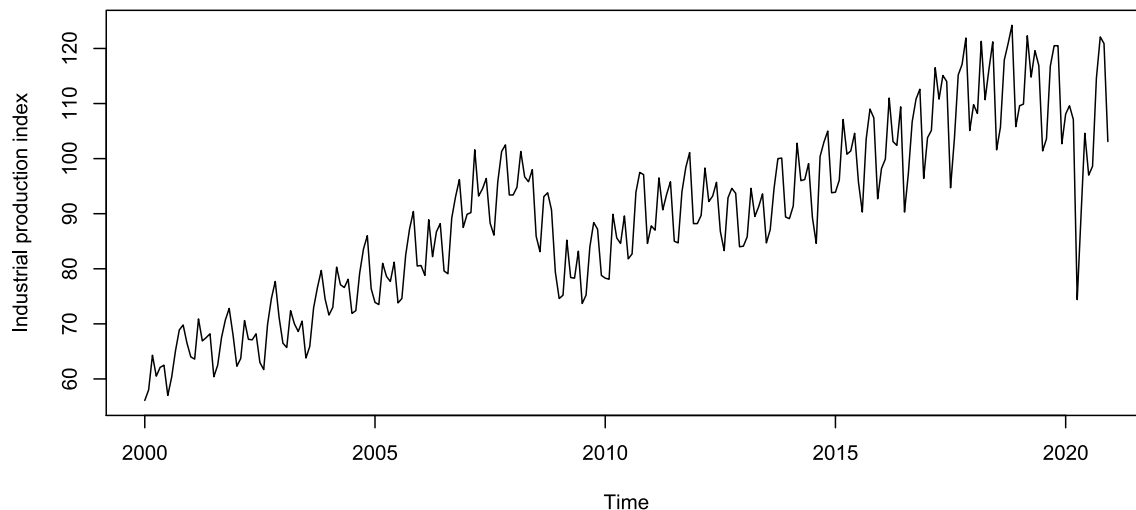


Figure 1. Industrial production index of the Czech Republic in the years 2000–2020.

4.2. Functional Representation

Industrial production can be seen as a continuous-time process, even if the index is given only at discrete points. To create a functional representation of the data, a B-spline basis was chosen, which is suitable for this type of data. The splines were defined by knots that were placed in each data point. For the construction of splines, polynomials of order six (degree five) were used, which provide sufficient flexibility to represent the behavior of the function and at the same time allow to obtain a continuous estimate of the first four derivatives of the function.

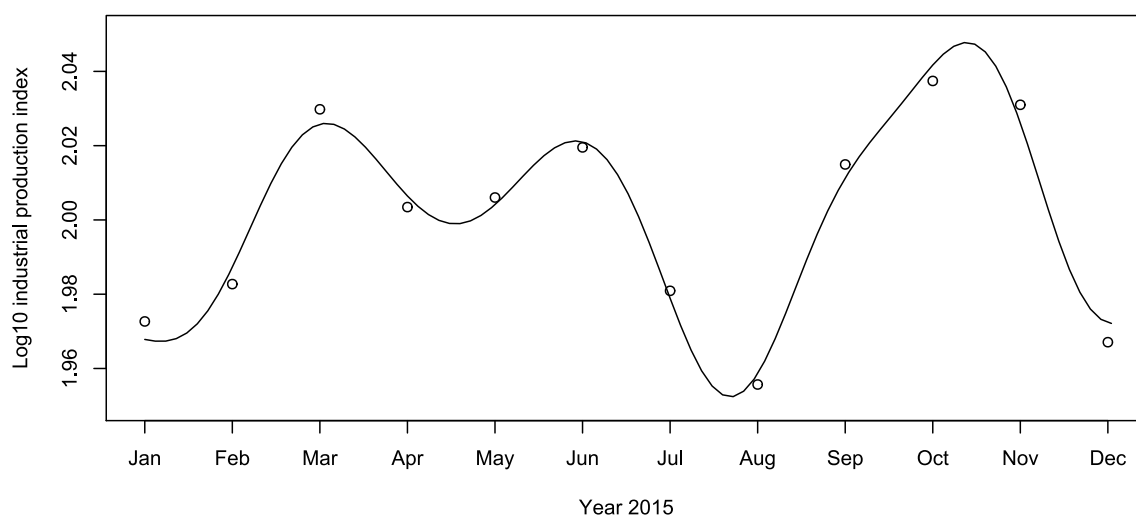
Roughness penalty smoothing was used to calculate the coefficients of the linear combination (2). This approach is based on the least squares method, but the aim is not only to minimize the sum of squared errors (SSE) but to minimize the characteristic

$$PENSSE = \sum_{j=1}^{252} [y_j - x(t_j)]^2 + \lambda \int_{2000}^{2020} [D^4 x(t)]^2 dt,$$

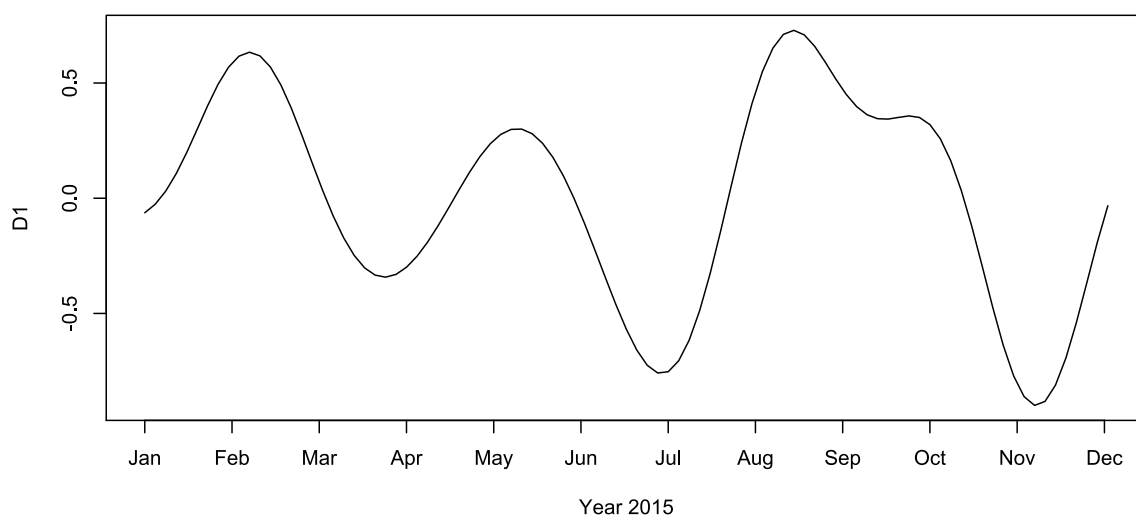
where $\lambda \int_{2000}^{2020} [D^4 x(t)]^2 dt$ is a penalty term that penalizes an overly complex and variable (rough) behavior of a function and ensures that the estimated function is naturally smooth (in general, this approach allows to capture only the essential characteristics of the behavior of the function without the influence of random perturbations and noise in the data). The fourth derivative of the function $D^4 x(t)$ was used for the penalty; the second derivative of the function represents its curvature and is usually chosen as a measure of the roughness of the function, but in subsequent analyzes the first and second derivatives of the function will be used, and it is required that also their behavior is not too rough, therefore, the second derivative of the second derivative of the function i.e. the fourth derivative of the function is used for the penalty (for this reason, polynomials of order six were used for spline construction). The smoothness or roughness of the function is now given by the choice of the smoothing parameter λ . The higher the value of λ , the stronger the effect of the penalty, and the resulting estimate of the function will be smoother, and vice versa, the smaller λ (closer to zero), the greater complexity of the estimated function will be allowed. In practice, the parameter λ is often chosen automatically using cross-validation, but here its value was determined manually so that the smoothness of functions and their derivatives is appropriate to the needs of subsequent analyzes (the value obtained by cross-validation would over-smooth the estimates).

The obtained estimate of the function and both derivatives is shown in Figure 2 for the year 2015 as an example.

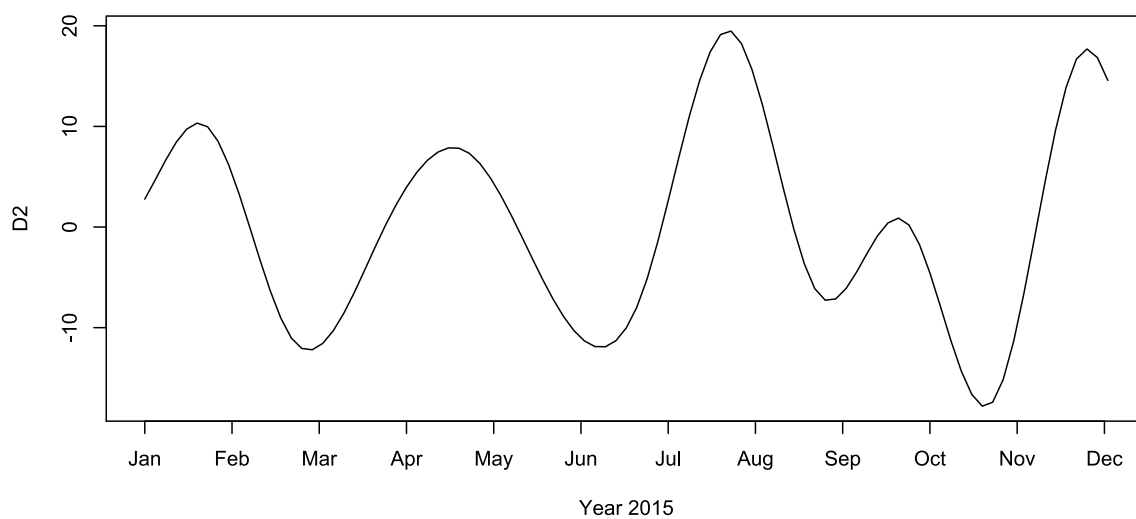
The graph of the function shows the seasonal character of the industrial production index, the index reaches higher values in March, June, and October, on the contrary, the decline in production occurs in the summer months and at the turn of the year. This nature of the behavior is the same for other years, with obvious exceptions, which will be described in more detail in the next part of the text.



(a)



(b)



(c)

Figure 2. Estimated function (a) and its first (b) and second (c) derivative.

4.3. Phase Plane Plots

As already mentioned, one of the advantages of the functional approach is the possibility to work also with derivatives of functions. Usually, the first or the second derivative is used. In the case of functions of time, the first derivative expresses velocity, and the second derivative expresses acceleration. The so-called phase plane plot, in which the first and second derivatives are plotted against each other, can then serve as a useful analytical tool.

Phase plane plots are typically used in physics to visualize the behavior of oscillating systems, such as a mathematical pendulum, whose motion can be considered harmonic and described by a sinusoid. The system has a certain energy, which is periodically converted from the form of potential energy to the form of kinetic energy and vice versa. When the pendulum is tilted to the extreme position, the first derivative of the function of its position in time i.e. velocity is zero, so the kinetic energy is zero and the potential energy reaches a maximum. Conversely, when the pendulum is in a vertical equilibrium position, the speed of motion is maximum, acceleration i.e. the second derivative is zero, and thus the kinetic energy is maximum and the potential energy is zero. This energy transfer can be represented by a phase plane plot, see Figure 3, the motion of the pendulum is described by the function $\sin(2\pi t)$, the first derivative has the form $2\pi \cos(2\pi t)$ and the second derivative $-(2\pi)^2 \sin(2\pi t)$.

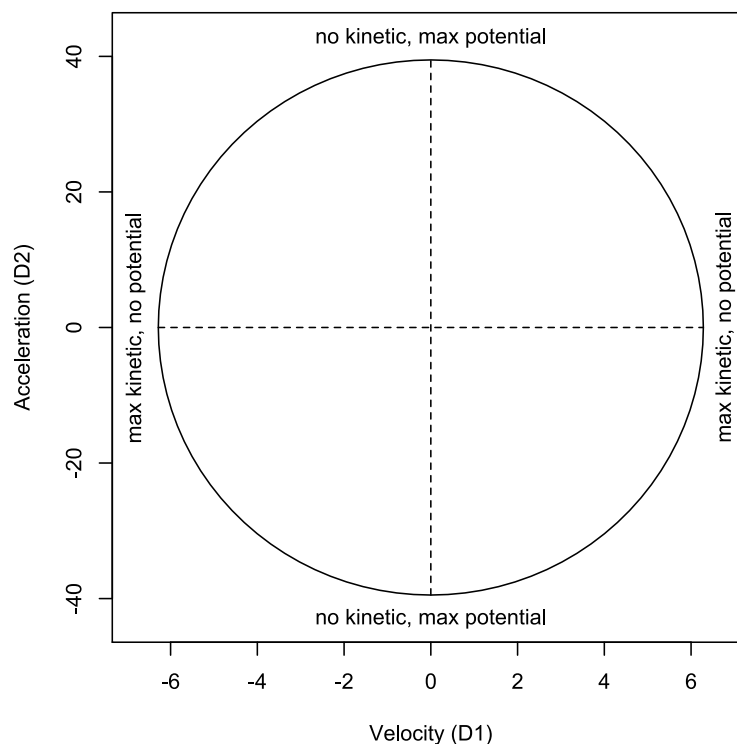


Figure 3. Phase plane plot for mathematical pendulum.

Energy transfer can be encountered also in other than just physical systems. From an economic point of view, available capital, human resources, and other factors which can be used, in the case of the index of industrial production, for industrial production, can be perceived as potential energy. The kinetic energy then corresponds to the ongoing production in which these resources are used. The production process undergoes periodic transitions, a period of high production (high kinetic energy), when resources are depleted (low potential

energy), is followed by a reduction in production (kinetic energy decreases) and replenishment of resources (potential energy increases), etc. In some periods, such as crises, however, there may also be situations where both the kinetic and potential energy are low, the phase plane curve is then close to zero.

4.4. Analysis of the Industrial Production Index

Phase plane plots were used for the analysis of industrial production in the Czech Republic in the period from 2000 to 2020. A phase plane plot was created for each year and the behavior of production in that year and the differences between years were examined.

Figure 4 shows a phase plane plot for the year 2015, which can be considered a typical year in a period of economic growth. The plot consists of a cyclic curve that begins near the middle with the designation of the month of January and continues clockwise throughout the year, with the labels indicating the months of the year. At the beginning of the year, the kinetic and the potential energy is low, during January the kinetic and the potential energy begins to grow, production increases, the rate of production growth first increases, then begins to decline, but production increases until March, when the rate drops to zero and then production will reduce. During April, production begins to grow again and continues to grow until June, when it begins to decline, but the decline is much more significant, which corresponds to the summer months and holidays, kinetic energy is low at this time and potential energy is high. In late summer, production increases rapidly, kinetic energy reaches a maximum and potential energy falls to zero, growth gradually slows down, production reaches its maximum in October and then begins to decline towards the end of the year.

Year 2015

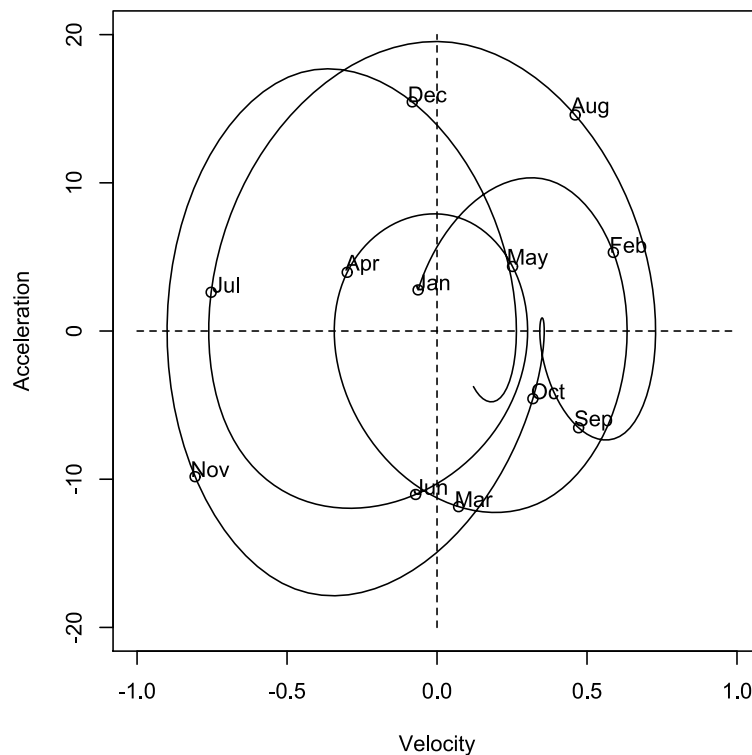


Figure 4. Phase plane plot for industrial production in the year 2015.

The characteristics of the development of industrial production are similar in other years, with the exception of the years when some significant events affecting the economy occurred. For comparison, the years 2008 and 2009, which were a period of economic crisis, as well as the year 2020 affected by the coronavirus pandemic will be shown.

Figures 5 and 6 show the phase plane plots for the years 2008 and 2009. In 2008, the beginning of the economic crisis is evident, in the second half of the year there is much less energy in the system than in other years and the usual significant autumn increase in production is lower and the decline continues until the following year. In the first half of 2009 there are more significant fluctuations in the production, the spring decline in production is more significant than in other years and the middle of the spring cycle is not shifted to the right to positive values of velocity corresponding to prevailing growth.

Figure 7 shows the phase plane plot for the year 2020. In March and April of this year, due to the onset of the coronavirus pandemic and the associated restrictions, a very significant decrease in production is evident (the plot is half the scale of previous plots). Subsequently, there is an increase in production, which peaks in June. The holiday decline in production is smaller than is typical in other years. The next second half of the year is already similar to the usual nature of production.

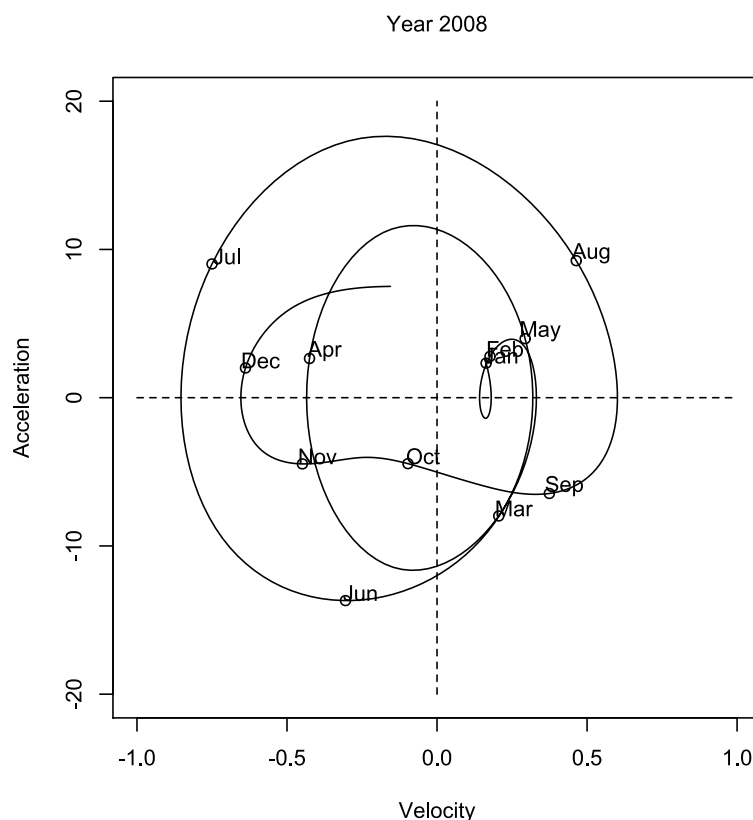


Figure 5. Phase plane plot for industrial production in the year 2008.

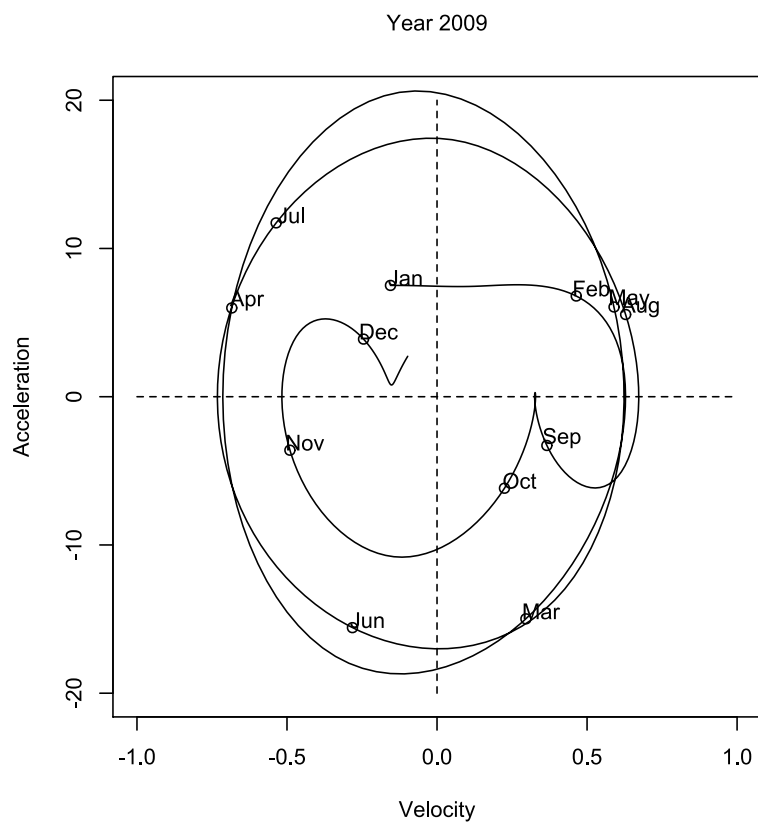


Figure 6. Phase plane plot for industrial production in the year 2009.

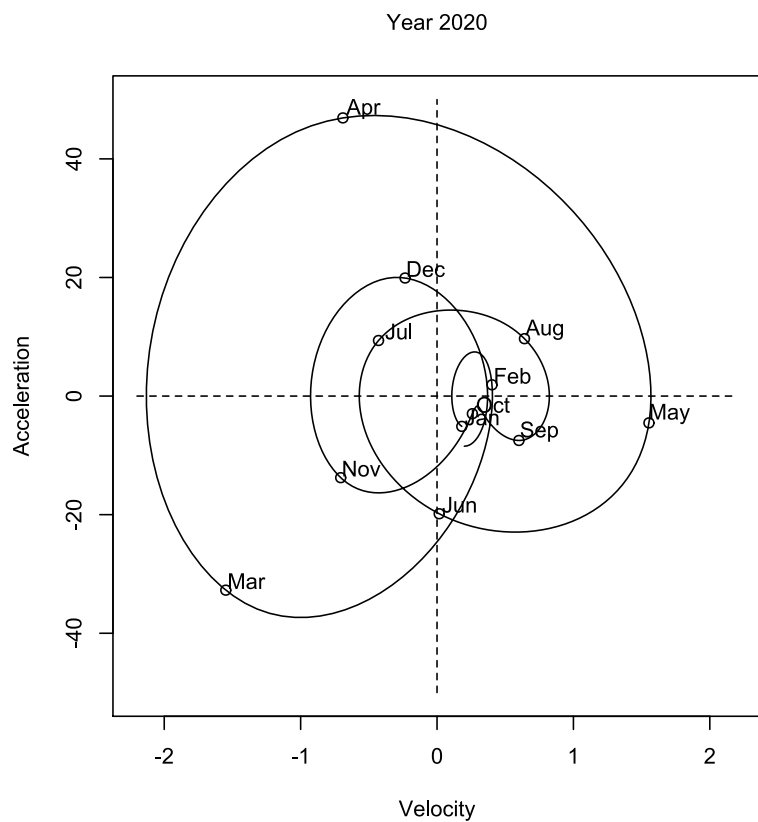


Figure 7. Phase plane plot for industrial production in the year 2020.

5. Conclusions

The paper dealt with the possibilities of using functional data analysis in econometrics. A lot of economic data takes the form of observations of time-continuously evolving processes and can thus naturally be perceived as functional data. The search and review of articles showed that functional data analysis can find various applications in describing and modeling the behavior of various economic variables. Furthermore, the paper presented the main theoretical fundamentals of the functional approach and then showed its possible use in the exploratory analysis of the index of industrial production in the Czech Republic in the years 2000–2020. A functional representation of the data was created, and the derivatives were used in the analysis, which were plotted in phase plane plots. The plots were created for each year, which made it possible to study the seasonal character of production and compare differences between years, specifically focusing on the economic crisis in 2008 and 2009 and the coronavirus crisis in 2020. Phase plane plots allow better examination of the dynamics of industrial production, not only in terms of its growth or decline, but because of the representation of derivatives, it is possible to focus more on examining the rate of growth or decline and its acceleration or deceleration also with the possibility to observe the impact of various economic shocks. Interpretation with respect to energy transfer in the economic system is also possible. The exploratory analysis could be further followed, for example, by creating a functional model for the development of the industrial production index. The functional approach has other possibilities of use, working with derivatives of functions is just one of the benefits it brings. Functional data analysis can often help answer questions that are difficult for classical statistical methods.

Acknowledgments: The paper was supported by the Specific Research Project at the Faculty of Informatics and Management of the University of Hradec Králové, the Czech Republic.

References

- Bapna, R., Jank, W., & Shmueli, G. (2008). Price formation and its dynamics in online auctions. *Decision Support Systems*, 44(3), 641–656. <https://doi.org/10.1016/j.dss.2007.09.004>
- Brockhaus, S., Fuest, A., Mayr, A., & Greven, S. (2018). Signal regression models for location, scale and shape with an application to stock returns. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, 67(3), 665–686. <https://doi.org/10.1111/rssc.12252>
- Cai, T. (2018). Financial risk management based on functional data analysis. *Journal of Discrete Mathematical Sciences and Cryptography*, 21(6), 1397–1400. <https://doi.org/10.1080/09720529.2018.1527484>
- Caldeira, J., & Torrent, H. (2017). Forecasting the US Term Structure of Interest Rates Using Nonparametric Functional Data Analysis: Forecasting the US Term Structure of Interest Rates Using Nonparametric Functional Data Analysis. *Journal of Forecasting*, 36(1), 56–73. <https://doi.org/10.1002/for.2414>
- Caldeira, J., Gupta, R., Suleman, M. T., & Torrent, H. S. (2020). Forecasting the Term Structure of Interest Rates of the BRICS: Evidence from a Nonparametric Functional Data Analysis. *Emerging Markets Finance and Trade*, 1–18. <https://doi.org/10.1080/1540496X.2020.1808458>
- Canale, A., & Vantini, S. (2016). Constrained functional time series: Applications to the Italian gas market. *International Journal of Forecasting*, 32(4), 1340–1351. <https://doi.org/10.1016/j.ijforecast.2016.05.002>
- Cao, R., Horváth, L., Liu, Z., & Zhao, Y. (2020). A study of data-driven momentum and disposition effects in the Chinese stock market by functional data analysis. *Review of Quantitative Finance and Accounting*, 54(1), 335–358. <https://doi.org/10.1007/s11156-019-00791-x>
- Czech Statistical Office. (2021). *Industry - Time series* [Data set]. Retrieved January 8, 2021 from https://www.czso.cz/csu/czso/pru_ts

- Das, S., Demirer, R., Gupta, R., & Mangisa, S. (2019). The effect of global crises on stock market correlations: Evidence from scalar regressions via functional data analysis. *Structural Change and Economic Dynamics*, 50, 132–147. <https://doi.org/10.1016/j.strueco.2019.05.007>
- Hays, S., Shen, H., & Huang, J. Z. (2012). Functional dynamic factor models with application to yield curve forecasting. *The Annals of Applied Statistics*, 6(3), 870–894. <https://doi.org/10.1214/12-AOAS551>
- Hsing, T., & Eubank, R. L. (2015). *Theoretical foundations of functional data analysis, with an introduction to linear operators*. John Wiley and Sons, Inc.
- Kearney, F., Cummins, M., & Murphy, F. (2018). Forecasting implied volatility in foreign exchange markets: A functional time series approach. *The European Journal of Finance*, 24(1), 1–18. <https://doi.org/10.1080/1351847X.2016.1271441>
- Kearney, F., Cummins, M., & Murphy, F. (2019). Using extracted forward rate term structure information to forecast foreign exchange rates. *Journal of Empirical Finance*, 53, 1–14. <https://doi.org/10.1016/j.jempfin.2019.05.002>
- Kearney, F., Murphy, F., & Cummins, M. (2015). An analysis of implied volatility jump dynamics: Novel functional data representation in crude oil markets. *The North American Journal of Economics and Finance*, 33, 199–216. <https://doi.org/10.1016/j.najef.2015.04.006>
- Kearney, F., & Shang, H. L. (2020). Uncovering predictability in the evolution of the WTI oil futures curve. *European Financial Management*, 26(1), 238–257. <https://doi.org/10.1111/eufm.12212>
- Kim, J.-M., & Jung, H. (2018a). Time series forecasting using functional partial least square regression with stochastic volatility, GARCH, and exponential smoothing: Functional partial least square regression. *Journal of Forecasting*, 37(3), 269–280. <https://doi.org/10.1002/for.2498>
- Kim, J.-M., & Jung, H. (2018b). Relationship between oil price and exchange rate by FDA and copula. *Applied Economics*, 50(22), 2486–2499. <https://doi.org/10.1080/00036846.2017.1400652>
- Kokoszka, P., & Reimherr, M. (2017). *Introduction to functional data analysis*. CRC Press, Taylor & Francis Group.
- Kokoszka, P., Miao, H., & Zheng, B. (2017). Testing for asymmetry in betas of cumulative returns: Impact of the financial crisis and crude oil price. *Statistics & Risk Modeling*, 34(1–2). <https://doi.org/10.1515/strm-2016-0010>
- Kokoszka, P., Miao, H., Stoev, S., & Zheng, B. (2019). Risk Analysis of Cumulative Intraday Return Curves. *Journal of Time Series Econometrics*, 11(2). <https://doi.org/10.1515/jtse-2018-0011>
- Müller, H.-G., Sen, R., & Stadtmüller, U. (2011). Functional data analysis for volatility. *Journal of Econometrics*, 165(2), 233–245. <https://doi.org/10.1016/j.jeconom.2011.08.002>
- Oomen, R. (2019). Price signatures. *Quantitative Finance*, 19(5), 733–761. <https://doi.org/10.1080/14697688.2018.1532102>
- Peng, J., Paul, D., & Müller, H.-G. (2014). Time-warped growth processes, with applications to the modeling of boom–bust cycles in house prices. *The Annals of Applied Statistics*, 8(3), 1561–1582. <https://doi.org/10.1214/14-AOAS740>
- Ramsay, J. O., & Silverman, B. W. (2005). *Functional data analysis* (2nd ed). Springer.
- Reddy, S. K., & Dass, M. (2006). Modeling On-Line Art Auction Dynamics Using Functional Data Analysis. *Statistical Science*, 21(2), 179–193. <https://doi.org/10.1214/088342306000000196>
- Reithinger, F., Jank, W., Tutz, G., & Shmueli, G. (2008). Modelling price paths in on-line auctions: Smoothing sparse and unevenly sampled curves by using semiparametric mixed models. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, 57(2), 127–148. <https://doi.org/10.1111/j.1467-9876.2007.00605.x>
- Scott, M. A., & Handcock, M. S. (2005). Persistent Inequality? Answers From Hybrid Models for Longitudinal Data. *Sociological Methods & Research*, 34(1), 3–30. <https://doi.org/10.1177/0049124105277194>
- Seya, H., Yoshida, T., & Tsutsumi, M. (2016). Ex-post identification of geographical extent of benefited area by a transportation project: Functional data analysis method. *Journal of Transport Geography*, 55, 1–10. <https://doi.org/10.1016/j.jtrangeo.2016.07.004>
- Wang, D., Xu, Y., He, L., & Liu, R. (2018). Spatial and Temporal Differences in the Relationships between Residents' Income and Consumption in China: A Dynamic Analysis Using Functional Data Analysis. *Sustainability*, 10(12), 4703. <https://doi.org/10.3390/su10124703>
- Wang, S., Jank, W., & Shmueli, G. (2008). Explaining and Forecasting Online Auction Prices and Their Dynamics Using Functional Data Analysis. *Journal of Business & Economic Statistics*, 26(2), 144–160. <https://doi.org/10.1198/073500106000000477>
- Wang, Z., Sun, Y., & Li, P. (2014). Functional Principal Components Analysis of Shanghai Stock Exchange 50 Index. *Discrete Dynamics in Nature and Society*, 2014, 1–7. <https://doi.org/10.1155/2014/365204>

Spatial Differentiation of Tax Collection Costs in Poland

Lukasz FURMAN*, Paulina KOZA

Carpathian State University, Krosno, Poland; lukasz.furman@kpu.krosno.pl; paulinakoza19@gmail.com

* Corresponding author: lukasz.furman@kpu.krosno.pl

Abstract: The article was devoted to presenting the concept of the cost of collecting taxes, which are borne by the state. The article discusses the division of this cost according to the type system of costs, which functions in accounting. The division of costs by type distinguishes the costs of consumption of materials and energy, depreciation of tangible and intangible assets, external services, social insurance and other employee benefits, taxes and fees and other costs. These costs are incurred by tax offices and customs and fiscal offices involved in tax collection in Poland. In each province tax collection is supervised by tax administration chambers, which determine at the provincial level the total cost of collection. These are the total costs incurred by tax offices, customs and tax administration offices and tax administration chambers. In the course of writing the article, a hypothesis was put forward: there is a variation in the cost of tax collection within individual provinces in Poland. To verify the hypothesis, the method of analyzing statistical data consisting of annual total tax receipts and annual total costs by type was used. The study covered the period from 2015 to 2019.

Keywords: tax collection cost; cost by nature; tax receipts; tax administration

JEL Classification: H20; H21

1. Introduction

The issue of tax collection costs is a concept that is closely related to the functioning of the public finance sector. In any market economy, the state influences the economy to some extent through various methods. A certain instrument is the tax system, which allows accumulating public revenues. This fulfills the fiscal function. The state, while collecting public levies, must have worked out the principles of their collection and appropriate infrastructure facilities with employees. Tax collection results in costs on the part of the state or local government (as institutions authorized to collect taxes). This topic is extremely broad because some costs associated with tax collection already arise in the legislation of tax laws. The final stage, where the costs of collection occur, is the enforcement of the tax when the taxpayer voluntarily fails to pay the tax.

Thus, the purpose of this article is to present the concept of cost of tax collection and its various aspects presented in the literature. In the article it was also decided to verify the hypothesis which reads: in individual provinces of Poland there is a variation in the cost of tax collection. Both domestic and foreign literature was used in writing the article.

2. Methodology

As it was mentioned in the introduction, the paper decided to verify the hypothesis that there is a differentiated cost of tax collection in 16 voivodeships in Poland. A Statistical data analysis method was used to reject or confirm the hypothesis. For statistical analysis, the following data were obtained: On the amount of generic costs incurred by the institutions collecting taxes in each province for the state budget. On the amount of taxes collected for the state budget in each province. The time period of the study was from 2015 to 2019.

3. Concept of the Principle of Low-Cost Tax Collection

The costs of tax collection have already been recognized by classical economists. Adam Smith in his work commented on the tax system in tax principles. One of those rules was specifically about the rules for collecting taxes. He wrote that in collecting taxes the state should keep in mind the principle of cheapness. It indicated that tax collection should be done at the lowest possible cost. This is especially true for a state that collects taxes. Other principles he created are the principle of equality, the principle of certainty and the principle of convenience. However, when analyzing the cost system of tax collection from the point of view of the tax collector than the principle of cheapness becomes the most important (Smith, 2012).

Subsequent economists developed the tax principles introduced by Adam Smith. In the nineteenth century A. Wagner, referring to the classical principles of taxation, observed that the principle of cheapness should concern the tax collector and the taxpayer. This resolution of the case takes into account the interests of both parties (Sosnowski, 2012).

Nor has the cheapness of the tax collection system lost its relevance in the economic realities of the 21st century. Economists continue to confirm that it is a guiding principle that should be taken into account by authorities legislating on public tributes. Such a solution is primarily based on the effectiveness of the public finance sector (Nowak, 2007a). In foreign publications we read about it, among others. in publications by Turner et al. (1998).

In Polish publications we can find references to the feature of cheapness of the tax collection system. It is visible especially in publications of N. Gajl, S. Owsiak, J. Głuszewski, W. Matuszewski, E. Małecka-Ziemińska. M. Kosek-Wojnar, K. Surówka, T. Famulska. These authors recognized that a feature of modern economy is the pursuit of its efficiency. The public finance sector should present appropriate solutions to economic realities - including a well-functioning tax collection system, which should pay attention to the costs of its functioning (Nowak, 2007b).

An interesting analysis of the principles of tax collection was presented by Franek and Adamczyk (2017). Among the existing principles, particular attention has been paid to the principle of cheapness, which is assessed in different tax systems using specific metrics. Most commonly, it is a measure defined as the ratio of the cost of operating a tax administration to the tax revenue generated in a country (Franek & Adamczyk, 2017).

The tax collection process evolves in every economy. The public administration, including tax administration, is increasingly computerized, which was noticed by, among others by Żak (2011).

4. Discussion

The subject related to the functioning of the principle of cheapness of tax collection was decided to check on the example of empirical data coming from the Polish tax administration, which functions in each of 16 voivodeships. The structure of this administration consists of: 16 fiscal administration chambers, 400 fiscal offices, 16 customs and fiscal offices. The chambers of fiscal administration are institutions that supervise the functioning of fiscal offices and customs and fiscal offices. Tax offices, on the other hand, collect both direct and indirect taxes from taxpayers. These taxes include, among others: personal income tax, corporate income tax, value added tax, excise tax, gaming tax, tonnage tax, tax on certain financial institutions, tax on civil law transactions, inheritance and donation tax.



Figure 1. Territorial division of the National Tax Administration Units in Poland.

(Source: <https://www.gov.pl/web/kas/struktura-kas>)

In turn, the customs and tax offices collect customs duty, import VAT resulting from customs declarations, domestic excise tax, excise tax on intra-Community acquisitions, import excise tax, tax on gaming, tax on extraction of certain minerals, VAT on intra-Community acquisitions of motor fuels, amounts representing the value of excise tax stamps, duties on legalization of excise tax stamps.

These tax administration units are financed directly from the state budget. In each province, records of the amount of taxes collected and the amount of costs incurred for operation are kept by the chamber of tax administration. Thanks to its accounting records, it is able to control the amount of costs incurred, as mentioned in the article by Furman (2011). Costs incurred by type refer to reporting periods, which are calendar years. Due to legal regulations, entities of the public finance sector in Poland are obliged to record them on an annual basis. Costs incurred by type include depreciation of tangible and intangible assets, consumption of materials and energy, external services, salaries, social security and other employee benefits, taxes and fees, other costs by type (Konopka, 2021).

Table 1. Total costs by type incurred by Tax Administration Chambers in individual provinces in 2015-2019 (in PLN million) (Source: Tax administration chambers by voivodeship)

Lp.	Voivodeship	2015	2016	2017	2018	2019
1.	Dolnośląskie	225.5	289.1	410.7	430.3	472.1
2.	Kujawsko-pomorskie	184.1	187.9	254.2	263.2	297.5
3.	Lubelskie	29.6	159.3	357.4	372.3	415.9
4.	Lubuskie	79.7	100.5	186.5	197.6	221.1
5.	Łódzkie	203.6	257.5	347.6	370.3	408.6
6.	Małopolskie	225.9	290.0	429.6	452.2	499.3
7.	Mazowieckie	446.7	574.5	799.7	841.7	930.9
8.	Opolskie	65.9	90.7	136.7	169.7	196.3
9.	Podkarpackie	137.8	141.7	282.6	294.4	331.4
10.	Podlaskie	68.4	87.2	208.2	222.4	248.2
11.	Pomorskie	166.0	208.0	329.8	340.1	379.1
12.	Śląskie	351.5	446.7	572.7	604.4	678.7
13.	Świętokrzyskie	90.5	94.8	125.3	136.1	150.6
14.	Warmińsko-mazurskie	85.9	109.9	213.1	216.1	240.8
15.	Wielkopolskie	345.9	350.4	457.0	478.6	528.9
16.	Zachodnio-pomorskie	139.9	180.3	278.9	290.1	323.5

In the data presented in Table 1, it can be seen what the sum of generic costs of the Administrative and Tax Chamber is in the province in 2015-2019. The dominant cost in each province is salaries. It is one of the main costs occupying the largest percentage in the generic costs. An upward trend in costs by type can be observed from year to year. The highest sum of incurred generic costs in 2015 was recorded in the Mazowieckie Voivodeship, while the lowest in the Świętokrzyskie Voivodeship. Taxes and charges have the lowest share of costs by type in each province.

The data presented in Table 2 show that the highest tax revenue is generated by the Mazowieckie voivodeship. In 2019, we may see a decrease in receipts in Lubuskie County, which can be explained by increased tax refunds. Mazowieckie and Małopolska are the richest regions of the country in terms of tax revenue.

Table 2. Total taxes collected in each province in 2015-2019 (in PLN million) (Source: Tax administration chambers by voivodeship)

Lp.	Voivodeship	2015	2016	2017	2018	2019
1.	Dolnośląskie	15,288.7	16,287.8	22,178.4	23,098.8	22,998.8
2.	Kujawsko-pomorskie	5,648.2	6,973.8	7,692.0	9,025.0	9,841.2
3.	Lubelskie	5,325.4	5,407.3	6,388.0	6,773.6	7,203.6
4.	Lubuskie	1,625.8	1,408.2	2,067.7	2,291.9	1,997.4
5.	Łódzkie	13,040.6	14,510.3	17,146.2	19,116.5	19,597.6
6.	Małopolskie	18,170.2	19,051.4	96,429.1	90,974.7	93,182.0
7.	Mazowieckie	92,099.1	104,096.9	124,347.7	129,753.4	138,950.2
8.	Opolskie	3,772.8	4,419.0	5,464.7	5,884.4	6,216.7
9.	Podkarpackie	5,096.7	5,356.2	7,243.2	8,304.4	8,198.6
10.	Podlaskie	2,449.7	2,559.9	3,681.3	3,863.1	4,257.6
11.	Pomorskie	13,408.9	15,477.2	17,536.9	20,962.2	23,434.4
12.	Śląskie	20,477.0	21,523.5	27,941.7	32,471.2	35,669.5
13.	Świętokrzyskie	2,570.3	2,925.0	3,458.9	3,882.4	4,467.3
14.	Warmińsko-mazurskie	2,732.7	2,579.8	3,643.9	4,003.0	4,166.2
15.	Wielkopolskie	23,017.8	24,589.2	28,922.3	32,093.0	34,337.4
16.	Zachodnio-pomorskie	4,546.7	4,695.5	4,903.9	5,518.2	6,368.3

Table 3. Dynamics of generic costs incurred by Tax Administration Chambers in individual provinces in 2015-2019 in % (Source: Tax administration chambers by voivodeship)

Lp.	Voivodeship	2015	2016	2017	2018	2019
1.	dolnośląskie	100%	128%	142%	105%	110%
2.	kujawsko-pomorskie	100%	102%	135%	104%	113%
3.	lubelskie	100%	539%	224%	104%	224%
4.	lubuskie	100%	126%	186%	106%	112%
5.	łódzkie	100%	126%	135%	107%	110%
6.	małopolskie	100%	128%	148%	105%	110%
7.	mazowieckie	100%	129%	139%	105%	111%
8.	opolskie	100%	138%	151%	124%	116%
9.	podkarpackie	100%	103%	199%	104%	113%
10.	podlaskie	100%	128%	239%	107%	112%
11.	pomorskie	100%	125%	159%	103%	111%
12.	śląskie	100%	127%	128%	106%	112%
13.	świętokrzyskie	100%	105%	132%	109%	111%
14.	warmińsko-mazurskie	100%	128%	194%	101%	111%
15.	wielkopolskie	100%	101%	130%	105%	110%
16.	zachodniopomorskie	100%	129%	155%	104%	112%

Analyzing the dynamics of costs by type in individual voivodeships, one can notice that the sum of the incurred costs changed. The largest increase in cost dynamics was recorded in Lubuskie Province in 2016 compared to 2015. It remained high in later years. In 2017, each of the provinces experienced a significant increase in generic costs compared to the previous year.

Table 4. Share of generic costs incurred by Tax Administration Chambers in 16 provinces in collected taxes on the territory of each province in 2015-2019 in % (own calculations)

Lp.	Województwo	2015	2016	2017	2018	2019
1.	Dolnośląskie	1.48%	1.77%	1.85%	1.86%	2.05%
2.	Kujawsko-pomorskie	3.26%	2.69%	3.30%	2.92%	3.02%
3.	Lubelskie	0.55%	2.95%	5.60%	5.50%	5.77%
4.	Lubuskie	4.90%	7.14%	9.02%	8.62%	11.07%
5.	Łódzkie	1.56%	1.77%	2.03%	1.94%	2.09%
6.	Małopolskie	1.24%	1.52%	0.45%	0.50%	0.54%
7.	Mazowieckie	0.49%	0.55%	0.64%	0.65%	0.67%
8.	Opolskie	1.75%	2.05%	2.50%	2.88%	3.16%
9.	Podkarpackie	2.70%	2.65%	3.90%	3.54%	4.04%
10.	Podlaskie	2.79%	3.41%	5.66%	5.76%	5.83%
11.	Pomorskie	1.24%	1.34%	1.88%	1.62%	1.62%
12.	Śląskie	1.72%	2.08%	2.05%	1.86%	1.90%
13.	Świętokrzyskie	3.46%	3.18%	3.55%	3.41%	3.30%
14.	Warmińsko-mazurskie	3.14%	4.26%	5.85%	5.40%	5.78%
15.	Wielkopolskie	1.50%	1.42%	1.58%	1.49%	1.54%
16.	Zachodniopomorskie	3.08%	3.84%	5.69%	5.26%	5.08%

The share of generic costs in collected taxes should oscillate below 2%, as it happens in developed economies. In 2015-2019, the calculated indicator in Table 4 remained below 2% in the provinces of Dolnośląskie, Łódzkie, Małopolskie, Mazowieckie, Pomorskie, Śląskie and Wielkopolskie. In the remaining voivodeships the share of costs was significantly higher (above 2%). In the case of voivodeships that operate along external state borders, there may be a situation of reimbursement of goods and services tax (in connection with international sales taxed at a 0% VAT rate), which in effect will reduce the total tax revenue.

The calculated indicators presented in the context of the hypothesis allow stating that it has been verified positively. Each of the 16 voivodeships in Poland was characterized by a different ratio of the share of generic costs incurred by the Tax Administration Chambers in collected taxes in each voivodeship. Therefore, it can be concluded that in administrative units such as voivodeships costs are incurred in a different amount.

5. Conclusions

The analysis showed that the topic of the cost of tax collection is very important from the point of view of the public finance sector and its efficiency. The differences in the calculated indicators of the cost of tax collection in the 16 voivodeships result primarily from the different value of the taxes collected and the type of costs incurred. The calculated indicators in Table 4 for each of the provinces allow to draw the conclusion that there are provinces in which it is necessary to take action to reduce costs, because the incurred costs by type are disproportionate to the recorded tax revenue. The lowest tax collection costs were in Mazowieckie, Wielkopolskie, Śląskie and Małopolskie voivodeships. Such a low ratio results from the fact that the highest number of taxpayers, both legal entities and natural persons, is

registered in the above mentioned voivodeships. Consequently, tax revenues are higher than in other provinces. On the other hand, in the eastern voivodeships (lubelskie, podkarpackie, podlaskie) the indicator of the share of costs by type in the tax revenue ranged from 2.65% to 11.07%. The level of this indicator, although higher than in other provinces, does not prove that high collection costs are incurred. This is due to the fact that tax revenues in the eastern border region are reduced by goods and services tax refunds due to export sales, which are taxed at a 0% rate. Thus, the indicator will be higher than in other Polish voivodeships. Summing up the subject of costs of tax collection in individual provinces of Poland, it should be stated that these costs will always vary. This is mainly due to the specificity of tax administration activities in all provinces.

References

- Franeek, S., & Adamczyk, A. (2017). Ocena systemów podatkowych państw Unii Europejskiej w świetle wypełniania zasad podatkowych. *Annales Universitatis Mariae Curie-Skłodowska, sectio H–Oeconomia*, 51(4).
- Furman, W. (2011). Kontrolna funkcja rachunkowości podatkowej. In B. Micherda (Ed.), *Współczesne aspekty realizacji kontrolnej funkcji rachunkowości* (pp. 249-258). Warszawa Difin.
- Furman, Ł. (2019). *Efektywny system poboru podatków*. CeDeWu.
- Konopka, K. (2021). Wynagrodzenie biegłego sądowego. In A. Baryłka (Ed.), *Poradnik biegłego sądowego* (pp. 171-197). CRB.
- Smith, A. (2012). *Badania nad naturą i przyczynami bogactwa narodów, Tom 1*. Wydawnictwo Naukowe PWN.
- Neumark, F. (1970). *Grundsätze der Besteuerung in Vergangenheit und Gegenwart*. Wiesbaden.
- Nowak, A. (2007a). Współczesne zasady podatkowe. In B. Fiedor, & J. Rymarczyk (Eds.), *Ekonomia i międzynarodowe stosunki gospodarcze* (pp. 14-15), Wydawnictwo Akademii Ekonomicznej im. Oskara Langego we Wrocławiu.
- Nowak, A. (2007b). Współczesne zasady podatkowe. In M. Stawicka, & M. Kędzierska (Eds.), *Wydatki publiczne a rozwój*. Wydawnictwo Akademii Ekonomicznej im. O. Langego we Wrocławiu.
- Sosnowski, M. (2012). Znaczenie zasad podatkowych dla systemu podatkowego. *Zeszyty Naukowe Uniwersytetu Szczecińskiego*, 108, 60-61.
- Turner, J., Smith, M., & Gurd, B. (1998). Recognising the Pitfalls in Tax Compliance Costs Research. *Revenue Law Journal*, 8.
- Żak, D. (2011). Rozwój elektronicznej administracji publicznej w Polsce. In J. Zieliński (Ed.), *Rola informatyki w naukach ekonomicznych i społecznych. Innowacje i implikacje interdyscyplinarne* (pp. 203-217).

Are Rural Stakeholder Needs Compliant with the Targets of the Europe 2020 Strategy? Text Mining Analysis of Local Action Group Strategies from Two Polish Regions

Marek FURMANKIEWICZ^{1*}, Krzysztof JANC², Iwona KACZMAREK¹, and Iga SOLECKA¹

¹ Wrocław University of Environmental and Life Sciences, Wrocław, Poland; marfum@interia.pl

² University of Wrocław, Wrocław, Poland

* Correspondence: marek.furmankiewicz@upwr.edu.pl; marfum@interia.pl

Abstract: The 1990s saw a considerable facilitation of the concept of area-based cooperation between stakeholders from the public, economic and social sectors in the European Union (EU) with regard to local resource management. EU support programmes have given rise to community-based partnerships referred to as Local Action Groups (LAGs), in which the stakeholders involved formulate local development strategies, the implementation of which is subsequently made possible through the external financial support of EU funds. This paper illustrates an attempt to assess the extent to which local strategies are consistent with the EU's Europe 2020 strategy, using the example of 27 LAGs from two Polish provinces. Text mining and content analysis are two methods employed herein. The analysis served to establish that the dominant issues for rural areas, that are correspondent to the Europe 2020 strategy, revolve around increasing employment, educating local communities and combating poverty through the use of social inclusion methods, with much less attention dedicated to the issues of greenhouse gas emission reduction and renewable energy development. The strategies in question emphasise innovation with regard to planned activities, insofar as it is perceived at the local level, which usually bears no relation to methodical research and development (R&D) work.

Keywords: Europe 2020 strategy; Europeanisation processes; area-based partnerships; Local Action Groups; Local Development Strategies; content analysis; text mining

JEL Classification: O21; D71; L31

1. Introduction

Initially prevalent within the liberal democracies of Anglo-Saxon countries and later propagated throughout the European Union (EU), the idea of local, area-based, cross-sectoral partnerships towards local development boasts a tradition of over 30 years (Esparcia & Abbasi, 2020; Hutchinson, 1994; Moseley, 2003; Rounds, 1993). The support for the development of partnerships in rural areas stemmed from the conviction that previous methods of top-down, exogenous development, focusing on the maximisation of agricultural production, were marred by a poor level of adaptation to local needs and

introduced many negative social and environmental effects (Boukalova et al., 2016; Furmankiewicz & Janc, 2012). Methods of managing local resources based on the idea of territorial governance have thus began to be supported on a larger scale (Moseley, 2003; Thuesen & Nielsen, 2014). At their core, they are associated with the concept of neo-endogenous development in an attempt to combine local and extra-local (national, pan-European) needs and aims (Ray, 2006), through local activities partially steered by subsidies from external support programmes (Böcher, 2008; Bosworth et al., 2020; Furmankiewicz & Campbell, 2019). The development of this approach in the EU began in 1991 with the creation of area-based partnerships referred to as Local Action Groups (LAGs), which itself was part of the implementation process for three LEADER Community Initiatives (1991-2006) and the national programmes which strived to imitate them (Furmankiewicz et al., 2015; Navarro, Cejudo, et al., 2016). This was followed by the establishing of the LEADER Axis found in national Rural Development Programmes (2007-2013) and the Community Led-Local Development (CLLD) approach (2014-2020) (Apostolopoulos et al., 2020; Konečný, 2019).

A rich body of literature is available on issues related to the cooperation of various stakeholders within LAGs and the local strategies which they implement (Cejudo & Navarro, 2020; Rodriguez et al., 2019; Moseley, 2003), yet the question of the compliance of local strategies formulated by local stakeholders (with NGO participation) with the pan-European goals expressed in the Europe 2020 strategy – which is also related to the concept of Europeanisation (Dąbrowski, 2012; Székely, 2017) – is dedicated much less academic attention. Numerous studies indicate that EU funds are not always utilised in accordance with the strategies and rules defined by their policymakers (European Court of Auditors, 2010), and are not invariably conducive to levelling unequal development (Canete et al., 2018; Chruscinski et al., 2019). It also remains to be settled whether CLLD should be based entirely on local needs or perhaps take into account extra-local (national, pan-European) regulations and recommendations; this, in turn, leads to the problem of balancing these two dimensions of needs (Furmankiewicz, Królikowska et al., 2020; Navarro, Woods et al., 2016).

With the above-mentioned concerns in mind, the aim of this paper is to attempt at assessing whether the goals and tasks set out in Local Development Strategies for LEADER type partnerships (and based on the needs of local stakeholders) take into account the implementation of pan-European goals specified in *“Europe 2020. A strategy for smart, sustainable and inclusive growth”*, announced in 2010, and designed for the years 2010-2020 (European Commission, 2010). Towards this end, the authors use the example of LAG strategies from two Polish voivodeships (self-governing provinces): *województwo dolnośląskie* (Lower Silesia Province) and *województwo opolskie* (Opole Province). One additional aim of this preliminary research is to develop and discuss the use of text mining computer methods in analysing LAG strategy content.

2. The Europe 2020 Strategy and Community-Led Local Development

EU budgets are organised in seven-year cycles referred to as programming periods. The Programming Period 2014-2020 saw the application of the Europe 2020 strategy announced in 2010 (European Commission, 2010). The strategy defines the three main priorities of growth as “*smart*”, “*sustainable*” and “*inclusive*” (Bartniczak, 2012). Smart growth involves economical development based on knowledge and innovation; sustainable growth entails the promotion of a greener, more resource-efficient and competitive economy; inclusive growth is focused around supporting a high-employment economy in order to deliver social and territorial cohesion. These three priorities were elaborated in five quantifiable targets (European Commission, 2010):

Target 1: The employment rate for population aged 20-64 was to be increased to a minimum of 75%.

Target 2: 3% of EU GDP was to be invested in Research and Development.

Target 3: Greenhouse gas emissions were to be reduced to at least 20% compared to levels from 1990, the share of renewable energy in final energy consumption was to reach a minimum of 20% with energy efficiency increasing to a minimum of 20%.

Target 4: The share of early school leavers was to remain under 10% with at least 40% of the population aged 30-34 having a tertiary degree.

Target 5: The number of people at risk of poverty was to be decreased by about 20 million persons.

As a rule, the targets were formulated for the whole of EU (i.e. the indicators they outline would not have to be achieved individually by all member states), though each and every member state was obliged to include them in all programmes financed through the use of EU funds. Most LAGs in Poland were financed from the Polish Rural Development Programme for 2014-2020 (in turn financed from both EU and national funds), which partially acknowledged the above-mentioned objectives, in spite of them being less clearly specified than in their original European documents (Furmankiewicz, Królikowska et al., 2020). The LAGs themselves developed their strategies (Local Development Strategies – LDS) from the bottom up, based on the needs of local communities, but they had to comply with the national *Act of 20/02/2015 on local development with the participation of the local community* (Journal of Laws, item 378, Warsaw, Poland). The need to follow the guidelines of national documents imposed the following rules upon LAG strategies for rural areas (Ministerstwo Infrastruktury i Rozwoju, 2014): the principal area for LDS implementation had to consist of at least 2 communes (rural, urban-rural or small urban municipalities); LDS boundaries could not run through the internal areas of communes, but were not required to coincide with the boundaries of poviats (counties) and voivodeships (provinces); LDS were to be implemented in areas with populations ranging between 30,000 and 150,000 inhabitants.

The development of LAGs in Europe is related to the popularity of the concept of neo-endogenous development (Ray, 2006), which some authors consider to be a “*successful combination*” of the extreme models of exogenous (top-down) and endogenous (grass-roots –

completely bottom-up and based on local resources) development planning (Böcher, 2008). The concept involves supra-local institutions (state authorities or interstate organisations such as the EU) endorsing those bottom-up initiatives by local inhabitants which remain consistent with the goals set out in central strategies but refraining from imposing any specific actions on them. Since their activity is meant to be supported through funds from the EU, LAGs needed to be contractually obligated to ensure that their local strategies—established in the process of voluntary, bottom-up cooperation of local stakeholders—remain consistent with the objectives of national support programmes, which, in turn, have to be compatible with pan-European EU strategies and recommendations. LDS were additionally required to demonstrate the compliance of local activities with the objectives of the Polish Rural Development Programme (Ministerstwo Rolnictwa i Rozwoju Wsi, 2019), which itself had to be consistent with the objectives of the Europe 2020 strategy.

Assessing local strategies and evaluating their implementation is important both in its theoretical and practical aspects with regard to public policy and the disbursement of public funds (Kis et al., 2012). Literature on the subject abounds in technical and economic evaluations of LAG organisational features and their activities (Vrabková & Šaradín, 2017; Biczkowski, 2020), yet it is much more demanding to analyse the compatibility of local goals with those set out in superordinate strategies and documents, as it often requires the use of a qualitative analysis—not all activities can be easily quantified with performance indicators. Currently available research makes use of the distinction between endogenous, exogenous and hybrid evaluations, the latter combining both local and supra-local (national, EU) goals (High & Nemes, 2007). The approach adopted in this paper serves to assess the extent to which the extra-local goals expressed in the Europe 2020 strategy have been reflected in the strategies of local rural communities, by means of a top-down, endogenous evaluation.

3. Methodology

The analysis involves LAG strategy documents in Polish, established for the 2014-2020 European Programming Period. The Europe 2020 strategy has already been published at the time when local communities began working on their strategies – in 2015 – which allowed them to acknowledge the pan-European aims it had introduced.

The authors have chosen to use the text analytics method, also referred to as 'text mining', which is defined as a process aimed at obtaining useful, high-quality information from text data (Gaikwad et al., 2014). Text mining methods include: keyword search, machine learning, and linguistic and statistical techniques (Hotho et al., 2005). As a means of content analysis, it is used to search for keywords and key phrases in many scientific disciplines (Krajewski & Solecka, 2019; Szewrański & Kazak, 2020).

Analysis of any text material, due to the unstructured nature of the medium involved, is much more complex than analyses of numerical data. The complexity of the Polish language (which involves e.g. inflection of nouns by 7 grammatical cases and 3 genders, as well as adjectives by cases, numbers and genders, or verbs by persons and numbers) makes it much more difficult to successfully utilise machine processing when compared to e.g. English.

This makes it problematic to use ready-made text mining software designed with the latter in mind. For this reason, this study herein makes use of a two-step analysis of LAG strategy content: an initial computer search based on keywords which is followed by manual content analysis during which the automatically retrieved results are verified by authors.

In the first phase, the authors individually prepared a list of words that may appear in local strategies as part of expressions describing activity related to the implementation of a given target from the Europe 2020 strategy (the heuristic method). Next, through the process of discussion, they made use of the expert method, selecting from 2 to 5 words or word roots, which, in their opinion, were best suited as search keywords for the analysis.

The second phase of the analysis involved an automated search for the previously selected words and word roots within complete sentences from the text of a given LAG strategy (Table 1). The search was performed using a script prepared in the Python programming language, and aimed at identifying full sentences containing the keywords. The result of this computer-based text mining process was a list of expressions (6,291 records), with accompanying quantitative data on the number of keywords found in individual documents.

Table 1. The keywords used in text mining procedures. Original elaboration by the authors and Europe 2020 strategy (European Commission, 2010).

Short name	Europe 2020 aim (European Commission, 2010)	Search word roots or words (in Polish) and related collocations (translated in English)
1. Employment	The employment rate of the population aged 20–64 should increase to min. 75%	“zatrudn” (increasing employment); “pracy” (jobs, labour market); “zawodow” (professional activation); “bezroboc” (counteracting unemployment)
2. R&D	3% of the EU's GDP should be invested in the Research and Development	“naukow” (research); “innowac” (searching for innovative solutions)
3. Greenhouse gas	Greenhouse gas emissions should be reduced to at least 20% (...), renewable energy should achieve a min. 20% share in final energy consumption, while energy efficiency should increase to a min. of 20%	“energ” (renewable energy, energy saving, energy efficiency); “cieplarn” (greenhouse gases); “ciepła” (heat pump); “termomodernizac” (thermo-modernisation); “solar” (solar installations)
4. Education	The share of early school leavers should be maintained under 10% and at least 40% of the population aged 30–34 should have a tertiary degree	“kształc” (education, increasing the quality of education); “edukac” (educational activities, youth education)
5. Poverty	The number of people being at risk of poverty should decrease by about 20 million persons	“ubóstw” (combating poverty, preventing poverty); “wyklucz” (counteracting social exclusion); “włączeni” (actions towards social inclusion).

Note: Examples of words excluded during pre-qualification: entrepreneurship, renewable, university, training, didactic, homelessness.

In the third phase of the analysis, the context of the words and phrases used in the text was manually verified with regard to whether a given fragment was actually related to the targets outlined in the Europe 2020 strategy. Sentences not meaningfully related to their targets were promptly removed from the list, with those related to goals, needs and action plans being retained (content interpretation). Material related to the assessment of the

existing state of socio-economic development has been purposefully omitted, reducing the number of records to 2,895. The last phase revolved around a statistical analysis of records qualified for analysis, in an attempt to assess the level of importance of a given topic, as ascribed by the creators of the strategy.

The analysis involved LAGs from two provinces: Lower Silesia (with the capital in Wrocław) and Opole (with the capital in Opole) (Figure 1)—which constitute a single EU NUTS-1 statistical region—with the intentional omission of LAGs with headquarters located outside of this area, as well as one specialist Fisheries LAG from the Opole Province. In total, the analysis covered 27 LAGs (17 from Lower Silesia, 10 from the Opole Province). The area in question is characterised by a diversified economical structure, with industry and tourism playing a significant role and agriculture remaining complementary (Stacherzak & Hełdak, 2019; Struś et al., 2020).

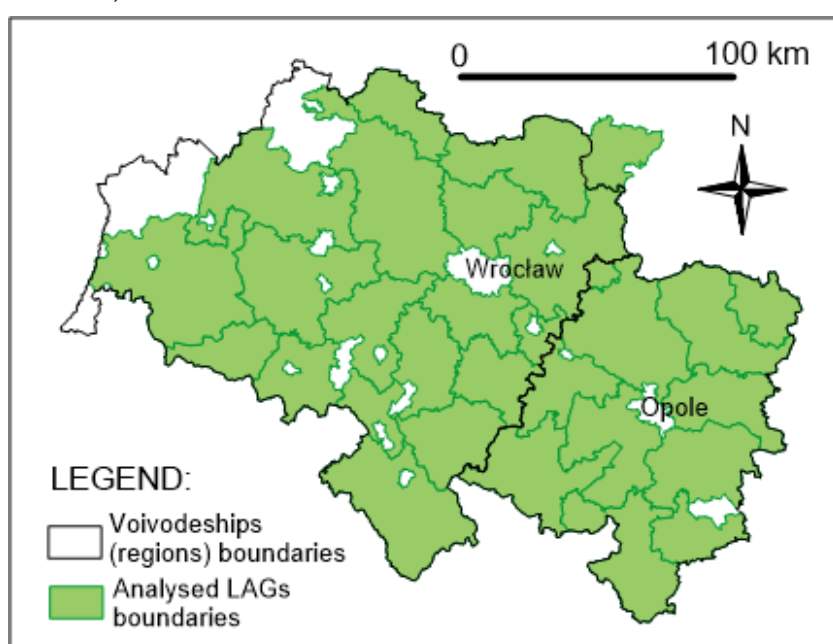


Figure 1. The areas of analysed LAGs with headquarters in the Lower Silesia and Opole provinces.
Source: Authors' elaboration.

Taking into account the small number of available methods aimed at assessing the compliance of local development strategies with superordinate strategies (Vrabková & Šaradín, 2017), this paper should be considered a preliminary study, serving to discuss and validate the usefulness of the methods adopted in the research it serves to illustrate.

4. Results

Among the 27 LAGs surveyed, only 14 (52%) included any reference to the Europe 2020 strategy in their own strategies (Figure 2), with more results available in LAGs from the Lower Silesia (65%) when compared to those operating in Opole Province (30%).

Target 1 of the Europe 2020 strategy (increasing employment) proved to be the most highly referenced in the analysed documents – this usually involved records indicating the need to create new jobs (Figure 3).

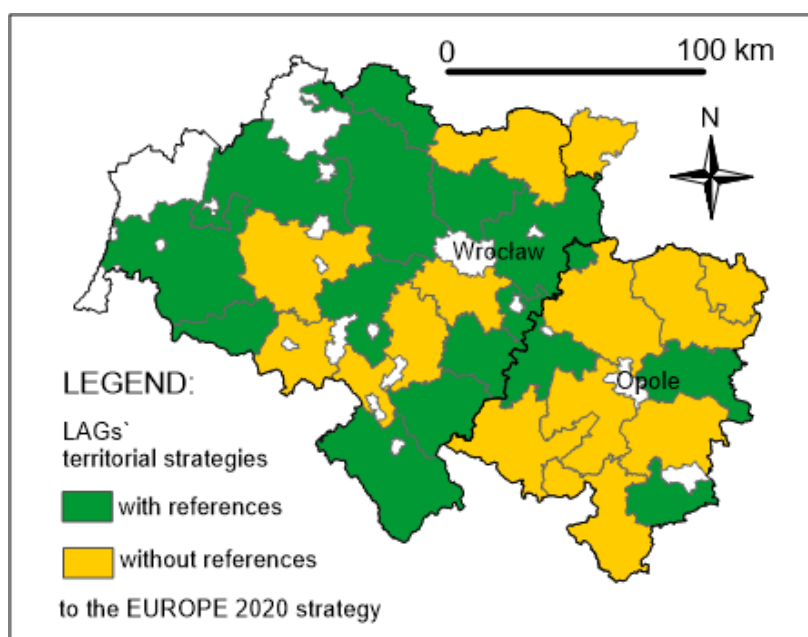


Figure 2. LAG territorial strategies with and without references to the Europe 2020 strategy. Source: Authors' elaboration.

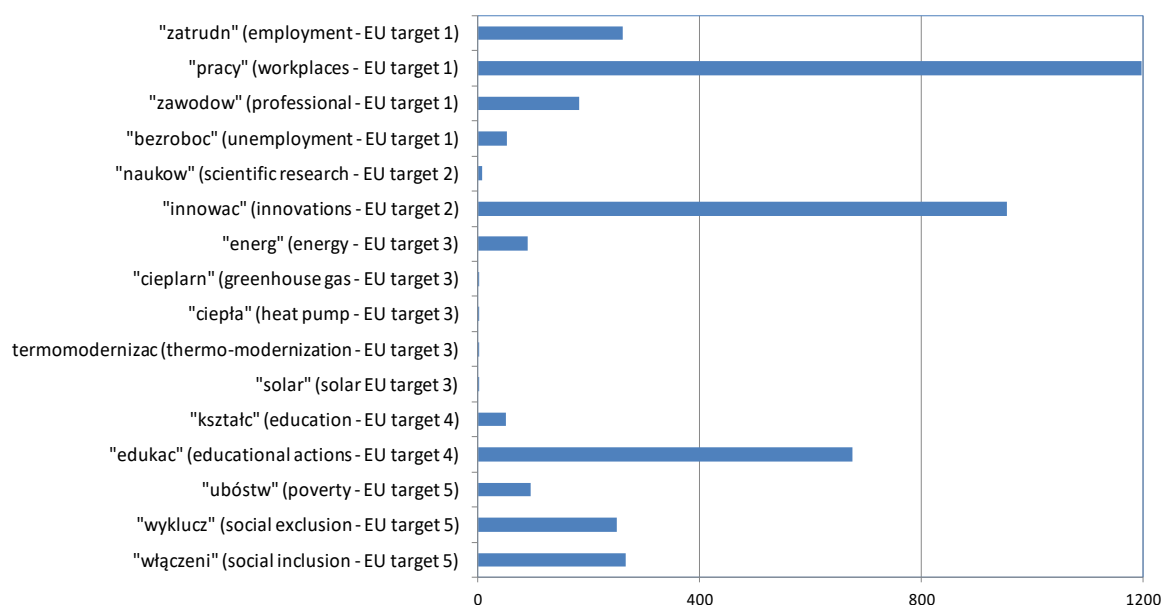


Figure 3. The number of analysed keywords found by means of text mining after being verified as partially or fully related to EU Europe 2020 targets. Source: Authors' elaboration.

Innovation was the second target most likely to be found in the studied documents – this was usually related to specific activities planned by the LAGs. However, further content analysis shows that the innovation in question was limited to a local scale, which meant that the use of recognised and familiar technologies and methods was also considered innovative, as long as they have not yet been used locally. Practically no information was available regarding the willingness to support research and development projects (there were no collocations of the “research” type). Only two LAGs have made explicit references to such endeavours, as their strategies mentioned the need for “a policy to support cooperation

between science and business (and thus support the development of innovation)” (LAG Kłodzka Wstęga Sudetów) or the need to support “research and development activities” (LAG Kraina św. Anny).

The third most frequently planned type of activity involved education, which corresponds with objective 4 of the Europe 2020 strategy. The education in question was, however, most often addressed to the general population and thus contained postulates of lifelong learning, intended for people of working and retirement age. While a significant portion of planned activity was also aimed at educating the youth, none of it was directly related to the goal of supporting them in obtaining higher education and afterwards returning to the area served by the LAG (e.g. scholarships, stipends, tutoring and other similar means of assistance). It is effectively only in large cities that young people are offered the possibility of obtaining higher education within the areas under analysis, which often entails the need for the rural youth to move into those urban centres. It is worth noting that the education-related activity outlined in LAG strategies centred around a variety of aspects of development, including the historical and cultural heritage of the region, ecological issues, as well as the fundamentals of entrepreneurship.

The authors of the strategies have dedicated significant attention to issues of social inclusion. This was most commonly addressed through activity aimed at social and economic activation (mobilisation) of the population, and was commonly accompanied by matters of combating poverty (Europe 2020 target 5), with focus on disadvantaged groups, whose deficiency was often linked to a lack of economic or professional activity.

Environmental issues have been given the least attention in the LAG strategies analysed in this study, with rare references to the implementation of measures aimed at counteracting climate change, including the reduction of greenhouse gas emissions. This holds true with regard to the relatively low amount of activity and projects designed to support the development and distribution of renewable energy to individual households and public facilities (both in terms of heating and electricity). This subject was clearly held in less regard by the local communities than the previously mentioned social and economic issues.

5. Discussion and Conclusions

The outcomes of the analysis serve to demonstrate that the most common issue addressed within the investigated partnerships and found to be compatible with the Europe 2020 strategy was the creation of workplaces, often associated with support for entrepreneurship. Other published research results show that such goals are indeed considered high priority by LAGs both in Poland (Furmankiewicz & Campbell, 2019; Hoffmann & Hoffmann, 2018) and in other countries (Camacho et al., 2020).

Both in our analyses and in available literature on the subject, the issues of social inclusion and activation of local communities emerges as one of the most important goals of the LAGs and public sector (Furmankiewicz et al., 2016; Heldak et al., 2018; Kola-Bezka, 2020). Much attention is paid to matters of social inclusion of disadvantaged groups (Navarro, Cejudo et al., 2016) and to the socio-cultural intangible values of partnership co-operation (Castellano-Álvarez et al., 2020). Educational activities are perceived as an

essential element required to increase human capital, which is in turn viewed as crucial with regard to the functioning of citizens on the labour market, i.e. finding a job or starting a business (Camacho et al., 2020). All this points to the solving of social issues as being among the most important goals pursued through LAG activity (Zajda, 2014). LAG strategies frequently include provisions supporting the education of young people in the areas they operate in, though there was no clear indication of the goal of increasing the number of people who would receive higher education and return to their place of residence.

Innovation is another aspect with a significant presence within the documents examined in this study, though it rarely referred to systematic research activities aimed at improving the quality of a service or product, as it is usually defined in R&D definitions (Witherick et al., 2001), but rather involved vague notions of “*new ideas*” and “*innovative projects*”. The strategies prioritised the undertaking of innovative activities by local entrepreneurs and farmers, and made frequent use of the idea of supporting social innovation, with some authors choosing to stress the significant role played by LAGs in this regard (Novikova et al., 2020). The expressed need to introduce new solutions serves to prove that there is a general awareness of the fact that when compared to urban areas and industrial districts, rural areas are characterised by a low level of actions aimed at innovation (Janc et al., 2020), and a poor degree of implementing information technologies (Galindo-Pérez-de-Azpillaga & Foronda-Robles, 2018) – a clear indication that they require additional support for this type of initiatives.

The subject of renewable energy sources was barely present in the studied material. The relatively low interest in matters related to climate change and the development of renewable energy sources had already been observed for rural LAGs in Poland (Furmankiewicz, Hewitt et al., 2020) and in other countries, like in Spain (Camacho et al., 2020; Servillo & De Bruijn, 2018), however, regarding the latter issue, rural areas in Poland have yet to make use of their significant potential (Szewranski et al., 2019). This would require deliberate support due to the “*energy poverty*” observed within Polish local communities (Piwowar, 2020).

Certain technical problems arose during the analysis process. The algorithm would at times fail to properly recognise a given sentence in pdf (Adobe Portable Document Format) documents (this was especially acute in the case of tables, page breaks, illustrations etc.). The phrases subject to automated search sometimes included from a few to several dozen words, which occasionally made it difficult to assess their meaning. 54% of records unrelated to Europe 2020 goals and to activity planned by a given LAG have been removed at the stage of analysing entire phrases. The qualification of the phrases was subjective, as it is difficult to apply strict logical and mathematical criteria in the qualitative assessment of the meaning of a sentence. The authors have thus concluded that the keyword search method should only be used for the preselection of data, though it may prove necessary when analysing a large number of documents (e.g. several hundred or more), as a single person would not be able to read and methodically evaluate their content within reasonable time. This indicates a need to develop a two-step approach combining the objective approach of the algorithm with the subjective approach of the researcher.

The results of the analysis, with research based on text mining methods, are largely consistent with the findings of analyses by authors making use of standard methodologies, i.e. they indicate that some of the goals of the Europe 2020 strategy which are related to modern technologies (target 2 and 3) may prove difficult to achieve through bottom-up, community-based development methods if they do not receive additional, targeted support.

Acknowledgments: This research was co-financed under the Leading Research Groups support project B190/0018/20 "Sustainable cities and regions" from the subsidy increased for the period 2020–2025 in the amount of 2% of the subsidy referred to Art. 387 (3) of the Law of 20 July 2018 on Higher Education and Science, obtained in 2019 by the Wrocław University of Environmental and Life Sciences and within the framework of project No. 2019/33/B/HS4/00176 financed by the National Science Centre in Poland. English correction by R. Chytrowski.

References

- Apostolopoulos, N., Liargovas, P., Stavroyiannis, S., Makris, I., Apostolopoulos, S., Petropoulos, D., & Anastasopoulou, E. (2020). Sustaining Rural Areas, Rural Tourism Enterprises and EU Development Policies: A Multi-Layer Conceptualisation of the Obstacles in Greece. *Sustainability*, 12(18), 7687. <https://doi.org/10.3390/su12187687>
- Bartniczak, B. (2012). State Aid as a Tool for Implementation of the Strategy "Europe 2020". In P. Jedlička (Ed.), *Hradec Economic Days* (Vol. 2, pp. 15–19). University of Hradec Králové. https://uni.uhk.cz/hed/site/assets/files/1051/proceedings_2012_2.pdf
- Biczkowski, M. (2020). LEADER as a mechanism of neo-endogenous development of rural areas: the case of Poland. *Miscellanea Geographica - Regional Studies on Development*, 24(4), 232–244. <https://doi.org/10.2478/mgrsd-2020-0041>
- Böcher, M. (2008). Regional Governance and Rural Development in Germany: the Implementation of LEADER+. *Sociologia Ruralis*, 48(4), 372–388. <https://doi.org/10.1111/j.1467-9523.2008.00468.x>
- Bosworth, G., Price, L., Hakulien, V., & Marango, S. (2020). Rural Social Innovation and Neo-endogenous Rural Development. In E. Cejudo, & F. Navarro (Eds.), *Neoendogenous Development in European Rural Areas: Results and Lessons* (pp. 21–32). Springer Geography. https://doi.org/10.1007/978-3-030-33463-5_2
- Boukalova, K., Kolarova, A., & Lostak, M. (2016). Tracing shift in Czech rural development paradigm (Reflections of Local Action Groups in the media). *Agricultural Economics – Czech (Zemědělská ekonomika)*, 62(4), 149–159. <https://doi.org/10.17221/102/2015-AGRICECON>
- Camacho, J. A., Rodríguez, M., & Sánchez, L. M. (2020). Employment and Job Creation in the LEADER Approach. In E. Cejudo & F. Navarro (Eds.), *Neoendogenous Development in European Rural Areas. Results and Lessons* (pp. 235–250). Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-33463-5_11
- Canete, A. J., Navarro, F., & Cejudo, E. (2018). Territorially unequal rural development: the cases of the LEADER Initiative and the PRODER Programme in Andalusia (Spain). *European Planning Studies*, 26(4), 726–744. <https://doi.org/10.1080/09654313.2018.1424118>
- Castellano-Álvarez, F. J., Masot, A. N., & Castro-Serrano, J. (2020). Intangibles of Rural Development. The Case Study of La Vera (Extremadura, Spain). *Land*, 9(6), 203. <https://doi.org/10.3390/land9060203>
- Cejudo, E., & Navarro, F. (2020). *Neoendogenous Development in European Rural Areas. Results and Lessons*. Springer Nature Switzerland AG. <https://doi.org/10.1007/978-3-030-33463-5>
- Chruscinski, J., Kazak, J. K., Tokarczyk-Dorociak, K., Szewranski, S., & Swiader, M. (2019). How to Support Better Decision Making for Sustainable Development? *IOP Conference Series: Materials Science and Engineering*, 471, 112008. <https://doi.org/10.1088/1757-899X/471/11/112008>
- Dąbrowski, M. (2012). Shallow or deep Europeanisation? The uneven impact of EU cohesion policy on the regional and local authorities in Poland. *Environment and Planning C: Government and Policy*, 30, 730–745. <https://doi.org/10.1068/c1164r>
- Esparcia, J., & Abbasi, F. (2020). Territorial Governance and Rural Development: Challenge or Reality? In E. Cejudo, & F. Navarro (Eds.), *Neoendogenous Development in European Rural Areas* (pp. 33–60). Springer Geography. https://doi.org/10.1007/978-3-030-33463-5_3
- European Commission. (2010). *Europe 2020. A strategy for smart, sustainable and inclusive growth*, Communication from the Commission 3.3.2010 COM(2010). European Commission. <https://doi.org/http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF>

- European Court of Auditors. (2010). *Implementation of the LEADER approach for rural development*.
https://www.eca.europa.eu/Lists/ECADocuments/SR10_05/SR10_05_EN.PDF
- Furmankiewicz, M., & Campbell, A. (2019). From Single-Use Community Facilities Support to Integrated Sustainable Development: The Aims of Inter-Municipal Cooperation in Poland, 1990–2018. *Sustainability*, 11(21), 5890. <https://doi.org/10.3390/su11215890>
- Furmankiewicz, M., Hewitt, R. J., Janc, K., & Kazak, J. K. (2020). Europeanisation of energy policy and area-based partnerships: Regional diversity of interest in renewable energy sources in local development strategies in Poland. *IOP Conference Series: Earth and Environmental Science* 609, 012033.
<https://doi.org/10.1088/1755-1315/609/1/012033>
- Furmankiewicz, M., & Janc, K. (2012). Partnerstwa terytorialne jako nowy model zarządzania rozwojem lokalnym - różnice regionalne i wpływ na aktywność mieszkańców. *Studia KPZK*, 140, 231–245.
<http://journals.pan.pl/dlibra/publication/111325/edition/96603/content>
- Furmankiewicz, M., Janc, K., & Macken-Walsh, Á. (2016). The impact of EU governance and rural development policy on the development of the third sector in rural Poland: A nation-wide analysis. *Journal of Rural Studies*, 43, 225–234. <https://doi.org/10.1016/j.jrurstud.2015.12.011>
- Furmankiewicz, M., Knieć, W., & Atterton, J. (2015). Rural governance in the new EU member states: The experience of the Polish LEADER+ Pilot Programme (2004–2008). In J. Buček, & A. Ryder (Eds.), *Governance in Transition* (pp. 133–153). Springer Geography. https://doi.org/DOI.10.1007/978-94-007-5503-1_7
- Furmankiewicz, M., Królikowska, K., & Przybyła, K. (2020). Goals of Elites and Local Communities in the European Union Neo-endogenous Development: Differences as the Constraints on Europeanisation? In P. Jedlička, P. Marešová, K. Firlej, & I. Soukal (Eds.), *Hradec Economic Days* (Vol. 10, pp. 176–187). University of Hradec Králové. <https://doi.org/10.36689/uhk/hed/2020-01-020>
- Gaikwad, S. V., Chaugule, A., & Patil, P. (2014). Text Mining Methods and Techniques. *International Journal of Computer Applications*, 85(17), 42–45. <https://doi.org/10.5120/14937-3507>
- Galindo-Pérez-de-Azpíllaga, L., & Foronda-Robles, C. (2018). Digital governance and information technologies in local action groups (LAGs). *Cogent Social Sciences*, 4, 1528730.
<https://doi.org/10.1080/23311886.2018.1528730>
- Hełdak, M., Stacherzak, A., & Przybyła, K. (2018). Demand and Financial Constraints in Eliminating Architectural and Technical Barriers for People with Disabilities in Poland. *Journal of Healthcare Engineering*, 2018(1297396). <https://doi.org/https://doi.org/10.1155/2018/1297396>
- High, C., & Nemes, G. (2007). Social learning in LEADER: Exogenous, endogenous and hybrid evaluation in rural development. *Sociologia Ruralis*, 47(2), 103–119. <https://doi.org/10.1111/j.1467-9523.2007.00430.x>
- Hoffmann, R., & Hoffmann, N. (2018). The Leader Programme as an Impulse for New Projects in Rural Areas *Quaestiones Geographicae*, 37(2), 141–150. <https://doi.org/10.2478/quageo-2018-0014>
- Hotho, A., Nürnberger, A., & Paaß, G. (2005). A brief survey of text mining. *LDV-Forum: Zeitschrift für Computerlinguistik und Sprachtechnologie GLDV-Journal for Computational Linguistics and Language*, 20(1), 19–62. https://jclcl.org/content/2-allissues/24-Heft1-2005/19-62_HothoNuernbergerPaass.pdf
- Hutchinson, J. (1994). The Practice of Partnership in Local Economic Development. *Local Government Studies*, 20(3), 335–344. <https://doi.org/10.1080/03003939408433731>
- Janc, K., Raczyk, A., & Dołzbłasz, S. (2020). Not Only in Cities: Creative Activities in Rural Areas with a Case Study of Lower Silesia. *Quaestiones Geographicae*, 39(2), 97–112. <https://doi.org/10.2478/quageo-2020-0013>
- Kis, K., Gal, J., & Veha, A. (2012). Effectiveness, efficiency and sustainability in local rural development partnerships. *APSTRACT-Applied Studies in Agribusiness and Commerce*, 6(3–4), 31–38.
<https://doi.org/10.22004/ag.econ.138118>
- Kola-Bezka, M. (2020). Are LAGs contributing to solving social exclusion problems? The case of Kujawsko-Pomorskie Voivodship. *Bulletin of Geography. Socio-economic Series*, 48, 35–45.
<https://doi.org/10.2478/bog-2020-0012>
- Konečný, O. (2019). The Leader Approach Across The European Union: One Method of Rural Development, Many Forms of Implementation. *European Countryside*, 11(1), 1–16. <https://doi.org/10.2478/euco-2019-0001>
- Krajewski, P., & Solecka, I. (2019). Management System of Urban Landscape in Poland on the Example of Wrocław in the Context of European Landscape Convention Implementation. *IOP Conference Series: Materials Science and Engineering*, 471, 112035. <https://doi.org/10.1088/1757-899X/471/11/112035>
- Ministerstwo Infrastruktury i Rozwoju. (2014). *Zasady realizacji instrumentu "Rozwój lokalny kierowany przez społeczność w Polsce"*. Ministerstwo Infrastruktury i Rozwoju.
http://www.rpo.wzp.pl/sites/default/files/zasady_realizacji_rlks_02042014.pdf

- Ministerstwo Rolnictwa i Rozwoju Wsi. (2019). *Program Rozwoju Obszarów Wiejskich na lata 2014-2020*. Ministerstwo Rolnictwa i Rozwoju Wsi.
<https://www.gov.pl/web/rolnictwo/-program-rozwoju-obszarow-wiejskich-2014-2020-prow-2014-2020>
- Moseley, M. J. (Ed.). (2003). *Local Partnerships for Rural Development. The European Experience*. CABI Publishing.
- Navarro, F. A., Cejudo, E., & Maroto, J. C. (2016). Participation of disadvantaged groups and governance in the LEADER and PRODER programmes in Andalucía, Spain. *Studies in Agricultural Economics*, 118, 47–54.
<https://doi.org/10.7896/j.1532>
- Navarro, F. A., Woods, M., & Cejudo, E. (2016). The LEADER Initiative has been a Victim of Its Own Success. The Decline of the Bottom-Up Approach in Rural Development Programmes. The Cases of Wales and Andalusia. *Sociologia Ruralis*, 56(2), 270–288. <https://doi.org/10.1111/soru.12079>
- Novikova, M., de Fátima Ferreiro, M., & Strykiewicz, T. (2020). Local development initiatives as promoters of social innovation: Evidence from two European rural regions. *Quaestiones Geographicae*, 39(2), 43–53.
<https://doi.org/10.2478/quageo-2020-0012>
- Piowar, A. (2020). Outline of the Problem of Energy Poverty in Poland – Trend and Extent. In P. Jedlička, P. Marešová, K. Firlej, & I. Soukal (Eds.), *Hradec Economic Days* (Vol. 10, pp. 634–641). University of Hradec Králové. <https://doi.org/20.500.12603/273>
- Ray, C. (2006). Neo-endogenous rural development in the EU. In P. Cloke, T. Marsden, & P. Mooney (Eds.), *Handbook of Rural Studies* (pp. 278–291). Sage. <https://doi.org/10.4135/9781848608016.n19>
- Rodriguez, M., Sanchez, L. M., Cejudo, E., & Camacho, J. A. (2019). Variety in local development strategies and employment: LEADER programme in Andalusia. *Agricultural Economics – Czech (Zemědělská ekonomika)*, 65(1), 43–50. <https://doi.org/10.17221/106/2018-AGRICECON>
- Rounds, R. C. (Ed.). (1993). *The structure, theory and practice of partnerships in rural development*. Agriculture and Rural Restructuring Group, Rural Development Institute.
- Servillo, L., & De Bruijn, M. (2018). From LEADER to CLLD: The Adoption of the New Fund Opportunities and of Their Local Development Options. *European Structural and Investment Funds Journal*, 6(3), 223–233.
https://estif.lexxion.eu/data/article/13233/pdf/estif_2018_03-007.pdf
- Stacherzak, A., & Heldak, M. (2019). Borough Development Dependent on Agricultural, Tourism, and Economy Levels. *Sustainability*, 11(2), 415. <https://doi.org/10.3390/su11020415>
- Struś, M., Kalisiak-Mędeliska, M., Nadolny, M., Kachniarz, M., & Raftowicz, M. (2020). Community-Supported Agriculture as a Perspective Model for the Development of Small Agricultural Holding in the Region. *Sustainability*, 12(7), 2656. <https://doi.org/10.3390/su12072656>
- Székely, V. (2017). Changes in commuting patterns in the territories covered by LEADER Local Action Groups: Slovakia, 2001 and 2011. *Studies in Agricultural Economics*, 119(1), 18–25. <https://doi.org/10.7896/j.1072>
- Szewrański, S., Kachniarz, M., Sylla, M., Swiader, M., & Tokarczyk-Dorociak, K. (2019). Spatio-temporal assessment of energy consumption and socio-economic drivers in rural areas in Poland. *Engineering for Rural Development*, 18, 1372–1378. <https://doi.org/10.22616/ERDev2019.18.N093>
- Szewrański, S., & Kazak, J. (2020). Socio-Environmental Vulnerability Assessment for Sustainable Management. *Sustainability*, 12(19), 7906. <https://doi.org/10.3390/su12197906>
- Thuesen, A. A., & Nielsen, N. C. (2014). A territorial perspective on EU's LEADER approach in Denmark: The added value of community-led local development of rural and coastal areas in a multi-level governance settings. *European Countryside*, 6(4), 307–326. <https://doi.org/10.2478/euco-2014-0017>
- Vrabková, I., & Šaradín, P. (2017). The Technical Efficiency of Local Action Groups: a Czech Republic Case Study. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 65(3), 1065–1074.
<https://doi.org/10.11118/actaun201765031065>
- Witherick, M., Ross, S., & Small, J. (Eds.). (2001). *A Modern Dictionary of Geography*. Arnold.
- Zajda, K. (2014). *New Forms of Social Capital of Rural Areas. A Case Study of Selected Polish Local Action Groups*. Lambert Academic Publishing.

Predicting Financial Distress in Companies Using the Original CCB Model

Vitezslav HALEK

University of Hradec Kralove, Czech Republic; vitezslav.halek@uhk.cz

Abstract: The aim of this research was to present a new methodology for the assessment of financial health of a company, called the Come Clean Bankruptcy (CCB) model. The ultimate objective of the model is to detect the signs of impending bankruptcy based on a set of selected financial indicators reflecting the capital structure, liquidity and overall growth of the company. The CCB model was applied on a data sample comprising 199 entities operating in the textile/clothing industry in the Czech Republic. The outputs were compared with the actual development of those companies in 2013-2020 in order to assess whether the model can be effectively employed in practice. especially in court proceedings, specialization criminal law. Courts are often faced with the question of determining the date on which a bankruptcy situation arose. The CCB model evaluates past data. Therefore, it is a suitable tool for proving whether the management knew about the economic development of the company.

Keywords: bankruptcy model; predicting risks; financial distress; Czech Republic

JEL Classification: C51; C52; C53

1. Introduction

Nowadays, there is a wide range of available organizational and financial measures for saving companies that found themselves in financial distress, each corresponding to the specific circumstances in the company and the causes of the financial distress. Though the efficacy of those measures is ever increasing, there is little doubt that it is much more advantageous, both in terms of time and financial costs, to prevent the bankruptcy in the first place, rather than to solve it once it occurs.

Bankruptcy is often misinterpreted. It is not the cause of the decline in value. It is the consequence of the decline. Above all, it represents a legal remedy allowing the creditors to take over a business that fails to meet its obligations due to the said decline in the value of assets. This means that with suitable tools, it is indeed possible to detect certain symptoms leading to the onset of bankruptcy. Financial analysis and corresponding models represent such tools.

The quality of existing financial analysis systems is determined directly by their complexity. Despite the fact that elementary methods of processing the data do not have the necessary explanatory power, they are used quite often. Complex systems allow for a more detailed depiction of the situation in the company, yet they tend to be confusing for the users of financial analyses. In fact, it has been shown that the users of financial analysis are able to understand less than three quarters of the analysis (Forrer, 1991). One of the main objectives

of the proposed model, unlike many other creditworthy/bankruptcy models, therefore is to provide a clear explanation of the obtained results.

Virtually all financial analyses require the use of data reported in financial statements. However, accounting data alone only reflects the past and not the prospects for the future. In other words, it defines the current values of strongly variable quantities (Kovanicova, 1999). These shortcomings can be eliminated by comparing the data with each other, expanding its explanatory power. That is why financial ratios are the fundamental methodological tool for financial analysis. Prediction models are often based on recommended values of indicators, which are nevertheless too broad. The CCB model, on the other hand, compares the individual ratios of a selected company with values of 199 competing entities operating in the same sector of economy, which increases the explanatory power of data and accuracy of the analysis. In addition, as a benchmark, it uses real data of entities which went bankrupt in the past in order to recognize patterns of impending bankruptcy.

1.1 Indicators of Financial Distress

One of the ways to recognize the patterns of impending bankruptcy is to follow the indicators of sustainable development of a company. The definition of sustainable development was first discussed by professor Robert C. Higgins (1984). It represents a situation of the company in which:

- Assumption A Proportional increase in sales = proportional increase in capital.
- Assumption B Equity is increased by retained earnings only.
- Assumption C The debt ratio does not change.

These assumptions are nevertheless not always valid. For example, equity does not always have to increase exclusively by the amount of retained earnings and increase in sales does not necessarily leads to increase in the value of total capital.

The main components defining sustainable development are as follows:

- a) Return on sales
- b) Dividend pay-out ratio
- c) Debt ratio
- d) Capital turnover rate

The proposed CCB model does not claim that respecting the main components of the sustainable development indicators leads to the growth / prosperity of a company, as proclaimed by many creditworthy models. It suggests that failure to respect the selected components leads to financial problems for the company.

The optimal capital structure is a major element affecting the likelihood of bankruptcy. The key work on the optimal capital structure of companies was written by economists Miller and Modigliani (1958). They concluded that, under certain conditions, the value of a company is independent of the company's capital structure. By gradually removing the assumptions of Miller and Modigliani's model, their followers (Jensen & Meckling, 1976; Myer & Majluf, 1984) and they themselves proved that the optimal capital structure exists and that it can be

approximately determined with mathematical calculations (Hluzkova, 2001). With moderate levels of indebtedness, the probability of distress is negligible and the tax benefits predominate. However, at some point, as the company continues to borrow more funds, the likelihood of financial distress dramatically increases. The company reaches a theoretical optimum when the current value of tax savings from additional borrowings is offset by an increase in the current costs of distress. Bankruptcy costs are born by creditors. Creditors, aware of this fact, demand compensation (in advance) in form of higher payouts, when the company is meeting its obligations. Standard financial analysis models (bankruptcy models) often consider the debt-to-equity ratio as a compromise between interest tax shield and costs of financial distress. In the domain of financial analysis, there are disputes about the influence of the interest tax shield on financial difficulties in general.

Another factor worth considering, in regards to the likelihood of bankruptcy, is the company's liquidity. The liquidity represents the probability of when and under which conditions the difference between company's income / expenditures will be balanced. The signs of imminent financial distress / bankruptcy of a company apparent from the evolution of cash flows (Table 1) over five years include:

Table 1. Signs of imminent financial distress

Decrease in	Increase in
Cash flow caused by decrease in profit	Short-term bank loans
Income, slower decrease in expenditures	Interests
Net cash flow caused by an increase in inventories and short-term receivables	Capital expenditures
Long-term debts	
Working capital	

2. Methodology

The CCB model methodology can be divided into 6 main stages, each corresponding to a specific way of processing the input data (Table 2).

Table 2. CCB model methodology

Stage		Reason	Goal
1	Ratios	Comparing companies according to absolute values is misleading	Organizing input data in order to set up the Du Pont chart
2	Du Pont chart	Global incorporation of examined variables	Defining financial leverage
3	Monitoring of the break-even point and financial leverage	The value of the company is affected by financial leverage	Defining the optimal indebtedness
		Considering company's performance	Company's risks
4	Incorporation of competing entities	Intercompany comparison	External environment of the company
5	Global analysis	Analysis of non-economic variables	Company as a whole
6	Bankruptcy intervals and decisions	Determining the probability of bankruptcy over time	Deciding on bankruptcy

The model is based on the following 11 financial ratios that are necessary for the prediction of financial distress. Abbreviations used in the equations are explained in Appendix.

$$\frac{LD + LV}{LD + CV + capital} \quad (1)$$

When a company borrows funds, it is expected to pay regular instalments. Debt provides the basis for financial leverage, since shareholders obtain the remaining amount once the creditors are paid off. Financial leverage has various definitions. For the purpose of the CCB model, the value of liabilities is added to the ratio of long-term debt to total capital, because long-term liability agreements (lease) oblige the company to pay a series of fixed payments.

Debt ratio is followed by earnings-to-interest ratio:

$$\frac{EBIT + A}{Interest} \quad (2)$$

Regular interest payments represent an obstacle that companies have to deal with in time to avoid bankruptcy. This ratio provides information on when the interest payments will no longer be covered by earnings.

$$\frac{A_C - D_{outstanding} + AP + Li_{other}}{A_{total}} \quad (3)$$

The creditor / analyst must assess whether the company will have enough cash to repay its debt, even in short-term horizon. The focus should therefore be on liquid assets. The weight of the liquidity ratio is insignificant in the model, as liquidity ratios are highly volatile. The ratio of net working capital to total assets is considered as the gross ratio of potential cash.

$$\frac{Cash + MS}{L_C} \quad (4)$$

The liquidity of assets also plays an important role. It is best illustrated on cash, marketable securities and outstanding receivables. The numerator of the ratio can be net of receivables, which seems like a more suitable option for bankruptcy purposes.

$$\frac{Cash + MS + Receivables}{DOE} \quad (5)$$

The equation 4 was modified by adding receivables and daily operating expenditure in order to yield another financial ratio analysed by the mode.

$$\frac{EBIT - (tax + TS)}{A_a} \quad (6)$$

Company performance is assessed with the return on total assets. If only operating performance is to be measured, we need to add interest tax shields to the taxes. This will allow to obtain taxes that the company would pay had it been fully funded by shares. Return is defined as earnings before interest, but after tax (with the 20% tax rate) and tax shields are obtained by multiplication of the tax rate and net interest. Rising assets in the denominator

put pressure on lower returns. This structure enables a comparison of entities with significantly different debt ratios.

$$\frac{P_s}{E_s} \quad (7)$$

The price-to-earnings ratio is a common evaluation benchmark used by investors. A high P/E ratio means that:

1. the investors expect significant dividend growth or,
2. the stock is not particularly risky, meaning that investors are prepared for smaller returns, or
3. the company anticipates a significant average growth and therefore pays out a large share of its earnings.

$$\frac{P_s}{RC^c} \quad (8)$$

The last fundamental characteristic observed within the CCB model is the relationship between the share price and its book value, which can be obtained with Tobin's Q. This ratio is similar to the market / book value ratio, except that the numerator q includes all debt + equity of the company, not just net equity. Similarly, the denominator includes all assets and not just net capital. These assets are reported in replacement costs, not acquisition costs.

The final three indicators – Interest tax shield (9), Expected Return on Debt (10) and Indebtedness (11) are presented below:

$$\frac{(EBITDA + (EBIT - EAT) + (interest\ expenses * 0,2))}{\sum LIABILITIES} \quad (9)$$

$$\frac{Operating\ Profit}{Equity} \quad (10)$$

$$\frac{EAT}{\sum LIABILITIES} + Debt\ Ratio * \frac{EAT}{\sum LIABILITIES - Expected\ Return\ on\ Debt} \quad (11)$$

The Du Pont analysis helps to get a better understanding of some of the key metrics of company's health, such as profit margin, financial leverage (calculated as total assets to total equity) or optimal equity-to-debt ratio. The standard DuPont diagram also contains information concerning the revenues and expenditures of analysed companies. The break-even point shows how operating income / cash flow is affected at different levels of expenditures and sales. We can assess whether a company uses its debt properly by comparing the return on equity to return on loans. The degree of operating leverage is defined as the change (%) in earnings per share to EBIT. Financial leverage provides interesting information. Comparison of the change in a) earnings per share and b) EBIT of the analysed company informs us about the risk that is taken by the shareholders.

Intercompany comparison of financial ratios represents a key element of the newly proposed model. The prediction provided by the model is retrospective; it uses past data (from 2013) to predict the development in companies during the following 7-year time span (2013-2020). The use of current data was for obvious reasons impossible (we would have to wait in order to see whether the prediction was accurate or not).

The incorporation of competing entities starts with the calculation of arithmetic mean (12) and standard deviation (13):

$$\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i \quad (12)$$

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2} \quad (13)$$

The arithmetic mean (x_{pj}) and standard deviation (s_{xj}) are then used in the process of standardization of individual indicators:

$$u_{ij} = \frac{x_{ij} - x_{pj}}{s_{xj}} \quad (14)$$

$$u_{oj} = \frac{x_{oj} - x_{pj}}{s_{xj}} \quad (15)$$

where the value of x_{ij} represents the value of the j -th indicator in the i -th company and u_{ij} and u_{oj} are the values of standardized variables. The equation (14) is used when the indicator has a +1 value whereas the equation (15) is used for indicators with a -1 value. Standard deviation is an estimate of the scale / uncertainty of the data. This method therefore eliminates the main deficiency of other methods, which is the insensitivity to the variance of values. The results obtained with this method are less sensitive to the extreme values of indicators within the set of companies.

The companies are ranked based on the integral dsv indicator. It is calculated as the arithmetic mean of the standardized values of individual indicators for the i -th company:

$$dsv = \frac{\sum_{j=1}^m u_{ij} * p_j}{\sum_{j=1}^m p_j}, i = 1, 2, \dots, n \quad (16)$$

The last step in the incorporation of competing entities consists of assigning the companies to one of the three intervals, based on their ranking. The lower 9% of the companies are considered being at high risk of bankruptcy. Those that ranked in the bottom 9-22% are considered approaching bankruptcy. The remaining 78% represent the companies for which bankruptcy could not be predicted.

3. Results

The first step of analysis consisted of collecting the data and calculating the financial ratios for each entity, as shown in Table 3. Table 4 includes arithmetic mean (\bar{x}_p) along with standard deviation (S_x) for each of the indicators, and the values of companies are transformed in the standardized form. The last step consisted of defining the integral indicator dsv in order to determine the final ranking of each entity. Entities were finally assigned to the corresponding risk interval based on the probability of bankruptcy.

Table 3. Indicators of Financial Distress

Company #	Debt Ratio	Earnings to Interest	Working Capital to Total Assets	Quick Ratio Net Of Receivables	Operating Cost	Interest Tax Shields	Return On Capital	Price to Earnings	Expected Return On Debt	Q Value	Indebtedness
1	0.63	-7.26	-0.76	0.01	3.89	-0.00	-0.06	-7.78	-0.20	0.70	0.03
2	0.52	-45.94	-0.11	0.23	1.01	-0.10	-0.17	18.29	-0.21	10.21	-0.16
3	0.06	9.92	0.44	1.67	5.43	0.06	0.01	88.73	0.02	0.61	0.01
4	1.94	0.00	0.26	0.03	2.42	-0.43	-0.43	1.87	0.87	2.28	-2.90
5	1.19	0.00	-0.20	0.11	2.15	0.06	0.03	1.05	0.20	1.25	-0.11
6	1.02	-4.76	0.22	0.07	0.72	-0.09	-0.11	-0.62	-4.15	1.90	3.87
7	0.72	28.74	-0.40	0.27	5.83	0.13	0.11	-15.58	0.34	1.66	-0.06
8	0.41	-81.99	0.46	1.58	6.92	0.18	0.04	-1.93	0.40	2.14	-0.23
9	0.52	0.00	0.50	1.73	23.62	0.00	0.00	7.05	0.10	2.41	-0.09
10	0.23	23.16	0.54	0.84	2.01	0.12	0.07	12.63	0.10	2.21	0.07
11	0.27	36,875.57	0.38	0.54	1.30	0.61	0.11	7.98	0.17	1.56	0.09
12	0.25	0.00	0.69	4.26	359.84	0.30	0.23	-20.43	0.11	1.20	0.27
13	0.06	0.00	0.88	16.96	3.82	0.20	0.13	8.35	0.17	3.42	0.13
14	0.46	-6.26	0.72	0.28	4.07	-0.11	-0.12	171.74	-0.15	1.06	-0.11
15	0.59	-4.86	-0.12	0.01	2.46	-0.06	-0.12	-1.59	4.59	0.72	-4.93
16	0.59	3.55	0.34	0.07	1.91	0.03	0.01	23.93	0.04	1.30	-0.02
17	0.48	2.11	0.53	-0.20	0.49	0.06	0.04	-3.76	0.17	2.31	-0.03
18	0.51	17.58	0.38	0.17	2.11	0.09	0.01	10.45	0.01	1.55	0.01
19	0.62	12.49	-0.03	0.05	2.21	0.11	0.05	3.11	0.15	1.19	-0.02
20	0.32	-38.66	0.17	0.32	2.13	-0.13	-0.18	7.84	-0.37	1.81	-0.06

As mentioned above, the CCB model used data reported for 2013 in order to predict evolution of selected companies during the following 7 years. According to the prediction, a total of 15 companies were at high risk of bankruptcy and 34 were approaching this state. Bankruptcy could not be predicted, but at the same time not ruled out, for the remaining 199 companies in the referential package.

A retrospective look at the real data shows that between 2013 and 2020, there were 9 companies (4.5% of the referential package) that either actually went bankrupt or have initiated insolvency proceedings. Out of the nine companies, three were successfully identified by the CCB model as „being at high risk of bankruptcy” or „approaching bankruptcy”. These were the companies Durocas Czech s. r. o., PRVNÍ CHRÁNĚNÁ DÍLNA s.r.o. and Schwinn Tschechien s.r.o.

Table 4. Ranking based on standardized values

Company Serial N°	Debt Ratio	Earnings to Interest	Working Capital To Total Assets	Quick Ratio Net of Receivables	Operating Cost	Interest Tax Shields	Return on Capital	Price-to-Earnings	Expected Return On Debt	(Q) Value	Indebtedness	Sum Total	Average	Rank
X _{pi}	1.67	295.51	-0.05	0.92	19.12	0.16	0.09	11.72	0.21	2.27	3.04	×	×	×
S _{xj}	9.42	1,681.02	3.14	6.15	224.43	1	1	44.98	1.05	3.85	46.99	×	×	×
11	-0.15	21.76	0.14	-0.06	-0.08	0.45	0.02	-0.08	-0.04	-0.18	-0.06	21.72	1.97	1
12	-0.15	-0.15	0.24	0.54	1.52	0.15	0.14	4.1	-0.1	-0.28	-0.06	5.95	0.54	2
13	-0.17	-0.14	0.3	2.61	-0.07	0.05	0.04	-0.08	-0.04	0.3	-0.06	2.74	0.25	3
14	-0.13	-0.15	0.25	-0.1	-0.07	-0.21	-0.21	3.56	-0.12	-0.31	-0.01	2.5	0.23	4
15	-0.11	-0.15	-0.24	-0.15	-0.07	-0.24	-0.24	-0.08	4.18	-0.4	-0.02	2.48	0.23	5
2	-0.12	-0.15	-0.1	-0.11	-0.08	-0.17	-0.17	0.15	0.23	2.06	-0.01	1.53	0.14	6
3	-0.17	-0.17	0.16	0.12	-0.06	-0.1	-0.08	1.71	-0.19	-0.43	-0.06	0.73	0.07	7
6	-0.07	-0.15	0.09	-0.14	-0.08	-0.09	-0.13	-0.11	1.16	-0.1	0.02	0.4	0.04	8
8	-0.13	-0.16	0.17	0.11	-0.05	0.03	-0.05	-0.12	0.18	-0.03	-0.01	-0.06	-0.01	9
4	0.03	-0.15	0.1	-0.14	-0.07	-0.21	-0.21	-0.22	0.63	0	0	-0.24	-0.02	10
9	-0.12	-0.15	0.18	0.13	0.02	-0.15	-0.09	-0.1	-0.1	0.04	-0.03	-0.37	-0.03	11
10	-0.15	-0.16	0.19	-0.01	-0.08	-0.04	-0.02	0.02	-0.1	-0.02	-0.06	-0.43	-0.04	12
1	-0.11	0	0	-0.15	-0.07	0	0	0	0	-0.41	-0.06	-0.8	-0.07	13
16	-0.11	-0.17	0.13	-0.14	-0.08	-0.12	-0.09	0.27	-0.16	-0.25	0	-0.72	-0.07	14
17	-0.13	-0.17	0.19	-0.42	-0.08	-0.09	-0.05	-0.13	-0.04	0.01	0	-0.91	-0.08	15
18	-0.12	-0.17	0.14	-0.12	-0.08	-0.06	-0.08	-0.03	-0.19	-0.19	-0.06	-0.96	-0.09	16
20	-0.14	-0.14	0.07	-0.1	-0.08	-0.08	-0.13	-0.09	-0.17	-0.12	0	-0.98	-0.09	17
19	-0.11	-0.17	-0.09	-0.14	-0.08	-0.04	-0.05	-0.19	-0.06	-0.28	0	-1.21	-0.11	18
5	-0.05	-0.15	-0.16	-0.13	-0.08	-0.09	-0.06	-0.24	-0.01	-0.26	-0.07	-1.3	-0.12	19
7	-0.1	-0.16	-0.95	-0.11	-0.06	-0.03	0.01	-0.38	0.12	-0.16	-0.07	-1.89	-0.17	20

4. Conclusions

Despite the fact that financial distress or bankruptcy may have a slightly different definition depending on the legislation applicable in particular country or state, it is always perceived as a situation that should be avoided. Prevention of bankruptcy is indeed always more convenient and less expensive than resolving the bankruptcy that already occurred. Due to the current pandemic and resulting uncertainty in the markets, we can expect that the interception of potential risks of financial distress will move even higher in the list of management priorities.

The presented CCB model is an analysis instrument designed specifically for this very purpose. It aims to detect the signs of impending bankruptcy based on selected indicators of financial health of a company, including sustainable development, optimal capital structure and liquidity. Ensuring the applicability of the model in practice was one of the key objectives

of the research. Its explanatory power was therefore tested on the data of 199 companies operating in the textile / clothing industry in the Czech Republic.

The comparison of predicted development and actual evolution of tested entities has shown that the CCB model was able to predict bankruptcy / insolvency proceedings in one third of the cases, despite the fact that the number of companies which found themselves in this situation was rather small, considering the extent of the referential package (only 9 out of 199). All the data required for the prediction were taken from standard financial statements.

It can thus be concluded that the described model represents a suitable and reliable tool for detecting financial distress in companies. Bankruptcy or insolvency is nevertheless a legal situation arising under specifically defined conditions. The CCB model should therefore be perceived as a mere support tool for the management and its outputs should prompt a further analysis or expert opinion of the circumstances in the given company.

References

- Bauweraerts, J. (2016). Predicting Bankruptcy in Private Firms: Towards a Stepwise Regression Procedure. *International Journal of Financial Research*, 7(2), 147-153. <https://doi.org/10.5430/ijfr.v7n2p147>
- Dutzi, A., & Rausch, B. (2016). Earnings Management before Bankruptcy: A Review of the Literature. *Journal of Accounting and Auditing: Research & Practice*, 1-21. <https://doi.org/10.5171/2016.245891>
- Forrer, J. (1991). Calculating Growth: Software Used for Financial Analysis in Economic Development. *Social Science Computer Review*, 9(2), 220-221. <https://doi.org/10.1177/089443939100900225>
- Karas, M., & Režňáková, M. (2015). Predicting Bankruptcy under Alternative Conditions: *The Effect of a Change in Industry and Time Period on the Accuracy of the Model*, 213, 397-403. <https://doi.org/10.1016/j.sbspro.2015.11.557>
- Kovanicova, D., et al. (1999). *Finanční účetnictví*. Prague: Polygon.
- Modigliani, F., & Miller, K. H. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. *American Economic Review*, 48(3), 261-297.
- Myer, S. C., & Majluf, N. C. (1984). Corporate Financing and Investment Decisions When Firms Have Information that Investors do Not Have. *Journal of Financial Economics*, 13(2), 187-221. [https://doi.org/10.1016/0304-405X\(84\)90023-0](https://doi.org/10.1016/0304-405X(84)90023-0)
- Schwartz, A. (2016). Bankruptcy Related Contracting and Bankruptcy Functions. *Oxford Business Law Blog*, 9, 363-394. <https://doi.org/10.4337/9781781007884.00022>
- White, M. J. (2016). Small Business Bankruptcy. *Annual Review of Financial Economics*, 8(1), 317-336. <https://doi.org/10.1146/annurev-financial-121415-032856>

Appendix

Table A1. Serial numbers of the companies. Companies in grey went bankrupt during the predicted period.

Company #	Company Name
1	Actual spinning a.s
2	ATRON, s.r.o
3	BRULEKO s.r.o
4	DIVERSO KV s.r.o.
5	Durocas Czech s. r. o.
6	KONYA - M s.r.o.
7	PRVNÍ CHRÁNĚNÁ DÍLNA s.r.o
8	RESCUE s.r.o
9	SAND s.r.o
10	CZ FORUS s.r.o
11	BIKERS CROWN, s.r.o
12	Clonestar Peptide Services, s.r.o
13	Fibertex Nonwovens, a.s
14	MEDOVINKA, s.r.o
15	VEBA, textilní závody a.s.
16	VLNAP a.s
17	ASSANTE s.r.o
18	B E M A T E C H, s.r.o
19	GUMOTEX, a.s.
20	Schwinn Tschechien s.r.o

Table A2. List of abbreviations used

Abbreviation	Meaning
A	Amortisation
A _a	Average Total Assets
AP	Accounts Payable
A _{total}	Total Assets
CV	Company Value
DOE	Daily Operating Expense
D _{outstanding}	Outstanding Debt
D _{sv}	Integral Indicator - Standardized Variable
E _s	Earnings per Share
L _c	Current Liabilities
LD	Long-term Debt
L _{iother}	Other Liabilities
LV	Lease Value
MS	Marketable Securities
P _s	Share Price
RC ^C	Replacement Cost of Capital

Business Activity and its Concentration in the Czech Republic and Poland in the years 2018–2020

Eva HAMPLOVÁ^{1*}, Beata BAL-DOMAŃSKA² and Kateřina PROVAZNÍKOVÁ¹

¹ University of Hradec Králové, Hradec Králové, Czech Republic; eva.hamplova@uhk.cz;
katerina.provaznikova@uhk.cz

² Wrocław University of Economics and Business, Wrocław, Poland; Beata.Bal-Domanska@ue.wroc.pl

* Corresponding author: eva.hamplova@uhk.cz

Abstract: The paper evaluates the business environment in two economies, by means of the number of actively operating business units in the Czech Republic and Poland in 2018 and 2020. The aim of this article is to assess which regions at the level of Nomenclature of Units for Territorial Statistics show the highest share of active entrepreneurs in terms of the population aged 15-64 in the given region. The subsequent evaluation of business activity over time is especially important. Data from the Czech Statistical Office and Statistics Poland, which are publicly available and can contribute to monitoring the impact of a pandemic crisis on entrepreneurs or the business environment, were used to analyze the concentration of active entrepreneurship. For the regional evaluation of the concentration of business activity, the characteristics of the organized statistical series were used, especially quartiles, and subsequently a map was created in order to visualize the differences in the concentration of business activity at the national and international level. In the Czech Republic, the concentration of entrepreneurs is higher in almost all regions than in Poland, despite the fact that the share of active entrepreneurs in the total number of registered is significantly lower than in Poland.

Keywords: business; business environment; national economy

JEL Classification: L25; L26; O10

1. Introduction

A regionally balanced business climate is not only a very important issue, but it could even be said to be the primary one, especially in a modern market environment, as it has a significant impact on employment (Thurik et al., 2008), where the business sector has become a key factor, on innovation, the state budget, or, last but not least, on the external economic balance (Stloukalová et al., 2015). The development of the number of statistical units of the enterprise type and their dynamics significantly declare the development of the business sector, the state of the given national economy and, last but not least, regional differences in business at the level of territorial units (Carree, 2015).

Small and medium-sized enterprises, which represent a substantial part of the business sector, have become an increasingly important part of economic development. In this context, it appears that small and medium-sized enterprises can be characterized as the main engine of economic growth. Research has shown that new firms grow faster than established ones

(Davidsson et al., 2002), thus making a significant contribution to job creation and compensating for job losses in large firms. Therefore, from the point of view of economic policy, it is necessary to know how business activity develops in a given country. This information can help to better target economic policy focused on the support of entrepreneurship (Hamplová & Kovárník, 2020).

Entrepreneurship is systematically linked to job growth and over time this relationship has intensified (Dvouletý & Orel, 2020). Entrepreneurship has the greatest impact on the region in which it operates, but it also has positive side-effects on job growth in neighbouring regions (Bal-Domańska, 2018). Entrepreneurship has greater national economic effects in more urbanized regions, where businesses benefit from a condensed market (Henderson & Weiler, 2010). It is the assessment of the intensity of absorption of business support in the regions that can be a significant factor in their disparities, although this is not clearly proven. Based on the analysis, it was not possible to prove the hypothesis that in the Czech Republic business entities operating in problem regions are preferred when it comes to deciding on the support of projects in the form of subsidies (Felixová, 2012).

2. Methodology

The internal database of the Czech Statistical Office obtained from the Register of Economic Entities and of the Statistics Poland was used in the processing of data used in this article. The basic difference between the data publicly available and the data used in this paper is in the concept of the so-called enterprises showing economic activity. According to the Czech Statistical Office, an enterprise showing economic activity is characterized by the fact that in the year of monitoring its activity was identified through the Financial Administration, the Social Security Administration alternatively other administrative sources. According to the Statistics Poland, declared entrepreneurial activity is characterized by the number of entities of the national economy in the REGON register (excluding natural persons running only individual farms). The presented data relate to the so-called active entities, i.e. those that have not reported, for example, the suspension of their activities, are not bankrupt or have not started their activity yet.

Records of the number of enterprises in the years 2018-2020 were obtained through the Information Services Department of the Czech Statistical Office and the Department of Coordination of Business Statistics and business cycle surveys of the Czech Statistical Office and Statistics Poland. The data are organized according to individual regions of the Czech Republic, of which there are 14, and according to individual voivodships of Poland, of which there are 16, and they document the specific number of business entities with identified activity in individual years. Data from the Czech Statistical Office (2020a) and Statistics Poland (2020) for 2020 and 2018 were accepted for the analysis. The basic unit for evaluating the concentration of business activity is the number of active entrepreneurs per 1,000 inhabitants aged 15-64. The number of inhabitants in individual regions was obtained from the data of the Czech Statistical Office (2020b) always as of 1 January of the given period. The characteristics of the ordered statistical series were used for the regional evaluation of the concentration of business activity, especially the quartiles.

2. Analysis of Concentration of Active Business Units in the Czech Republic and Poland in 2020-2018

Four regions in the Czech Republic (Prague, Central Bohemia, South Moravia, Moravia-Silesia) account for more than 50% of the total number of active businesses in the Czech Republic. In the total number of active business units, enterprises with up to 249 employees represent 99.84%. Representation of active business units has an overwhelming majority in the form of small and medium-sized enterprises (Hamplová & Kovárník, 2016). According to Statistics Poland (2020) the situation in Poland is similar. From Tab. 1 on the number of registered business entities, it is clear that 46% of registered entrepreneurs did not report business activity in 2020, which would be recordable through the Financial Administration, the Social Security Administration alternatively other administrative sources. From the point of view of the entire Czech Republic, the share of active business units is 54% as of 31 December 2020. The share of active business units within the CZ-NUTS 3 regions is shown in Tab. 1. The Karlovy Vary region even has only 51% of active business units overall registered. A change was recorded in all regions compared to 2018. The number of active entrepreneurs increased in absolute terms in all regions. In the Prague region it was even by 10%. This fact it is also evident from Tab. 1, where the change is evaluated relatively, i.e. as the ratio of the number of entrepreneurs declaring an activity to the number of entrepreneurs registered. Increased business activity is recorded in 13 regions of the Czech Republic.

Table 1. Number of registered and actually active entrepreneurs by CZ-NUTS 3 and by territorial division as of 31 December 2020, 2018. (Czech Statistical Office, 2020a)

Region CZ-NUTS 3	Registered (1)	Declared activity (2)	Ratio 2020 (2) / (1)	Ratio 2018	Number of registered entrepreneurs per 1,000 inhabitants in age (15 – 64)	Number of active entrepreneurs per 1,000 inhabitants in age (15 – 64)
Czech Republic	2,932,963	1,576,331	54% ↗	52%	428	230
Prague	644,586	380,723	59% ↗	56%	748	442
Central Bohemian	351,185	194,803	55% ↗	54%	398	221
South Bohemian	166,853	87,012	52% ↗	51%	407	212
Plzeň	147,671	73,071	49%	49%	390	193
Karlovy Vary	73,997	33,290	45% ↗	44%	390	175
Ústí nad Labem	176,004	83,717	48% ↗	46%	333	159
Liberec	118,076	57,144	48% ↗	47%	420	203
Hradec Králové	141,343	74,445	53% ↗	52%	408	215
Pardubice	122,901	65,585	53% ↗	52%	368	197
Vysočina	116,360	64,919	56% ↗	55%	357	199
South Moravian	326,100	175,952	54% ↗	53%	428	231
Olomouc	145,374	74,273	51% ↗	50%	361	185
Zlín	144,213	76,050	53% ↗	52%	387	204
Moravian-Silesian	258,300	135,347	52% ↗	51%	333	174

The number of active entrepreneurs per 1,000 inhabitants aged 15-64 is a category with which we will continue to work when evaluating the concentration of active business units. From the point of view of regions according to the territorial division of CZ-NUTS 3, the highest concentration can be recorded in the Prague region (442 entrepreneurs per 1,000

inhabitants aged 14-64), followed by the South Moravian region (231), the Central Bohemian region (221), Hradec Králové region (215), the South Bohemian region (212), Zlín region (203), Liberec region (203). The other half of the group consists of the Vysočina region (199), the Pardubice region (197), the Plzeňský region (193), the Olomouc region (185), the Karlovy Vary region (175), the Moravian-Silesian region (174) and Ústí nad Labem region (158). From the perspective of the CZ-NUTS 3 regions, this region appears to be the region with the lowest number of active business units per 1,000 inhabitants of this region (Fig. 1).

From Tab. 2 on the number of registered business entities, it is clear that 12% of registered entrepreneurs did not report business activity in 2020. From the point of view of the entire Poland, the share of active business units is 88% as of 31 December 2020. The share of active business units within the PL-NUTS 2 regions is shown in Tab. 2.

A change was recorded in all regions compared to 2018. Although the number of active entrepreneurs in all regions increased in absolute terms, a relative decrease was recorded in all voivodships. This fact is also evident from Tab. 2, where the relative change is evaluated, i.e. as the ratio of the number of entrepreneurs declaring activity to the number of registered entrepreneurs.

Table 2. Number of registered and actually active entrepreneurs by PL-NUTS 2 and by territorial division as of 31 December 2020, 2018. (Statistics Poland, 2020)

Region PL-NUTS 2	Registered (1)	Declared activity (2)	Ratio 2020 (2) / (1)	Ratio 2018	Number of registered entrepreneurs per 1,000 inhabitants in age (15-64)	Number of active entrepreneurs per 1,000 inhabitants in age (15-64)
Poland	4,663,378	4,103,598	88% ↘	90%	184	161
Dolnośląskie	396,046	348,356	88% ↘	90%	207	182
Kujawsko-pomorskie	209,750	186,604	89% ↘	91%	152	135
Lubelskie	192,737	168,061	87% ↘	90%	138	120
Lubuskie	120,839	106,038	88% ↘	90%	179	157
Łódzkie	261,498	229,999	88% ↘	90%	164	144
Małopolskie	426,306	375,185	88% ↘	90%	188	165
Mazowieckie	887,329	786,938	89% ↘	91%	251	223
Opolskie	105,694	95,009	90% ↘	92%	160	144
Podkarpackie	188,360	165,993	88% ↘	90%	131	115
Podlaskie	109,492	96,962	89% ↘	91%	138	122
Pomorskie	318,518	272,628	86% ↘	88%	206	176
Śląskie	494,282	434,964	88% ↘	90%	166	146
Świętokrzyskie	120,062	105,884	88% ↘	90%	147	130
Warmińsko-mazurskie	136,403	119,390	88% ↘	90%	142	124
Wielkopolskie	461,225	411,684	89% ↘	91%	199	177
Zachodnio-pomorskie	234,131	199,348	85% ↘	88%	207	177

A change was recorded in all regions compared to 2018. Although the number of active entrepreneurs in all regions increased in absolute terms, a relative decrease was recorded in all voivodships. This fact is also evident from Tab. 2, where the relative change is evaluated, i.e. as the ratio of the number of entrepreneurs declaring activity to the number of registered entrepreneurs.

From the point of view of regions according to the territorial division of PL-NUTS 2, the highest concentration can be recorded in Mazowieckie region (223 entrepreneurs per 1,000 inhabitants aged 15–64), followed by Dolnośląskie region (182), Wielkopolskie region (177.23), Zachodnio-pomorskie region (176.58), Pomorskie (176), Małopolskie region (165), Lubuskie region (157), Śląskie region (146). The other half of the group consists of Łódzkie region (144), Opolskie region (144), Kujawsko-pomorskie region (135), Świętokrzyskie region (130), Warmińsko-mazurskie region (124), Podlaskie region (122), Lubelskie region (120) and Podkarpackie (115). From the perspective of the CZ-NUTS 2 regions, this region appears to be the region with the lowest number of active business units per 1,000 inhabitants of this region (Fig 2).

3. Results and Discussion

From the information stated above it is evident that the two compared countries under with a very similar 50-year economic history share some clear similarities and, conversely, significant differences can be identified. Both evaluated countries have a very similar organizational structure of their national economy. The vast majority of business entities are included in the category of micro-company (Table 3).

Table 3. Number of actually active entrepreneurs according to the size as of 31 December 2020

Country	Declared activity TOTAL	Size 0 – 9 Number of employees	Size 10 - 49 Number of employees	Size 50 - 249 Number of employees	Size 250 => Number of employees
Poland	4,103,598 100%	3,945,983 96.2%	127,394 3.1%	26,113 0.6%	4,108 0.1%
Czech Republic	1,576,331 100%	1,519,429 96.4%	43,215 2.7%	11,367 0.7%	2,320 0.1%

More than 2/3 of business units have the form of a natural person without legal subjectivity and 1/3 of entrepreneurs have the form of legal persons (Table 4).

Table 4. Number of actually active entrepreneurs according to the legal forms as of 31 December 2020

Country	Declared activity TOTAL	Legal persons	Natural persons running a business
Poland	4,103,598 100%	1,272,464 31%	2,831,134 69%
Czech Republic	1,576,331 100%	458,475 29%	1,117,856 71%

Both countries are assessed almost identically according to the Doing Business study (World Bank, 2020). The study has compared business rules and regulations that characterize the business environment for 17 years.

However, the analysis shows a completely different intensity of specific entrepreneurs' involvement in the active business of a particular country. While in the Czech Republic an entrepreneur registers either as a natural person or a legal entity for the purpose of entrepreneurial activity, subsequently this activity is actually actively performed by every other entrepreneur. We can explain this fact mainly due to the very high involvement of

natural persons in business. These people have the business as a secondary form of income. In other words, they have a job and are employees and earn extra money from the business. The situation is completely different in the case of Poland. Although natural persons running only individual farms are not included in the number of business entities, approximately every 10 registered entrepreneurs will not participate in active business.

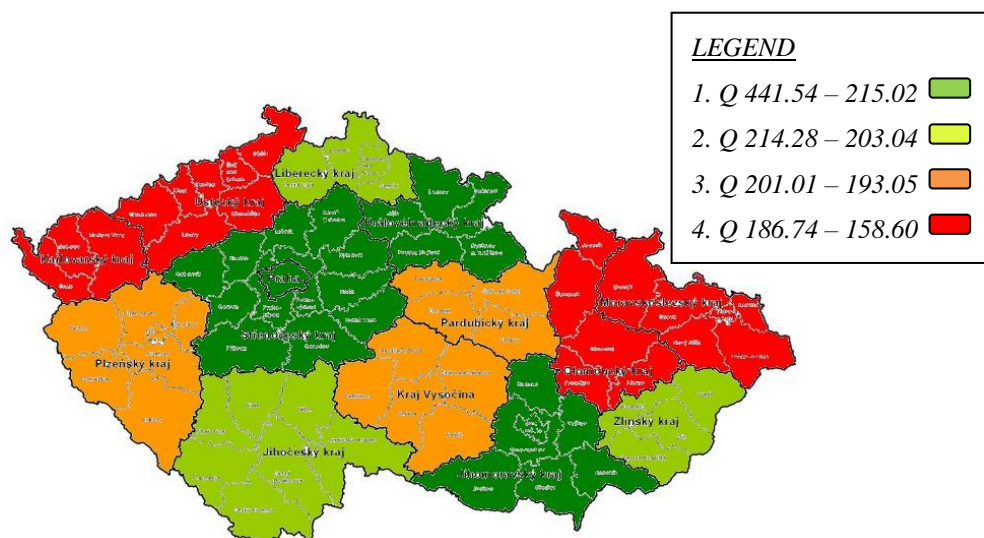


Figure 1. Number of entrepreneurs in regions of the Czech Republic per 1,000 inhabitants aged 15-64 as of 31 December 2020

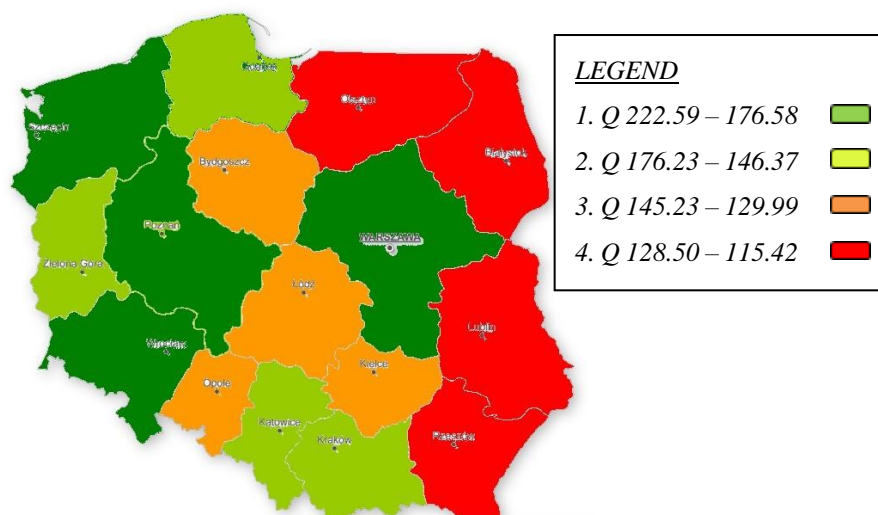


Figure 2. Number of entrepreneurs in voivodships of Poland per 1,000 inhabitants aged 15 – 64 as of 31 December 2020

4. Conclusions

This paper focused on the evaluation of the current situation of business activity in the Czech Republic and Poland. The aim was to map the extent of the involvement of entrepreneurs in individual countries and also in individual regions (voivodships), to visualize the differences at the national and international level. In the Czech Republic, the

share of active entrepreneurs is very low due to the number of registered entrepreneurs (54%), but compared to 2018, this involvement is 2% higher. In 2020, absolutely and relatively more entrepreneurs joined the business than in 2018. It follows from the above that the COVID 19 crisis has paradoxically increased business activity in the Czech Republic. Unfortunately, it cannot be ruled out that the motive for the increased activity was the widespread use of state aid in connection with government regulations restricting business activity during the COVID 19 pandemic. In Poland, the situation developed differently. The absolute number of registered entrepreneurs increased, but the relative number decreased by 2%. Relatively fewer entities declared business activity at the time of the 2020 crisis than in 2018. It was here that a problem related to the limitation of business activity may have arisen in 2020, which we cannot confirm due to the low detail of the analyzed data. When comparing entrepreneurial activity, which was evaluated in this paper on the basis of the number of activities of declaring entrepreneurs per 1,000 people aged 15-64, the concentration of these entrepreneurs is significantly higher in the Czech Republic and in almost all its regions than in Poland.

Acknowledgments: This research was funded by Specific research grant 2021 Economic Impacts under the Industry 4.0/Society 5.0 Concept at the Faculty of Informatics and Management of the University of Hradec Kralove, Czech Republic. It was prepared in cooperation with students of Ph.D. study at Department of Economics, namely with Ing. Lucie Novotná and Ing. Martin Král.

References

- Bal-Domańska, B. (2018). The Socio-economic Dimension of Industry in Subregions. *Argumenta Oeconomica Cracoviensia*, 19, 133–152. <https://doi.org/10.15678/AOC.2018.1907>
- Carree, M., Congregado, E., Golpe, A., & van Stel, A. (2015). Self-employment and job generation in metropolitan areas, 1969–2009. *Entrepreneurship & Regional Development*, 27(3–4), 181–201. <https://doi.org/10.1080/08985626.2015.1025860>
- Czech Statistical Office. (2020a). *Births and deaths of businesses* [Data set]. Database of the Statistical Business Register. Not public, internal document.
- Czech Statistical Office. (2020b). *Population of territorial units of the Czech Republic, 1 January 2020*. [Data set]. Retrieved December 12, 2020 from. <https://www.czso.cz/csu/czso/population-of-municipalities-1-january-2020>
- Davidsson, P., Kirchoff, B., Hatemi-J, A., & Gustavsson, H. (2002). Empirical Analysis of Business Growth Factors Using Swedish Data. *Journal of Small Business Management*, 40(4), 332–349. <https://doi.org/10.1111/1540-627X.00061>
- Dvouletý, O., & Orel, M. (2020). Individual determinants of entrepreneurship in Visegrád countries: Reflection on GEM data from the Czech Republic, Hungary, Poland, and Slovakia. *Entrepreneurial Business and Economics Review*, 8(4), 123–137. <https://doi.org/10.15678/EBER.2020.080407>
- Felixova, K. (2012). Evaluation of the absorption intensity of the entrepreneurial support in the regions funded intensely by the government. *E+M: Ekonomie a Management*, 15(1), 17–27.
- Hamplová, E., & Kovárník, J. (2020). Globalization and Entrepreneurship: Selected Topics in Visegrad Four Countries. *SHS Web of Conferences*, 74, 05009. <https://doi.org/10.1051/shsconf/20207405009>
- Hamplová, E., & Kovárník, J. (2016). Analýza vývoje počtu podnikatelských jednotek v České republice v letech 2008–2014. In *19th International Colloquium on Regional Sciences. Conference Proceedings* (pp. 226–232). <https://doi.org/10.5817/CZ.MUNI.P210-8273-2016-28>
- Henderson, J., & Weiler, S. (2010). Entrepreneurs and Job Growth: Probing the Boundaries of Time and Space. *Economic Development Quarterly*, 24(1), 23–32. <https://doi.org/10.1177/0891242409350917>
- Statistics Poland. (2020). *Kwartalna informacja o podmiotach gospodarki narodowej w rejestrze REGON rok 2020* [Data set]. Retrieved January 31, 2020, from <https://stat.gov.pl/obszary-tematyczne/podmioty-gospodarcze-wyniki-finansowe/zmiany-strukturalne-grup-podmiotow/kwartalna-informacja-o-podmiotach-gospodarki-narodowej-w-rejestrze-regon-rok-2020,7,8.html>

- Stloukalová, T., Jurčík, R., & Srdošová, K. (2015). Malé a střední podniky ve veřejných zakázkách krajů v České republice. In *18th International Colloquium on Regional Sciences. Conference Proceedings* (pp. 143–147). <https://doi.org/10.5817/CZ.MUNI.P210-7861-2015-18>
- Thurik, A. R., Carree, M. A., van Stel, A., & Audretsch, D. B. (2008). Does self-employment reduce unemployment? *Journal of Business Venturing*, 23(6), 673–686. <https://doi.org/10.1016/j.jbusvent.2008.01.007>
- World Bank. (2020). *Doing business 2020: Comparing business regulation in 190 economies*. The World Bank.

Selection of a Suitable Agile Methodology – Case Study

František HAŠEK and Hana MOHELSKÁ*

University of Hradec Králové, Hradec Králové, Czech Republic; frantisek.hasek@uhk.cz;
hana.mohelska@uhk.cz

* Corresponding author: hana.mohelska@uhk.cz

Abstract: Lean manufacturing and lean thinking, in general, have accompanied especially manufacturing companies for many decades. This is not different when developing software. Agile development methodologies are currently among the most used methods in software development and their supply is relatively wide. At the same time, the selection of a suitable method is fundamental, not only for timely delivery but mainly for the optimal functionality of the entire final solution. The agile methodology is mainly focused on value for the customer. This paper is focused on a case study of selecting a suitable agile methodology for a selected medium-sized company. The selection criteria were based on a discussion with the key employees, and then the weights for the particular criteria were determined using a questionnaire survey. The attributes of the selected methodologies were evaluated by experts from the selected company. Saaty's method was chosen for multicriteria decision-making. Subsequently, a decision support system (Criterium Decision Plus) was used to select a suitable methodology from the selection of the most used agile methods.

Keywords: agile software development; scrum; extreme programming; kanban

JEL Classification: M10; M11; M15

1. Introduction

In the 1960s, the branch of system engineering experienced a rise for which, as it turned out, it was not prepared. The rapid development caused an increase in demand and that caused problems with extensions, increases in price, or project crashes. Software development has evolved in many phases, one of them is called “code and fix” or waterfall methods like “heavyweight”, agile methods are considered like leading ones in the “lightweight” category. Each of these methods has been more or less successful, synergy between these approaches brings still better and better methods. (Oyong & Ekong, 2019).

In today's world of globalization and the increasingly advanced digitalization of the world, the constant expansion of lean manufacturing and sustainability is essential, these aspects could be achieved by agile methodologies that need to be implemented across the organization, from management to development teams. (Dänner & Doubek, 2020).

The term agile can be described as dynamic, limber or adaptable. Everyone in the team does what is just needed. Traditional software development techniques do not allow a later change of the assignment, while agile methodologies allow not only to modify the assignment during development but also to check and correct errors, thus becoming almost

flawless (Neelu & Kavitha, 2020). These methods are based on a frequent delivery of software, customer satisfaction, intensive cooperation with customers and requirements that can be changed anytime. However, there are several challenges, for example, scalability, smooth control of development or the ability for remote collaboration (Younas et al., 2019). The main features of agile methodologies are timely delivery of software, interaction with the customer, re-learning from previous iterations, operational changes at any stage of project development and so on. (Younas et al., 2019). To achieve the mentioned features, an agile manifesto was designed with four basic values (*Manifesto for Agile Software Development*, n.d.):

- individuals and interactions over processes and tools,
- working software over comprehensive documentation,
- customer collaboration over contract negotiation,
- responding to change over following a plan.

Users of agile software development methods appreciate the ability to manage changing priorities, project visibility, delivery speed or team morale. Scrum, Kanban, and Extreme programming belong to the world's most used agile methodologies in 2019. (*State of Agile*, n.d.).

1.1. Extreme Programming

The Extreme Programming methodology was introduced in 1999, also known as XP, and is one of the most efficient, light, flexible, and fun methods of software development. It is suitable for small and medium-sized teams that have unclear or variable assignments. This method is called extreme because it brings commonly used procedures and principles to extreme dimensions, where the team is constantly focused on one functional element. The key to the success of the XP method are four fundamental values: communication, simplicity, feedback and courage. Communication is essential in project management because many problems are caused by poor communication. With the help of simplicity, it is possible to implement functional changes in the shortest possible time without delay, which are modified and further improved thanks to the feedback. The last key method is courage, thanks to which fundamental steps and changes can be realized. The subliminal value is the respect for team members, without which XP could not succeed. (Beck & Makovec, 2002).

1.2. Kanban

The roots of the Kanban method go back to Japan, where the method was used to regulate visitors in temples, where each visitor took one ticket at the entrance and returned it at the exit. The number of tickets was limited and thus the capacity of the temple. In project management, Kanban is used for efficient visualization using a Kanban board, which reduces work in progress and minimizes throughput, thus achieving faster delivery and better quality of software delivery. An example is a board divided into processes (e.g. To Do - In Progress - Done), in which taskbars are located. The maximum number of tickets on the board should be limited (Zayat & Senvar, 2020).

1.3. Scrum

The Scrum methodology is based on lean thinking and empiricism and it is used as a process framework for managing the development of complex products. This process consists of constant interaction within a team in which its members work together from the beginning to the end of development. For Scrum to work properly, it has to consist of Scrum teams and associated roles, activities, artifact, and rules. Scrum is defined as simple, easy to understand, but extremely difficult to master (Schwaber & Sutherland, 2017).

Scrum teams are self-organizing teams that choose how the work will be done and that consist of the product owners, the development team, and the Scrum master. People in scrum are not divided into sub-teams or hierarchy and the maximum number of members of the Scrum team are around 10 because communication in smaller groups is much easier. Developers are people who develop any part of a product whose skills are usually broad. The product owner is responsible for maximization of value during working on the project, communication and management of backlog. Scrum Master's work is based on disseminating the know-how about theory and practice of the Scrum in the Scrum team and whole organization. (Schwabre & Sutherland, 2020).

2. Methodology

To determine the weights of the selected criteria, a questionnaire survey was conducted, which took place within the company. The company that the case study focuses on belongs to the medium-sized companies, employs 90 people, and is focused on software development. Before the main survey, a pilot study was carried out in cooperation with the product director to verify the feasibility of the questionnaire and then the anonymous questionnaire was distributed to 10 employees interested in agile software development. The questionnaire contained 21 questions of pairwise evaluation of selected criteria.

As the method for multicriteria decision making, Saaty's method was chosen, which compares pairs of criteria with each other. Respondents were therefore asked to take this step and always evaluate the two criteria. The weights of the individual criteria were obtained using Saaty's matrix, and then the arithmetic mean for each criterion was determined from the different weights. The final weights are entered in Table 1.

Table 1. Final weights of the selected criteria

Criterion	Weights
The degree of complexity of the methodology	0.031
The degree of documentation	0.054
The degree of error	0.227
Specification of the customer requirements	0.315
Delivery time	0.179
Defining responsibility	0.068
Communication across the team	0.126
Σ	1.000

Respondents consider the specification of the customer requirements to be the most important criterion. They chose it because they perceive the correct understanding of the customer as the most important factor, with the incorrect specification of requirements, the work of the entire team will be in vain. The second most important criterion was the degree of error. As with the incorrect specification, the high error rate leads to inefficiency of the performed work. The effort to eliminate errors within the entire team is reflected in the perceived importance of this criterion. The third criterion according to the importance is the delivery time. The company should release a new version of the system without much time delay. Communication across the team finished in the fourth place and overtook the criteria for defining responsibility, the degree of documentation and the degree of complexity of the methodology. Communication is a key part of agile development. On the contrary, respondents chose as the least important criterion the degree of complexity of the methodology.

3. Results

Presently, several methods are used for agile development, the three most used will be assigned to individual criteria according to the suitability of the methodology. An expert opinion together with research were used for this selection. The selection included methodologies: Scrum, Kanban, and Extreme Programming (XP), these three mentioned methodologies were listed as the most used in 2019 (figure 1), with the exception of hybrid methodologies.

3.1. Evaluation of Methods According to Criteria

For the final selection of the methodology, the Criterium Decision Plus software was selected, in which the weights of the individual criteria were determined and below the methodologies will be evaluated based on the selected criteria. The opinion of an expert from the given company was used to evaluate the methodologies.

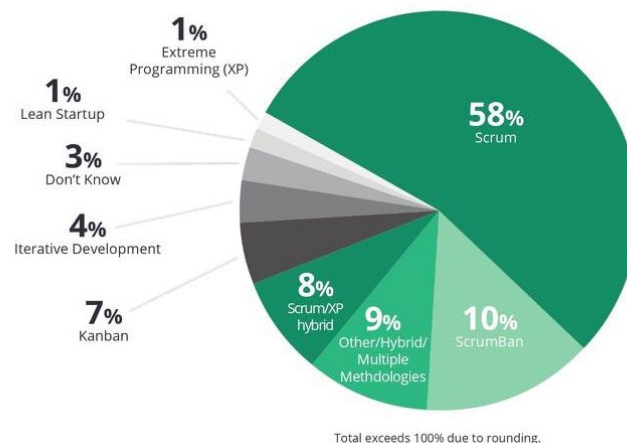


Figure 1. The agile methodology used in 2019 (*State of Agile*, n.d.)

The degree of complexity of the methodology

Although the purpose of agile methodologies is simplicity, the Kanban methodology, which has its roots in lean manufacturing, was described as the simplest. The Kanban methodology in its basis does not dictate or prohibit anything, it only has to follow three principles: visualize the work, minimize the time of passage and limit the work in progress. The Scrum and XP methodologies have been identified as similarly complex, as they already have to follow certain procedures but they cannot be considered complicated.

The degree of documentation

Even though one basic value of the Agile Manifesto says that it prefers working software to exhaustive documentation, this does not mean that the documentation can be omitted altogether and no attention paid to it. The degree of documentation depends on the claims of the contracting authority. From this point of view, Extreme Programming turned out to be the most suitable method, as one of the twelve practices are the standards for the writing source text, which developers must adhere to. The source code represents part of the documentation in the XP methodology. Thanks to the established rules for writing code, it is not a problem to know the individual lines, even if they were written by someone else.

The degree of error

Some factors can affect the degree of error, whether it is the motivation of the employee or his abilities. The advantage of Extreme Programming is that it follows the practice of a forty-hour week, which contributes significantly to reduce errors. Thus, workers do not make mistakes that would stem from their fatigue.

Specification of the customer requirements

In traditional development, it has been common for customer requirements not to be well defined or for misunderstanding by the application manufacturer. This was mainly due to the insufficient communication between the two parties. Scrum defines the important role of the Product Owner, who is a part of the team and is responsible for individual system requirements. In the XP methodology, the customer is also assigned to the developer's workplace but does not have precisely defined tasks, he is only available to programmers. Therefore, the Scrum method was chosen as the best for the specification of the customer requirements.

Delivery time

With delivery time, the priority is not to delay the release of a new version. Scrum seems to be the most appropriate methodology, which divides development into multiple iterations (in the case of Scrum sprints), with working software at the end of each sprint to avoid delivery delays. The Kanban methodology has been placed right behind Scrum with the principle of minimizing passage time, so the delivery should be realized as soon as possible.

Defining responsibility

All selected methodologies share responsibility within the whole team. When someone has a problem, it is not the individual's, but everyone's problem. However, the most suitable methodology is Scrum because the role of the product owner is responsible for all system requirements (Product Backlog).

Communication across the team

Communication is one of the fundamental pillars of all agile methodologies. The methodologies were evaluated concerning the added value which communication offers. The Scrum methodology was rated the best, it includes a lot of meetings in the whole process, starting with planning and ending with a retrospective. However, daily meetings where members exchange information are most beneficial. Although the XP methodology does not set any meetings, it uses the practice of pair programming, in which programmers are in constant communication contact.

Table 2. Features of the methodologies for selected criteria

Lowest Level	Scrum	Kanban	XP	Model
The degree of complexity of the methodology	0.170	0.660	0.170	0.031
The degree of documentation	0.250	0.250	0.500	0.054
The degree of error	0.200	0.200	0.600	0.227
Specification of the customer requirements	0.530	0.170	0.300	0.315
Delivery time	0.560	0.320	0.120	0.179
Defining responsibility	0.500	0.250	0.250	0.068
Communication across the team	0.540	0.160	0.300	0.126

Based on the multi-criteria analysis and using the management tool for decision support Criterium Decision Plus, the resulting graph (figure 2) was compiled, which selects the most suitable agile methodology for implementation in the selected company.

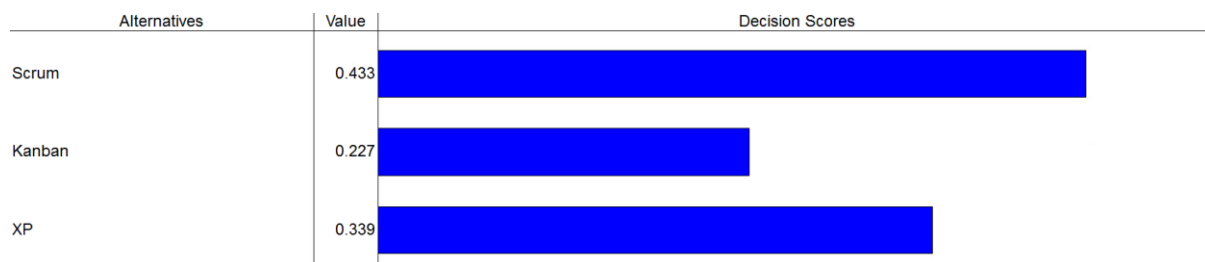


Figure 2. Graph of the selection of the optimal methodology

It is noticeable from the output that the Scrum method is the best choice. This happened mainly due to the more detailed elaboration of the methodology, its dominance is confirmed by the fact that it is the most used agile methodology in the world. The second position was taken by the XP (Extreme Programming) methodology. Kanban turned out to be the least suitable of the examined methodologies. It seems to be very abstract and is more suitable as a complementary methodology. In the next discussion, it would be appropriate to combine the two methodologies with the fact that the basic framework would be the Scrum methodology and would be enriched with some principles from another methodology.

4. Conclusions

For the objective assignment of the weights, a questionnaire survey was carried out, in which five employees (experts) performed a pairwise evaluation of selected criteria. From the results, the weights of individual criteria were determined with the help of Saaty's matrix, and these criteria were evaluated by selected agile methodologies. As a result, decision

support system Criterium Decision Plus selected the most suitable agile methodology for implementation in the analyzed company, the Scrum method, which is the most used agile methodology in the world (the State of Agile, n.d.). Contribute to this result, Scrum is very flexible. For many companies, implementing an agile approach means increasing competitiveness.

Acknowledgments: The paper was written with the support of the specific project 2021 grant “Determinants of cognitive processes impacting the work performance” granted by the Faculty of Informatics and Management, the University of Hradec Králové, Czech Republic.

References

- Beck, K., & Makovec, P. (2002). *Extrémní programování*. Grada Publishing.
- Dänner, K., & Doubek, S. (2020). *Factors Influencing the Success of “Agile Working” in Manufacturing Companies. Manifesto for Agile Software Development*. (n.d.). <http://agilemanifesto.org/>
- Neelu, L., & Kavitha, D. (2020). Software Development Technique for the Betterment of End User Satisfaction using Agile Methodology. *TEM Journal*, 9(3), 992–1002. <https://doi.org/10.18421/TEM93-22>
- Oyong, S. B., & Ekong, V. E. (2019). An explorative survey of formal and agile software development methods. *Global Journal of Pure and Applied Sciences*, 25(1), 71. <https://doi.org/10.4314/gjpas.v25i1.10>
- Schwaber, K., & Sutherland, J. (2017). *The Scrum Guide*. <https://www.scrumguides.org/docs/scrumguide/v2017/2017-Scrum-Guide-US.pdf>
- Schwabre, K., & Sutherland, J. (2020). *The Scrum Guide*. <https://www.scrumguides.org/docs/scrumguide/v2020/2020-Scrum-Guide-US.pdf#zoom=100>
- State of Agile. (n.d.). 15th Annual State of Agile Survey. <https://stateofagile.com/#ufh-i-615706098-14th-annual-state-of-agile-report/7027494>
- Younas, M., Jawawi, D. N. A., Ghani, I., Shah, M. A., Khurshid, M. M., & Madni, S. H. H. (2019). Framework for Agile Development Using Cloud Computing: A Survey. *Arabian Journal for Science and Engineering*, 44(11), 8989–9005. <https://doi.org/10.1007/s13369-019-03923-6>
- Zayat, W., & Senvar, O. (2020). Framework Study for Agile Software Development Via Scrum and Kanban. *International Journal of Innovation and Technology Management*, 17(04), 2030002. <https://doi.org/10.1142/S0219877020300025>

Impacts of COVID-19 on the Labour Market – Evidence from the Czech Republic

Martina HEDVIČÁKOVÁ^{1*} and Zuzana KOZUBÍKOVÁ²

¹ University of Hradec Králové, Hradec Králové, Czech Republic; martina.hedvicakova@uhk.cz.

² University of Žilina, Žilina, Slovak Republic; zuko@frcatel.fri.uniza.sk

* Corresponding author: martina.hedvicakova@uhk.cz

Abstract: The current pandemic has far-reaching consequences for people's lives, employment and family life; has also changed the economic environment. The Covid-19 pandemic had, among other things, significant effects on the labour market, which has undergone significant changes. Thanks to the support of the Czech government and its program, the unemployment rate in 2020 remained so far at 3.51%, which is the lowest unemployment rate of all EU countries. The labour market also opens up space for a more significant implementation of the Industry 4.0 concept, which can increase the competitiveness of companies. The aim of the article is to analyse the dynamic development of basic values observed in the labour market (employment, unemployment, wage developments, etc.) in individual quarters since 2018. Furthermore, the Czech government's employment support programs and the main changes that may occur as a result of the Covid-19 pandemic were presented. The paper presents a multilevel analysis of given condition, as it also takes into account the framework of global changes, which we became part of before the arrival of Covid-19. Without these changes, it is not possible to move advance in with the Industry 4.0 initiative.

Keywords: unemployment; Industry 4.0; economy; labour market; changes

JEL Classification: E24; J21; O11

1. Introduction

The labour market has experienced significant changes related to the Covid-19 pandemic since 2020. These changes had a significant impact on all economic sectors, including employers and employees. The government of the Czech Republic had to deal with the support of the labour market and the employees themselves. The impacts of Covid-19 were in all areas but to varying degrees.

COVID-19 focused on this topic. People are affected in the context of the Covid-19 pandemic differently depending on their social class or caste, gender and age, and the country in which they live (van Barneveld et al., 2020).

From a macroeconomic point of view, the pandemic will primarily have effects on the gross domestic product (GDP) and the labour market.

As the authors state (Sakshaug et al., 2020): “The COVID-19 pandemic and associated government lockdown restrictions have fuelled a high demand for survey data on how individuals and establishments are coping with the restrictions. However, the pandemic has

also dramatically affected surveys themselves, forcing research institutes to adapt their fieldwork operations to the uncertain and evolving conditions.”

The COVID-19 pandemic and subsequent lockdowns with various national measures have had a significant impact on labour mobility around the world. These changes in the labour market also lead to changes in labour relations (Reichelt et al., 2020).

Given the macroeconomic impact of the Covid-19 pandemic, it is also necessary to analyse the impact on the Industry 4.0 initiative. Industry 4.0 is gaining in relevance and importance due to the ongoing pandemic. Due to the lack of jobs in the labour market, shortages of workers due to quarantine reasons, uncertainty in demand, various restrictive measures of the government, etc., Industry 4.0 is gaining huge potential.

From the position of the global economy, the formation of Industry 4.0 is not only a tool for achieving strategic goals in international marketing and profit-making by certain states but a means for solving global human problems and achieving global economic progress and social well-being (Sozinova, 2019).

With Industry 4.0, the necessary substitution of labour by capital can occur. However, this substitution must be made in such a way that there is no further rise in unemployment (Hedvicakova, 2018; Hedvičáková & Král, 2019; Maresova et al., 2018; Svobodová & Hedvičáková, 2015).

According to Ragulina (2019), the management of the development of Industry 4.0 should be carried out in light of the progress made in shaping the knowledge economy. The offered priorities and the developed logical scheme of development management of Industry 4.0 in modern economic systems, depending on the progress in the formation of the knowledge economy, takes this peculiarity into account and enables its best use for the economic system.

Different countries approach the Industry 4.0 initiative differently and also support it in different financial amounts. The biggest difference in the formation of Industry 4.0 is between developing and developed countries. Compared to developed countries, where the process of forming Industry 4.0 was started earlier and focused on marketing and social results, developing countries face institutional (absence of state policy of forming Industry 4.0) and financial obstacles and seek economic goals (Bogoviz et al., 2019; Král & Hájek, 2018; Matějček & Marešová, 2020).

The current epoch we are just living is characterised by the development of advanced electronics and digital technologies. This is reflected by increasing productivity and dynamic economic growth in developed industrial countries (Kozubíková, 2016). How stated in Kucharčíková et al. (2015) the key role in this massive productivity increase belongs to human capital. In order for this to apply in the conditions of the knowledge society, new skills and competencies are also aimed at supporting innovation. It is innovations in production that accelerate the technological development of the industry.

From Kozubíková (2016) further follows that the labour market requires highly qualified individuals in these disrupted times. The workforce must be equipped with new skills and competencies. This is the only way to create the preconditions for increasing productivity and maintaining competitiveness. This underlines the need to build a quality education system.

2. Methodology

The COVID-19 pandemic has caused a global health crisis that has rapidly transformed the economy and its consequences are visible in a huge labour market (Lee et al., 2020). In this article, we will deal with the consequences of a pandemic on the labour market in the Czech Republic. Create an ongoing pandemic is the current assessment of the labour market and especially its further development is affected by a high degree of uncertainty. The prediction of further development is even more uncertain and therefore we will analyse the year 2019 and 2020 in particular.

To better illustrate the effects of the pandemic on the labour market, the individual regions of the Czech Republic were also analysed.

The aims of the paper are to capture the dynamic development of basic values observed in the labour market (employment, wage developments etc.) in the Czech Republic due to the Covid-19 pandemic.

For the purposes of the article, primarily primary sources were used. Information about the labour market in the Czech Republic was drawn mainly from the Czech Statistical Office and the Ministry of Labour and Social Affairs. Information on programs supporting entrepreneurs and employees was drawn primarily from the Ministry of Industry and Trade of the Czech Republic. Knowledge from scientific articles and professional conferences was also used in the preparation of the paper.

3. Results

The following figure 1 shows the development of the share of unemployed persons in the Czech Republic for the period 2005-2020. The figure shows that the share of unemployed persons was the highest in 2014 when it reached 7.70%. Since then, there has been a decline, which did not stop until 2019. In 2019, there was an excess of labour demand in the Czech Republic over labour supply. There was also an increase in average wages. In 2020, the share of the unemployed increased for the first time due to the onset of the Covid-19 pandemic. The share of the unemployed was 3.51% in 2020. This percentage is Despite the ongoing pandemic after the natural rate of unemployment.

The general unemployment rate was 3.1% in December 2020 in the Czech Republic. This is the lowest unemployment rate of all European Union countries. Despite rising slowly, the current level of unemployment is lower than the assigned level of unemployment. The graph shows that there was no significant increase in the number of unemployed due to the pandemic, and the Czech Republic maintains the lowest unemployment rate among EU countries. According to Eurostat, the unemployment rate in the Euro area is 8.3% and in the EU-27 the unemployment rate is 7.5% in December 2020 (see Figure 2).

Now we will focus in detail on the labour market in the Czech Republic in individual quarters from 2018-2020. Figure 3 shows that employment grew in 2018 and the Czech Republic amounted to economic growth. In 2019, there was already a slight decline and slowdown in economic growth before the Covid-19 pandemic began. The first restrictive measures related to Covid-19 were at the end of the first quarter of 2020 and manifested themselves mainly in the second quarter when it was the largest. The decrease in the number

of employees in thousands and the associated increase in the number of unemployed responded to this. During the summer months and the beginning of autumn, there was a slight recovery, but in the last quarter, there were again increased restrictive measures and rising unemployment.

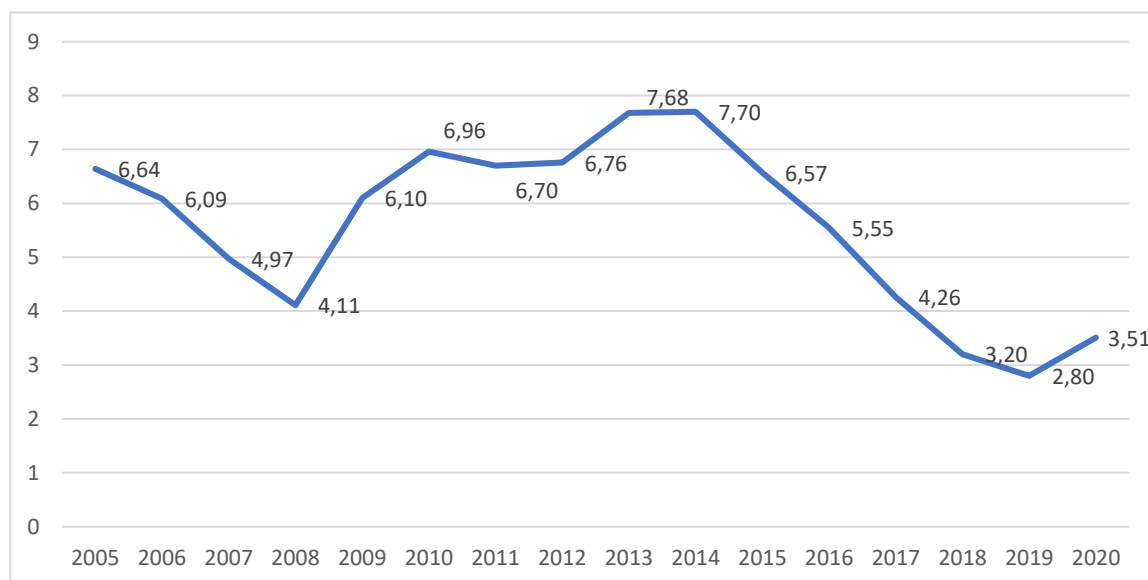


Figure 1. Share of unemployed persons as a percentage in the Czech Republic. Source: own processing based on (Český statistický úřad, 2021a)

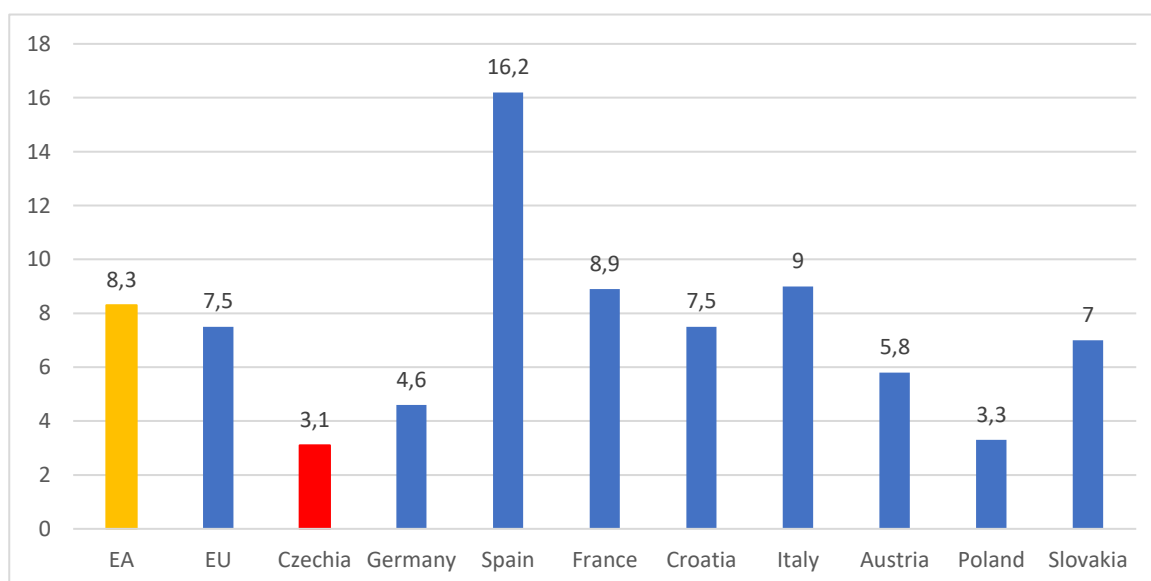


Figure 2. Seasonally adjusted unemployment in % in December 2020, totals. Source: own processing based on (Eurostat, 2021)

In the 3rd quarter of 2020, the average gross monthly nominal wage per recalculated number of employees in the national economy increased by 5.1% compared to the same period of the previous year, it increased by 1.7% in real terms. The nominal wage was CZK 35,402 (see Figure 4). The median wage was CZK 31,183 (Český statistický úřad, 2021b). Figure 3 shows that in the third quarter increased the number of employees and also the growth of nominal wages (see Figure 4).

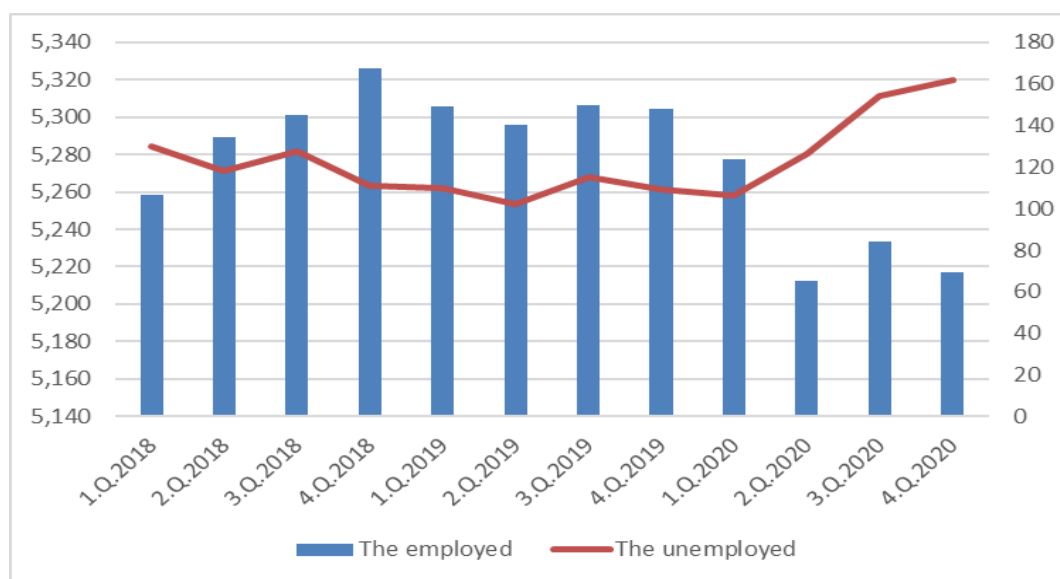


Figure 3. The employed and the unemployed in the Czech Republic. Source: own processing based on (Český statistický úřad, 2021)

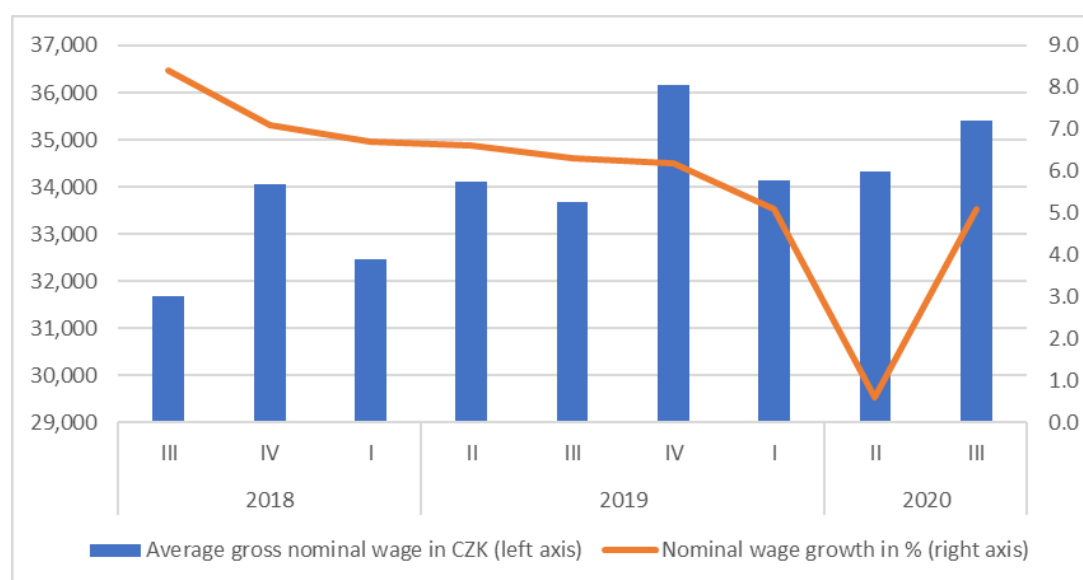


Figure 4. Average monthly wage – quarterly data (absolute numbers and year-on-year changes). Source: own processing based on (Český statistický úřad, 2021b)

3.1. Development of Employment and Unemployment in the Fourth Quarter of 2020 in the Czech Republic

Total employment decreased by 87.5 thousand year-on-year. Persons and reached 5,217.2 thousand persons in the 4th quarter of 2020. This is a decrease of 1.6%. According to the methodology of the International Labor Organization (ILO), the number of unemployed increased by 52.5 thousand people. There was an increase in the number of economically inactive by 49.8 thousand (Český statistický úřad, 2021).

The number of unemployed women increased more than the number of unemployed men (ratio of 55.5 thousand women compared to 32.0 thousand men). At the same time, the total number of entrepreneurs (self-employed) decreased by 1.3 thousand. The decrease in

the number of entrepreneurs with employees (employers) by 7.6 thousand is negative. It is positive that the number of entrepreneurs without employees increased by 6.3 thousand (Český statistický úřad, 2021).

According to the Czech Statistical Office (Český statistický úřad, 2021), which has been conducting a Labour Force Survey since April 2020 on issues related to the impact of the coronavirus crisis on the labour market. The results for the 4th quarter of 2020 show that the economic impact of unemployment on the household is considered by the vast majority of newly unemployed persons to be temporary and manageable. Compared to the 2nd quarter of the same year, 12.4% of respondents (by 4.4 pp less) experienced serious impacts and household insolvency, 34.0% of respondents (difficult by 7.1 pp) perceived heavy but manageable economic impacts, and 53.6% of respondents consider the temporary and manageable effects of a pandemic crisis (by 11.4 pp more).

Economic measures to support maintaining employment adopted by the Government of the Czech Republic during a pandemic Covid-19 (Vláda České republiky, 2020):

The Government of the Czech Republic has prepared a new package of programs to help affected segments and extended the validity of some measures that were already in force during the spring crisis:

- Tax relief
- Support for maintaining employment
- Support for innovative companies in connection with a pandemic
- Entrepreneurship support (culture, sports, bus, rent)
- Measures for employees

The Antivirus Employment Support Program, which is designed to help companies protect jobs and compensate employers for a significant portion of labour costs when their economic activity has been threatened by the spread of COVID-19, has been extended by a government decision. Antivirus A (now Antivirus Plus) until 31 December 2020, Antivirus B is still valid until 31 October 2020.

- **The Antivirus A (Plus) program** applies to companies for which there has been a forced restriction of operations on the basis of a government crisis measure or a regulation of hygiene quarantine (obstacles to work on the part of the employer or employee).
- Retroactively from 1 October, in the case of establishments that had to be completely closed, the state will pay employers 100 percent of the super-gross wage up to CZK 50,000 per employee.
- In the case of a quarantined employee, compensation remains at 80 percent per employee.
- **Antivirus B** applies to companies whose employees have had a barrier to work on the part of their employer due to economic difficulties related to the consequences of the spread of coronavirus.
- **The Antivirus C** program applies to companies with up to 50 employees and consists of the waiver of social security contributions for June, July, and August 2020, whereby the

employer must meet the conditions for maintaining employment and maintaining salaries and pay employee premiums on time.

- **The COVID 19 Technology Program** supports projects that are directly related to combating the further spread of coronavirus through the acquisition of new technological devices and equipment, (the subsidy can reach up to 20 million crowns; in total, at least 300 million crowns are available). It is a program supporting innovative companies in connection with a pandemic.

The most important measures for employees include the approval of a crisis nursing home and the extension of the validity of the certificate.

3.2. Changes in the Labour Market

The changes in the labour market will be based on research by ManpowerGroup (Hovorková, 2020):

- Managers should understand the needs of each employee to avoid unsubstantiated assumptions and subconscious prejudices when evaluating employee performance.
- The skills needed will be constantly changing. Therefore, companies should support employees in training and acquiring new skills, and support distance learning so that employees' knowledge corresponds to the ever-changing needs of the company.
- Teleworking is not the only way to provide employees with more work flexibility and better work-life balance. For positions where a presence in the workplace is required, companies can offer their employees the opportunity to determine the beginning and end of working hours and more flexible work planning.
- The Covid-19 pandemic evokes feelings of isolation, stress, fear and anxiety and also leads to reflection on the value of health, well-being, family. Emotional well-being should be given the same emphasis as physical or organizational measures.
- At a time when stress is increasing and the biggest fear of employees is that they will lose their jobs, it is important to have good guidance at a distance, clear communication, a culture that allows you to combine work at work and from home.
- There may be a reduction in working hours for which companies should already be preparing.
- Pay more attention to the Industry 4.0 concept and gain a competitive advantage from it.
- Due to the pandemic, flexible forms of work (especially teleworking and teleworking) will be increasingly promoted. This flexibility has its pitfalls, especially in the form of casualization of the workforce - in the Czech Republic has the flexibility often form very precarious temporary contracts, employment agreement, contract of employment or even Svarc system. (Sociologický ústav & Akademie věd ČR, v.v.i., 2021)
- The concept of Industry 4.0 and the related substitution of labour by capital will be further promoted. Companies that invest in new technologies and automated robotic lines will gain a competitive advantage.
- The labour market will change due to the Industry 4.0 concept. Some jobs will disappear, but others will be created.

- Due to the Industry 4.0 concept, the average wage will increase as the demands on a skilled workforce increase.
- There will be an emphasis on lifelong learning for workers.
- By substituting labour for capital, the unemployment rate may rise.
- Demands for the growth of leisure time will increase. Even due to the concept of Industry 4.0, working hours can be reduced.
- Differences in unemployment rates between men and women may widen. Gender differences in the average wage may also persist.

4. Discussion

COVID-19 and blocking measures can affect gender inequality in the employment of women. A pandemic may not only be reflected in current changes in the labor market, but also in a change in gender roles in households as a result of changes in the division of labor, as Reichelt et al. (2020) point out. The question for discussion is whether the differences in employment and the average wage for individual sexes will deepen further. Women are currently disadvantaged, for example, by caring for children who have online tuition and, according to the Statistical Office of the Czech Republic, women are more in nursing care. This means lower incomes and a higher probability of losing a job.

Although the coronavirus (COVID-19) pandemic appears to disproportionately affect those in informal employment, they often receive less government support than the formally employed. This has short-term and long-term economic implications. The COVID-19 pandemic can accelerate current trends and force new solutions to better protect basic occupational safety while helping companies remain competitive. Of particular importance are government policies that promote job security, income security, steps to formalize employment, and justice for informal employees (Webb et al., 2020).

5. Conclusions

In advance, the impact of a pandemic on both labour supply and demand will be large, and an appropriate labour market policy can help revitalize the team by adapting quickly and effectively to the changing labour market (Lemieux et al., 2020).

The average number of hours worked per week decreased by 3.6 hours year-on-year to 31.6 hours in the Czech Republic due to Covid-19 (Český statistický úřad, 2021).

The current situation can contribute to greater availability of flexible forms of employment, especially teleworking, the often-mentioned home-office and the digitization of work. The fact that companies and organizations are currently being pushed to provide adequate technical equipment and to put in place internal policies that allow for more flexible forms of work, including more frequent work from home, could facilitate the combination of care and work in the future and thus have a positive impact on the situation of employed women, who combine work and care more often than men (Sociologický ústav & Akademie věd ČR, v.v.i., 2021).

The concept of Industry 4.0, which is focused on robotics and production automation, is now gaining in importance. By using new automated robotic lines and ICT, companies can

achieve higher productivity and efficiency. In the long run, they can achieve economic growth and a higher market share. Štěpán Jurajda from CERGE-EI (Svaz průmyslu a dopravy České republiky, 2020) stated that: “Long-term research, for example from Germany, shows us that companies that implement Industry 4.0 do not lay off their employees. But on the contrary, companies that do not introduce these technologies are gradually losing their position in the market and losing employees. “The analysis also showed that employees in companies that have invested in robotics, automation, or use artificial intelligence make more money than people in companies where they use these technologies in less or not at all.

The further development of employment and the average wage will be based on the further development of the Covid-19 pandemic. At this time, it is not possible to predict further developments. It will also be important how the end of the state employment support program Antivirus, which has not lost thousands of jobs, will affect the labour market.

Acknowledgments: „The work was supported by the internal project “SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept”, 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic“. The authors thank Martin Král for help with preparing this paper.

References

- Bogoviz, A. V., Osipov, V. S., Chistyakova, M. K., & Borisov, M. Y. (2019). Comparative Analysis of Formation of Industry 4.0 in Developed and Developing Countries. In E. G. Popkova, Y. V. Ragulina, & A. V. Bogoviz (Eds.), *Industry 4.0: Industrial Revolution of the 21st Century* (Vol. 169, pp. 155–164). Springer International Publishing. https://doi.org/10.1007/978-3-319-94310-7_15
- Český statistický úřad. (2021a). *Hlavní makroekonomické ukazatele*. https://www.czso.cz/csu/czso/hmu_cr
- Český statistický úřad. (2021b). *Průměrné mzdy — 3. Čtvrtletí 2020*. <https://www.czso.cz/csu/czso/cri/prumerne-mzdy-3-ctvrtleti-2020>
- Český statistický úřad. (2021). *Zaměstnanost a nezaměstnanost podle výsledků VŠPS - 4. Čtvrtletí 2020*. <https://www.czso.cz/csu/czso/cri/zamestnanost-a-nezamestnanost-podle-vysledku-vsps-4-ctvrtleti-2020>
- Eurostat. (2021). *Unemployment statistics*. https://ec.europa.eu/eurostat/statistics-explained/index.php/Unemployment_statistics
- Hedvicakova, M. (2018). Unemployment and effects of the first work experience of university graduates on their idea of a job. *Applied Economics*, 50(31), 3357–3363. <https://doi.org/10.1080/00036846.2017.1420895>
- Hedvičáková, M., & Král, M. (2019). Benefits of KPIs for Industry Sector Evaluation: The Case Study from the Czech Republic. *E&M Ekonomie a Management*, 22(2), 97–113. <https://doi.org/10.15240/tul/001/2019-2-007>
- Hovorková, K. (2020). *Lidé chtějí po pandemii pracovat jinak. To tu od války nebylo, říká personalistka*. ManpowerGroup. https://zpravy.aktualne.cz/finance/lide-chteji-po-pandemii-pracovat-jinak-to-tu-od-valky-nebylo-r~ddefd520f2a311ea8972ac1f6b220ee8/?utm_source=www.seznam.cz&utm_medium=sekce-z-internetu#dop_source_zone_name=hpfeed.sznhp.lptag&dop_ab_variant=null
- Kozubíková, Z. (2016, September). The 4th industrial revolution: A challenge for the education system. In *International Conference on Informatization of Economic and Management Processes*.
- Král, M., & Hájek, L. (2018). Analysis of Parliamentary Elections Costs in the Czech Republic. In P. Maresova, P. Jedlicka, & I. Soukal (Eds.), *Hradec Economic Days* (pp. 472–481). <https://doi.org/10.36689/uhk/hed/2018-01-046>
- Kucharčíková, A., Tokarčíková, E., & Ďurišová, M. (2015). Human capital efficiency in trading company. In *The 9th International Days of Statistics and Economics. Conference Proceedings, 2015* (pp. 892–901). https://msed.vse.cz/msed_2015/sbornik/front.html
- Lee, S., Schmidt-Klau, D., & Verick, S. (2020). The Labour Market Impacts of the COVID-19: A Global Perspective. *The Indian Journal of Labour Economics*, 63(S1), 11–15. <https://doi.org/10.1007/s41027-020-00249-y>
- Lemieux, T., Milligan, K., Schirle, T., & Skuterud, M. (2020). Initial Impacts of the COVID-19 Pandemic on the Canadian Labour Market. *Canadian Public Policy*, 46(s1), S55–S65. <https://doi.org/10.3138/cpp.2020-049>
- Maresova, P., Soukal, I., Svobodova, L., Hedvicakova, M., Javanmardi, E., Selamat, A., & Krejcar, O. (2018). Consequences of Industry 4.0 in Business and Economics. *Economies*, 6(3), 46. <https://doi.org/10.3390/economies6030046>

- Matějček, M., & Marešová, P. (2020). Open Business Model and Open Innovation: Bibliographic Analysis. In P. Maresova, P. Jedlicka, K. Firlej, & I. Soukal (Eds.), *Hradec Economic Days* (pp. 515–526). <https://doi.org/10.36689/uhk/hed/2020-01-059>
- Ragulina, Y. V. (2019). Priorities of Development of Industry 4.0 in Modern Economic Systems with Different Progress in Formation of Knowledge Economy. In E. G. Popkova, Y. V. Ragulina, & A. V. Bogoviz (Eds.), *Industry 4.0: Industrial Revolution of the 21st Century* (Vol. 169, pp. 167–174). Springer International Publishing. https://doi.org/10.1007/978-3-319-94310-7_16
- Reichelt, M., Makovi, K., & Sargsyan, A. (2020). The impact of COVID-19 on gender inequality in the labor market and gender-role attitudes. *European Societies*, 1–18. <https://doi.org/10.1080/14616696.2020.1823010>
- Sakshaug, J. W., Beste, J., Coban, M., Fendel, T., Haas, G.-C., Hülle, S., Kosyakova, Y., König, C., Kreuter, F., Küfner, B., Müller, B., Osiander, C., Schwanhäuser, S., Stephan, G., Vallizadeh, E., Volkert, M., Wenzig, C., Westermeier, C., Zabel, C., & Zins, S. (2020). Impacts of the COVID-19 Pandemic on Labor Market Surveys at the German Institute for Employment Research. *Survey Research Methods*, 229–233. <https://doi.org/10.18148/SRM/2020.V14I2.7743>
- Sociologický ústav & Akademie věd ČR, v.v.i. (2021). *Dopady opatření proti pandemii na ženy a muže na trhu práce*. <https://www.soc.cas.cz/aktualita/dopady-opatreni-proti-pandemii-na-zeny-muze-na-trhu-prace>
- Sozinova, A. A. (2019). Causal Connections of Formation of Industry 4.0 from the Positions of the Global Economy. In E. G. Popkova, Y. V. Ragulina, & A. V. Bogoviz (Eds.), *Industry 4.0: Industrial Revolution of the 21st Century* (Vol. 169, pp. 131–143). Springer International Publishing. https://doi.org/10.1007/978-3-319-94310-7_13
- Svaz průmyslu a dopravy České republiky. (2020). *Trendy na trhu práce: Průmysl 4.0 zvýší produktivitu i mzdy*. <https://www.spcr.cz/projekty/probihajici-projekty/14170-trendy-na-trhu-prace-prumysl-4-0-zvysi-produktivitu-i-mzdy>
- Svobodová, L., & Hedvičáková, M. (2015). Doing Business in the Countries of Visegrad Group. *Procedia Economics and Finance*, 34, 453–460. [https://doi.org/10.1016/S2212-5671\(15\)01654-8](https://doi.org/10.1016/S2212-5671(15)01654-8)
- van Barneveld, K., Quinlan, M., Kriesler, P., Junor, A., Baum, F., Chowdhury, A., Junankar, P. (Raja), Clibborn, S., Flanagan, F., Wright, C. F., Friel, S., Halevi, J., & Rainnie, A. (2020). The COVID-19 pandemic: Lessons on building more equal and sustainable societies. *The Economic and Labour Relations Review*, 31(2), 133–157. <https://doi.org/10.1177/1035304620927107>
- Vláda České republiky. (2020). *Podpora a úlevy pro podnikatele a zaměstnance*. <https://www.vlada.cz/cz/media-centrum/aktualne/podpora-a-ulevy-pro-podnikatele-a-zamestnance-180601/>
- Webb, A., McQuaid, R., & Rand, S. (2020). Employment in the informal economy: Implications of the COVID-19 pandemic. *International Journal of Sociology and Social Policy*, 40(9/10), 1005–1019. <https://doi.org/10.1108/IJSSP-08-2020-0371>

Analysis of the Mortgage Market in the Czech Republic

Martina HEDVIČÁKOVÁ¹ and Alena POZDÍLKOVÁ²

¹ University of Hradec Králové, Hradec Králové, Czech Republic; martina.hedvicakova@uhk.cz

² University of Pardubice, Pardubice, Czech Republic; alena.pozdilkova@upce.cz

* Corresponding author: martina.hedvicakova@uhk.cz

Abstract: During the beginning of 2020, the coronavirus pandemic spread worldwide. Governments have responded with tough restrictive measures. The Czech National Bank decided to support the economy and reduced the 2W repo rate twice during March 2020 and for the third time in May 2020 to the current 0.25%. In addition to low interest rates from the CNB, there is very high competition in the mortgage market, which reduces the average interest rate on mortgage loans. Mortgage loans are thus more affordable. The aim of the article is to analyze the current situation on the mortgage market and predict their further development. Using correlation analysis will be shown, that trends of interest rate and number of mortgage loans and their volume are not similar. This will be illustrated by graph, which will show decreasing trend of interest rate and increasing rate of number and volume of mortgages. Using significance test of correlation co-efficient will be verified, that even the trends in absolute values are not similar.

Keywords: mortgage market; loan; interest rate; correlation analysis

JEL Classification: E43; G21

1. Introduction

A coronavirus pandemic has hit the world. In addition to the health of the population, this pandemic also affected the economies of the affected countries. The individual countries have taken restrictive measures to spread the virus, but these measures have had a severe impact on state budget expenditures. Governments are trying to stimulate the economy. Within the monetary economy, central banks are trying to support the economy with declining interest rates. Falling interest rates should stimulate the economy and make loans cheaper. This article focuses on the analysis of the mortgage market, which will also be affected by the crisis. Banks have learned from the previous financial and subsequent economic crisis and are working to eliminate risks. One way to minimize risks is to set a minimum amount of LTV, which the CNB regulates the mortgage market. Kinghan et al. (2019) find that LTVs fell by approximately 1.4 percentage points after the measures, with larger reductions recorded for high income borrowers.

Tse (1997) shows that under conditions of uncertainty when default risk is present, and if absolute risk aversion is increasing in wealth, a rise in wealth of the bank will lower the amount of asset to be allocated in risky loans even if credit can be properly priced. Chambers et al. (2009) find that the loan structure is a quantitatively significant factor in a household's

housing finance decision. The model suggests that the mortgage structure preferred by a household is dependent on age and income and that loan products with low initial payments offer an alternative to mortgages with no down payment. These effects are more important when inflation is low. The presence of inflation reduces the real value of the mortgage payment and the outstanding loan over time reducing mobility.

Kokas et al. (2020) find that the higher their market power the lower is the growth rate of lending relative to deposits. As a result, in periods of falling deposits higher market power for the average bank is associated with a greater fall in lending, consistent with amplification of adverse effects during relatively bad times. Kim (2015) analyze how mortgage loan modification policies, after a sudden drop in house prices, affect household choices in the mortgage and unsecured loan markets.

Mortgage loans can also be used to finance business activities or as collateral for households. A standard New Keynesian model is extended to include a rich financial system in which financially constrained banks lend to firms and homeowners via default long-term loans. The model generates two endogenous components of interest rate spreads on mortgages and corporate loans: i) a default premium and ii) a liquidity premium (Ferrante, 2019).

2. Methodology and the Aim of the Paper

Interest rate data (2W repo rate) are from the Czech national bank. Data on interest rates on mortgage loans are from the Hypoindex. In the article they are presented as average interest rates in percentage for mortgage loans.

Mortgage loans have been a type of consumer loan since 1 December 2016. According to Act No. 257/2016 Coll., There is a new "consumer loan for housing", which significantly improves the position of consumers and regulates the business environment in this area. In this article, these loans will be referred to as mortgage loans or mortgages.

The aim of correlation analysis is to determine the strength of linear dependence between quantities. Then a zero correlation coefficient means that the quantities are independent. If the assumption of two-dimensional normality is not satisfied, the zero value of the correlation coefficient cannot be inferred more than that the quantities are uncorrelated. The closer the relationship between the two variables, the closer the absolute value of the correlation coefficient is to one. Negative correlation coefficients express indirect correlation (with increasing values of one variable the values of the other variable decrease). (Hedvicakova & Pozdílková, 2018; Pozdílková & Hedvičáková, 2017; Svobodova & Hedvicakova, 2018)

Significance of correlation coefficient can be verified using significance test of the correlation coefficient. The test statistic is $T = r \sqrt{\frac{n-2}{1-r^2}}$, if $|T| \geq t_{n-2,0.975}$, time series are similar in character over a given time period (Draessler et al., 2011; Hedvicakova et al., 2020; Hedvičáková & Pozdílková, 2018; Král, 2017).

The aim of this contribution is to analyze the current situation on the mortgage market and predict its further development with regard to the current economic situation in connection with the coronavirus pandemic. Based on the development of the 2W interest rate,

which the Czech National Bank is trying to revive the economy, the effects on mortgage loans will be analyzed and the development of the average interest rate on these loans will be predicted. The authors will also be based on the past crisis, when the Czech National Bank tried to stimulate the economy through a fall in interest rates.

Using correlation analysis will be shown trends of interest rate, number of mortgage loans and their volume. This analysis will be done for the period January 2019 to March 2020.

3. Current Situation in the Mortgage Market

The current average interest rate according to the Hypoindex for March 2020 is 2.44% for mortgage loans. Since January 2020, the average interest rate has been rising very slowly. The coronavirus pandemic has not yet reached the mortgage market. The volumes of provided mortgages increased again after a weak beginning of 2020 and also almost attacked the volumes from the strong year 2018. On the contrary, the average amount of provided mortgage loan stopped after seven months and its value decreased slightly to the current 2,546,560 CZK.

Mortgage volumes rose again in December 2020. In December, banks arranged mortgage loans worth more than 29.5 billion crowns. The average mortgage amount approached the limit of three million Czech crowns. According to the Fincentrum Hypoindex indicator, the average mortgage interest rate fell again to 1.96%. This average interest rate on mortgage loans has been falling for nine months in a row. However, its decline is slowing down. While in May and June 2020 the average rate fell by another nine basis points, in December it was only two basis points (Hypoindex.cz, 2021b).

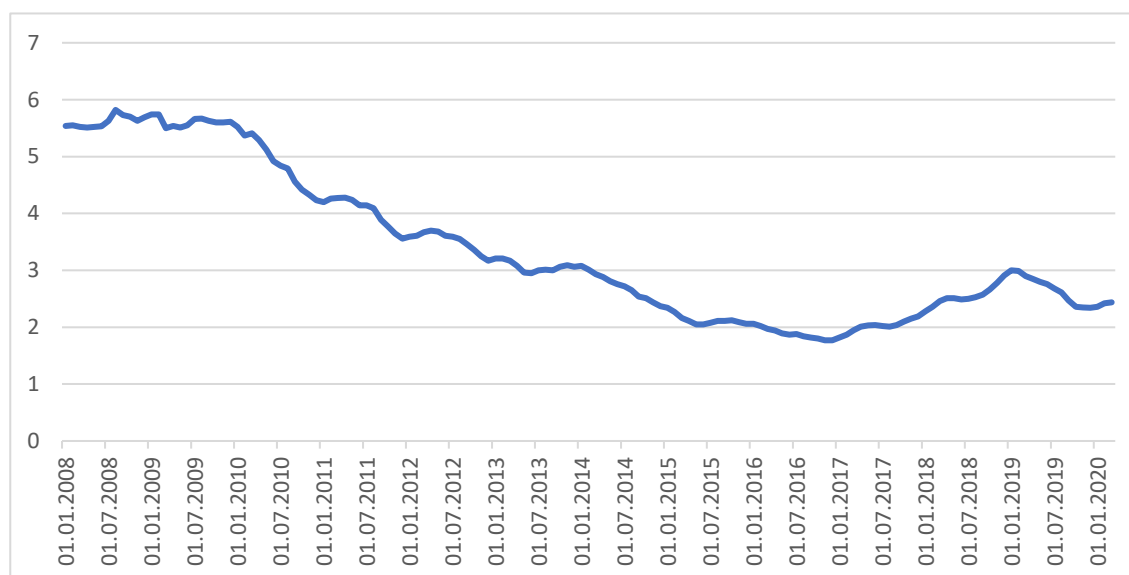


Figure 1. Interest rate in %, source own processing using (Hypoindex.cz, 2021a)

The growing level of the average mortgage shows that the growth of real estate prices has not slowed much yet, despite the coronavirus crisis. Growth in property prices could slow down and stabilize in 2021 (Hypoindex.cz, 2021b).

On February 7, 2020, the Czech National Bank (CNB) first increased the 2W repo rate by 0.25% to 2.25%. In the following month of March, due to the coronavirus pandemic, the CNB reduced the 2W repo rate on March 17, 2020 to 1.75% and twenty days later to another 0.75% to 1%. Due to the measures of the Czech government, the CNB responded on 11 May 2020 by further reducing the interest rate to the current 0.25%.

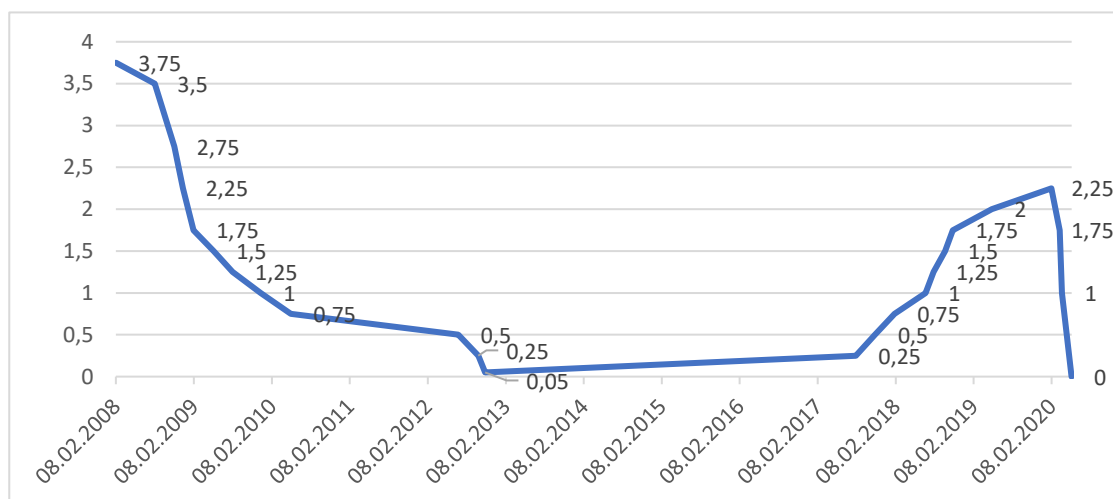


Figure 2. 2W Repo rate in %, source own processing using (Česká národní banka, 2021)

Banks respond to the current market situation, where the economy is going into recession due to coronavirus, mainly by lowering LTV limits and lending less money to clients in relation to the mortgage value of real estate. The central bank relaxed credit limits for new mortgages. With effect from 1 April 2020, the Czech National Bank increased the LTV limit from 80 to 90 percent, with the exception of investment mortgages, the DSTI limit (the ratio of total debt to the net monthly income of the loan applicant) increased from 45 to 50 percent and the DTI limit (ratio of the amount of debt to the net income of the loan applicant) has been canceled. But banks prefer security and try to minimize risks (Hypindex.cz, 2021a).

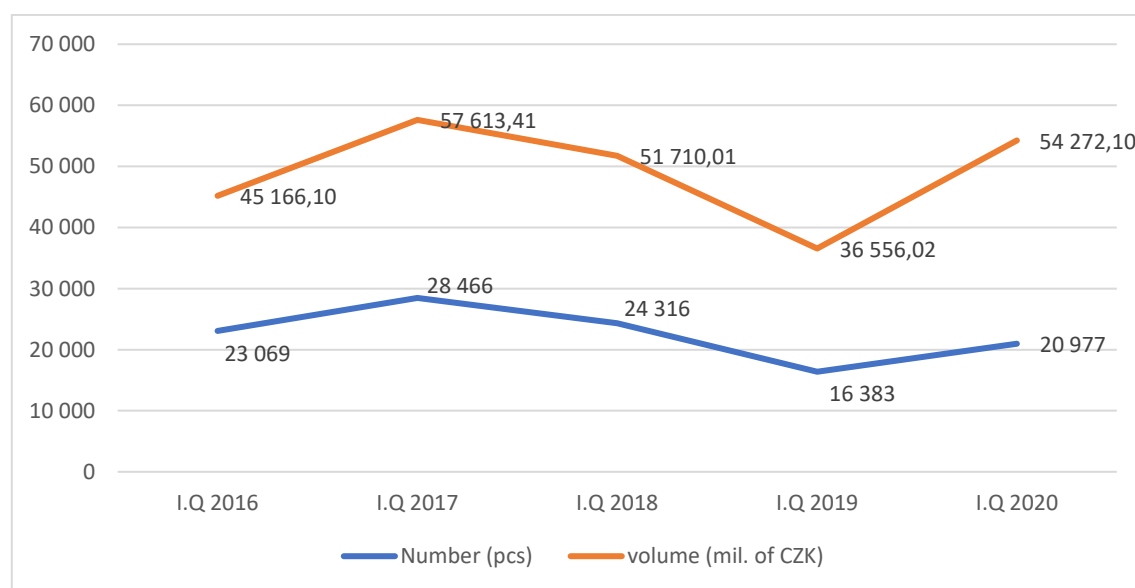


Figure 3. Development of the volume and number of mortgage loans in the first quarter of 2016–2020, source own processing using (Hypindex.cz, 2021b)

3.1. Correlation Analysis

In this article correlation coefficients between interest rate and number of mortgages, respectively volume of mortgages will be calculated. Their significance will be verified using significance test of the correlation coefficient, where the test statistic (Hedvicakova, 2017; Hedvicakova et al., 2020; Hedvičáková & Pozdílková, 2018)

$$T = r \sqrt{\frac{n-2}{1-r^2}} \quad (1)$$

If $|T| \geq t_{15-2,0.975} = t_{13,0.975} = 2.16$, series have a similar trend.

From the given relation we will calculate correlation coefficient r :

$$\begin{aligned} 2.16 &\leq r \sqrt{\frac{15-2}{1-r^2}} \\ (2.16)^2 &\leq \frac{r^2}{\sqrt{1-r^2}} \sqrt{13} \\ \frac{r^2}{\sqrt{1-r^2}} &\geq \frac{(2.16)^2}{\sqrt{13}} \\ \frac{r^2}{\sqrt{1-r^2}} &\geq 1.2940 \\ |r| &\geq 0.8391 \end{aligned} \quad (2)$$

Correlation coefficient for interest rate and number of mortgages is -0.668, so the equation (2) is not fulfilled and these two times series do not have similar trend.

Correlation coefficient for interest rate and volume of mortgages is -0.8238, so the equation (2) is not fulfilled and these two times series do not have similar trend, but the difference between the two values is very small here.

The negative sign of the correlation coefficient indicates a decreasing trend of one variable and an in-creasing trend of the other variable, as can also be seen in the following graph.

In this graph, the variables number of mortgages and the total volume of mortgages are described on the main axis on the left, and the variable interest rate is described on the minor axis on the right. This is necessary due to the very different scale of the individual variables.

5. Conclusions and Discussion

Although the Czech National Bank cut key interest rates twice in March and lowered the 2W repo rate again to 0.25% in May 2020, the current mortgage market has not changed significantly. Large commercial banks are still waiting, and interest rates have been rising slowly until March 2020. Banks expect a higher risk margin, mainly due to the moratorium

on loan repayments. Tse (1997) shows that loan loss expectation plays an important role in determining credit rationing. On the other hand, there is a lot of competition in the mortgage market, which significantly affects the interest rate. In particular, newly established banks or "low-cost" banks are trying to gain a foothold in the mortgage market.

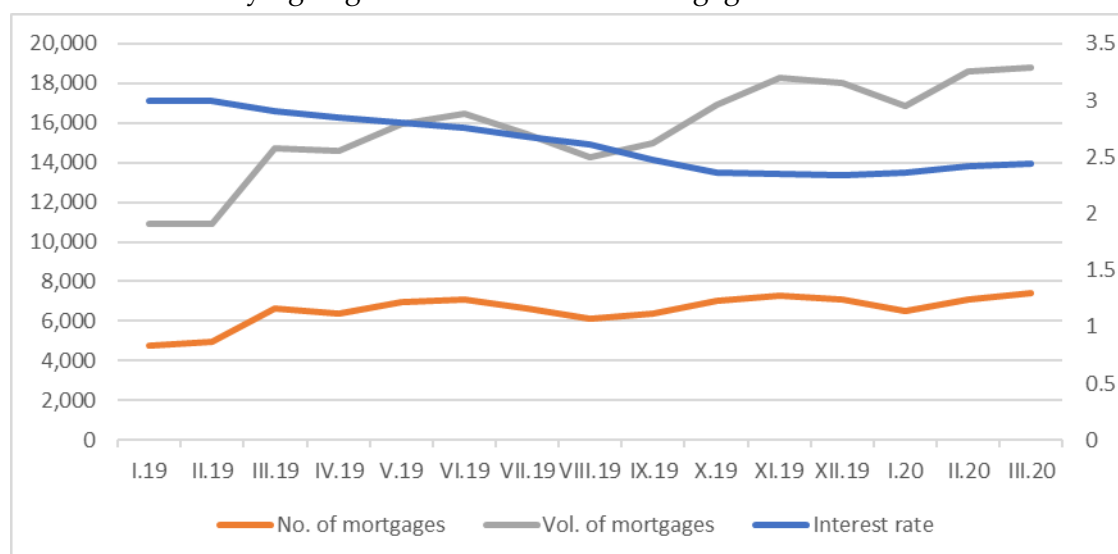


Figure 4. Development of the volume, number of mortgage loans and interest rate, source own processing using (Hypoindex.cz, 2020)

The government bill of April 2020 abolishes the real estate acquisition tax of 4%, with retroactive effect. The tax will no longer be paid by anyone who acquired the property in December 2019 at the latest. The proposal further regulates the extension of the time test for income from the sale of real estate not intended for own living from 5 to 10 years. The extension of the time test will be effective for real estate acquired after 1 January 2021. The aim of the measure is to reduce the space for speculators in the real estate market.

The second change concerns the abolition of the possibility to claim interest deductions from newly concluded housing loan agreements as a non-taxable part of the tax base. Interest deductions will still be available to any buyer who acquires the property in December 2021 at the latest. This means that for properties acquired between December 2019 and December 2021, the buyer will not pay the acquisition tax and will be allowed to claim deductions. interest on a housing loan from the tax base. The aim of the measure is to encourage the real estate market negatively affected by the coronavirus crisis and to support the availability of one's own housing (Žurovec, 2020).

Correlation analysis showed, that trends of interest rate and number of mortgage loans and their volume are not similar. This is illustrated by graph, which shows decreasing trend of interest rate and increasing rate of number and volume of mortgages. Using significance test of correlation coefficient was verified, that even the trends in absolute values are not similar.

The question for discussion is how the real estate market and the mortgage market will develop further. Due to the ongoing pandemic, a state budget deficit of CZK 300 billion is currently planned. If we compare the current situation with 2008, when the last financial and later economic crisis in the Czech Republic began, there has been a fall in real estate prices

and a subsequent significant rise in real estate prices since 2013, when the economy expanded and GDP grew. In addition, at a time of economic crisis, unemployment is rising and thus the purchasing power of the population is declining. However, external factors are at work here and this situation has not yet been sufficiently analyzed and only time will tell what effects the current pandemic will have on the real estate market and mortgage loans.

Due to the fact that the Czech National Bank cut interest rates twice during March and for the third time in May, many consumers expect that the interest rate on mortgage loans will fall. Some analysts even predict a reduction in the interest rate on mortgages to the values of 2016 and 2017, when interest rates reached their minimum. Given the current situation, where banks are still waiting for government action on coronavirus, it can be predicted that banks in this uncertainty will wait for interest rate cuts and it can be assumed that this risk will be reflected in i.e. Risk margin, which is part of the interest rate. Due to the pandemic, most economists expect the economy to enter a recession. This recession will have a major impact on the banking market. The market is expected to fall in GDP, rise in unemployment and the related loss or inability to pay its liabilities. Some affected consumers may have problems repaying loans, etc. Banks are preparing for this situation and a possible solution is to reduce LTV (effective from 1 April 2020, the central bank increased the LTV limit from 80 to 90 percent, except for investment mortgages), limit DSTI (ratio of total debt and net monthly in-come of the loan applicant) increased from 45 to 50 percent and the limit of DTI indicator (ratio of debt and net income of the loan applicant) was abolished, banks tightened mortgage conditions for foreign income for commuters, stricter Clients working in the sector most affected by the coronavirus crisis (hospitality, tourism, transport), as well as clients who have only employment agreements or agency income, etc., also have conditions. At the same time, the conditions for refinancing mortgage loans are being tightened.

In April 2020, a new law on the credit moratorium from the workshop of the Ministry of Finance will allow bank clients to postpone the repayment of loans and mortgages to any bank and non-bank provider for up to half a year (Ministerstvo financí České republiky, 2020). The postponement of repayments represents a higher administrative burden for banks and the associated higher costs that will have an impact on the economic result.

At the beginning of 2020, an increase in the average interest rate on mortgages was predicted due to risks, and a decrease in the average amount of a mortgage loan was expected, as well as the number of newly concluded mortgages. The amount and number of new mortgage loans is also affected by the real estate market and the development of individual real estate prices. Due to the expected economic recession, it was predicted that real estate sales would most likely stagnate and real estate demand would decline. For this reason, there could also be a decline in interest in new mortgages. However, this interest will also be affected by a possible decline in property prices, which were very high before the pandemic.

As expected, the Czech National Bank (CNB) left rates unchanged at its December meeting. The price of resources on the interbank market has been rising for several months, but banks are currently holding back competition in raising rates.

Although the average mortgage interest rate fell to 1.96% in December 2020, according to the Fincentrum Hypoindex (Hypoindex.cz, 2021b), banks' current mortgage rates have almost froze.

The last indicator is the Interest rate swap (IRS), for which the value decreased significantly during March. The question for discussion is how interest rates will react to this in the current conditions.

Acknowledgments: The work was supported by the internal project “SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept”, 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic. In addition, the authors thank Martin Král for her help with the project.

The paper is also supported by institutional support of University Pardubice.

References

- Česká národní banka. (2021). *Měnověpolitické nástroje*. <https://www.cnb.cz/cs/menova-politika/mp-nastroje/>
- Chambers, M. S., Garriga, C., & Schlagenhauf, D. (2009). The loan structure and housing tenure decisions in an equilibrium model of mortgage choice. *Review of Economic Dynamics*, 12(3), 444–468. <https://doi.org/10.1016/j.red.2009.01.003>
- Draessler, J., Soukal, I., & Hedvičáková, M. (2011). Cluster analysis of the demand side of the retail core banking services market. *E&M Ekonomie a Management*, (4), 102–114.
- Ferrante, F. (2019). Risky lending, bank leverage and unconventional monetary policy. *Journal of Monetary Economics*, 101, 100–127. <https://doi.org/10.1016/j.jmoneco.2018.07.014>
- Hedvicakova, M. (2017). Key study of bank accounts for young people with using multi-criteria optimization and fuzzy analysis. *Applied Economics*, 49(36), 3599–3610. <https://doi.org/10.1080/00036846.2016.1265073>
- Hedvičáková, M., & Pozdílková, A. (2018). Analytical and Statistical Research of State and Households Health Care Expenditures in the Czech Republic. In *Hradec Economic Days, 2018* (Vol. 8, pp. 311–318).
- Hedvicakova, M., & Pozdílková, A. (2018). The Development of Mortgage Loans with Using Regression Analysis. *Journal of Engineering and Applied Sciences*, 13, 7003–7007. <https://doi.org/10.36478/jeasci.2018.7003.7007>
- Hedvicakova, M., Pozdilkova, A., & Piwowar, A. (2020). Analysis of the Health Spending and GDP in the Visegrad Group and in the Germany. In P. Maresova, P. Jedlicka, K. Firlej, & I. Soukal (Eds.), *Hradec Economic Days* (Vol. 10, pp. 235–243). <https://doi.org/10.36689/uhr/hed/2020-01-026>
- Hypoindex.cz. (2020). *Fincentrum Hypoindex březen 2020: Pandemie zatím hypoteční trh neovlivnila*. <https://www.hypoindex.cz/clanky/fincentrum-hypoindex-brezen-2020-pandemie-srazil-hypotecni-trh-o-cvrtinu/>
- Hypoindex.cz. (2021a). *Fincentrum Hypoindex – vývoj*. <https://www.hypoindex.cz/hypoindex-vyvoj/>
- Hypoindex.cz. (2021b). *Fincentrum Hypoindex prosinec 2020: Sazby překvapivě dál klesají, objemy lámou rekordy*. <https://www.hypoindex.cz/clanky/fincentrum-hypoindex-prosinec-2020-sazby-prekvapive-dal-klesaji-objemy-lamou-rekordy/>
- Kim, J. (2015). Household's optimal mortgage and unsecured loan default decision. *Journal of Macroeconomics*, 45, 222–244. <https://doi.org/10.1016/j.jmacro.2015.05.002>
- Kinghan, C., McCarthy, Y., & O'Toole, C. (2019). How do macroprudential loan-to-value restrictions impact first time home buyers? A quasi-experimental approach. *Journal of Banking & Finance*, 105678. <https://doi.org/10.1016/j.jbankfin.2019.105678>
- Kokas, S., Vinogradov, D., & Zachariadis, M. (2020). Which banks smooth and at what price? *Journal of Corporate Finance*, 65, 101509. <https://doi.org/10.1016/j.jcorpfin.2019.101509>
- Král, M. (2017). Modelling of Savings in Decentralised Cash Processing Costs in the Czech Republic. In *Hradec Economic Days 2017* (pp. 478–485).
- Ministerstvo financí České republiky. (2020). *PŘEHLEDNĚ: Odklad splátek úvěrů a hypoték kvůli koronaviru*. <https://www.mfcr.cz/cs/o-ministerstvu/sluzby-verejnosti/komunikace-s-verejnosti/casto-kladene-otazky/uverove-moratorium-38130>
- Pozdílková, A., & Hedvičáková, M. (2017). Regression Analysis of Mortgage Loans on the Czech Banking Market. In *Liberec Economic Forum 2017 : Proceedings of the 13th International Conference* (pp. 19–27).
- Svobodova, L., & Hedvicakova, M. (2018). Mortgage Loans as a Way of Financing Business Activities. *Journal of Engineering and Applied Sciences*, 2018(13), 457–462. <https://doi.org/10.36478/jeasci.2018.457.462>

- Tse, R. Y. C. (1997). Optimal loan size and mortgage rationing. *Journal of Property Finance*, 8(3), 195–206.
<https://doi.org/10.1108/09588689710175024>
- Žurovec, M. (2020). *Daň z nabytí nemovitých věcí zrušena se zpětným účinkem k prosinci 2019*. Ministerstvo financí České republiky. <https://www.mfcr.cz/cs/aktualne/tiskove-zpravy/2020/zruseni-dane-z-nabyti-nemovitych-veci-se-38157>

Suitability of Machine Learning Methods for Prediction of Popularity on Social Media in Comparison of Different Data Sets

Jan HRUŠKA

University of Hradec Králové, Hradec Králové, Czech Republic, hruskja3@uhk.cz

Abstract: The growing popularity of various social media and the use of neural networks in recent years has brought predicting opportunities in various sectors. Social networks, in conjunction with neural networks, are often used in healthcare (prediction of whether a disease occurs or symptoms return) or business (what will be the profit or error rate of the products) and are playing an important economic and marketing change in the 21st century. The aim of the presented project is to contribute to a deeper understanding of which machine learning method to use for which data set in order to ensure the best possible prediction success across different industries. A total of 10 methods were used and the success of a total of 13 data files was tested with the help of specialized software for machine learning and the Python programming language. Of all the methods tested, the highest success rate on most datasets was with the Random Forrest method. The success rate ranged from 58.38% to 98.65%. Out of the total number of 13 datasets, the Random Forrest method was 5 times the best in accuracy.

Keywords: machine learning; prediction; efficiency

JEL Classification: C53

1. Introduction

The constant development of social media and interactive behavior among users often causes user-generated content to spread rapidly over the Internet. The popularity of social media and its content allows us to understand these activities, which have an impact on social, economic, and government activities. Modeling and predicting the popularity of online content is an important area of social media research and can have a positive impact in many ways on public administrations, organizations, businesses, and online security. For example, it can support crisis management by knowing the effects of natural disasters, terrorism, or crime (Chen et al., 2019). In business, this prediction can help analyze current trends, and concerns among users and provide valuable information for risk modeling and highlight potential benefits (Cerchiello et al., 2017).

However, the prediction is not a trivial task. The amount of content generated on the Internet and by users on social media is huge. Methods are also constantly evolving and often have many possible settings. For example, there are hundreds of millions of active users per month on Facebook and Twitter alone, and linking their relationships is a very complicated issue (Ballings et al., 2016; Moro et al., 2016). The data is also often not structured and there are

many informal expressions. Last but not least, there are many factors that affect the success of a prediction, such as the size of a data file, the number of variables, the correlation between variables, and so on. In the case of social media, also text content, user type and time of addition, length of the post, selected image or video, positive or negative attunement, appropriateness and length of the title, number of responses during the first few hours, and many other variables (Szabo & Huberman, 2008; Vazquez et al., 2014).

Popularity prediction studies primarily use property-based methods (Tsur & Rappoport, 2012; Weng et al., n.d.). These methods and models are highly dependent on choosing the right functions, which can be time-consuming and requires expertise. If inappropriate properties are selected, the model will be inaccurate and fragile. Initial studies focused on simple regression models, but some models in recent years using the popularity of stochastic modeling (Mishra et al., 2016). Quite often, however, these models use only time series prediction and ignore other valuable information to predict popularity.

The popularity of social media is increasing attention to online content in terms of the number of shares, tweets, views, or "likes." Popularity prediction is focused on predicting these variables using various properties, such as a text post, event, video, or image. Existing approaches in these prediction models fall into four categories: pure property prediction, time series analysis, cascade process analysis, and in-depth machine learning (Chen et al., 2019).

The prediction uses properties to extract variables such as surface variables (such as publication time, content length, title length, or number of images and links in a post), cumulative variables (number of articles published simultaneously), text properties (for example in the text), semantic properties (possibly selected locations, people or organizations and their current popularity) or physical characteristics (temperature, weather) (Bandari et al., 2012; KR et al., 2018).

There are several possible neural networks for machine learning or deep neural networks that can be used to predict popularity. But the basic neural network has become a repetitive neural network (RNN). Extension models for this basic neural network are LRCN (Long-term Recurrent Convolutional Networks) (Donahue et al., 2014), LSTM (Serban et al., 2015), and GRU (Gated Recurrent Unit) (Chung et al., 2014). However, neural networks assume changes monotonic for the entire sequence, and these factors can be more complex on social media, in addition to variables such as sharing time (business hours, evenings, weekends), and can be difficult to capture using classical repetitive neural networks (RNNs).

However, fewer studies pay attention to research focused on the implementation of predictive systems, which can be effectively used to predict the development of the paper before its publication. A system capable of predicting the impact of a published individual impact of a paper can provide a valuable advantage in deciding on communication through social media, in customizing the promotion of products and services. Based on the outcome of these predictive systems, advertising managers could make decisions. Data mining provides an interesting approach to extracting predictive knowledge from raw data. However, most studies focus on reactively evaluating what users say through a series of responses, posts, or tweets.

1.1 Benefits of Social Media Marketing

- Large audience – Facebook has more than 2.7 billion monthly active users. Twitter has more than 320 million monthly active users, Instagram more than 500 million, and this makes social media a great opportunity for creators around the world and across all industries.
- Free Creation - The beginning of creating any marketing strategy is free on all major social media. Of course, paid marketing tools guarantee that the number of potential customers will increase drastically, but marketing can be done completely free of charge.
- Encourages sharing - Perhaps the most unique benefit of social media is the ability to get help from their followers. People share things with their networks, from photos and recipes to interesting articles and hot deals. Unlike other forms of Internet marketing, such as sites and paid advertising, content on social media is often shared. Followers can share with their followers, who then share with their followers, giving a wider reach (at a lower cost) than a traditional marketing campaign (Ding et al., 2019).
- Stronger brand loyalty - In addition to increasing brand reach, social media can increase brand loyalty. A study by The Social Habit shows that 53% of Americans who follow certain brands on social networks are more likely to be loyal to those brands. Social media is more than a selling point (Svobodová & Hedvičáková, 2018). Instead, it facilitates two-way communication that allows you to build meaningful relationships with existing and potential customers. This makes them more confident in their decision to trust their business and encourages them to choose your brand in the future.

1.2. Disadvantages of Social Media Marketing

- Negative Feedback - The biggest disadvantage of social media marketing is that negative feedback can be devastating. Social media users can write whatever they want. A happy customer can leave perfect reviews, but unhappy customers can leave angry, hateful comments, and everyone on social media sees it.
- Embarrassment - With various marketing posts and campaigns, it's easy to make a mistake or just use a bad ambiguous word that can escalate with a large audience.
- Time consuming - Creating and maintaining an interactive marketing profile on most social media can take a long time and effort. If the social media team is small with limited resources, it can be difficult to maintain good results.

In recent years, a completely new marketing channel has opened up for marketing specialists. Companies now have a unique opportunity to respond very quickly and to some extent personally to customer opinions, questions or complaints about defective goods. Advertising through word of mouth (WoM) is extremely attractive for them. It is a free form of advertising, where customers tell others that they like a certain company, product or service. People have recommended products and services since ancient times and did not need the Internet or computers. In recent years, however, we have increasingly encountered electronic verbal transmission. If information is spread extremely quickly through personal transmission, one can even speak of viral marketing. This term was allegedly first used in

1996 in the business magazine Fast Company and got its name due to its similarity to the spread of various diseases. More specifically, it can be defined as "electronic word of mouth, in which a given form of marketing message concerning a company, brand or product is transmitted at an exponentially increasing rate, often via social media." (Ding et al., 2019).

2. Methodology

The aim of this work is to use analysis and testing to reveal which method is most suitable for prediction on the data obtained by the programmed algorithm (shown below) and also in general and which methods are suitable for different datasets according to the number of variables in the dataset and its size. The data provide information about articles on the Internet and with their help, the author tries to predict the success of the article in terms of the number of shares (available information listed directly with the article). The Python programming language and the Selenium web browsing library were used to program the algorithm. IBM SPSS Statistics software was used for the first data analysis and WEKA (Waikato Environment for Knowledge Analysis), Keras software was used for the creation and testing of neural networks. In the case of Keras software, this is another Python library. The expected number of saved articles was just over a thousand before starting data acquisition, but this number was increased to almost 17 thousand due to the acceleration of the algorithm. The analyzed articles are from the website mashable.com, which unfortunately continued to cancel the display of shares during this work, there are other sites, which list the number of shares, but are often focused on one specific area such as healthcare (psychcentral.com) or social media marketing (socialmediaexaminer.com). Another suitable site for this research would be thenextweb.com, but for simplicity, article variables were loaded only from the Mashable page. PyCharm software was used for programming. Random Forest, Naive Bayes, and K Nearest Neighbors methods will be programmed to analyze the success of the prediction. The success will then be compared in tables with other methods from WEKA software.

2.1. Datasets

All datasets are freely available datasets from the site (<https://github.com/renatopp/arff-datasets/tree/master/classification>). The only data set obtained by the author using the programmed algorithm is listed in Table 1 as "Articles". The variables obtained include:

- TitleWords = number of words in the title of the article
- TitleCharacters = number of characters in the article title
- TotalWordsInArticle = number of words in the whole article
- TotalCharactersInArticle = number of characters in the article title
- TotalParagraphs = total number of paragraphs
- AverageWordLengthInTitle = average length of the word in the article title
- AverageWordLengthInArticle = average word length in the whole article
- NumberOfImages = number of images in the article
- NumberOfHrefs = number of links in the article

- PositiveWordsInArticle = number of positive words in the article
- NegativeWordsInArticle = number of negative words in the article
- PositiveDividedByNegativePolarityInArticle = number of positive words divided by the number of negative words in the article (article polarity)
- PositiveDividedByAllWordsInArticle = number of positive words divided by all words in the article
- NegativeDividedByAllWordsInArticle = number of negative words divided by all words in the article
- PositiveWordsInTitle = number of positive words in the article title
- NegativeWordsInTitle = number of negative words in the article title
- PositiveWordsInTitleDividedWordsInTitle = number of positive words in the title divided by the number of words in the article title
- NegativeWordsInTitleDividedWordsInTitle = number of negative words in the title divided by the number of words in the article title
- WordsInFirstParagraph = number of words in the first paragraph
- CharactersInFirstParagraph = number of characters in the first paragraph
- PositiveInFirstParagraph = number of positive words in the first paragraph
- NegativeInFirstParagraph = number of negative words in the first paragraph
- PositiveInFirstDividedByWordsInFirst = number of positive words in the first paragraph divided by the number of words in the first paragraph
- NegativeInFirstDividedByWordsInFirst = number of negative words in the first paragraph divided by the number of words in the first paragraph
- DayPosted = day of the month the article is added (1-31)
- MonthPosted = month when the article is added
- YearPosted = year when the article is added

The last variable examined:

- NumberOfShares = total number of shares on all social networks combined

To obtain the number of positive and negative words, the entire analyzed text was compared word for word with the external documents positiveWords.txt and negativeWords.txt. These documents contain positive and negative English words. These lists are freely available at <https://positivewordsresearch.com/sentiment-analysis-resources/>. After downloading the files, it was necessary to go through the documents manually and remove the words for which the polarity is questionable. For example, the word "joke" was listed as negative and so on.

In the case of other datasets, there is a wider range of predictions. There are datasets for predicting whether the symptoms of a disease will return (dataset "Diabetes" and "Breast Cancer"), datasets for predicting quality (Glass, Wine Quality, Soybean, Ionosphere), as well

as predicting the type of plant by leaves ("Iris"), or whether the person is a Republican or a Democrat ("Votes") or whether the customer is credible ("German Credit").

3. Results

For the programmed methods, the prediction success for the "Articles" dataset was 51.33% for the Naive Bayes method, 58.38% for the Random Forest method, and 55.64% for the K Nearest Neighbor method. Then, the following table 1 was expanded with other data sets listed in the methodology and machine learning methods available in the WEKA software.

Table 1. Comparison of methods for selected datasets and their prediction success.

Method\Dataset	Iris	Weather	Contact Lenses	Diabetes	Breast Cancer	Glass	Wine Quality	Labor	Votes	German Credit	Articles	Soybean	Ionosphere
Number of variables	4	4	5	8	9	9	11	16	16	20	27	35	35
Number of possible prediction outputs	3	2	3	2	2	7	10	2	2	2	2	19	2
Number of instances	150	14	24	768	286	214	3429	57	435	700	16784	683	351
Naive Bayes	94.12%	60.00%	37.50%	78.54%	71.13%	49.32%	45.28%	94.74%	91.22%	76.37%	51.33%	90.52%	82.35%
Random Forest	96.08%	80.00%	50.00%	78.54%	71.10%	78.08%	63.46%	89.47%	98.65%	76.89%	58.38%	93.10%	80.67%
K Nearest Neighbor	96.08%	40.00%	50.00%	72.80%	72.16%	67.12%	55.57%	78.95%	91.90%	73.11%	55.64%	88.79%	91.60%
Logistic regression	98.02%	60.00%	62.50%	79.31%	68.04%	54.79%	53.00%	89.47%	97.97%	75.63%	53.49%	93.53%	85.71%
RepTree	92.16%	60.00%	37.50%	75.48%	65.98%	57.53%	50.26%	84.21%	97.97%	72.69%	53.87%	80.17%	84.87%
Support Vector Machines	100.00%	60.00%	37.50%	68.20%	65.98%	64.38%	53.69%	89.47%	96.62%	71.85%	54.92%	84.91%	89.08%
MultilayerPerceptron	98.04%	60.00%	50.00%	80.08%	74.23%	57.53%	54.63%	89.47%	97.30%	76.89%	53.10%	55.60%	81.51%
RBFClassifier	94.12%	60.00%	37.50%	77.01%	69.07%	50.68%	52.40%	78.95%	96.62%	75.63%	54.07%	44.83%	89.92%
Stochastic Gradient Descent	NA	60.00%	NA	80.84%	71.13%	NA	NA	84.21%	97.97%	76.89%	53.66%	NA	83.19%
Fuzzy Unordered Rule Induction Algorithm	96.08%	40.00%	37.50%	80.46%	65.98%	64.38%	52.92%	89.47%	97.40%	73.11%	56.05%	93.10%	88.24%

The table shows selected methods and datasets along with the prediction success. The grayed out methods are those methods that were programmed in the Python programming language where success was tested. Other methods were run in WEKA software. The highlighted data set "Articles" is described above in the article, which was obtained using the created algorithm. The method with the highest accuracy for the given dataset is highlighted in bold. Among the selected datasets, Random Forest proved to be the most universal method. This method also has the best success for predicting popularity on social networks in this work. This success rate is 58.38%, which means that if an article structure is inserted into a method, this method can indicate with the stated accuracy whether the article will be shared more than the average.

4. Discussion

The worldwide spread of social media has led to exponential growth in Internet users, leading to a whole new environment for customers, the exchange of ideas and feedback on products and services. (Bandari et al., 2012). Thanks to rapid development, social media may become the most important media channel for brands and clients in the near future (Szabo & Huberman, 2008). Companies soon realized the potential of using online social services to influence customers and include social media marketing and other various surveys. Nowadays, a number of companies, social networks and individuals already use various predictive models, and this work can point to the fact of which methods are suitable for which issues and for which platform.

Social media websites such as Twitter, Facebook, and YouTube are based on human interaction and user-generated content. This leads to the creation and exchange of huge amounts of user-generated content in one-to-many communications. Social media-oriented people tend to publish texts, audio, or video related to their lives, thereby demonstrating their tastes and opinions (Ding et al., 2019).

The data available on social media platforms provide a wealth of information on human behavior and social interaction. Social media provides data to understand needs and opinions. By analyzing what is available on social media, it is possible to identify important personality traits, i.e. traits or characteristics specific to humans, which can then be used not only to describe their personality. (Lima & Castro, 2014). All this information can be used as a further extension of various datasets and after appropriate modification of the data can be inserted into the methods presented in this work and further refine predictions in many different areas (for example, profit generation, detection and prediction of user mood, disease spread prediction, prediction election result and much more).

The limits of this work include focusing on a smaller number of websites providing articles and the number of shares of their article. The limit of this work may also include focusing only on the years 2013 and 2014.

5. Conclusions

Of the methods tested in this project, including Naive Bayes, Random Forest, K Nearest Neighbor and subsequently also logistic regression, decision tree, support vector machines,

and other modifications, the success rate ranged from 37.5% to 100%, where the Random Forest method was the most successful (in 5 of 13 datasets). The worst methods in overall accuracy were methods RepTree, RBFClassifier, and Fuzzy Unordered Rule Induction Algorithm.

Today, businesses and organizations are increasingly inclined to take advantage of the ubiquitous impact of online social media such as Facebook, Twitter, and Instagram. These companies and their campaigns reach different categories of users very quickly, as many people spend most of their time on online social media (Ducange et al., 2019).

However, effective prediction of the number of shares on social media will be related to a large number of other variables such as user characteristics (age, nationality, frequency of sharing, number of social networks used, ...) or domain characteristics (who wrote the article, what is the site traffic, whether they have paid advertising, how much they spend on advertising and the like).

Overall, the predicting is a popular but complex topic. This fact is also pointed out by the fact that for almost every data set there was the most accurate method and it is, therefore, necessary to think carefully about the prediction method used depending on how large a data set is available and how many prediction outputs are possible.

Acknowledgments: The work was supported by the internal project “SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept”, 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic. I would also like to thank doctoral student Martin Matějčíček for his help in sorting and preparing data.

References

- Ballings, M., Van den Poel, D., & Bogaert, M. (2016). Social media optimization: Identifying an optimal strategy for increasing network size on Facebook. *Omega*, 59, 15–25. <https://doi.org/10.1016/j.omega.2015.04.017>
- Bandari, R., Asur, S., & Huberman, B. A. (2012). The Pulse of News in Social Media: Forecasting Popularity. ArXiv:1202.0332 [Physics]. <http://arxiv.org/abs/1202.0332>
- Cerchiello, P., Giudici, P., & Nicola, G. (2017). Twitter data models for bank risk contagion. *Neurocomputing*, 264, 50–56. <https://doi.org/10.1016/j.neucom.2016.10.101>
- Chen, G., Kong, Q., Xu, N., & Mao, W. (2019). NPP: A neural popularity prediction model for social media content. *Neurocomputing*, 333, 221–230. <https://doi.org/10.1016/j.neucom.2018.12.039>
- Chung, J., Gulcehre, C., Cho, K., & Bengio, Y. (2014). Empirical Evaluation of Gated Recurrent Neural Networks on Sequence Modeling. ArXiv:1412.3555 [Cs]. <http://arxiv.org/abs/1412.3555>
- Ding, K., Wang, R., & Wang, S. (2019). Social Media Popularity Prediction: A Multiple Feature Fusion Approach with Deep Neural Networks. In *Proceedings of the 27th ACM International Conference on Multimedia* (pp. 2682–2686). <https://doi.org/10.1145/3343031.3356062>
- Donahue, J., Hendricks, L. A., Rohrbach, M., Venugopalan, S., Guadarrama, S., Saenko, K., & Darrell, T. (2014). Long-term Recurrent Convolutional Networks for Visual Recognition and Description. ArXiv:1411.4389 [Cs]. <http://arxiv.org/abs/1411.4389>
- Ducange, P., Fazzolari, M., Petrocchi, M., & Vecchio, M. (2019). An effective Decision Support System for social media listening based on cross-source sentiment analysis models. *Engineering Applications of Artificial Intelligence*, 78, 71–85. <https://doi.org/10.1016/j.engappai.2018.10.014>
- Lima, A. C. E. S., & de Castro, L. N. (2014). A multi-label, semi-supervised classification approach applied to personality prediction in social media. *Neural Networks*, 58, 122–130. <https://doi.org/10.1016/j.neunet.2014.05.020>

- Mishra, S., Rizioiu, M.-A., & Xie, L. (2016). Feature Driven and Point Process Approaches for Popularity Prediction. In *Proceedings of the 25th ACM International on Conference on Information and Knowledge Management - CIKM '16* (pp. 1069–1078). <https://doi.org/10.1145/2983323.2983812>
- Moro, S., Rita, P., & Vala, B. (2016). Predicting social media performance metrics and evaluation of the impact on brand building: A data mining approach. *Journal of Business Research*, 69(9), 3341–3351. <https://doi.org/10.1016/j.jbusres.2016.02.010>
- Serban, I. V., Sordoni, A., Bengio, Y., Courville, A., & Pineau, J. (2015). Building End-To-End Dialogue Systems Using Generative Hierarchical Neural Network Models. ArXiv:1507.04808 [Cs]. <http://arxiv.org/abs/1507.04808>
- Svobodová, L., & Hedvičáková, M. (2018). Factors Determining Optimal Social Media Network Portfolio for Accounting Firms: The Case of the Czech Republic. In S. A. Al-Sharhan, A. C. Simintiras, Y. K. Dwivedi, M. Janssen, M. Mäntymäki, L. Tahat, I. Moughrabi, T. M. Ali, & N. P. Rana (Eds.), *Challenges and Opportunities in the Digital Era* (Vol. 11195, pp. 425–435). Springer International Publishing. https://doi.org/10.1007/978-3-030-02131-3_38
- Szabo, G., & Huberman, B. A. (2008). Predicting the popularity of online content. ArXiv:0811.0405 [Physics]. <http://arxiv.org/abs/0811.0405>
- Tsur, O., & Rappoport, A. (2012). What's in a hashtag?: content based prediction of the spread of ideas in microblogging communities. In *Proceedings of the Fifth ACM International Conference on Web Search and Data Mining - WSDM '12*, 643. <https://doi.org/10.1145/2124295.2124320>
- Vázquez, S., Muñoz-García, Ó., Campanella, I., Poch, M., Fisas, B., Bel, N., & Andreu, G. (2014). A classification of user-generated content into consumer decision journey stages. *Neural Networks: The Official Journal of the International Neural Network Society*, 58, 68–81. <https://doi.org/10.1016/j.neunet.2014.05.026>
- Weng, L., Menczer, F., & Ahn, Y.-Y. (2014). Predicting Successful Memes Using Network and Community Structure. In *Proceedings of the International AAAI Conference on Web and Social Media*, 8(1). Retrieved from <https://ojs.aaai.org/index.php/ICWSM/article/view/14530>

The Influence of Modern Education System in the Selection of a Higher Education Institution

Erika S. HUSZÁRIK, Kamilla SÁNTA and Patrik BAŠA*

¹ J. Selye University, Komarno, Slovakia, huszarike@ujss.sk; s.kamilla315@gmail.com; patrik.basa111@gmail.com

* Corresponding author: patrik.basa111@gmail.com

Abstract: Education plays a central role in society in terms of well-being in life, and can also be defined as an engine of economic development. The timeliness of our topic is given by the fact that one of the most important human factors in 21st century society is knowledge. The main goal of our research is to provide an insight into the relevant influencing factors that arise when a student selects a higher education institution. Furthermore, our goal is to provide a comprehensive picture of the most important motivational factors of high school and grammar school graduates that arise in them before choosing a higher education institution. The primary data collection of our research took the form of a direct mail questionnaire, during which we examined the intentions of high school and grammar school graduates to continue their education, as well as the influencing factors that play an important role in their lives in terms of further education. Based on our results, we have created an order of preference and a stepwise representation, which helps higher education institutions to increase the motivation of prospective students and to develop an appropriate education system.

Keywords: motivation; higher education system; selection; key factors

JEL Classification: I20; I21; I23

1. Introduction

For all countries, education is paramount in order to develop and prosper. Education shapes people's character and intelligence. It also provides a sense of motivation for everyone. The traditional education system at the tertiary level is a system where the student receives a systematic education at the university by taking "full-time" / part-time required courses. However, this type of system also has several disadvantages. Many developments can be expected in the period ahead, one of the foundations of which is the ongoing health crisis. One of the most likely developments in the next generation education system is online education, which is still being tried variously around the world today. Based on these, it can be said that online education has made rapid progress in recent years and at the same time has become one of the most debated subjects in the field of education. It has removed some of the main barriers to classroom education, such as location, accessibility, or just travel costs. Technological and pedagogical innovation has made the training system more backward. This experimental and choice-based education system is currently enjoyed by students at primary, secondary and tertiary levels. The use of a self-learning model through audio and video information is becoming increasingly popular and easier to apply among students.

Higher education has the potential to provide different forms of distance learning, for example through TV channels, online education portals, in order to encourage the emerging generation to continue to develop.

The Choice-Based Credit System (CBCS) is a significant step forward in the model of education because it provides an opportunity to personalize learning in higher education. Such-based programs allow students to progress at their own pace, incorporate the process of prior learning assessment, and provide a logical framework for developing knowledge, skills, and experience to the value set by the institution. The CBCS helps students gain hands-on experience that is translated into academic credits. The system also works well for adults who return to school after a few years of work experience in order to complete their studies. This competency-based system requires better planning of courses than is currently the case with the traditional credit-based system. The competency-based system requires that all students be provided with hundreds of opportunities to understand the subject. The difficulties and limitations of the CBCS model prepare and support students at different rates due to their different abilities, in contrast to current classroom instruction. Competency models recognize the value of experiential learning in which students can develop and hone their skills. It is important to highlight that the logic of the competency-based credit system is compelling through individual, online, and traditional classroom learning. With regard to the online education system, it can be said that it is an advantage for students to have access to educational services anywhere, anytime, which features significantly save valuable time for students. The main benefits of online mobile education include prevalence, personalization, reduced costs, flexibility, increased convenience, and time savings. The competency-based credit system represents a significant improvement in the educational model by designing a new assessment system. It also provides an opportunity to personalize learning in higher education by providing appropriate guidance in the selection and assessment of subjects. The current driving force in the CBCS is to provide lower-cost educational opportunities through higher education institutions through flexible programs (Aithal & Aithal, 2016).

1.1. Overview of the Higher Education System

Qualifications in Europe are comparable through the European Qualifications Framework. Most study programs include lectures and seminars, and assessment is done through essays and exams. Work in industry as well as the development of related projects are part of several study programs.

The main European training structures are:

- Bachelor's degree – Most full-time bachelor courses in Europe last 3 or 4 years. The first step is to complete a high school education. This is variable, so the admission requirements for the chosen study program must be checked in each case. This training is a great way to acquire the most significant skills and knowledge that will help you advance in your career.

- Master's degree – Most full-time masters courses in Europe last 1 or 2 years. A master's degree is required to complete a bachelor's degree. A master's degree is a great way for a student to gain deeper or additional skills and knowledge that will help them advance their careers. It is especially helpful in gaining professional status.
- Doctoral/PhD training – Most full-time doctoral programs last 3 or 4 years. Bachelor's and master's degrees are also required to obtain a doctoral degree. The doctoral degree is ideal for those who are passionate about research. They are especially useful if the student wants to work at the university and also aims to become an expert in a particular field. Doctoral degrees usually involve a lot of independent study and research specializing in a topic. The student only needs to attend a few lecture and seminar, mostly doing independent research under the guidance of their supervisor. The purpose of a doctoral degree is to generate new information and ideas or to conduct original research to help advance a topic. It is also the student's responsibility to prepare for their doctoral dissertation during the study program.

In addition to the three main levels of study listed, students can complete many other higher education qualifications. The higher education system offers a wide range of study programs across Europe. Students can study astrophysics, biotechnology, energy management, history, information technology, international relations, languages, law, medicine, sociology, economics and much more. Most higher education study programs have a “modular” structure. This means that students can create a personalized study program by selecting several different modules or study units each year. There are thousands of universities, research institutes and higher education institutions in Europe (European Commission, 2017).

In the vast majority of countries, the introduction of the European Credit Transfer and Accumulation System (ECTS) was based on different legislation. Such legal frameworks are now in place in almost all countries. Each country and institution is currently focusing on the actual implementation and maintenance of the ECTS system. There is a need to support and encourage institutions so that the ECTS system can be properly embedded and implemented on the basis of learning outcomes and student workload (European Commission, 2009).

A university is a higher education institution that is entitled to at least 8 bachelor's and 6 master's degrees, or provides doctoral training, thus giving it the opportunity to award a doctoral degree. The University of Applied Sciences is a higher education institution with at least 4 bachelor's and 2 master's degrees and at least 2 dual courses in the field of engineering, informatics, agriculture, science or economics (Eurydice, online).

An article in the Portfolio published in 2020 shows that in Hungary, about 110,000 diplomas were issued by higher education institutions without language exams. Tamás Schanda stated that the government decided in the spring to temporarily abolish the previously prescribed requirements because the current health crisis threatens not only people's health, but also the economy and livelihood. Thanks to this change, young people will be in a better position in the labor market, as they will also have the opportunity to apply for job opportunities that they will not have before receiving their degree. The first step in

the economic protection plan was that students who passed the final exam by 31 August 2020 could receive their degree even in the absence of a language exam. These measures apply to all forms of training except doctoral training. The opportunity was also available to students who would have had to take even more language exams to graduate (Portfolio, 2020).

Table 1 clearly shows that the number of live births showed a steadily declining trend between 1992 and 2001. Based on these, it can be stated that the number of students applying to a higher education institution results in a decrease due to this.

Table 1. Changes in the number of births in Hungary between 1992-2001 (Hungarian Central Statistical Office, 2020)

Year	The population, January 1. given in thousands of people	Average, January 1.	Live birth	Mortality	natural increase, depopulation (-)
		Altogether	Altogether	Altogether	Altogether
1992	10374	37.5	121724	148781	-27057
1993	10365	37.6	117033	150244	-33211
1994	10350	37.7	115598	146889	-31291
1995	10337	37.8	112054	145431	-33377
1996	10321	38	105272	143130	-37858
1997	10301	38.1	100350	139434	-39084
1998	10280	38.3	97301	140870	-43569
1999	10253	38.5	94645	143210	-48565
2000	10222	38.7	97597	135601	-38004
2001	10200	39.2	97047	132183	-35136

1.2. Key Motivational Competencies When Selecting a Higher Education Institution

The need for further learning can be inserted into several steps of Maslow's pyramid. In the course of further studies, students acquire a profession and a qualification, which is a basic requirement for employment in the labor market, which results safety, permanence and housing for them. The university community, the professionals, satisfy the need to belong somewhere. If we examine the higher level needs, we can conclude that the desire for recognition and prestige can be achieved by obtaining a degree. The self-realization at the top of the Pyramid of Maslow can be interpreted in this respect as meaning that students choose a major that suits their interests in order to satisfy their academic interest (Hofmeister & Tóth, 2006).

According to Rámháp (2017), Hungarian young people can be divided into several groups based on their attitudes towards further learning, which are as follows:

- Prestige-oriented – Individuals who want to acquire outstanding knowledge, have serious career plans, good educator, performance and a reputable institution are important to them.
- Experience seekers – Students for whom the completion of minimum conditions is important, in addition a good community, a good atmosphere and student programs can be

included here. They are primarily looking for an institution where the conditions are relatively easier to meet and also feel good.

- Considered – The third group includes students whose decisions about further study are primarily determined by comfort, a favorable price, and a favorable future job. Value for money is important to them.

According to Rámháp, these groups should be taken into account, for example, during segmentation, as well as in the development of supply, the creation of a university image, and the creation of an appropriate communication strategy (Rámháp, 2017).

Students' motivation is also greatly influenced by external factors. These factors can be grouped into effects (based on rational consideration) as well as impacts of social environment and culture (behind which it is not necessary to find rational consideration). Decisions based on rational judgment include labor market opportunities, place in the social hierarchy, direct monetary expenditure and benefits, expected risk, legal constraints, system opportunities, information / orientation, and guidance systems (Halász, 2001; Belas et al., 2019).

Institutional choice models have been known in the literature since 1980. Csuka and Banász (2014) classify the models describing the election process into three groups.

- Economic models – They are based on maximizing utility and risk reduction is typical for young students. As a critique of the model can be stated that in all cases a rational decision and a complete supply of information are assumed.
- Sociological models – For this model, the emphasis is on social status as well as individual factors. Family and social background and education come to the fore. Parents' education is also a significant influencing factor. It has been criticized that the decision is placed solely on the socio-sociological aspect.
- Mixed models – It is a combination of the two models listed previously, which manifests itself as assuming a rational decision but in turn taking into account the influential role of social background (Csuka & Banász, 2014).

Institutional selection aspects can be approached from the perspective of student factors as well as institutional factors. In the case of the former, the opinion of social and economic status, parents' education, budget, financial support, career, parents, friends, teachers are authoritative. From an institutional point of view, geographical location, size, type of training, reputation, ranking and quality of education are important aspects. In addition, the infrastructure and equipment of the institution is an important influencing factor (Rámháp, 2017).

What opportunities do universities have today to encourage students to choose a higher education institution?

This is well illustrated by the so-called enrollment marketing model found in Kuráth's (2007) doctoral dissertation. The system includes external, and internal factors. Let's see exactly what they can be:

- External influencing factors – characteristics of the city, availability of main institutions, unique nature of institutions, number of competitors, financing methods, demographic environment, lifestyle
- Internal influencing factors – efficiency of admission information, admission requirements, marketing, quality of education, new trainings, training scale, favorable reimbursement, condition of classrooms, infrastructure, research opportunities, career opportunities, modern education organization

In addition, this includes, for example, additional services such as a library, an IT network, a study department, various mobility programs, or even scholarship opportunities. Students can also be attracted by the cultural opportunities offered by the university (sports facilities, accommodation, or even dining options). Among the enrollment marketing activities, university “open days” can be highlighted, where students have the opportunity to tour the campus as well as gather information at various booths. Other options include the annual Education Exhibition (Kuráth, 2007).

The decision-making process for further education in a higher education institution can be divided into three stages: the first phase, during which the student is willing to continue his / her studies at the university or college, the second phase, during which he / she starts visiting the university / colleges, and the third phase, when students choose the higher education institution to which they will apply. The student’s socio-economic status, test scores, and study average (GPA) all play a role in the selection of the institution. However, students tend to update their educational expectations based on changes in academic information (Jackson, 2015).

Information on the use of students’ learning strategies can be extremely useful in achieving multiple goals. From the perspective of educators, it can be said that they are thus able to develop interventions designed to encourage learners to use useful learning strategies based on this type of information. In addition, students can use the information to better understand their general learning approaches. Finally, education becomes evaluable, for example, by adjusting the level of educational control, cooperative learning, and the use of educational technology. Research on the learning strategies employed by students is essential for planning optimal education (Meijs et al., 2019).

We found an extremely interesting study on the topic, which is related to the dissertation of Kéri (2015) for the National Scientific Student Conference. In her research, she specifically examines the motivations of foreign students to study in Hungary. The work shows that the students come to Hungary mostly because they had a specific goal and high expectations, and an important factor is that the Hungarian degree is accepted within the European Union. It is interesting and extremely instructive that the subjects of the research agreed the least that they would like to find a job in Hungary after graduating. In our view, this could be one of the most important factors that should be changed. Perhaps, if we get an answer on how to encourage students to continue their studies, it is conceivable that we will also get an answer on how to encourage them to settle in Hungary. To do this, however, we need to understand their motivations. In her hypothesis study, Kéri (2015) concluded that students

are most motivated to learn about new cultures, learn languages (in this case, they refer specifically to English), and gain new experiences. This is a good starting point for learning their motivation. Extrinsic motivational factors also include the fact that a lot of students come with their acquaintances and a lot of people are influenced by the information and experience they hear from acquaintances, friends and relatives about the university. Intrinsic motivation clearly includes the acquisition of new knowledge as well as language learning opportunities. We believe that by “strengthening” these, we can make a major contribution to increasing students’ motivation (Kéri, 2015).

2. Methodology

The main goal of our research is to provide an insight into the influencing factor of modern education systems in the selection of a higher education institution. In our study, we examine modern education systems as well as the operation of the higher education system. Following this, we place great emphasis on the motivational factors of students that play a key role in the selection of a higher education institution. Considering the practical part of our research, our goal is to provide a comprehensive picture of these motivational factors in relation to Hungary. As a last step, the authors formulate the main conclusions and suggestions on the topic. The aim of the research in this problem area is to provide a comprehensive picture of the most significant motivational factors of high school students that arise in them before choosing a higher education institution. In conducting our research, we examined the higher education system and sought answers to the role that modern education systems play in the selection of a higher education institution. Based on these, we conducted primary research in Hungary in order to get a comprehensive picture of the key factors for students that play a role in the selection of an institution. As a first step, a research plan was developed that included the research methodology, as well as hypotheses and assumptions related to the topic. In the first part of our study, modern education systems and the higher education system were presented with the help of domestic and international literature. For the practical part, our primary data collection took the form of a direct mail questionnaire, with the help of which we examined secondary school institutions in Hungary. In sending out our questionnaire, we asked secondary school instructors to please ask only graduate students to complete the questionnaire. The construction was done using Survio and Google Form Builder software. The authors believed that they could only and comprehensively provide a comprehensive picture to the reader by specifically addressing the individuals personally affected by this topic. The feedback responses were coded using Microsoft Excel, and then we applied the SPSS program to examine our formulated hypotheses. In the first part of our method of quantitative analysis, we were interested in which category graduating students belong to based on their grades. In this, the research subjects had the opportunity to mark one of the following answer options: excellent (5), good (4), average (3), sufficient (2). Then we looked for the answer to whether they would like to continue their studies at a higher education institution. In our next question, we placed great emphasis on which factors influence the most when choosing a higher education institution if they want to continue their studies. Responses included, for example, the standard of a

university, the professionalism of the lecturers, the equipment of the university, the level of language teaching, scholarship opportunities, mobility programs, or even the proximity of the university to their place of residence. Students had the opportunity to answer the question on a Likert scale from one to five.

After reviewing the theoretical part of our analysis, the next important part of our research was the presentation of the results of our study. With the help of the hypothesis formulated in connection with the topic, we wanted to research what motivational factors are present among Hungarian secondary school students when choosing a higher education institution. Two research questions were formulated as assumptions:

1. In selecting a higher education institution, the students who perform best consider the reputation and quality of the institution as an important factor.
2. When selecting a higher education institution, it is irrelevant for the students who perform best to be close to their place of residence.

We considered it an important factor to present our results to the reader in an appropriate way after answering the central question. As a result, we illustrate the results of the research using various graphic solutions. Based on the order of importance of the motivational factors encountered in graduating high school students, the first step was to create a preference order. In addition, we aimed to make a step-by-step representation of the elements of the pyramid we created on which higher education institutions have an influential power. A total of 311 high school students joined our primary data collection. When filling in the questionnaires, we placed great emphasis on the recipients, is the leaders and teachers of secondary schools and grammar schools, asking for the help of students who want to study further, and strengthening the camp of students with excellent or good grades. Taking these factors into account, 270 of the 311 responses received were evaluable for us.

3. Results

The subjects of the research were asked about the destination country in case they wanted to study abroad. Students who would prefer to study abroad prefer English higher education institutions (20.7%). The second most popular country is the United States (14.7%), followed by Austria (12%). They believe that when choosing a higher education institution, the most important thing is that they are taught by qualified instructors (4.39) (preferably masters in the field) and that they can successfully enter the labor market and obtain a well-paying job after graduation. (4.40). After learning which factors, how important are considered by the best performing students, we selected those on which higher education institutions have an influential power. Universities and colleges cannot influence the institution's proximity to the student's place of residence, the fact that the student's acquaintances visit the university or college, nor the fact that the education is free for the student or that the student gets a well-paying job. just because he graduated there. A stepwise representation of the eight selected elements was made, as illustrated in Figure 1. Using the knowledge acquired during the preparation of the study for each degree, we placed the factors outlined above in a logical order.

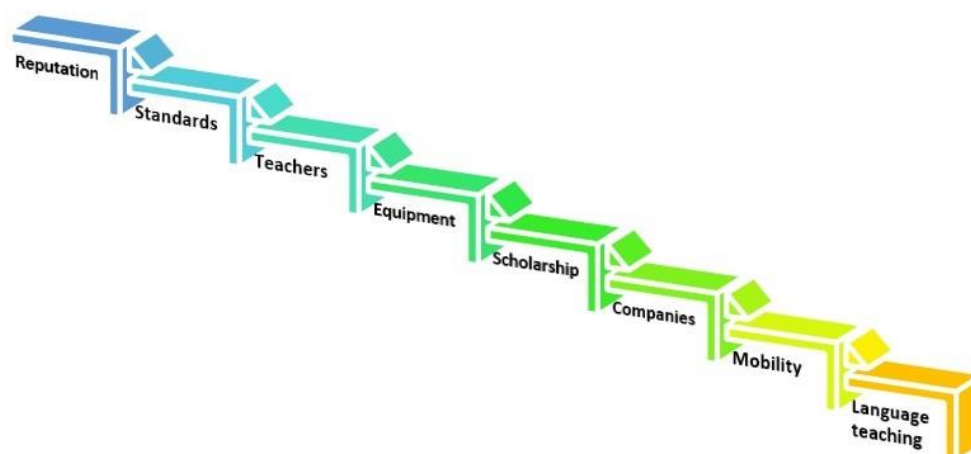


Figure 1. Stepwise representation in terms of increasing the reputation of Hungarian higher education institutions

The higher we go up the stairs, the harder it is to reach the factor at that level in a higher education institution. We have placed the level of language teaching at the lowest level, as to achieve this it is necessary for the institution to launch language courses. Mobility requires various partner institutions to which students can even travel to study under the Erasmus+ program. By acquiring new culture, new views, new knowledge, they broaden their horizons. In addition to liaising with other higher education institutions, it is important that the institution also has relationships with various companies. This can be relevant for dual training, internships, but also for future job search. On the further steps, elements were placed which require a larger amount of material to provide. This also includes scholarships covered by own resources, which not all institutions can afford, but which, according to future students, also play an important role in the selection of a higher education institution.

The equipment of the institution also depends on this factor, as students feel much more comfortable in a beautiful, modern environment where the technical conditions they require are given, the classrooms are equipped and the library offers a wide range of specialist literature. If we go one step higher, we will meet with teachers from higher education institutions. Capital also plays a role in this case, as instructors need to be provided with a competitive salary. If the language teaching is adequate, there are mobility opportunities, the institution maintains good relations with various companies, there are opportunities to receive scholarships, the institution is well equipped and the teachers have a great deal of professional knowledge, which leads to an increase in the quality of the higher education institution. And if all this is fulfilled, the rise in the standard will attract the growth of the reputation and the recognition of the institution. This is at the top of our stepwise representation.

The first assumption can be said to be false as it has not been fully substantiated. Although the best performing students say that the quality of a higher education institution is one of the most important factors when choosing a higher education institution, reputation has only found a place in the lower part of our pyramid. The other assumption is that when

choosing an institution, it is not relevant that it is close to the student's place of residence. This suggestion has been confirmed.

4. Discussion

In the first part of our study, we provided an insight into the functioning of higher education systems. Then we examined the institutional factors that have a motivating effect on high school graduates to choose that university for their further study. As a next step, with the help of domestic and international literature, we grouped the Hungarian students in terms of their further learning attitude. In addition, we placed great emphasis on reviewing each institutional choice model, and the options which available to each higher education institution to encourage prospective students to make good decisions. As a last step, we sought an answer to the question of what are the motivational factors for foreign students, based on which they made the decision that they would like to continue their studies in Hungary. In the next part of our study, we present to the reader the aim and the methodology of the research. Our quantitative questionnaire research included two central research question on which we based our analysis. We were interested the opinion of Hungarian high school graduates about the factors that matter the most to them before choosing a higher education institution. In the course of our research results, we have created a stepwise representation that helps higher education institutions to increase their reputation.

5. Conclusions

As a first step in our analysis, we selected the factors that are influenced by higher education institutions in order to achieve a preference for prospective students. Although institutions are not able to influence the distance of between the student's home and the institution, whether the student's acquaintances are the students of the university, nor whether the education is free for that student or whether he or she gets a good job after graduating. As a result, in order to be successful in marketing and communication, they need to focus the activities they are able to influence. Based on our results, we have prepared a stepwise representation in order to provide a comprehensive picture for higher education institutions about which factors need to be strengthened in the future. It is important to note that in order to be successful, universities should only move to the next level if the ones before it have been completed. In today's knowledge-society, it is paramount importance that institutions launch their own language courses, provide Erasmus+ programs, and maintain good relation with companies. Furthermore, it is not possible to go without a word about the various scholarship opportunities and the professionalism of the instructors. If institutions take these factors into account, they can achieve greater success in the future. The main limitation of our research was caused by the pandemic. As a result, it was more difficult to reach graduating high school students. Because of the pandemic, we reached them online with questionnaires sent to schools, however, as this was an indirect method, it was difficult to reach as many students as possible. If we had had the opportunity to visit the schools in person, it would probably have resulted more completions. In the future, we would like to

extend our research to more countries, and we also would like to expand the literature of the topic.

Acknowledgments: The scientific article is a partial output from the KEGA project 005UJS-4/2019 entitled "Streamlining Managerial Skills of the generations Z and Y by gamification on the context of linking science and practice", which is solved at the Faculty of Economics and Informatics of the J. Selye University in Komárno.

References

- Aithal, P. S., & Aithal, S. (2016). Impact of on-line education on higher education system. *International Journal of Engineering Research and Modern Education*, 1(1), 225-235. <https://doi.org/10.5281/zenodo.62029>
- Belas, J., Gavurova, B., Korony, S., & Cepel, M. (2019). Attitude of University Students toward entrepreneurship environment and toward entrepreneurship propensity in Czech Republic and Slovak Republic. *International Comparison. Economic Research – Ekonomika Istraživanja*, 32(1), 2500-2514. <https://doi.org/10.1080/1331677X.2019.1615972>
- Csuka, G., & Banász, Z. (2014). Lehetőségek és döntések. *Educatio*, 23(4), 616-631.
- European Commission. (2009). *Higher education in Europe 2009: Developments in the Bologna Process*. Education, Audiovisual and Culture Executive Agency.
- European Commission. (2017). *Higher education in Europe*. https://ec.europa.eu/education/study-in-europe/planning-studies/european-higher-education_en
- Eurydice. (2020, January 20). *Magyarország: Az oktatási rendszer felépítése*. European Commission. https://eacea.ec.europa.eu/national-policies/eurydice/magyarorsz%C3%A1g/organisation-education-system-and-its-structure_hu
- Halász, G. (2001). *Az oktatási rendszer*. Műszaki Könyvkiadó.
- Hofmeister, T. Á. (2006). *Fogyasztói magatartás*. Aula Kiadó.
- Hungarian Central Statistical Office. (2020). *Népesség, népmozgalom (1900-)*. https://www.ksh.hu/docs/hun/xstadat/xstadat_hosszu/h_wdsd001a.html
- Jackson, S. J. (2015). Does an early college readiness signal discourage college application and enrollment? *Journal of Research on Educational Effectiveness*, 8(3), 380-399. <https://doi.org/10.1080/19345747.2014.984885>
- Kéri, A. (2015). A magyar felsőoktatásban tanuló külföldi hallgatók motivációjának vizsgálata. *TDK műhelytanulmányok: „első szárnypróbálgatások”, (15)*, 21-38.
- Kuráth, G. (2007). *A beiskolázási marketing szerepe a hazai felsőoktatási intézmények vonzerőfejlesztésében*. Pécsi Tudományegyetem Közgazdaságtudományi Kar. Regionális Politika és Gazdaságtan Doktori Iskola.
- Meijs, C., Neroni, J., Gijssels, J. M. H., Leontjevas, R., Kirschner, A. P., & Groot, D. R. (2019). Motivated strategies for learning questionnaire part B revisited: New subscales for an adult distance education setting. *The Internet and Higher Education*, 40, 10-11. <https://doi.org/10.1016/j.iheduc.2018.09.003>
- Portfolio. (2020). *Csaknem 110 ezer diplomát állítottak ki nyelvvizsgamentesen Magyarországon*. <https://www.portfolio.hu/gazdasag/20200910/csaknem-110-ezer-diplomat-allitottak-ki-nyelvvizsgamentesen-magyarorszagon-448242>
- Rámháp, S. (2017). *Felsőoktatási továbbtanulási motivációk Magyarországon. A változó ifjúság és a piacosodó felsőoktatás tükrében*. Széchenyi István Egyetem. Regionális- és Gazdaságtudományi Doktori Iskola.

A Study on the Evaluation of Agricultural Modernization in China

Yanhua CHANG¹ and Bo SHI²

¹ Shanxi Institute of Business and Technology, Xiaodian District, Taiyuan City, Shanxi Province;
393629332@qq.com

² School of Economics and Management, Northwest University, Chang'an District, Shaanxi Province;
shibonwu@sina.com

* Corresponding author: 393629332@qq.com

Abstract: In this paper an agricultural modernization evaluation system is constructed from four dimensions, and by using entropy method the comprehensive index of agricultural modernization is calculated in 31 provinces (including central government directly administrated municipalities, autonomous regions) in China. The results show that the level of agricultural modernization in China is generally on the rise and is in the initial stage of modernization. In terms of various regions, the level of agricultural modernization is in the following order: the eastern region, the northeast region, the central region, and the western region. There is an obvious gap between different regions in agricultural modernization, with Beijing, Shanghai and other places in the leading position, and Qinghai, Gansu and other places at the bottom. Accordingly, policies should be put forward, including increasing the input of agricultural modernization and carrying out development strategies for different regions.

Keywords: agricultural modernization; index system; entropy value method; evaluation

JEL Classification: F32; F72

1. Introduction

In a session of the National People's Congress in 1954, the then Premier Zhou Enlai, put forward the concept of the "four modernizations", including agricultural modernization, reform and opening up to now, since then, a number of central documents and conferences have emphasized and proposed the theme of promoting agricultural modernization, which fully demonstrates the importance attached by the party and the state to the issue of agriculture, rural areas and farmers. Although China's agricultural modernization has made considerable progress, its agricultural foundation is still weak on the whole, which is an obvious weak part in the "Four Modernizations" (Zhang, 2015). In October 2016, the State Council issued the National Plan for Agricultural Modernization (2016-2020), which points out the direction for the objective evaluation of agricultural modernization.

As for the evaluation of agricultural modernization, scholars have used many methods to conduct research, mainly including Delphi method, analytic hierarchy process, principal component analysis method, key parameter comparison method and other measurement methods. For example, Delphi method and multi-level analysis method are combined to carry

out comprehensive measurement from four aspects including agricultural input, agricultural output, rural social development and agricultural sustainable development (Zhong, 2018). The agricultural modernization evaluation system is divided into four dimensions (output, population, benefit, technology) and 15 basic indicators by using principal component analysis, and the main influencing indicators of agricultural modernization are extracted to measure the agricultural modernization index (Zhang, 2016). Select representative indicators of agricultural modernization to comprehensively compare the gap between Jiangsu Province and developed countries (Liy, 2012). This document provides a reference for the evaluation of agricultural modernization research, especially provide a mature index system, try to build from four dimensions, using entropy method to measure agricultural modernization of China's 31 provinces composite index, to grasp the different province agricultural modernization level and the regional difference, in order to promote agricultural modernization development theory and data support.

2. Construction of Agricultural Modernization Evaluation Index System

2.1. Construction of Index System

This paper follows the basic principles of systematization, emphasis and operability, combines the concept and actual situation of agricultural modernization in China, and refers to the representative evaluation index system of agricultural modernization in China (Long et al., 2014; Chen et al., 2018; Du et al., 2018). From four dimensions of agricultural input, agricultural comprehensive output, rural social development and agricultural ecology, the evaluation index system of China's agricultural modernization was constructed. Agricultural input level includes indicators such as machinery, science and technology, land and capital; the comprehensive agricultural output level includes the land output rate, agricultural labor productivity, grain output per unit cultivated land area, added value of agriculture, forestry, animal husbandry and fishery, etc. The level of rural social development includes the urbanization rate, urban residents' income level, Engel's coefficient and other index factors. The level of agricultural o-ecological level includes the rate of water-saving irrigation, the coverage rate of greening, the rate of agricultural disaster, the amount of fertilizer applied, the area of soil erosion control, the coverage rate of forest and other index factors (see Table 1).

2.2. Research Methods

In this study, entropy method was used. Firstly, the indexes were standardized. Secondly, MATLAB software was used to calculate the entropy value and weight of each index. Finally, according to the weights determined, the comprehensive evaluation value of agricultural modernization development level of 31 Provinces (including central government directly administrated municipalities, autonomous regions) in China from 2009 to 2018 was calculated.

Table 1. Evaluation index system of China's agricultural modernization

Level indicators	The secondary indicators	Index calculation	Unit	Weight
Agricultural input level	Total power of farm machinery	Total power of agricultural machinery/total arable area	kw/hm ²	5%
	Labor all agricultural science and technology input	Total number of agricultural science and technology personnel/total population of primary industry	%	6%
	Effective irrigation rate	Irrigation area of cultivated land/area of cultivated land	%	5%
	Financial support for agriculture and rural areas	Total amount of financial support for agriculture/arable land	%	14%
Agricultural synthetical output level	Land yield rate	Gross agricultural output value/cultivated area	Yuan/hm ²	8%
	Agricultural labor productivity	Gross agricultural output value/total rural population	10,000Yuan/person	4%
	Grain output per unit cultivated area	Total grain output/total arable area	kg/hm ²	5%
	Added value of agriculture, forestry, animal husbandry and fishery	Added value of agriculture, forestry, animal husbandry and fishery/gross output value of agriculture, forestry, animal husbandry and fishery	%	2%
Rural social development level	Rate of urbanization	Urban population/total population	%	4%
	Income level of urban and rural residents	Per capita disposable income of urban and rural residents	%	3%
	Engel coefficient	Food expenditure/total consumption expenditure of rural residents	%	4%
Agricultural ecological level	Agricultural disaster rate	Total disaster area/total disaster area	%	6%
	Application amount of agricultural chemical fertilizer	Fertilizer application rate/arable land area	kg/hm ²	4%
	Control area of soil erosion	Soil erosion control area	hm ²	25%
	Percentage of forest cover	Total forest area/total land area	%	5%

Standardization of index values

In order to eliminate the influence of dimension between each index, the entropy method is used to standardize the index. The calculation formula is as follows:

Positive indicators:

$$Y_{ij} = (X_{ij} - X_{min}) / (X_{max} - X_{min}) \quad (1)$$

Negative indicators:

$$Y_{ij} = (X_{max} - X_{ij}) / (X_{max} - X_{min}) \quad (2)$$

In Equations (1) and (2), Y_{ij} is the standardized value of the j^{TH} index of the i^{th} sample, X_{ij} is the original value of the j^{TH} index of the i^{th} , X_{max} and X_{min} are the maximum and minimum values of the j^{TH} index respectively.

Determination of weights

Calculate the proportion of each index according to formula

$$C_{ij} = Y_{ij} / \sum_{i=1}^n Y_{ij} \quad (3)$$

According to Equation (4), the entropy of index j can be calculated:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^n C_{ij} \ln C_{ij} \quad (4)$$

Difference coefficient of the j index was calculated according to Equation

$$d_j = 1 - e_j \quad (5)$$

Calculate the weight of each index according to Equation

$$w_j = d_j / \sum_{j=1}^m d_j \quad (6)$$

The comprehensive evaluation value is calculated according to Equation

$$V_i = \sum_{j=1}^m w_j Y_{ij} \quad (7)$$

2.3. Data Sources

The research uses the related data from the China Statistical Yearbook of Land and Resources, Science and Technology of China Statistical Yearbook, "China Water Resources Statistical Yearbook, China Statistical Yearbook, China rural statistical yearbook, China Environment Statistical Yearbook, the Population of China Statistical Yearbook, China Forestry Database and the Provincial publicly available data.

2.4. Stage Division

Based on the evaluation of agricultural modernization at home and abroad, according to the characteristics of agricultural development, this study divides agricultural modernization into preparation stage, starting stage, preliminary realization stage, basic realization stage and comprehensive realization stage. The comprehensive evaluation value range are respectively, [0-0.3], [0.3-0.5], [0.5-0.7], [0.7- 0.9], [0.9-1].

3. Comprehensive Evaluation of the Level of Agricultural Modernization in China

3.1. The Level of Agricultural Modernization Is on the Rise

In this paper, the entropy method was used to standardize 15 original data of 31 Provinces (including central government directly administrated municipalities, autonomous regions) in China from 2009 to 2018, and the corresponding evaluation value was calculated to analyze the development trend of China's agricultural modernization level and regional differences (see Figure 1 and Figure 2). As shown in Figure 1, the level of agricultural modernization in China is on the rise as a whole, from 0.25 in 2009 to 0.53 in 2018, with an average annual growth rate of 9.6%. Although there have been some fluctuations in individual years, the overall upward fundamentals have not been affected.

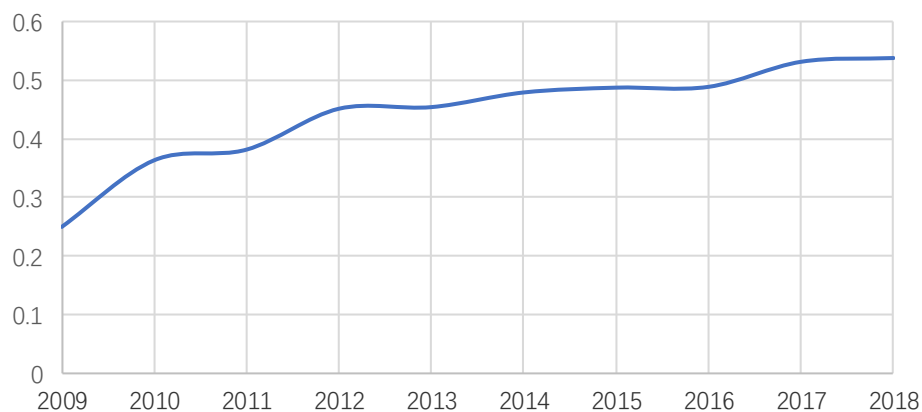


Figure 1. Development level of China's agricultural modernization from 2009 to 2018

3.2. The Development Level of Agricultural Modernization in Various Regions is Obviously Different

In this paper, Provinces in China are categorized into eastern, central, western and northeast regions, and the change status of the comprehensive evaluation index of China's agricultural modernization in 2018 is obtained by evaluation, as shown in Figure 2. The comprehensive index of agricultural modernization in the eastern region is 0.59, which is the region with the fastest development of agricultural modernization, followed by the northeast region with 0.54. The comprehensive index of agricultural modernization in central China is 0.53. The comprehensive index of agricultural modernization in the western region is 0.52, which is the slow development among the four regions. The reason is that the comprehensive index of some Provinces in the western region, such as Qinghai, Guizhou,

Inner Mongolia and Chongqing, is relatively low and in the initial stage of agricultural modernization development, which affects the development of agricultural modernization in the western region to a large extent.

There is significant agricultural modernization level gap, Beijing, Shanghai and some other Provinces have been in the forefront; Qinghai, Gansu, and some others are in the bottom. For example, in 2013 the absolute gap between Beijing and Qinghai was 0.262, and it increased to 0.271 in 2015, 0.394 in 2018, showing a trend of widening the absolute gap.

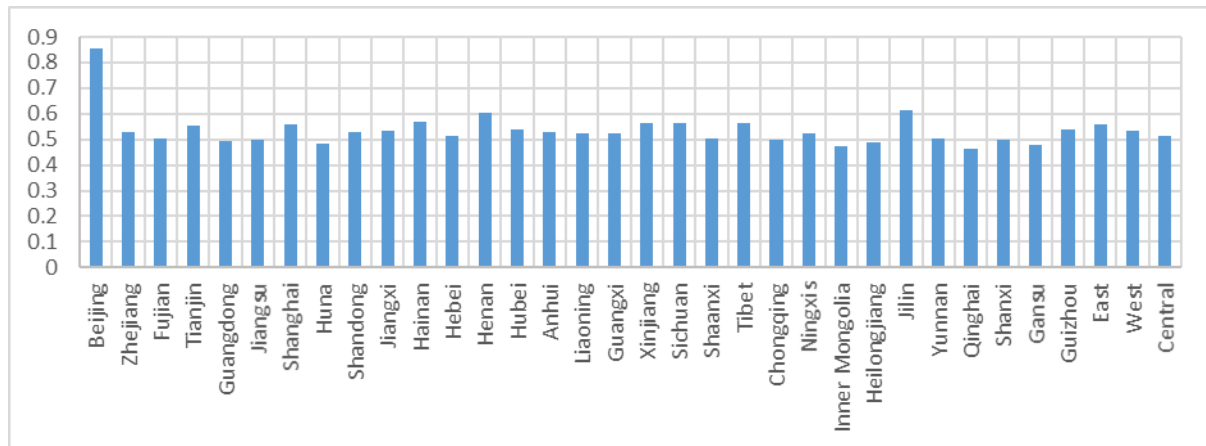


Figure 2. Comprehensive index of Agricultural modernization development in China in 2018

4. Conclusions and Policy Suggestions

4.1. Conclusion

The results show that the development level of agricultural modernization in China is generally on the rise from 2009 to 2018, and it is in the preliminary realization stage of modernization. At the same time, the level of agricultural modernization in different regions is quite different, the gradient is rising and the whole level is low. First of all, there is a large gap in the level of agricultural modernization in different regions. The level of agricultural modernization in Beijing, Shanghai and other places is in the leading position in the country, and the level of agricultural modernization in Qinghai, Gansu and other places is in the last place, with great differences, which is reflected in the differences of various indicators. Secondly, from the perspective of sub-regions, the development level of agricultural modernization shows an upward trend of gradient in western region, central region, northeast region and eastern region. Thirdly, the areas that have initially realized agricultural modernization and those that have basically realized agricultural modernization, although the growth rate is fast, the comprehensive index of agricultural modernization is low, the shortcoming is prominent, and the agricultural modernization is at the overall low level.

4.2. Based on the Analysis, the Following Suggestions are Put forward for China's Agricultural Modernization

To increase input in agricultural modernization. First, government funding should be increased and be focused on solving problems such as weak agricultural infrastructure.

Second, input should be increased in agricultural science and technology, encourage the establishment of agricultural research projects, organize agricultural research institutes, colleges and universities and enterprises to jointly tackle technological problems, and accelerate the transformation of scientific and technological achievements. Third, the comprehensive quality of professional farmers should improve. To train a group of skillful and professional farmers, understanding and technology, good management is important.

In order to improve the overall level of agricultural modernization, different strategies should be adopted in combination with the actual situation of each region. For the regions that are located between the initial stage and the basic stage of realization, they should base on the geographical advantages, optimize the allocation of agricultural resources, improve the utilization rate of resources, pay attention to the improvement of resources and environment, maintain the leading position in the country, and take the lead in entering the basic realization stage. For the regions which are located at the initial stage and ready for development. The policy should focus on, in light of their actual conditions, finding gaps and strengthen weak links so as to further increase their overall agricultural production capacity and speeding up economic development.

References

- Zhang, H. Y. et al. (2015). Agricultural modernization with Chinese characteristics: objective positioning, reform and innovation. *Chinese Rural Economy*, 1, 4-13.
- Zhong, L. N., & Li, S. B. (2018). Evaluation on the Development Level of Agricultural Modernization in Shaanxi Province. *Research on Agricultural Modernization*, 1, 57-64.
- Zhang, H., & Li, B. (2016). Comprehensive evaluation of agricultural modernization level in China. *Rural Economy*, 12, 53-57.
- Li, X. et al. (2012). The difference of agricultural modernization level between Jiangsu and developed countries. *Jiangsu Agricultural Sciences*, 12, 385-387.
- Long, D. P., Li, T. S., Miao Y.Y., & Yu, Z. S. (2014). Spatial differentiation and types of agricultural modernization development in China. *Acta Geographica Sinica*, 2, 214-226.
- Chen J. T., Zhang, Q. H., & Lv, J. Q. (2018). Evaluation of the level of agricultural modernization in China and its influencing factors. *Chinese Journal of Agricultural Resources and Regional Planning*, 2, 205-213.
- Du, Y. E., Pan, C. Y., & Song, S. F. (2018). Evaluation of the degree of agricultural modernization in China based on the agricultural statistical data of different provinces. *Agrotechnical Economics*: 3, 79-89.

The Influence of Tax Information Exchange Agreements on the Behaviour of Slovak Companies in Relation to Tax Havens

Michal IŠTOK¹ and Marcela TAUŠOVÁ²

¹ Matej Bel University in Banská Bystrica, Banská Bystrica, Slovakia, michal.istok@umb.sk

² Technical University of Košice, Košice, Slovakia, marcela.tausova@tuke.sk

* Corresponding author: michal.istok@umb.sk

Abstract: International ownership through tax havens is assumed as being one of the main reasons for applying profit-shifting methods and techniques. Since the last financial crisis, much more attention has been paid to aggressive tax planning worldwide. Tax information exchange agreements (TIEAs) are one of the major tools in combatting aggressive artificial profit-shifting to jurisdictions with zero or very low taxation. The goal of this article is to analyse the influence of concluded TIEAs in the behaviour of Slovak based companies in relation to tax havens. We analysed available data from Slovak companies with links to tax havens between 2005 and the first quarter of 2020 as provided by the company Bisnode and the list of contracting states for the purpose of the automatic information exchange according to the Act No. 359/2015 Coll. on automatic exchange of financial account information. During our analysis we primarily used regression and distribution analysis. Our results suggest that TIEAs have a statistically significant influence in slowing down the number of Slovak companies residing in tax havens. Our investigation further indicates that there are different results obtained for different categories of tax havens.

Keywords: Slovak companies; tax information exchange agreements; tax havens

JEL Classification: G38; H25; H26

1. Introduction

The number of Slovak companies linked to tax havens has been constantly growing since 2005. While in 2015, 1,510 Slovak companies were linked to tax havens, in the first quarter of 2020 this number has already reached 5,257 (Bisnode, 2018, 2020a). This trend as recorded by the company Bisnode is in contrast with the data available for Czech based companies, where a gradual year-on-year decrease is recorded. For example, in 2015 13,419 Czech companies were linked to tax havens, while in the first quarter of 2020 it was only 11,741 (Bisnode, 2020b). Rohan and Moravec (2017) worked out an analysis that focused on the reaction of Czech taxpayers on concluded TIEAs with preferential tax jurisdictions. They state that the concluded TIEAs play an important role as a preventive tool because the taxpayers lose their anonymity.

Nakamoto et al. (2019) identified the key companies for international profit-shifting and found that intermediate entities are based mainly in the Netherlands and the United Kingdom (jurisdictions with wide double tax treaty networks). According to the analysis of

Janský and Palanský (2019), profits in the amount of 564.8 mil. USD were artificially transferred out of the Slovak Republic in 2016, representing a tax gap of approximately 124.3 mil. USD. Nerudová et al. (2018) pointed out the importance of corporate entities owned by shareholders through destinations outlined in the Panama papers in international tax planning. Their results further highlight the importance of establishing registries of UBOs (Ultimate Beneficial Owners) in the EU.

The Organisation for Economic Co-operation and Development (OECD) through the Global Forum on Transparency and Exchange of Information for Tax Purposes (Global Forum) is actively extending its impact globally through its Tax Information Exchange Agreement (TIEA) initiative which commenced in the early 2000s and has grown in intensity since 2009 in terms of agreements negotiated and the roll out of peer review reports for Global Forum members (Sawyer, 2011). Regarding transparency, corporate tax havens have been investigated by Bennedsen and Zeume (2018). They uncovered some interesting findings. TIEAs increase average shareholder value by 2.5%. This effect is even stronger for more complex tax havens. Their research showed that some companies respond to TIEAs by moving subsidiaries to tax havens not involved in automatic tax information exchanges. They also highlight that tax havens are used for expropriation activities beyond aggressive tax planning and increased transparency is appreciated by non-controlling shareholders. Avi-Yonah and Savir (2015) list that the U.S. have three methods for revealing taxpayers' income from tax havens – TIEAs, double tax treaties and FATCA (Foreign Account Tax Compliance Act)/IGAs (Intergovernmental Agreements). They state that both FATCA and IGAs have a tremendous psychological effect on taxpayers. Sawyer (2017) provides historical legislation on automatic information exchanges together with Hong Kong's engagement with BEPS and states that increased sophistication in international tax planning is needed compared with the past. Contrary to the mentioned authors, Kemme et al. (2017) found extremely limited evidence that TIEAs reduce tax evasion. The following table contains an overview of individual DAC directives and their characteristics.

Table 1. Overview of DAC directives. (Financial Administration of the Slovak Republic, 2020)

Legal framework	Exchange content	Data/information (categories)
Directive DAC 1 2011/16/EU	Income and expenditure	Royalties, pensions, life insurance, real estate, and dependent activities
Directive DAC 2 CRS + FATCA 2014/107/EU	Financial accounts	Residence, account holder, account balances and turnovers
Directive DAC 3 2015/2376/EU	Transfer pricing opinions	Transfer pricing opinions, advance pricing agreements and methods
Directive DAC 4 (CbCR) 2016/881/EU	Multinational enterprise groups	Group members by country, main activities, revenues, profits
Directive DAC 6 2018/822/EU	Cross-border tax planning arrangements	Value of cross-border arrangement, involved parties, measure description

The Ministry of Finance of the Slovak Republic publishes a list of states for the purpose of financial accounts verification according to Article 7(2) of the Act no. 359/2015 Coll. on the automatic exchange of information on financial accounts for the purposes of tax administration and on the amendment of certain acts, which are contractual party to an

international agreement or another party with which the European Union has an agreement. At the end of 2019, this list contained 118 contracting states (Financial Administration of the Slovak Republic, 2019).

2. Methodology

Elaboration of this analysis is generally based on the paper of Rohan and Moravec (2017). These authors used the difference-in-differences method to predict Czech taxpayers' behaviour. Similarly, to their analysis, we also used the database provided by the company Bisnode for the overview and development of several Slovak companies linked to tax havens. As we work with the list of Slovak companies linked to tax havens as provided by Bisnode, we also took over the list of tax havens from this database and the jurisdictions were divided into three categories:

- a) OFFSHORE JURISDICTIONS (OFF): Bahamas, Belize, Bermuda, British Virgin Islands, Gibraltar, Guernsey (United Kingdom), Jersey (United Kingdom), Cayman Islands, Marshall Islands, the Netherlands Antilles, Panama, Man Island, and Seychelles.
- b) MIDSHORE JURISDICTIONS (MID): Hong Kong, Cyprus, Malta, United Arab Emirates, United States of America; and
- c) ONSHORE JURISDICTIONS (ON): Liechtenstein, Latvia, Luxembourg, Monaco, and the Netherlands.

This categorization was made primarily based on potential benefits and often utilizing the foreign entity on the first ownership level in international holdings (e.g. Hebous, 2011; Jansky et al., 2018; Nakamoto et al., 2019). In our analysis we used the list of signed/concluded TIEAs for Slovakia. The list of valid TIEAs for individual jurisdictions was taken over from the official list as published on the website of the Financial Administration of the Slovak Republic (2019). For the default critical date (before and after the application of TIEAs) we chose the date to which the selected accounts/information started to be exchanged and verified for our analysis. To analyse and evaluate the data and trends we used mainly the regression and distribution analysis.

3. Results

Based on the available data and information, our analysis focuses on the period between 2005 and the first quarter of 2020. We compared behaviour trends of Slovak companies measured over the number of relocated companies to tax havens (direct equity links) before and after the effective start of the tax information exchange. We focused and analysed the average increase in the number of Slovak companies relocating to tax havens for different categories of tax havens. For most of the jurisdictions, the information started to be automatically exchanged from 2016 except for the Bahamas (2019), Hong Kong (2019), the United Arab Emirates (2019), Panama (2018), Monaco (2017) and the United States of America (2014). Our analysis consists of different steps and levels. Firstly, we focused on whether the trends development changed after the effective exchange of information for all tax haven

groups in total. As we examined the differences in trends for all jurisdictions, 2016 was the critical date selected (according to most jurisdictions).

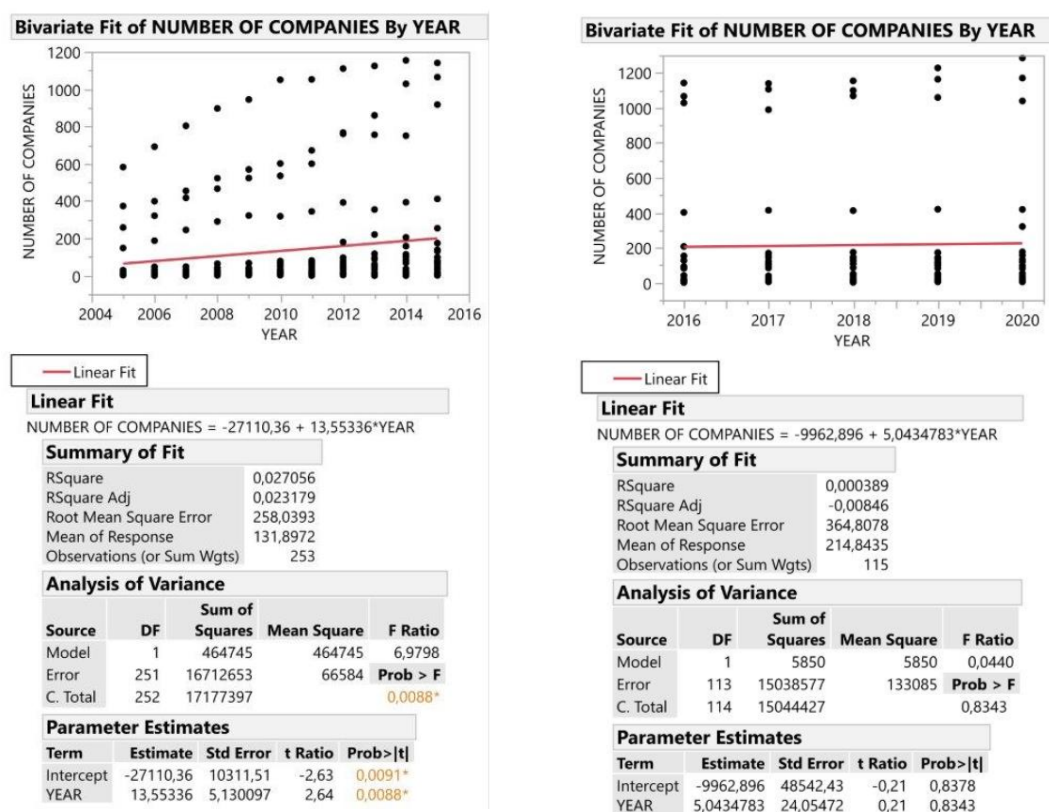


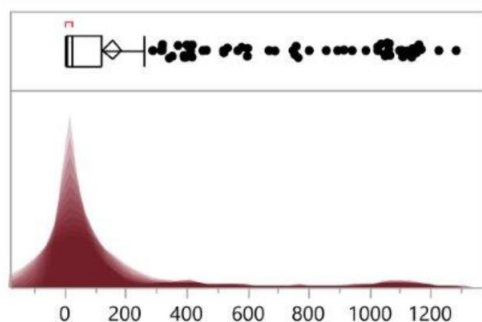
Figure 1. Regression analysis of trends for time periods 2005-2015 and 2016-2020.

The results of the regression analysis suggest that the TIEAs directly affect the average increase of new companies linked to tax havens. While in the period before the application of TIEAs the average number of new companies was 13.553, after the application of TIEAs this number dropped to 5.043. As there is a different distribution between the selected tax havens (e.g. the highest number in the first quarter was achieved by the U.S.A. (1,285), the lowest figures achieved the Isle of Man (5)), we performed a distribution analysis.

For the entire monitoring period and for all countries analysed together, the results show that the average increase in the number of companies is 158 with a standard deviation of 299, which is reflected in the high values of the coefficient of variation (CV), which represents a variation of 189%. First, we began an analysis of all trends and changes for all Slovak companies linked to tax havens regardless of categorization or division. The obtained results showed that there are statistically significant changes and based on these results we performed a detailed analysis for selected groups of tax havens. For the first categorization we opted for tax haven categories as stated in the methodology (onshore, midshore and offshore).

Distributions

NUMBER OF COMPANIES



Quantiles

100.0%	maximum	1285
99.5%		1236,835
97.5%		1135,625
90.0%		583,8
75.0%	quartile	119,5
50.0%	median	25
25.0%	quartile	7
10.0%		2
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	157,81793
Std Dev	298,79769
Std Err Mean	15,575906
Upper 95% Mean	188,44716
Lower 95% Mean	127,18871
N	368
CV	189,33063
Minimum	0
Maximum	1285
Median	25

Figure 2. Distribution analysis

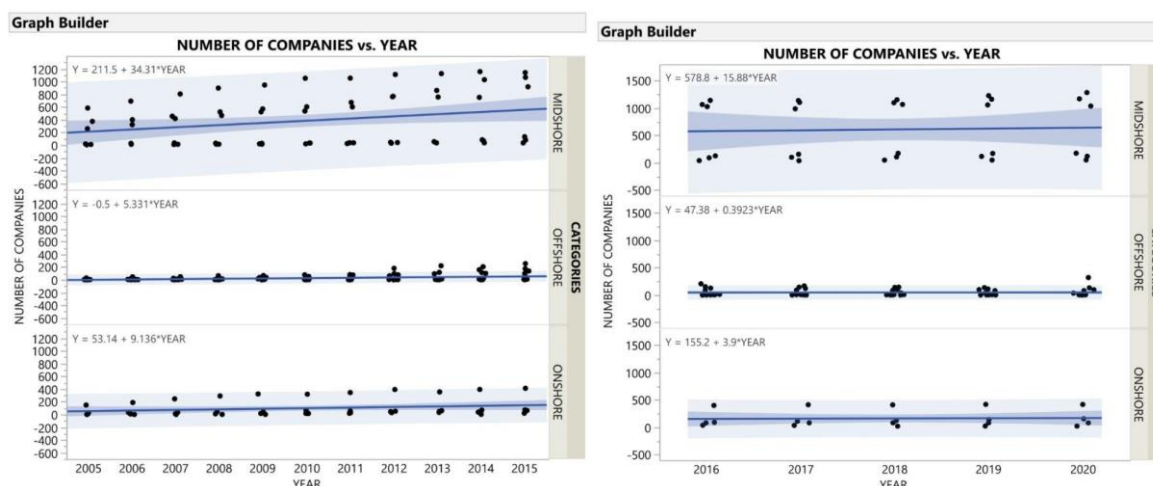


Figure 3. Trends development by tax haven groups

The results obtained suggest that the most significant slowdown in the average increase in the number of companies relocating to tax havens is recorded for the midshore category (a change from 34.31 to 15.88, which represents a decrease of 53%). This category is the fastest growing category before and even after the application of TIEAs. The jurisdictions from this category on the first ownership level are mainly used for tax planning activities (often linked to artificial profit-shifting). The second most significant slowdown in the average increase in the number of companies occurred in the onshore category (a change from 9.13 to 3.9, which represents a decrease of 57%). In recent years, the slowest average increase in the number of companies has been recorded for the offshore category, while after the application of TIEAs this average increase is almost null (a change from 5.331 to 0.392, representing a decrease of 92%). Using an offshore company in the first ownership level in international tax holding is generally not used as there is a high withholding tax (19% or 35%) applied. The offshore companies on the first ownership level are mainly used to hide the UBO. For the second categorization we focused on the division of tax havens with or without concluded double tax treaties with the Slovak Republic. Signed bilateral tax treaties are a key assumption in the application of profit-shifting methods and techniques mainly if the company does not reside

in another EU member state (no possibility to use EU Directives for the purpose of reducing tax or being exempt from withholding taxes).

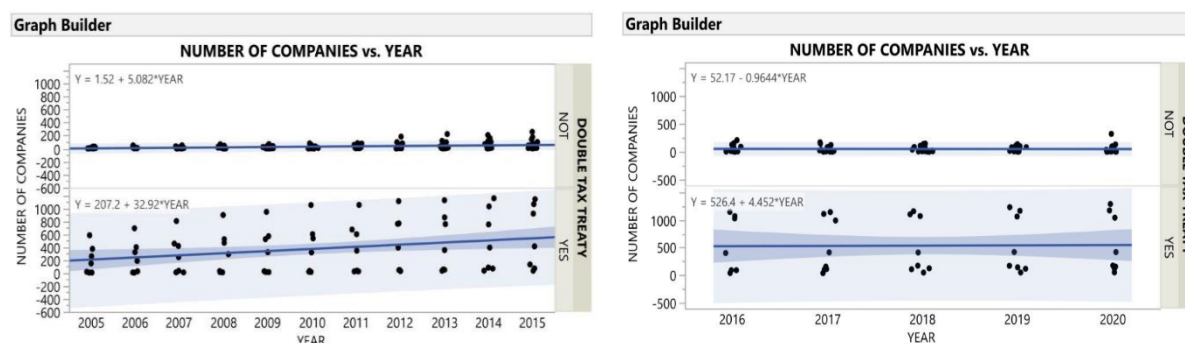


Figure 4. Trends development by double tax treaty category.

The Slovak Republic has currently no signed double tax treaties with any jurisdiction from the offshore category. This means that the average increase in the number of companies for jurisdictions with no signed double tax treaty (change from 5.082 to 0.964) is similar to the total offshore category. This dramatic change is recorded for the category of jurisdictions with signed double tax treaties (change from 32.92 to 4.452). Results showed that the TIEAs caused different developments (increase) of new companies in some categories of tax havens (jurisdictions) and from this we can also deduce that the use of profit shifting methods (or their combination) changed, because some profit-shifting channels/structures are often related to selected jurisdictions depending on the legislation. However, it is more likely that companies change their behaviour in applying profit-shifting methods and techniques based on actual trends in the resistance against artificial profit-shifting to zero or low-tax jurisdictions (e.g. more intensive use of new tax hybrid arrangements without using direct equity links on a first ownership level, change of tax residence or increased use of trusts and foundations). The last examined categorization is based on whether the jurisdiction is a contracting state for the purpose of TIEAs.

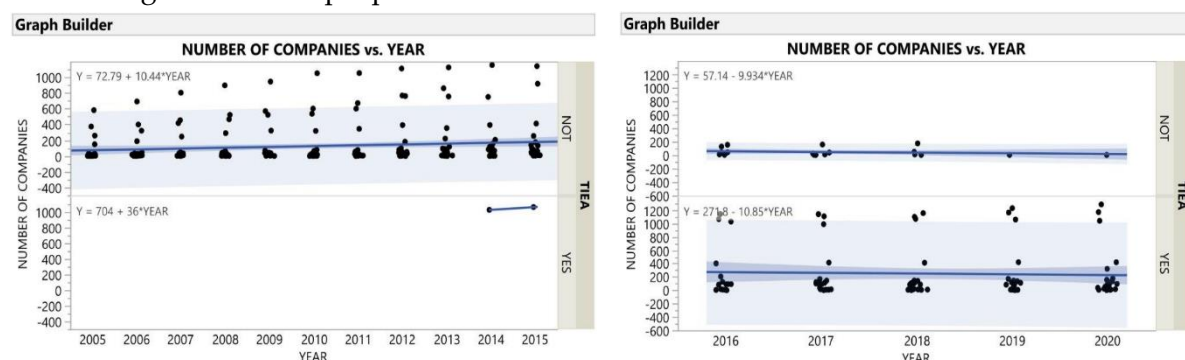


Figure 5. Trends development by TIEAs category.

The output of the regression analysis is affected by the fact that before 2016 only the United States of America was a contracting state for FATCA purposes. The obtained results again confirm that there has been a slow-down in the average increase in the number of companies linked to tax havens since 2016 - there is a recorded decline in the average increase

from 36 to 10.85 for contracting states and from 10.44 to 9.934 for non-contracting states. The decline is much lower for non-contracting states as these jurisdictions are not practically affected by the application of TIEAs.

The output of our analysis helps to create the justified assumption that some Slovak companies respond to TIEAs by moving their subsidiaries/headquarters to jurisdictions not involved in an automatic tax information exchange. From this point of view, our results are in line with Bennedsen and Zeume (2018). In terms of TIEAs efficiency in combatting artificial profit-shifting to tax havens, the current position of the Slovak Republic can be assessed as somewhere between the trends described by Rohan and Moravec (2017) and Kemme et al. (2017). While studies from Rohan and Moravec (2017) indicate that the number of Czech companies linked to tax havens decreased by 42.8% after the application of TIEAs with these jurisdictions, the study of Kemme et al. (2017) outlines the low effectiveness of the application of TIEAs in reducing tax evasion.

The effectiveness of concluded TIEAs could differ among countries. As the automatic information exchange is a relatively new tool, there is limited academic or professional evidence on the experiences or the practical impacts. However, what can be assumed is that important roles are played by the quality of domestic tax legislation, the specific attention paid by the individual financial administrations and the quality of the business environment. To the best of our knowledge, this is the first research investigation into the influence of TIEAs on the behaviour of Slovak companies in relation to tax havens. Our research has several limitations. We analysed only the connection between Slovak companies and selected jurisdictions and only through direct equity links. As was already mentioned, there is a justified assumption that many tax hybrid arrangements are currently constructed without direct equity links on the first ownership level or constructed by using different entities (e.g. trusts, foundations or investments funds) where specific reporting rules apply. The list of tax havens used is also debatable, unquestionably certain jurisdictions are missing, e.g. the United Kingdom. The future research of this area should also be associated with an analysis of the efficiency of corporate income tax revenue collection in relation to tax havens. Currently, there has been no available research performed in the Slovak Republic in this area, but according to the study of Moravec et al. (2019), the shift of taxable profit to tax havens influences the corporate income tax collection in Slovakia (e.g. the corporate income tax efficiency for 2015 was at the level of 0.680291).

The intense struggle against artificial profit shifting to tax havens brings increased corporate (and personal) income tax revenues to a state's economy. The higher efficiency of direct income tax collection is important mainly in periods affected by crisis, such as the COVID-19 crisis for example. It can be clearly assumed (and in many cases already confirmed) that the TIEAs system is an important tool in this area and its importance will gradually increase.

4. Conclusions

The study confirmed the influence of concluded TIEAs in the behaviour of Slovak based companies in relation to tax havens. Statistically the application of TIEAs significantly slowed

down the average increase in the number of Slovak companies relocating to tax havens despite a year-on-year increase in the absolute values. This trend is confirmed for all tax haven categories, but we observed many additional trend developments. The largest slowdown in the average increase of Slovak companies relocating to tax havens was recorded in the midshore category, where the average number after the application of TIEAs decreased from 34.31 to 15.88 per year, a difference of 18.43 for newly relocated companies. The next largest difference we observed was in the onshore category with 5.236. Following on from that we come to the offshore category with a slower 4.938 average increase in the number of companies. The midshore category has recorded the highest average increase of relocated companies even after the application of TIEAs, from which it can be assumed that tax planning is the most common incentive in the relocation of new companies to tax havens. In the application of TIEAs, we also see a slowdown in the average increase recorded for double tax treaty categories of tax havens, where the largest slowdown in the average increase was recorded for the category of jurisdictions with signed double tax treaties (28.468) and less so for the no double tax treaty category (4.117). The last differences observed were for contracting and non-contracting states (involved or not involved in a system with TIEAs). The jurisdictions which have signed up to TIEAs during the investigated period recorded a threefold average increase decline, while the average increase rate for jurisdictions outside the TIEAs system remained almost unchanged.

References

- Avi-Yonah, R. S., & Savir, G. (2015). *Find it and tax it: From TIEAs to IGAs* (Research Paper No. 443). University of Michigan Public Law. <https://doi.org/10.2139/ssrn.2567646>
- Bennedsen, M., & Zeume, S. (2018). Corporate Tax Havens and Transparency. *The Review of Financial Studies*, 31(4), 1221–1264. <https://doi.org/10.1093/rfs/hhx122>
- Bisnode. (2018). *Z daňových rajov je riadený historicky najväčší počet firiem*. <https://www.bisnode.sk/o-bisnode/o-nas/novinky/z-danovych-rajov-je-riadeny-historicky-najviac-firiem/>
- Bisnode. (2020a). *Počet našich firiem v daňových rajoch prekročil hranicu 5-tisíc*. <https://www.bisnode.sk/o-bisnode/o-nas/novinky/pocet-nasich-firiem-v-danovych-rajoch-prekrocil-hranicu-5-tisic/>
- Bisnode. (2020b). *Odliv firem z daňových rájů mírně zpomalil. Marshallovy ostrovy se vymykají statistikám*. <https://www.bisnode.cz/o-bisnode/o-nas/novinky/odliv-firem-z-danovych-rajov-mirne-zpomalil/>
- Financial Administration of the Slovak Republic. (2019). *Zoznam zmluvných štátov na účely preverovania finančných účtov podľa zákona č. 359/2015 Z. z. o automatickej výmene informácií o finančných účtoch na účely správy daní a o zmene a doplnení niektorých zákonov*. https://www.financnasprava.sk/_img/pfsedit/Dokumenty_PFS/Infoservis/AVI/2019/2019.12.06_zoz_stat_prev_uct.pdf
- Financial Administration of the Slovak Republic. (2020). *AVI – Automatická výmena informácií*. https://www.financnasprava.sk/sk/infoservis/avi/_1
- Hebous, S. (2011). *Money at the Docks of Tax Havens: A Guide* (Working Paper Series No. 3587). CESifo. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1934164
- Jansky, P., Meinzer, M., & Palansky, M. (2018). *Is Panama Really Your Tax Haven? Secrecy Jurisdictions and the Countries They Harm* (Working Paper: 23/2018). IES. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3267366
- Janský, P., & Palanský, M. (2019). Estimating the scale of profit shifting and tax revenue losses related to foreign direct investment. *International Tax and Public Finance*, 26, 1048–1103. <https://doi.org/10.35188/UNU-WIDER/2018/463-6>
- Kemme, D. M., Parikh, B., & Steigner, T. (2017). Tax Havens, Tax Evasion and Tax Information Exchange Agreements in the OECD. *European Financial Management*, 23(3), 519–542. <https://doi.org/10.1111/eufm.12118>

- Moravec, L., Rohan, J., & Hinke, J. (2019). Estimation of international tax planning impact on corporate tax gap in the Czech Republic. *E&M Ekonomie a Management*, 22(1), 157-171. <https://doi.org/10.15240/tul/001/2019-1-011>
- Nakamoto, T., Chakraborty, A., & Ikeda, Y. (2019). Identification of key companies for international profit shifting in the Global Ownership Network. *Applied Network Science*, 58(4), 1-26. <https://doi.org/10.1007/s41109-019-0158-8>
- Nerudová, D., Solilová, V., Litzman, M., & Janský, P. (2018). International tax planning within the structure of corporate entities owned by the shareholder individuals through Panama Papers destinations. *Development Policy Review*, 38(1), 124-139. <https://doi.org/10.1556/204.2020.00026>
- Rohan, J., & Moravec, L. (2017). Tax information exchange influence on Czech based companies' behavior in relation to tax havens. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 65(2), 721-726. <https://doi.org/10.11118/actaun20176502072>
- Sawyer, A. (2011). The OECD's tax information exchange agreements an example of (in)effective global governance? *Journal of Applied Law and Policy*, 41-54.
- Sawyer, A. (2017). An update on Hong Kong's exchange of information developments and engaging in with BEPS. *Asia Pacific Law Review*, 25(2), 170-189. <https://doi.org/10.1080/10192557.2017.1396663>

Management of Sustainability, Its Measurement and Relevance in the Enterprise

Patricia JÁNOŠOVÁ* and Emese TOKARČÍKOVÁ

University of Žilina, Žilina, Slovakia; Patricia.Janosova@fri.uniza.sk, Emese.Tokarcikova@fri.uniza.sk

* Corresponding author: Patricia.Janosova@fri.uniza.sk

Abstract: The commitment of the enterprise to act in a sustainable way requires decision-making based on an appropriate set of sustainability indicators. The current knowledge about sustainability offers numerous indicators and best practices. However, not all indicators are verified in practice and implementable for every enterprise. The article deals with the results of our survey in conditions of Slovak business environment, which showing a disproportion of the numbers and types of recorded sustainability metrics in practices. This causes a question that despite of the fact, that sustainability measurement requires a holistic approach, whether the selected set of sustainability indicators efficient to fulfill the given enterprise's and its stakeholders' needs. Based on we are offering a suggestion how to create a basic priority for this multicriterial choice problem. Setting up the main criteria and their multilateral relations improving management of choosing appropriate measurement and its relevance for the given enterprise. In our opinion, the most effective way is to create a framework of indicators for each of the business sectors.

Keywords: sustainability; management; indicators; decision making; measurement

JEL Classification: Q01; M00; L00

1. Introduction

Economic theory teaches us that the main goal of all enterprises is to maximize their profits. However, in the world with limited sources (factors of production) to focus solely only to profit generation is no more enough. This one-sided orientation of the management does not bring long-term sustainability and certainty of successful business activities of the enterprise. Due this reason behind increasing social pressures also the business environment is changing. Enterprises are more and more engaging in interactions with their stakeholders, their corporate strategies are affected by the social and environmental impact of their business.

Our article firstly describes the result of our survey focused on the perception of sustainability issues by Slovak enterprises with analysis what type of sustainability indicators they prefer in their measurement and reporting. Based on literate review and the findings of our survey, we discuss and make suggestions for managers, how to orient and choose appropriate set sustainability indicators and metrics. Why? Sustainability from our point of view cannot be just a matter of enterprise' marketing or making only a good impression.

As a definition says sustainability means "meeting our own needs without compromising the ability of future generation to meet their own needs" (Brundtland report,

1987), so measurement of indicators should be tailored for a specific business sector and their current and future stakeholders to ensure lasting prosperity. Sustainability indicator, according to our understanding and relevant to performance measurement, is a summary measure that informs managers on the stage of, or change in, the business environment that is being measured. Following, the metric is the measured value(s) used to assets specific indicators, which defines the units and how indicators is being measured. In case of quantifiable sustainability goals and their respective indicators enable the systematic tracking of set sustainability targets and guiding sustainability trajectories (Lutje & Wohlgemuth, 2020). Our understanding is based on scientific theories and practice where researchers prefer two basic ways of understanding the purpose of sustainability indicators. The first way is that sustainability indicators are “data carriers” so measures entities whose identity exclusively relies on the variables and parameters whit which they associated, independently from the context, purpose, and logistics behind their use (Elgert, 2018; Gudmundsson, 2003). The second way is that sustainability indicators are a “message carriers”, so they are arguments, ideas, and expectations that particular actors mobilize regarding sustainability issues. (Lehtonen et al. 2016, Kates et al., 2005).

1.1. Literature Review

The Directive 2014/95/EU requires large enterprises (those that have 500+ employees operating in the EU and are public interest entities) “to disclose relevant non- financial information to provide investors and other stakeholders with a more complete picture of their development, performance and position and the impact of their activity. (Directive 2014/95/EU, 2014). Another publication, such as UN Global Compact GRI Guideline is the basic key framework of sustainability reporting since the late 1990s. The vision of these pioneers is to push every organization to adapt sustainability forms as an essential part of their strategies, plans, and business activities. UN Global Compact with Agenda 2030 explaining through 17 Sustainable Development Goals how business leaders could act towards sustainability and decrease the disparities between countries (Inescu et al., 2018; Strakova et al., 2016). According to Verboven and Vanherck (2016), the objectives of AGENDA 2030 are designed to be applicable in both developing and developed countries. The objectives of AGENDA 2030 contain a total of 230 indicators, and due to the difficulty of recording them, each country in the world must choose those indicators that are characteristic of it. In this context, we see unexplored potential for defining indicators of sustainable development, which will be characteristic of business sectors and has not yet been developed.

Surveys, like research paper based on correlation analysis by Socolius et al. (2018) show that the acceptance of the enterprise’ management in terms of the sustainable development is in a close relationship with implementing voluntary reporting and the willingness to increase sustainability activities.”

Sustainability indicators recommended by authorities help not only for managers, but also for researchers to measure the enterprise’ business involvement in sustainable activities, to help to identify business opportunities, strengthen trust and above all, to increase employee motivation. Ejarque and Campos (2020) in their study confirm that a focus on

sustainability in the enterprise is essential. They also state that the literature offers several frameworks to support the implementation of sustainable elements in the enterprise, but empirical evidence in this area is still lacking and the presented frameworks are not verified.

Indicators related to the human and social sustainability measure a maintenance and improvement of the human capital investments and promote business values that respect human capital. Kucharcikova and Miciak (2018) as well Vetrakova et al. (2018) offers verified metrics and approaches for the assessment of how effectively the enterprise uses human capital. Expert teams led by and Lorincova et al. (2018) explaining how indicators about employee's motivation, in terms of occupation classification and age, as a managerial tool can be used for approximation of employees 'needs with enterprise goals.

Environmental sustainability indicators are measuring how enterprise minimize negative impact (externalities) of own business activities on the environment. EMS standards were created on the strict legislative requirements, but unfortunately sometimes was considered cost rather than a resource or opportunity. Evaluation of environmental indicators also leads to suggest how to implement complex control quality management not only in enterprises, but even in organization like it is shown by Tomaskinova et al. (2013). Ecological footprint is a frequently used environmental indicator identifying the reduction potential of the enterprise (Costa et al., 2019).

Future economic equity and fairness could be achieved with strong and stable economy built on the innovation and investments. Better use of resources and economic impacts of describing performance from different stakeholders' perspective might involve a conceptual and practical attitude building a bridge between them and enterprise own financial performance (Malichová & Durisova, 2015). Decision making based on knowledge about economic performance indicators directly impacts enterprises 'ability to maintain a sustainable long-term business and to distribute wealth. (Malichová & Miciak, 2019).

Although in some cases, sustainability indicators may overlap, it is important to identify which specific set of them is unique for selected enterprise and make a decision, how their measurements and reporting to effectively incorporate it on the operative and strategic level of the management.

2. Methodology

As part of the paper aimed at identifying indicators of sustainable development in enterprises in the Slovak Republic, we have initially identified the following research questions:

- *Which specific indicators in the enterprise does the management consider to be the most important?*
- *What types of indicators based on the triple bottom line model are recorded in the enterprise?*
- *Which types of indicators based on the triple bottom line model have the highest incidence in enterprises?*

Our paper focused holistically on identifying indicators of sustainable development in enterprises in the Slovak Republic. Respondents introduced us to the main indicators that they record in the enterprise and which are of great importance to them. In some cases, these

were activities in which the extent of action was recorded. The total number of enterprises that participated in the paper was 79. Based on size, they are specified as follows: Micro – 4, Small -29, Medium-sized 24, Large -22, Total -79.

3. Results

We divided the achieved results and specific indicators applied in enterprises on the basis of the triple bottom line model. We found that out of the total number of indicators, 56% of indicators were of an environmental nature, 33% of indicators were of a social nature and only 11% were of an economic nature (Figure 1 and Figure 2). When determining economic indicators, we often encounter the problem of public reporting and measurement. This is due to the fact that enterprises are obliged to record most economic indicators due to legislation. Therefore, it is difficult to determine which economic indicators are reported by enterprises in accordance with sustainable development.

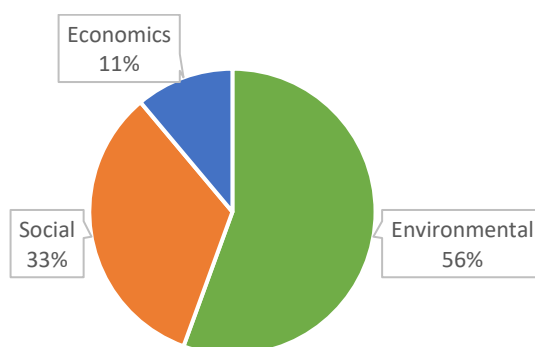


Figure 1. Variety of indicators based on the triple bottom line model. (own survey, 2020)

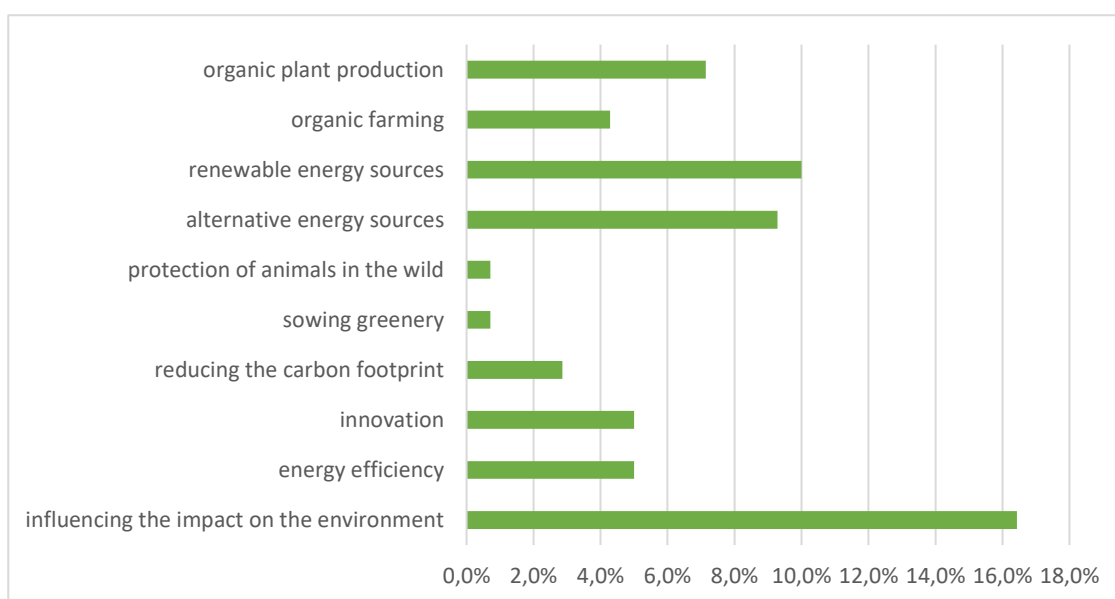


Figure 2. Proportion of environmental indicators during measurement (own survey, 2020)

In terms of environmental indicators, the highest incidence is recorded in the enterprise's focus on influencing the enterprise's impact on the environment (16.4%), the use of renewable

energy sources (10%) and alternative energy sources (9.3%). By their nature, these important indicators fall within the objectives of the UN program called AGENDA 2030.

When determining social indicators (Figure 3) the focus on employee development was the most represented (12.1%). It is very important for the management of the enterprise to develop the potential of employees, motivate them at work and focus on their satisfaction and responsibility. In the second place in the occurrence of social indicators, the protection of employees' health occurred (8.6%). The enterprise's management takes care of the health and safety of its employees, but also their health outside work. In every enterprise, it is essential that the workforce is loyal to the enterprise, while it is necessary to pay attention to the health and satisfaction of employees. In the third place with the highest frequency of occurrence is a significant influence of stakeholders.

The term broadly covers a range of groups, namely: suppliers, customers, employees, management, shareholders, associations, trade unions, politicians, regional and state representatives. In most cases, the enterprise's management itself pointed out that it is the stakeholders who have a significant internal and external influence on the enterprise's activities. Therefore, focusing on their business impact is essential.

The indicators represented in the lowest number include provided benefits for employees (5.7%), community support (2.1%) and cooperation with sheltered workshops (0.7%). It is a priority for the employer to employ skilled, responsible, and loyal employees. Employee benefits are currently the second most important reason when choosing a job or staying in employment in Slovakia. One of the increasingly popular forms of providing employee benefits is currently the "cafeteria system".

Community support, in which we advise education, sports activities and other activities for the development of citizens, has always been one of the popular forms of support from businesses. Thanks to them, the enterprise builds a good name and uses them as a suitable form of marketing. Cooperation with sheltered workshops in Slovakia is carried out only to a very small extent (Figure 3).

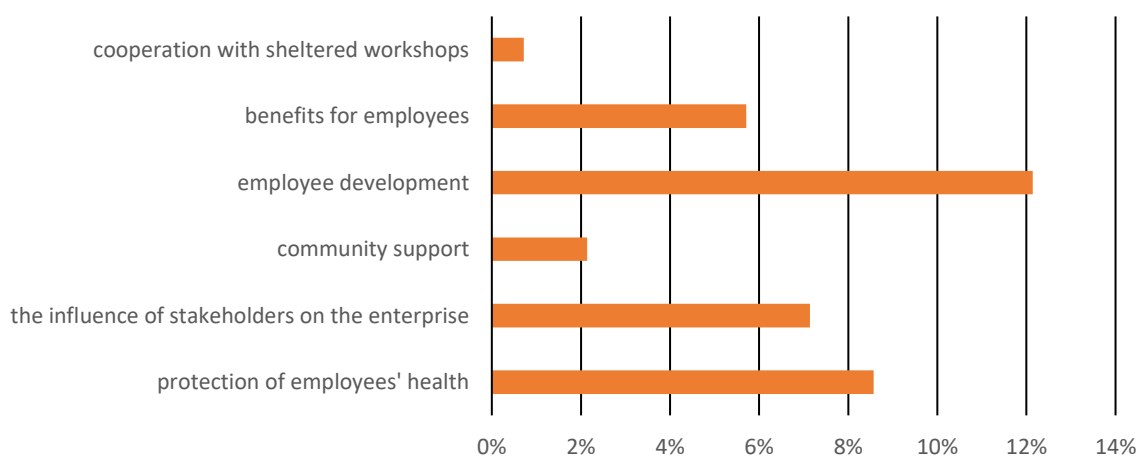


Figure 3. Proportion of social indicators during the measurement. (own survey, 2020)

Finally, if we divide all the indicators that we recorded during the research, according to the triple bottom line model, we get the following Figure 4.

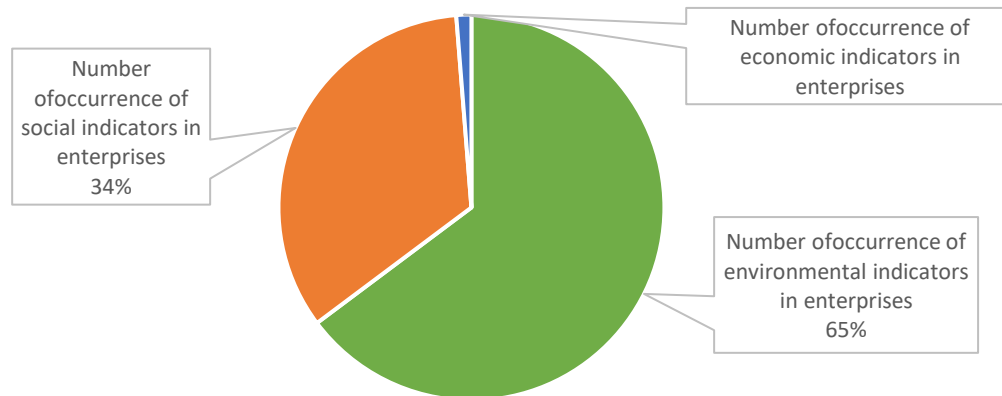


Figure 4. Total share of sustainability indicators measured in enterprises. (own survey, 2020)

As many as 65% of all indicators have an environmental character, 34% have a social character and only 1% show indicators of an economic nature. The ratio of indicators from our research based on the triple bottom line is therefore 65: 34: 1, while the ratio of indicators based on GRI reporting (G3 guideline) from the perspective of the triple bottom line is 38:51:11.

4. Discussion

More and more enterprises disclosure sustainability reports or social balance reports to communicate their progress towards achievement sustainability goals. They usually use GRI Standards and trying to offer a complete holistic picture of all their sustainability issues and activities, but

- *Is it possible to be in every area (Economy, Society, Environment) successful?*
- *What about enterprises who are just starting with their efforts towards sustainability?*
- *Where must they start?*

Our personal interviews with managers cooperated on our survey showed us, that there is an existing need to find appropriate way which set of indicators is suitable for measurement resp. reporting and linking structurally, conceptual, and chronologically to improve the decision-making process in a certain enterprise.

This is a multicriterial decision choice problem which requires to design a decision – making model based on understanding and analyzing a current situation and enterprise needs. Certainly, aspects can evaluate conflicting criteria in decision making, but also some aspects for given enterprise are irrelevant. Our suggestions there are focused on further aspects of multicriterial decision-making process how to choose appropriate sustainability indicators for their own enterprise (Figure 5).

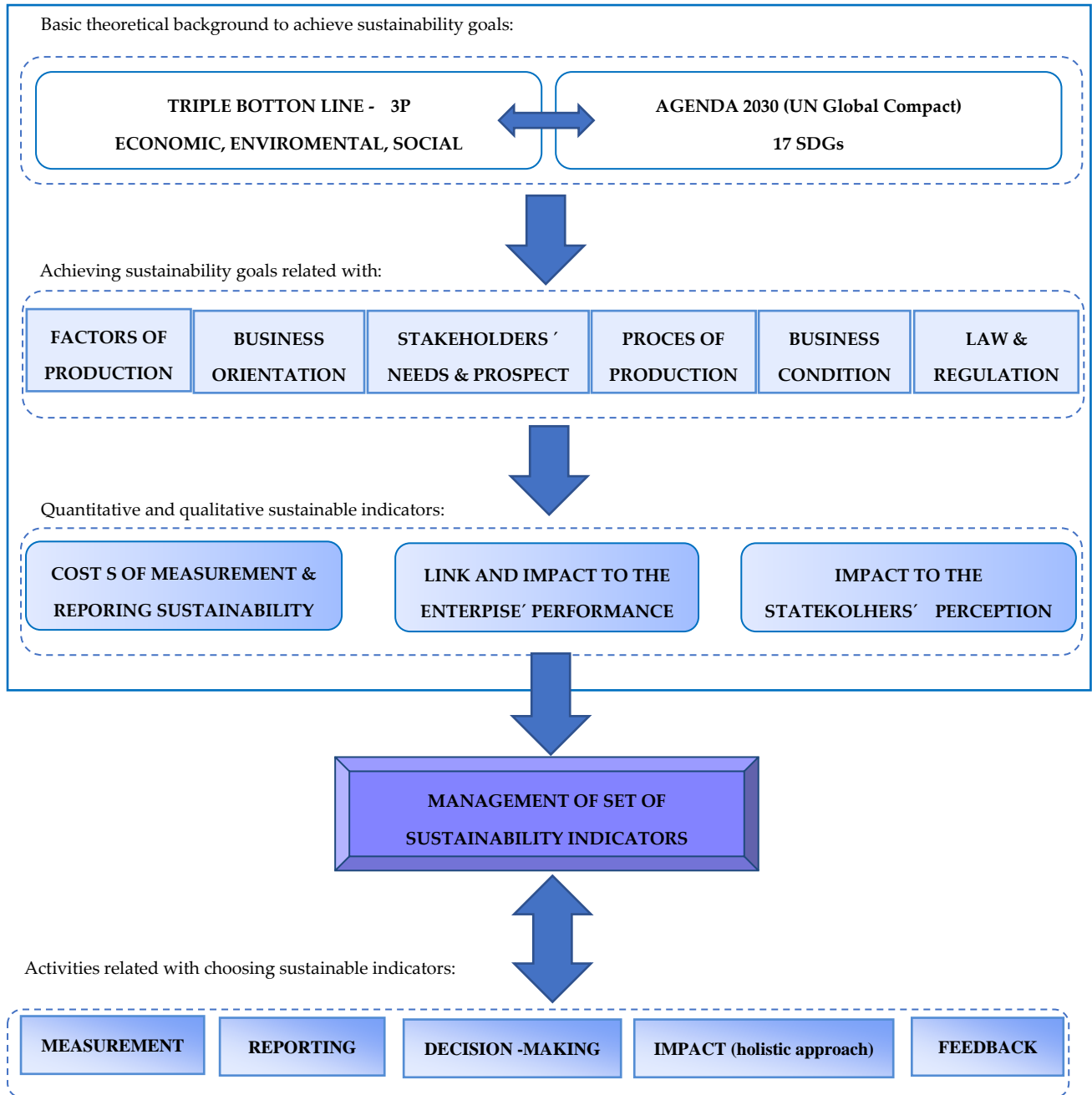


Figure 5. Set of aspects for multicriterial decision making how to choose sustainability indicators for given enterprise.

1. aspect: Which theory allows for managers to capture and implement activities leading to sustainability more precisely for their concrete enterprise and offer them also to improve business performance? Is it enough to be guided by theory of triple bottom line and stakeholder 'theories, or managers should be following more detailed UN 's 17 SDGs? How to choose criteria which topic of sustainability are should be prioritized by the enterprise?

2. aspect: The answers the above questions managers of a selected enterprise can find by comparison of activities towards sustainability to:

- Sources (Factors of production) needed for the production process (as well in case of provision of services) and further business model of the enterprise.

- Business orientation of the enterprise with regard i.e., sector of where operates, the size of the market, competition ability, existing laws & regulations, type, and characteristics of produced product or provided service, etc.
- Stakeholders needs and prospect – to be focused on the importance of anyone directly or indirectly involved by internal and external surroundings of production or provision of services or broader stakeholders (Benn et al., 2014).

3. aspect: Certainly, acting in a sustainable way, also measurement and reporting sustainability indicators generates costs. (Durisova & Kucharcikova, 2014) In a business context, managers want to refer the efficient use of assets to maintain enterprise profitability over time. Usage of modern business performance evaluation methods is helpful, but not always lead same results. Hence, researchers warn to check them every time, which of them are suitable for measuring and to create a performance portfolio (ranking) (Onuferova et al., 2020). In a sustainability context the measurement of impact to the stakeholder's perception, indeed brings out additional costs, is essential to know which indicators are worth to measure and report and how to use i.e., ICT to decrease these costs. Software support in praxis and the significance of dashboards for decision process in the enterprises provide views of key performance indicators (Teplická et al., 2020), and also knowledge of social network usage (Cenkova & Steingartner, 2020) and create a base for competitiveness. Subsequently relationship binding of environmental, social and governance scores and sustainability performance can assign priorities how to implement sustainability into the enterprise strategies and practice. (Rajesh & Rajendran, 2020)

4 aspect: This aspect summarizes the managerial activities vice-versa affected by choosing the appropriate unique set of the sustainability indicators for selected enterprise. In case of measurement manager should be capable quantify the enterprise's value to the stakeholders, which is central for purpose-driven leadership approach and decision-making process. This sustainable evaluation can use i.e., grey-based approach, used by Agrawal and Vinodh (2019) or multiple attribute decision making tools like shown by Ecer et al. (2019) or De Steur et al. (2019), etc.

5. Conclusions

Sustainability requires a holistic approach to the enterprise's activities and needs. For this reason, the fulfillment of sustainability goals is very complex and demanding process even in small enterprise. Managers in their decision-making process should deal with the multicriterial choice problem of what to prioritize. We are convinced, that managers must also deal with analysis and effects, which can be through series of sustainability indicators reflected in enterprise's sustainability engagements and also enterprise's performance. The presented survey conducted in 79 enterprises in Slovakia provided us with a picture of the situation of recording indicators of sustainable development in practice. Each of the enterprise is characterized by different indicators that need to be recorded. The survey shows that enterprises generally focus mainly on addressing environmental issues. This is a consequence of managers' awareness of the need to protect the environment. This is mainly

due to the need to maintain a healthy environment for the next generations of people, animals, and plants on the planet. Our future research therefore will be specified to develop sector-specific environmental indicators. The reason is the need to focus on those indicators that significantly affect the environment and their recording is highly justified.

Acknowledgments: This work was supported by Grant System of University of Zilina No. 8058/2020. Creating a system of relevant indicators of sustainable business development for effective business management.

References

- Agrawal, R., & Vinodh, S. (2020). Sustainability evaluation of additive manufacturing processes using grey-based approach. *Grey Systems: Theory and Application*, 10(4), 393–412. <https://doi.org/10.1108/GS-08-2019-0028>
- Benn, S., Dunphy, D., & Griffiths, A. (2014) *Organizational change for corporate sustainability*. Routledge, Oxford.
- Brundtland report. (1987). *Our Common Future: Report of the World Commission on Environment and Development*. UN Documents. <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>
- Cenková, R., & Steingartner, W. (2020). Use of internet social networks in academic. *Journal of Information and Organizational Sciences*, 44(2), 275-295.
- Costa, I., Martins, F. G., & Alves, I. (2019). Ecological Footprint as a Sustainability indicator to analyze energy consumption in a Portuguese textile facility. *International Journal of Energy and Environmental Engineering*. 10(4), 523-528, <https://doi.org/10.1007/s40095-018-0268-6>
- Directive 2014/95/EU. *Disclosure of non-financial and diversity information by large companies and groups Sustainability/Corporate Social Responsibility (CSR) and the European Union*. European Union, The European Parliament and The Council of the European Union. <http://eur-lex.europa.eu/legal-content/EN/LSU/?uri=CELEX:32014L0095>
- DeSteur, H., Temmerman, H., Gellzsch, X., & Canavari, M. (2019). Drivers, adoption, and evaluation of sustainability practice in Italian wine SMEs. *Business Strategy and Environment* 29(2), 744-762. <https://doi.org/10.1002/bse.2436>
- Durisova, M., & Kucharcikova, A. (2014). The Quantitative Expression of Factors which Affect the Cost of Transport Enterprise. In *18th International Conference on Transport Means 2014* (pp. 190-193). Kaunas Univ Technol, Kaunas, Lithuania.
- Ecer, F., Pamucar, D., Zolfani, S. H., & Eshkalag, M. K. (2019). Sustainability assessment of OPEC countries: Application of a multiple attribute decision making tool. *Journal of Cleaner Production*, 241. <https://doi.org/10.1016/j.jclepro.2019.118324>
- Ejarque, A. T., & Campos, V. (2020). Assessing the Economy for the Common Good Measurement Theory Ability to Integrate the SDGs into MSMEs. *Sustainability*, 12(24). <https://doi.org/10.3390/su122410305>
- Elgert, L. (2018). Rating the sustainable city: 'Measurementality', transparency, and un-expected outcomes at the knowledge-policy interface. *Environmental Science. Policy* 79, 16–24. <https://doi.org/10.1016/j.envsci.2017.10.006>
- Gudmundsson, H. (2003). The policy use of environmental indicators -learning from evaluation research. *Journal of Transdisciplinary Environmental Studies*, 2(2), 1-12.
- Inescu, R. V., Zlati, M. L., Antohi, V.M., & Stanciu, S. (2018). Reduced Inequalities as Factor of Sustainable Development: The Analysis Under Econometric Models. *Sustainability*, 10(10). <https://doi.org/10.3390/su10103523>
- Kates, R. W., Parris, T. M., & Leiserowitz, A. A. (2005). What is sustainable development? Goals, indicators, values, and practice. *Environ.: Sci. Policy Sustain. Dev.* 47(3), 8–21.
- Kucharcikova, A., & Miciak, M. (2018). Human Capital Management in transport Enterprises with the Acceptance of Sustainable Development in the Slovak Republic. *Sustainability*, 10(7). <https://doi.org/10.3390/su10072530>
- Lehtonen, M., Sébastien, L., & Bauler, T. (2016). The multiple roles of sustainability indicators in informational governance: between intended use and unanticipated in-fluence. *Current Opinion in Environmental Sustainability*, 18, 1–9. <https://doi.org/10.1016/j.cosust.2015.05.009>
- Lutje, A., & Wohlgemuth, V. (2020). Tracking Sustainability Targets with Quantitative Indicator Systems for Performance Measurement of Industrial Symbiosis in Industrial Parks. *Administrative Science*, 10(1). <https://doi.org/10.3390/admsci10010003>

- Lorincova, S., Hitka, M., Starchon, P., & Stachova, K. (2018). Strategic Instrument for Sustainability of Human Resource Management in Small and Medium-Sized Enterprises Using Management Data. *Sustainability*, 10(10). <https://doi.org/10.3390/su10103687>
- Malichova, E., & Durisova, M. (2015). Evaluation of Financial Performance of Enterprises in IT Sector. In *9th International Scientific Conference on Business Economics and Management (BEM)* (vol. 34, pp. 238-243). Tech Univ Zvolen. Procedia Economics and Finance.
- Malichova, E., & Miciak, M. (2019). The Model of Managerial Decision - making on Investment in Medium - sized In *17th International Scientific Conference Hradec Economic Days* (vol. 9, pp. 45-56). University of Hradec Kralove.
- Onuferova, E., Cabinova, V., & Vargova, T. D. (2020). Analysis of modern methods for increasing and managing the financial prosperity of businesses in the context of performance: a case study of the tourism sector in Slovakia. *OECONOMIA COPERNICANA*, 11(1), 95-116. <https://doi.org/10.24136/oc.2020.004>
- Rajesh, R., & Rajendran, C. (2020). Relating Environmental, Social and Governance score and sustainability performances of firms: An empirical analysis. *Business Strategy and the Environment*, 29(3), 1247-1267. <https://doi.org/10.1002/bse.2429>
- Socolius, M., Grosu, V., Hlaciuc, E., & Stanciu, S. (2018). Analysis of Social Responsibility and Reporting Methods of Romanian Companies in the Countries of the European Union. *Sustainability*, 10(12). <https://doi.org/10.3390/su10124662>
- Strakova, J., Kucharcikova, A., Partlova, P., & Vachal, J. (2016). Foreign Direct Investment and Transport Serviceability - a Prerequisite for the Development and Stability of National and Regional Economies. *NASE MORE*, 63(3), 204-210. <https://doi.org/10.17818/NM/2016/SI24>
- Teplická, K., Steingartner, W., Kadárová, J., & Hurná, S. (2020). Dashboards – effective instrument of decision in synergy with software support. *Polish Journal of Management Studies*, 22(1), 565-582. <https://doi.org/10.17512/pjms.2020.22.1.36>
- Tomaskinova, J., Tomaskin, J., & Rakalova, M. (2013) Management of Sustainable development of schools by evaluation of file indicators of sustainable development of school. In *7th International Technology, Education and Development conference (INTED 2013)* (pp. 4791-1795). INTED Proceedings, Valencia.
- United Nation Global Compact. *Sustainable Development Goals 2030 - SDGs*. <https://www.unglobalcompact.org/sdgs>
- Verboven, H., & Vanherck, L. (2016). Sustainability management of SMEs and the UN Sustainable Development Goals. *Uwf UmweltWirtschaftsForum*, 24(2-3), 165-178. <https://doi.org/10.1007/s00550-016-0407-6>
- Vetrakova, M., Hitka, M., Potkany, M., Lorincova, S., & Smerek, L. (2018) Corporate Sustainability in the Process of Employee Recruitment through Social Networks in Conditions of Slovak Small and Medium Enterprises. *Sustainability*, 10(5). <https://doi.org/10.3390/su10051670>

The Use of PR Tools and Analysis of Their Effectiveness as Viewed by Managers of Czech Chemical Companies

Martina JELINKOVA*, Hana LOSTAKOVA and Katerina MACHACKOVA

University of Pardubice, Pardubice, Czech Republic, martina.jelinkova@upce.cz, hana.lostakova@upce.cz

* Correspondence: martina.jelinkova@upce.cz

Abstract: The paper presents the results of primary quantitative research aimed at determining the degree of use of various PR tools and evaluating their perceived effectiveness with the public. The respondents were managers of chemical industrial companies in the Czech Republic. It compares the use and perceived effectiveness of the monitored PR tools and identifies those that should be maintained, those that need to be developed and also those that should be restrained. This provides managers with a suitable guide for effective management of PR communication. The findings are supplemented by an analysis of differences in the use of monitored PR tools by the size of companies and differences in the perception of the effectiveness of the monitored PR tools according to different characteristics of respondents. It was confirmed that PR tools aimed at the public are used to a greater extent by larger companies (more than 250 employees) and respondents' views differ the most in the perceived effectiveness of press releases.

Keywords: public relations; PR tools; influencing the public; chemical industry

JEL Classification: L60; M21; M31

1. Introduction

Public relations (PR) are a standard part of corporate communication, the aim of which is to create and support effective strategic two-way communication between the company and its surroundings (Meyers, 2016). Opinions on the definition of PR differ among experts and there are more than five hundred definitions today (Garcia-Nieto et al., 2020). The most frequently cited definition of PR from 1978 by the British Institute of Public Relations, which described PR as "the deliberate, planned and sustained effort to establish and maintain mutual understanding between an organisation and its publics" (Novotna & Musil, 2017; Kopecky, 2013; Ftorek, 2010). This definition was modified by the PRSA (Public Relations Society of America) in 2011–2012 so that the definition of PR even more respected the role of relationships, mutual respect, and strategic communication: "public relations is a strategic communication process that builds mutually beneficial relationships between organizations and their publics." (Corbett, 2012)

It clearly follows from the definition of PR that an important step in PR management is to precisely define those groups of the public on which their activities will focus. Proper identification of PR target groups is crucial for the company (Musil, 2005) as it predetermines

the usable PR techniques and tools as well as the type of information communicated. (Destiny, 2018) In the current literature, target groups are often referred to by the collective term "stakeholders". According to Heskova and Starchon (2009), there are two basic groups of stakeholders who require different forms of communication and communication channels and include two basic areas of activity (Kotler & Keller, 2012; Kotler et al., 2019):

- Internal Public Relations are focused primarily on employees, the goal is to motivate and harmonize them with the culture, interests and strategic goals of the organization.
- External Public Relations are focused on maintaining and improving relationships with key partners, interest groups and the public, their goal is to improve the image of the organization.

Logically, the two groups of PR activities are fundamentally different. However, even within each area of PR, it is possible to trace the variability of using different PR tools according to a specific category of target stakeholders. This is confirmed by research by Sommerfeldt et al. (2019), who also believe that the specificity of the use of different PR tools will depend on the type of company and industry.

Given the focus of our research, we directed our attention on mapping those PR tools that, in the opinion of experts, could be used in external PR specifically towards the general and local public. Many authors deal with these PR tools in various contexts. According to most authors (e.g. Svoboda, 2009; Foret, 2011; Hejlova, 2015; Rubtcova & Pavenkov, 2019; Solmonova & Volkonskij, 2019), the most used PR tools aimed at influencing the general and local public include:

- information publicity, such as press releases, press conferences or discussions, annual reports, corporate magazines, bulletins, newsletters, etc.;
- advertising of the organization that is a combination of advertising and public relations and is not focused on a specific product, but on the company as a whole. According to the above-mentioned authors, advertising of the organization can be realized through, for example, websites, billboards, leaflets, posters and media messages promoting only the company and, for example, its social activities, this can also include information published in the media or otherwise published about sponsorship or organizing events, etc.;
- the organization of special events that attract the attention of the selected target group and strengthen its relationship with the brand or organization. According to the above-mentioned authors, these events include, for example, social events (concerts, balls, shows, etc.), ceremonial opening of new companies, branches or stores, events for launching new products into the market, open days, etc.;
- sponsorship of cultural, political, sporting or social activities.

Heskova and Starchon (2009) also include media identities in these basic PR tools, which, according to the authors, mainly include company logos and slogans, letterheaded papers, business cards and corporate dress code. Hejlova (2015) also considers the recommendation of celebrities or opinion leaders, or celebrity endorsement, to be an important PR tool that

has a strong public impact, when a known person's name or face is associated with a certain brand or product, expressing his/her personal support. Last but not least, according to some authors (e.g. Jelinkova et al., 2017; Fawkes, 2018), important PR tools can also include the implementation and presentation of socially responsible activities (CSR), i.e. activities presenting economic, social, environmental and philanthropic corporate responsibility (Tetrevova, 2017; Tetrevova et al., 2019).

From a search of available professional literature, it is clear that there are a number of PR tools recommended for the company's work with the public. Although research by some authors (e.g. Sommerfeldt et al., 2019) suggests that these tools are likely to be used differently with different efficiencies specifically in different industries, there are no studies addressing the feasibility of instruments and monitoring their effectiveness by sector. We therefore tried to close this gap in our research and conducted research comparing the use and effectiveness of various external PR tools specifically in the chemical industry. As part of the research, we monitored all the PR tools listed below (a total of 25 tools) divided into three categories:

- General PR tools: press releases; press conferences; annual reports; corporate newspapers and magazines; bulletins and newsletters; internet presentation of the company; occasional publications; business advertising and identity media.
- PR events: corporate presentation events; thematic conferences or symposia; company days or lectures; company workshops; organization of social events and meetings; organization of events aimed at starting the operation of an entity; open days; organization of charitable (benefit) auctions or events; sponsorship of cultural, political, sports and social events.
- Presentation of social responsibility activities: presentation of information on business activities and economic results; presentation of information on the company's care for employees; presentation of information on the company's care for the environment; presentation of information on the implementation and support of ethical behaviour of your company; presentation of information about the charitable activities of your company.

Our goal was to contribute to the management of effective corporate communication and to identify those PR tools on which companies should focus their attention and increase their use or maintain their level as they appear to be very effective with the public and to specify those PR tools the use of which in relation to the public should be reduced, not developed or innovated in such a way as to increase their impact on the public. We were also interested in whether the use of the given PR tools differs depending on the size of the company and whether opinions on the impact of PR tools on the public differ depending on the different characteristics of the respondents.

2. Methodology

Due to the unfavourable epidemiological situation, an electronic survey using an interactive online questionnaire was chosen as the method of primary quantitative research.

Employees of chemical industrial companies associated in the Association of Chemical Industry of the Czech Republic were addressed, namely product managers, employees of marketing and sales departments and employees of the press department or PR. Respondents were selected by deliberate judgment. The database of contacts was created on the basis of an analysis of the websites of companies associated in the Association of Chemical Industry of the Czech Republic and personal contacts. 53 completely completed questionnaires were obtained. The return on research was about 20%.

The research verified, among other things, the following hypotheses:

H1: Due to their tradition, general PR tools (see above) will be widely used by companies, but if they are not online, they will be ineffective with the public.

H2: PR events will be less used due to their high financial demands and also less effective from the point of view of companies in influencing the public.

H3: The implementation and presentation of socially responsible activities will be widely used for its modernity and also, from the point of view of the respondents, very effective with respect to the public.

H4: Larger companies use PR activities towards the public to a greater extent than small companies.

H5: Older and more experienced employees will have more confidence in more traditional PR tools.

The hypotheses were verified on the basis of the obtained results, which were statistically processed using the IBM SPSS Statistics software platform and are presented below.

3. Research Results

The research can be divided into two parts. In the first part of the questionnaire, the level of use of the above-specified PR tools in the addressed companies was determined. A scale of 1-3 was used for the evaluation, where 1 = not used at all, 2 = partially used, 3 = fully used. The second phase of the survey concerned the findings of the impact of the given PR tools on the public as perceived by the respondents. The respondents used a scale of 1-4, where 1 = no influence, 2 = rather minor influence, 3 = rather greater influence, 4 = major influence.

The rate of use and the perceived impact of various PR tools on the public were analysed on the basis of the relative frequencies of respondents' responses, the median and the average ranking. The Friedman test at a significance level of 0.05 was used to determine whether the rate of use and the perceived impact on the public were statistically different for different PR tools. Due to the small size of the sample, this test was also suitable owing to the verbal rating scale. In all cases tested, the Friedman test showed a significance of less than 0.05. It can therefore be stated that the level of use of PR tools and their perceived impact on the public differ statistically significantly in all monitored cases.

Comparison of the degree of use and perceived effectiveness of the monitored PR tools with the public

The analysis of research results and a comparison of the rate of use and perceived effectiveness allowed us to identify four categories of PR tools:

- The most used and, at the same time, the most effective PR tools in relation to the public (see Table 1).
- Widely used but ineffective (or insufficiently effective) PR tools in relation to the public (see Table 2).
- Little-used but highly effective PR tools in relation to the public (see Table 3).
- Little-used and, at the same time, insufficiently effective PR tools in relation to the public (see Table 4).

We managed to include a total of 13 examined PR tools in these categories; the remaining 12 were in the area of average usage or average efficiency, and therefore it was not possible to categorize them. The specific order of effectiveness and use of the monitored tools has already been published by the authors of the paper, see Jelínková, Lošťáková, and Macháčková (2020).

Table 1. The most used and, at the same time, the most effective PR tools in relation to the public

PR tools analysed	Rate of use of PR tools according to respondents *)					Influence of PR tools on the public according to respondents **)					
	Relative response rates (%)			Median	Average ranking	Relative response rates (%)				Median	Average ranking
	1	2	3			1	2	3	4		
Internet presentation of the company	2	51	47	2	17.07	8	20	47	25	3	16.15
Sponsorship of sports events	13	51	36	2	15.22	5	23	40	32	3	16.51
Implementation and presentation of information about the company's care for the environment	19	46	35	2	14.68	0	15	47	38	3	19.38

* The scale 1-3 is used, where 1 = not used at all, 2 = partially used, 3 = fully used

** The scale 1-4 used, where 1 = no influence, 2 = rather minor influence, 3 = rather greater influence, 4 = major influence

Table 2. Widely used but ineffective (or insufficiently effective) PR tools in relation to the public

PR tools analysed	Rate of use of PR tools according to respondents *)					Influence of PR tools on the public according to respondents **)					
	Relative response rates (%)			Median	Average ranking	Relative response rates (%)				Median	Average ranking
	1	2	3			1	2	3	4		
Annual reports	26	25	49	2	15.10	17	49	25	9	2	10.35
Corporate newspapers and magazines	28	30	42	2	14.62	15	32	42	11	3	12.76
Occasional publications	26	34	40	2	14.28	16	45	28	11	2	11.04

* The scale 1-3 is used, where 1 = not used at all, 2 = partially used, 3 = fully used

** The scale 1-4 used, where 1 = no influence, 2 = rather minor influence, 3 = rather greater influence, 4 = major influence

The PR tools listed in Table 1 need to be supported and developed using the latest trends, especially those in the field of communication and information technologies. Digital PR, including the company's website, is a modern and rapidly developing area, as is the interest in corporate social responsibility, which also includes corporate environmental

responsibility. By effectively allocating resources to these PR tools, companies can make the most of their expected effectiveness to the public.

The use of these PR tools, which are probably obsolete with regard to the public, should probably be limited and targeted to other groups of stakeholders. The problem with their usability towards the public is their often-incomplete digitization and transfer to the online environment. Solving this problem could strengthen the impact of these tools on the public. Nevertheless, it seems that the company should not be too active in this category of tools and that it should rather promote tools that are much more effective with the public.

Table 3. Little-used but highly effective PR tools in relation to the public

PR tools analysed	Rate of use of PR tools according to respondents *)					Influence of PR tools on the public according to respondents **)					
	Relative response rates (%)			Median	Average ranking	Relative response rates (%)				Median	Average ranking
	1	2	3			1	2	3	4		
Open days	30	36	34	2	13.43	8	19	33	40	3	18.11
Creating a quality employee care system and informing about it	25	50	25	2	13.24	6	21	46	27	3	16.54
Implementation of charitable activities of the company.	19	58	23	2	13.42	4	31	40	25	3	15.88

* The scale 1-3 is used, where 1 = not used at all, 2 = partially used, 3 = fully used

** The scale 1-4 used, where 1 = no influence, 2 = rather minor influence, 3 = rather greater influence, 4 = major influence

The PR tools listed in Table 3 hide the greatest potential for further development and focus of interest of the PR department of chemical companies. These tools are probably wrongly neglected and more attention needs to be paid to them in the future. It is true that the possibilities for holding open days are limited due to the frequent dangers of chemical plants. Nevertheless, it would be worth considering using this PR tool at least to a limited extent as it would probably be highly appreciated by the public. From the point of view of the quality of the employee care system, the problem is probably not its non-existence, but rather its ineffective communication, which could be easily solved by incorporating appropriate information in the online environment.

Table 4. Little-used and, at the same time, insufficiently effective PR tools in relation to the public

PR tools analysed	Rate of use of PR tools according to respondents *)					Influence of PR tools on the public according to respondents **)					
	Relative response rates (%)			Median	Average ranking	Relative response rates (%)				Median	Average ranking
	1	2	3			1	2	3	4		
Identity media	38	36	36	2	11.96	21	34	30	15	2	11.42
Bulletins, newsletters	45	40	15	2	9.96	21	49	26	4	2	9.18
Press conferences	49	42	9	2	9.09	15	45	29	11	2	11.16
Sponsorship of political events	72	21	8	1	7.14	43	27	21	9	2	8.52

* The scale 1-3 is used, where 1 = not used at all, 2 = partially used, 3 = fully used

** The scale 1-4 used, where 1 = no influence, 2 = rather minor influence, 3 = rather greater influence, 4 = major influence

In the opinion of the interviewed managers, the low rate of use of these tools is justified due to their low effectiveness and any effort to develop these PR tools seems ineffective in relation to the public.

Analysis of differences in the use and effectiveness of PR tools depending on the characteristics of companies and respondents

When processing the research results, attention was also paid to the analysis of differences in the use of researched PR tools according to different characteristics of the company and analysis of differences in the perceived impact of each PR tool on the public depending on different characteristics of respondents. Differences were verified using the Kruskal–Wallis test at the 5% level of significance. The following tables present the results only for those PR tools for which any statistically significant differences were found, i.e. where the significance was less than 0.05.

The most statistically significant differences were demonstrated in the level of use of various PR tools depending on the size of the company. The results are shown in Table 5.

Table 5. Differences in the use of different PR tools by company size

PR tools	Use of PR tools by company size (average ranking) *)		Kruskal–Wallis test	
	Small and medium-sized enterprises	Large enterprises	χ^2	Sig.
Press releases	18.40	31.56	10.826	0.001
Press conferences	20.73	30.11	5.808	0.016
Corporate newspapers and magazines	14.65	33.91	22.685	0.000
Bulletins, newsletters	21.30	29.75	4.547	0.033
Identity media	21.15	29.84	4.586	0.032
Business presentation events	21.25	29.78	4.778	0.029
Thematic conferences or symposia	20.30	30.38	6.210	0.013
Company days or lectures, workshops	18.20	31.69	11.415	0.001
Open days	18.35	31.59	10.608	0.001
Sponsorship of cultural events	19.75	30.72	7.580	0.006
Sponsorship of sports events	20.58	30.20	6.028	0.014
Sponsorship of social events	20.78	30.08	5.453	0.020
Presentation of information about the company's care for employees	19.23	31.05	8.997	0.003
Presentation of information about the company's care for the environment	18.85	31.28	9.704	0.002
Presentation of information on the implementation and support of ethical business conduct	16.05	33.03	17.642	0.000
Presentation of information about charitable activities of the company	18.55	31.47	11.337	0.001

* The use was assessed on a scale of 1-3 (1 = not used at all, 3 = fully used).

According to this characteristic, a difference in the use of 16 monitored PR tools was found, which is 62% of all monitored PR tools. In all cases, the tools are used more in larger enterprises (i.e. with more than 250 employees).

Statistically significant differences in the perception of the impact of some PR tools on the public were found depending on the following characteristics of the respondents:

- gender of the respondent (see Table 6),
- age of the respondent (see Table 7),
- educational attainment of the respondent (see Table 8),
- level of management at which the respondent is employed (see Table 9).

Table 6. Differences in the perception of the impact of PR tools on the public by gender of the respondent

PR tools	Impact of PR tools by gender of respondents (average ranking) *)		Kruskal-Wallis test	
	Men	Women	χ^2	Sig.
Internet presentation of the company	25.23	38.40	3.948	0.047

* Perception was assessed on a scale of 1-4 (1 = no impact, 4 = major impact)

Table 6 shows that the company's internet presentation, which is a frequently used PR tool, is perceived by women as more effective than men. This interesting fact would probably deserve a deeper analysis.

Table 7. Differences in the perception of the impact of PR tools on the public by age of the respondent

PR tools	Impact of PR tools by age of respondents (average ranking) *)		Kruskal-Wallis test	
	Up to 45 years	Over 45 years	χ^2	Sig.
Press releases	20.68	28.52	4.059	0.044

* Perception was assessed on a scale of 1-4 (1 = no impact, 4 = major impact)

Table 7 shows that when analysing the differences in the perception of the impact of PR tools on the public by age of the respondent, a statistically significant difference was found only in press releases. Older respondents (over 45 years) perceive this tool as more effective with the public. This may be a reflection of a certain conservatism, where older employees may have more confidence in this traditional PR tool as they consider it to be tried and tested over the years.

Table 8 shows that statistically significant differences depending on the respondent's educational attainment were demonstrated for 4 PR tools. According to university-educated respondents, all of these groups of PR tools have a greater impact on the public than respondents with lower education believe. It is possible that more educated employees assume a greater desire of the public for information and therefore a greater interest of the public in the above-mentioned PR tools.

Table 8. Differences in the perception of the impact of PR tools on the public by educational attainment of the respondent

PR tools	Impact of PR tools by educational attainment of respondents (average ranking) *)		Kruskal–Wallis test	
	Secondary education with exit exam	University education	χ^2	Sig.
Corporate newspapers and magazines	18.88	28.79	4.459	0.035
Thematic conferences or symposia	18.42	28.93	4.949	0.026
Events aimed at starting the operation of a particular entity or its branch	16.13	29.61	8.022	0.005
Open days	17.75	29.13	5.872	0.015

* Perception was assessed on a scale of 1-4 (1 = no impact, 4 = major impact), Source: (Authors)

Table 9 shows that respondents working at a higher level of management believe that press releases and press conferences have a greater impact on the public than that estimated by those from lower levels of management.

Table 9. Differences in the perception of the impact of PR tools on the public by level of management

PR tools	Influence of PR tools by level of management (average ranking) *)		Kruskal–Wallis test	
	Higher level of management	Lower level of management	χ^2	Sig.
Press releases	29.08	20.13	4.139	0.042
Press conferences	29.04	20.23	4.124	0.042

* Perception was assessed on a scale of 1-4 (1 = no impact, 4 = major impact)

4. Discussion

The use of various PR tools in corporate communication is a traditional way the company influences the public so as to improve the image of the company in its eyes. Today, companies have a plethora of opportunities that are evolving in connection with the development of modern telecommunications and information technology. Still, companies are often unclear as to which PR tools they should really invest in so that their impact on the public is effective. Our research seeks to help companies orient themselves in the efficiency and use of various PR tools. Although it was aimed specifically at companies in the chemical industry, we believe that the results could be similar for other industries. However, this should be verified by further follow-up research.

Our hypothesis H1 has only been partially confirmed. Although some traditional PR tools are really widely used by companies and if they are not in the online environment (such as the company's website), they are also ineffective, according to respondents - see annual reports, corporate newspapers and magazines and occasional publications - but there are also PR tools from this category, which are insufficiently effective from the respondents' point of view, but companies do not use them much with the public either (identity media, bulletins, newsletters, press conferences). In general, it can be stated that traditional PR tools need to be carefully considered for their effectiveness and companies should try to implement modern technologies and trends in order to increase their effectiveness with the public. As

confirmed by a number of studies, such as Allagui and Breslow (2016), digital tools and platforms are playing an increasingly important role in supporting PR efforts to reach the public. Nevertheless, the use of technology can never replace the creative implementation of a PR strategy and the production of effective content (Wolf & Archer, 2018).

We believe that Hypothesis H2 can undoubtedly be rejected. Almost all monitored types of PR events have fallen into the area of average use and perceived effectiveness with the public. Sponsorship of sporting events was even rated as highly used and effective. The only tool not used by businesses is sponsorship of political events as they do not consider it effective. However, the relatively frequent use of PR events confirmed by this research does not mean that these events are used effectively. For example, research by Pokumensah et al. (2018) suggests that the use of PR events is frequent within PR, but often not fully coordinated to meet the company's goals. In addition, managers' assumptions about the effectiveness of these actions may be erroneous. This is confirmed by a survey of Freita et al. (2020) on the effectiveness of esports sponsorship, claiming that all interviewed experts believed that esports sponsorship would positively affect the brand image of sponsors, but only one third of the interviewed fans admitted their brand perception had improved due to the sponsorship.

As regards Hypothesis H3, only one side of the assumption has been confirmed, namely that the implementation and presentation of these activities has a major (environmental, social and philanthropic activities of the company) or medium (economic responsibility) impact on the public. The fundamental role of environmentally responsible activities from the public's point of view is also confirmed by a study by IPSOS (IPSOS, 2020). Unfortunately, this modern PR tool has not been consistently used by companies so far. The statement applies both to companies operating in the Czech Republic and to companies operating in a number of other countries, especially developing countries (KPMG, 2020). It applies both to companies in non-controversial industries, such as TOP100 companies in the Czech Republic or Ukraine (Tetreva et al., 2019), and to companies in controversial industries, such as chemical companies in the Czech Republic (Tetreva, 2018a, 2018b), in Ukraine (Tetreva et al., 2020) and Slovakia (Tetreva, 2018c). The fact is, as confirmed by our research, that many companies carry out a number of socially responsible activities, but fail to communicate effectively about them in relation to the public (Tetreva et al., 2020). This problem is particularly significant in the field of social and philanthropic activities (Tetreva et al., 2019, 2020).

Hypothesis H4 has been clearly confirmed by our research. It has been proven that larger companies (over 250 employees) use 16 monitored PR tools to a greater extent than smaller companies. As regards the other monitored PR tools (9 PR tools), no statistically significant difference has been found depending on the size of companies. The preference for smaller communication activities in terms of marketing tools in small businesses is also confirmed by the research of Lizbetinova et al. (2019), who claim that there is a range of limitations in marketing communication activities of small enterprises resulting from restricted finances as well as from the fact that owners and employees of small enterprises tend to be generalists rather than specialists, so their marketing expertise is often limited. The issue of the

effectiveness of communication of CSR activities in small companies is addressed by Morsing and Spence (2019), who are inclined to believe that requiring extensive communication activities from small businesses is often inefficient.

Hypothesis H5 assumed that older and more experienced employees would have more confidence in more traditional PR tools. The senior managers' tendency to adhere to established traditional principles while trying to avoid unproven tools in communication is confirmed by Kusuma et al. (2020). But the assumption of Hypothesis H5 has been confirmed only with press releases. This often-used PR tool is viewed as more effective not only by senior managers (over 45 years old), but also by respondents from a higher level of business management.

Although the limitations of the research results are obvious - a relatively small number of respondents and focus only on the chemical industry - we believe that it has provided interesting insight into the issue and will allow companies to more efficiently allocate resources among the range of PR tools currently available to companies. In the future, it would certainly be interesting to monitor the usability and effectiveness of PR tools in relation to other stakeholders and to compare the results with other industries. Last but not least, it would be appropriate to find out whether managers' assumptions about the effectiveness of PR tools in relation to the public correspond to reality and to conduct a survey directly with the public.

Acknowledgments: In this section you can acknowledge any support given which is not covered by the author contribution. This may include administrative, technical, and foremostly financial support. Please add a grant title and number if applicable.

References

- Allagui, I., & Breslow, H. (2016). Social media for public relations: Lessons from four effective cases. *Public Relations Review*, 42(1), 20-30. <https://doi.org/10.1016/j.pubrev.2015.12.001>
- Corbett, G. (2012, March). *A Modern Definition of Public Relations*. <http://prdefinition.prsa.org/index.php/2012/03/01/new-definition-of-public-relations/>
- Destiny, A.O. (2018). Understanding the concept of publicity in Public relations: a synoptic review. Kuwait Chapter of the Arabian. *Journal of Business and Management Review*, 7(2), 32-34. <https://doi.org/10.12816/0046066>
- Fawkes, A. G. J. (2019). A Global Capability Framework: Reframing Public Relations for a Changing World. *Public Relations Review*, 45, 101781. <https://doi.org/10.1016/j.pubrev.2019.05.002>
- Foret, M. (2011). *Marketing communication* (in Czech) (3rd ed.). Computer Press.
- Freitas, B. D. A., Contreras-Espinosa, R. S., & Correia, P. A. P. (2020). Sponsoring Esports to Improve Brand Image. *Scientific annals of economics and business*, 67(4), 495-515. <https://doi.org/10.47743/saeb-2020-0030>
- Ftorek, J. (2010). *Public relations and politics: who and how manages our destinies with our consent* (in Czech). Grada Publishing.
- Garcia-Nieto, M. T., Vinaras-Abad, M., & Cabezuelo-Lorenzo, F. (2020). Half a century in the evolution of the Concept of public relations (1970-2020). Review article. *Profesional de la Informacion*, 29(3). <https://doi.org/10.3145/epi.2020.may.19>
- Hejlova, D. (2015). *Public relations* (in Czech). Grada Publishing.
- Heskova, M., & Starchon, P. (2009). *Marketing communication and modern trends in marketing* (in Czech). Oeconomica.
- IPSOS. (2020, April 22). *Corporate Social Responsibility: There Is Growing Pressure to Treat Employees Fairly*. <https://www.ipsos.com/cs-cz/spolecenska-odpovednost-firem-roste-tlak-na-ferove-chovani-k-zamestnancum>
- Jelinkova, M., Lostakova, H., & Machackova, K. (2020). The Level of Use of Public Relations Tools and Evaluation of their Impact on the Reputation of Chemical Companies from the Perspective of the Czech

- Public. In *Proceedings of 11th International Scientific Conference "Business and Management 2020"*.
<https://doi.org/10.3846/bm.2020.518>
- Kopecky, L. (2013). *Public relations: history - theory – practice* (in Czech). Grada Publishing.
- Kotler, P., & Keller, L. K. (2013). *Marketing management* (14th ed.). Grada Publishing.
- Kotler, P., Armstrong, G., Harris, L. C. & He, H. (2019). *Principles of marketing* (8th ed.). Pearson Education Limited.
- KPMG (2020, December). *The Time Has Come. The KPMG Survey of Sustainability Reporting 2020*.
<https://assets.kpmg/content/dam/kpmg/xx/pdf/2020/11/the-time-has-come.pdf>
- Kusuma, H., Muafi, M., Aji, H. M., & Pamungkas, S. (2020). Information and Communication Technology Adoption in Small- and Medium-Sized Enterprises: Demographic Characteristics. *Journal of Asian Finance Economics and Business*, 7(10), 969-980. <http://doi.org/10.13106/jafeb.2020.vol7.no10.969>
- Lizbetinova, L., Starchon, P., Lorincova, S., Weberova, D., & Prusa, P. (2019) Application of Cluster Analysis in Marketing Communications in Small and Medium-Sized Enterprises: An Empirical Study in the Slovak Republic. *Sustainability*, 11(8), 2302. <http://doi.org/10.3390/su11082302>
- Morsing, M., & Spence, L. J. (2019). Corporate social responsibility (CSR) communication and small and medium sized enterprises: The governmentality dilemma of explicit and implicit CSR communication. *Human relations*, 72(12), 1920–1947. <http://doi.org/10.1177/0018726718804306>
- Musil, M. (2005). *Mass media and publicity* (in Czech). Oeconomica.
- Myers, C. (2016). What's the legal definition of PR? An analysis of commercial speech and public relations. *Public Relations Review*, 42(5), 821-831. <https://doi.org/10.1016/j.pubrev.2016.10.005>
- Novotna, E., & Musil, M. (2017). *About PR - introduction to public relations* (in Czech). Prague University of Economics and Business.
- Pokumensah, J. B., Marfowaa, M. O., Bonsu, T. T., & Dankwa, A. (2018). Use of Public Relations Events as Strategic Marketing Tool. *Journal of Applied Sciences, Arts and Theology*, 2, 49-55.
<http://hdl.handle.net/123456789/525>
- Rubtcova, M., & Pavenkov, O. (2019). PR-Tools and Youth Policy in Political and Socio-Economic Situation in Russia. *IRAJ-International Conference on Humanities, Social Science and Business Management (ICHSSBM)*, 2019. Available from <https://ssrn.com/abstract=3317578>
- Solmonova, K. V., & Volkonskij, Y. K. (2019). Image Formation as the Basic Subject of the Organization: PR Tools and Their Role in the Formation of a Positive Image. *Коммуникология: электронный научный журнал*, 4(3), 7-15.
- Sommerfeldt, E. J., Yang, A., & Taylor, M. (2019). Public Relations Channel "Repertoires": Exploring Patterns of Channel Use in Practice. *Public Relations Review*, 45, 101796. <https://doi.org/10.1016/j.pubrev.2019.101796>
- Svoboda, V. (2009). *Public relations: modern and efficient* (in Czech) (2nd ed.). Grada Publishing.
- Tetreova, L. (2017). Communication of socially responsible activities by sugar-producing companies. *Listy cukrovarnické a řepářské*, 133(12), 394–396.
- Tetreova, L. (2018a). Communicating CSR in high profile industries: Case study of Czech chemical industry. *Inzinerine Ekonomika-Engineering Economics*, 29(4), 478–487. <https://doi.org/10.5755/j01.ee.29.4.19199>
- Tetreova, L. (2018b). Communicating socially responsible activities of chemical companies in the Czech Republic. *Chemické listy*, 112(2), 122–127.
- Tetreova, L. (2018c). Corporate social responsibility of chemical companies in Slovakia. *Przemysl Chemiczny*, 97(12), 2120–2123. <https://doi.org/10.15199/62.2018.12.21>
- Tetreova, L., Patak, M., & Kyrylenko, I. (2019). Web-based CSR communication in post-communist countries. *Applied Economics Letters*, 26(10), 866–871. <https://doi.org/10.1080/13504851.2018.1508866>
- Tetreova, L., Patak, M., & Kyrylenko, I. (2020). CSR web communication in controversial industries: The example of chemical companies based in post-communist countries. *Journal of Promotion Management*, 1–23. <https://doi.org/10.1080/10496491.2020.1851849>
- Wolf, K., & Archer, C. (2018). Public relations at the crossroads: The need to reclaim core public relations competencies in digital communication. *Journal of Communication Management*, 22(4), 494-509.
<http://doi.org/10.1108/JCOM-08-2018-0080>

Contracting as Part of New Public Management: Focus on Services Provided for Patients with Alzheimer's Disease in the Czech Republic

Daniela KANDILAKI, Kristina RANDLOVÁ and Peter PAŽITNÝ*

Prague University of Economics and Business, Prague, Czech Republic; daniela.kandilaki@vse.cz; rank01@vse.cz; peter.pazitny@vse.cz

* Corresponding author: peter.pazitny@vse.cz

Abstract: In this article we focus on contracting as a tool of modern public administration and we aim to underline, that contracting is widely used for securing social and healthcare services for patients with Alzheimer's disease. In this context, we also see contracting as useful tool for assessing the costs of these services, since the "price" of the contract can be seen as its costs from the perspective of the customer, which is in this case the public system (regions), the health insurance funds and the families and patients themselves. Also, it is important to highlight, that the "price" of the contract between the public sector and the providers does not at all correspond to real costs that occur to providers of social care, so these providers can many times be underfinanced and seek financial resources also from other sources.

Keywords: new public management; contracting; social services; healthcare services; Czech Republic

JEL Classification: H75; J14; J24

1. Introduction

New public management (NPM) is a concept that applies management techniques from the private to the public sector. This innovation applies tools to the public system with an aim to improve its efficiency, effectiveness and financial stability, taking into account the specificities of public services. The NPM is a deliberately adopted measure aimed at promoting responsible and better service delivery, reducing inefficiencies in public administration and preventing misuse of resources. In this sense, the citizen is perceived as a customer who receives public sector services.

NPM reforms often require political leadership, institutional reform, and a shift in organizational culture. For effective implementation, it is necessary to move from hierarchical management and control to more market relationships. Such a transformation in organizational culture cannot be achieved quickly, it is a long-lasting process. During the implementation of the elements of the NPM, the actors must, among other things, deal with the reluctance of those who were satisfied with the previous system and are not willing to give up their influence.

This article aims to: (1) define contracting as part of NPM, (2) introduce contracting as a vital part of providing social services in Czech Republic and (3) discuss, that contracting can

be a baseline approach for providing care for patients with Alzheimer's Disease and can be a good benchmark for assessing cost related to this disease without knowing the real costs of providers.

2. Methodology

In this article, a qualitative analysis of data and related documents was applied. The work draws on publications that deal with the issue of modern trends in corporate administration, specifically New public management. From the tools of New public management, contracting of social services in the Czech environment is selected and analyzed in more detail. Important part of the information sources were documents describing the functioning and financing of social services in the Czech Republic. The information gathered from various sources (mainly the 14 regions) is grouped and viewed as a whole, which discovers interesting causality and interconnection of individual facts.

From methodological point of view, we are also focusing on contracting as baseline factor for securing social and healthcare services for patients with Alzheimer's Disease (AD). This methodology for expenditure monitoring built in this way has a key advantage. It is consistent across all three sectors and it shares the view of the contracting entity. In the health care system, it is the health insurance company, in the social system it is the region, and, in the family, it is the caring family itself. The common denominator is therefore the willingness to contract and the willingness to pay for the service. Thus, this contracting methodology can in no way calculate the real costs of individual providers, but that is not its purpose either.

3. Results

3.1 New Public Management

The NPM was one of the main approaches to public sector reform adopted by many Western nations between the early 1980s and the mid-1990s (Gruening, 2001). The United Kingdom is considered to be the place of origin and the starting point for subsequent development around the world. In adopting the NPM as a new direction, there are differences in the implementation of managerial change not only between countries, but also between different sectors. Differences in the implementation of managerial changes affect different priorities and different goals. The instruments of the NPM vary from country to country, but the core of the instruments and the main idea remain the same. The NPM core includes the following items:

- Separate performance from policies
- More autonomy for line managers in operational management, both in policy development and implementation
- Management and control based on measured results
- Public institutions must formulate their goals in terms of results and outputs
- Production must be subject to a constant comparison of quality and prices.

From an implementation perspective, we observe two categories of NPM (Pollitt et al., 2007). The first category consists of countries that have decided since 1980 to follow the path

of intensive implementation of the NPM (Great Britain, New Zealand). The second category includes countries that have implemented only some parts of the NPM (e.g., the Nordic countries of Europe, part of France and Italy, Spain). A separate chapter are the countries of Eastern and Central Europe implementing the NPM, mainly due to the urging of the European Union and the IMF. Among the tools of New public management used in the Czech Republic, we can include budgeting, controlling, delegation, motivation, communication, elements of competition, user payments, benchmarking, privatization, contracting, decentralization and change of legal form.

The impact of NPM reforms is diverse and it would be a mistake to assume that the implementation of the NPM and its individual instruments brings only positives. Hood and Dixon (2015), discussing the theoretical principles of the NPM and their implementation, point out that the NPM did not produce a public administration that would cost less resources and work better, rather the opposite is true. Dan et al. (2015), created reviews and evaluations of 32 empirical articles related to the application of NPM, from which resulted a classification of 7 possible impacts of the implementation of NPM systems (Table 1). According to Dan, it can be stated that none of the analyzed articles evaluated the reforms based on the elements of the NPM as reforms completely unsuccessful, but also as completely successful. Most of the studies analyzed (18) can be classified as type V. "NPM reforms can have significant positive effects but can be hampered by insufficient administrative capacity or an unsatisfactory context". The idea underlying this category is that there is some evidence of positive impacts, but the evidence is less convincing due to barriers like lack of capacity or contextual factors hampering reform. Last, but not least, the concept of NPM has also radically increased institutional and political complexity.

Table 1. Impacts of the implementation of New public management. (Dan et al., 2015)

I.	NPM reforms do not work regardless of administrative capacity and type of context
II.	NPM reforms do not work mainly due to insufficient administrative capacity
III.	NPM reforms do not work mainly due to an inappropriate context
IV.	NPM reforms work, although they may lead to some unintended consequences and trade-offs
V.	NPM reforms can have significant positive effects, but are limited by administrative capacity or an unsatisfactory context may be limited
VI.	NPM reforms work, although they may lead to some unintended consequences and trade-offs
VII.	NPM reforms usually always work

The company's setting and a certain skepticism about the elements of the NPM gave way over time to the development of the concept of Post-New public management. Authors Dreschler and Randmaliiv (2015) present the development of NPM to Post-NPM in several ways. One of them is the model of the Neo-Weber state, which takes over the positive elements of the NPM. Other directions of development include, in particular, the New Public Administration or coordination emphasizing Joint-Up Governance and Whole-of-Governance. These directions gradually led to the Post-NPM, which characterizes public administration today (Kandilaki, 2019).

3.2 Contracting

Contracting is one of the NPM tools. The basis of this instrument are contractual agreements between a public body and a usually private (in some cases public) provider. When using this principle, the “costs” for service delivery are viewed as expenditures from the perspective of the customer, which in this case is the public sector. Thus, the contracting approach does not take into account the real costs of the provider, but the “costs” are determined by the payment, subsidy or the price of the contract.

In Czech Republic, contracting is widely used in the field of social services, which includes a wide range of actors and multiple sources of funding. The mechanism for financing social services is shown in Figure 1. Due to large number of stakeholders, it is necessary to contract all individual relationships, both in terms of control over the whole process and financial transparency.

Social services are paid from (1) state budget, (2) regional budgets, (3) municipalities, (4) grants, (5) public health insurance, as well as (6) direct payments from service users. Users of social services can be allocated a financial allowance for care for the necessary services, which is paid to them by the state from the public budget every month. A small percentage of income is also made up of founders' contributions and donations. The majority of financial resources comes from contracts with regional authorities, which publish their contracting strategies and policies regularly, which increase transparency of procedures and controls. Contracting can then be an effective tool of management, benchmarking and control (Pažitný & Kandilaki, 2020).

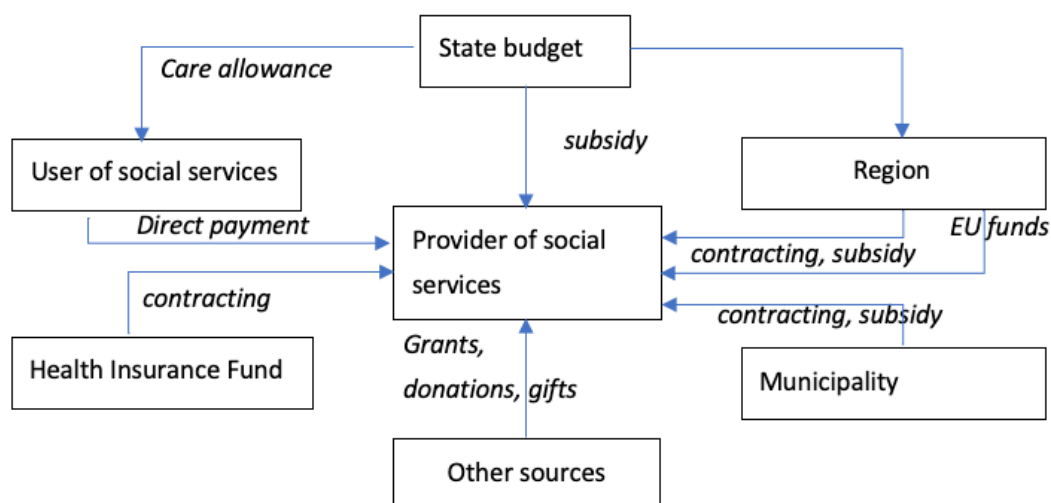


Figure 1. Mechanism of financing social and health services. (Kučerová, 2014)

3.3 Contracting Services for Patients with Alzheimers Disease (AD)

According to this principle of contracting, there are three main systems in which services for patients with AD are contracted. Health system, social system and family. In the health care system, the health insurance company contracts and the patient uses the healthcare services. In the social system of the service, the region contracts and the service are used by the patient. In family care, the service is contracted directly by the patient or family.

Contracting in the healthcare system. Health services provided to patients with AD are defined by a contract between the health insurance company and the providers. Resources for reimbursement are from the health fund of health insurance companies. Patient participation is very limited in this case. Contracts with health insurance fund cover mainly the provision of outpatient services, inpatient services and medicines. The main source of income from public health insurance is compulsory wage deductions. The scope of paid services and the conditions for their payment are regulated by Act No. 48/1997 Coll.

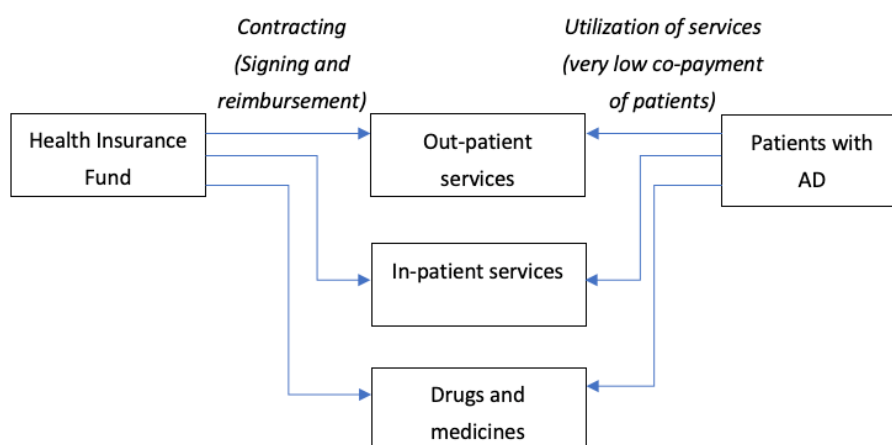


Figure 2. Mechanism of contracting healthcare services for patients with AD

Contracting in the social system works differently in each region, but in all regions, we can recognize common features. The regional network of services represents a network of social services, which are included in the contracting base of the region. Each region has its own strategy for including social services in the network. Social services can be divided into inpatient, outpatient and field care. Field and outpatient services are most often contracted in the form of fulltime equivalents (FTE) or hours. For inpatient services, contracting per bed is used. The amount of the subsidy per full-time equivalent / bed consists of several sources (subsidies from the ministry, regions, participation of the municipality), while almost every service requires a financial participation of the client. The amount of participation is defined by the rules of the region. The health insurance company can also pay extra for individual types of services.

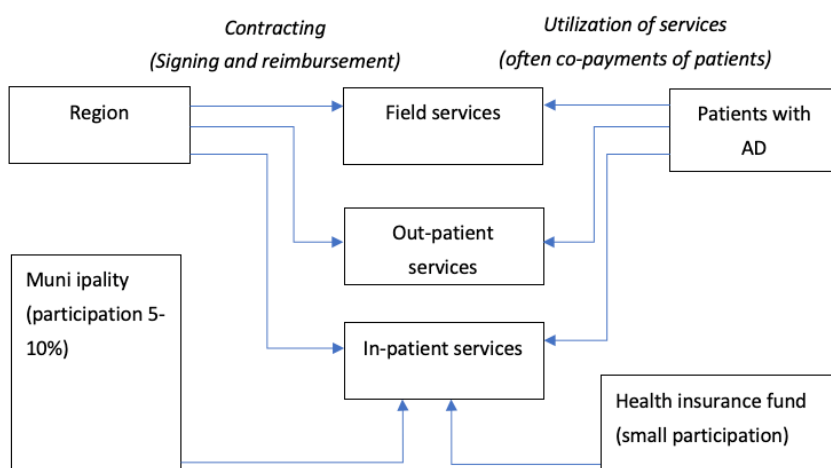


Figure 3. Mechanism of contracting social services for patients with AD

Contracting by the family. A large number of patients do not receive any medical or social services (or use them to a minimal extent) and are cared for by their loved ones, spouse, partner, family, or friends. These patients are mostly at home. Unofficial careers, homes (gray zone), are also often sought after. A typical example of the gray zone is alcoholics, because in the official social system, alcoholism is a contradiction to the provision of a service. Many patients who are at home may have the first stages of the disease, or they may be patients with a higher degree who are not hospitalized for various reasons. This is due to waiting times or because the family takes care of the patient itself. Their costs can be divided into 3 parts: (1) Direct health and social expenditure, (2) Indirect medical expenses and (3) Indirect costs.

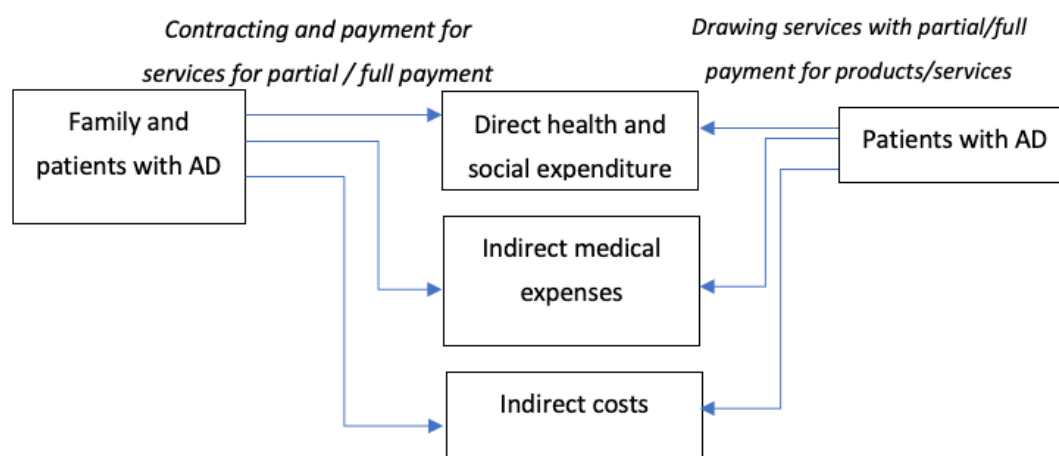


Figure 4. Mechanism of contracting health and social services for patients with AD

In the case of contracting by the client (its family), the set prices in the social services are mainly covered by the region, the healthcare services have the client's financial participation as a rule. An indispensable part of contracting are agreements on cooperation in the provision of social and health services. These are contracts between providers at the same or similar level of the hierarchy in case one provider is not able to cover all services provided to users. Cooperation agreements usually have a price for services also fixed using a contracting approach. (MLSA, 2019; Pažitný & Kandilaki, 2020).

4. Discussion

Regarding the technical requirements, the concluded contracts must contain all the usual prerequisites. First of all, basic information about contracting parties must be provided. In the case of clients, it is the name, permanent residence, birth number. For companies and organizations, it is necessary to state the name of the organization, registered office, identification number. The contract also includes the subject of the contract, which is most often the service. The contract also contains information on the scope of services provided, the time interface and the price for the services provided. The prices of services are set in the contracts by agreement between the parties involved. However, the agreed prices according to the contracting approach may not reflect the amount of costs for the contracted services. Thus, contracts can often be disadvantageous for one party. Contracting may therefore lead

to inefficient allocation of resources. At the same time, there may be a discrepancy between the actual situation and one of the basic goals of the NPM - to support responsible and better provision of services (Act No. 108/2006 Coll.).

In the case of an agreement on cooperation in the provision of social and health services, the inquirer tries to buy the services as cheaply as possible and chooses the most affordable providers from among the available offers. However, this can lead to a price struggle for providers of demanded services. Thus, contracts are often concluded at prices that do not reflect the real costs of the provider but are below their threshold. The price struggle between providers can also lead to a reduction in the quality of the services they provide. Therefore, the quality of social and health services must be regularly checked by the inspection of the provision of social services.

Regarding the contracts concluded between the state and the provider, the origin of the unfavorable contracting of social care is different. The Czech Republic is currently in a situation where social and health services are significantly underfunded. As in other countries, the Czech Republic is gradually aging. The issue of population aging brings with it a larger number of people with requirements for social and health care. According to the analysis of financial costs of social services of the Ministry of Labor and Social Affairs, the costs of homes for the elderly and homes with a special regime increased by 37% from 2013 to 2018. Although state social welfare contributions are also growing, they are not able to fully cover the requirements of providers. There is a situation where it is necessary to distribute insufficiently large amounts among a large number of facilities (Červenková, 2013; MLSA, 2019).

5. Conclusions

Contracting health and social services for patients with AD is a widely used strategy in Czech Republic. Contractors can be either regions, health insurance funds and families as well. Due to the fact that social and health services are highly dependent on public finances of the state, the limited budget for these services may be a significant problem. The lack of funds is manifested mainly in social services, which are partially covered by subsidies. Underfunded social services are a reason for contracting for amounts that are below the real costs of providers. Providers often seek additional financing among clients and their families.

However, public contracting of private providers, which is disadvantageous for social health service providers, can lead to a chain reaction that shifts the need for funding to cover the real costs of care from a public-provider contract to a provider-client relationship. Providers of these services are forced to demand higher direct payments from clients of social and health care facilities, which help them cover the costs of operating the facility.

Although most clients are provided with a care allowance, which helps to cover the costs of the necessary social and health care, this allowance does not always help to cover the amount required for the services provided. The care allowance reaches various values in the Czech Republic, in connection with the health condition and degree of dependence of the patient on the other person. The care allowance is paid in the range from CZK 3,300 to CZK 19,200. However, the analysis of the financing of social services of the Ministry of Finance

and Social Affairs shows that even after the inclusion of the care allowance, 21% of the total costs of social services are covered from clients' own resources. The maximum amounts for social services are limited by Decree No. 505/2006 Coll. Nevertheless, there is often a situation where the prices of social and health care are so high that the family members of the patient are forced to pay for the amount of care provided (MLSA, 2019a, 2020b).

Acknowledgments: This work was supported by the Technology Agency of the Czech Republic (TAČR) under the grant TL01000300.

References

- Act no. 108/2006 *On social services*. Czech Republic. The Parliament of The Czech Republic.
https://www.mpsv.cz/documents/20142/372809/Annex_3_social_services_act.pdf/6ca5e9bd-2308-5c5f-b383-bce1d9e09e47
- Act no. 48/1997 *on Public Health*. Czech Republic. The Parliament of The Czech Republic.
<http://aplikace.mvcr.cz/sbirka-zakonu/ViewFile.aspx?type=c&id=3007>
- Červenková, V. (2013). *Financování služeb sociální péče pro seniory v ČR – současné problémy a výzvy*. Univerzita Karlova v Praze.
- Dan, S., & Pollitt, C. (2015). NPM Can Work: An optimistic review of the impact of New Public Management reforms in central and eastern Europe. *Public Management Review*, 17(9), 1305-1332.
<https://doi.org/10.1080/14719037.2014.908662>
- Drechsler, W., & Randma-Liiv, T. (2015). The new public management then and now: Lessons from the transition in Central and Eastern Europe. In *Implementation of New Public Management Tools. Experiences from transition and emerging countries* (pp. 33-49).
- Gruening, G. (2001). Origin and theoretical basis of New Public Management. *International public management journal*, 4(1), 1-25.
- Hood, C., & Dixon, R. (2015). What we have to show for 30 years of new public management: Higher costs, more complaints. *Governance*, 28(3), 265-267. <https://doi.org/10.1111/gove.12150>
- Kandilaki, D. (2014). *Finanční ochrana ve zdravotnictví České republiky v kontextu New Public Managementu* (Doctoral dissertation), Vysoká škola ekonomická v Praze.
- Kučerová, P. (2014). *Financování sociálních služeb v praxi*. Univerzita Pardubice.
- MPSV - Ministerstvo práce a sociálních věcí (2019). *Analýza financování sociálních služeb*.
- PMSV - Ministerstvo práce a sociálních věcí (2020). *Příspěvek na péči*. <https://www.mpsv.cz/-/prispevek-na-peci>
- Pažitný P., & Kandilaki, D. (2020). *Metodologické rámce kalkulace současné ekonomické zátěže. Kontraktingový princip*. Projekt TAČR.
- Pollitt, C., Van Thiel, S., & Homburg, V. (2007). *New public management in Europe*. Basingstoke: Palgrave Macmillan.

Healthcare Worker Capacities in Social Services for Elderly Care: Qualification and Demographic Structure

Lenka KOMÁRKOVÁ^{1*}, Petra MAREŠOVÁ², Peter PAŽITNÝ¹, Daniela KANDILAKI¹, Filip ZEMEK³ and Zuzana TRUHLÁŘOVÁ²

¹ Prague University of Economics and Business, Prague, Czech Republic; lenka.komarkova@vse.cz; peter.pazitny@vse.cz; daniela.kandilaki@vse.cz

² University of Hradec Králové, Hradec Králové, Czech Republic; petra.maresova@uhk.cz; zuzana.truhlarova@uhk.cz

³ University Hospital Hradec Králové, Hradec Králové, Czech Republic; zemek.filip@gmail.com

* Corresponding author: lenka.komarkova@vse.cz

Abstract: An essential challenge concerning the aging of the population is long-term care for the elderly. It raises personnel and financial needs to provide this care. The paper aims to describe the state of the personnel capacities in healthcare provision within social care services for the elderly in the Czech Republic. The data source was the social services statements for 2017 filed at the Ministry of Labor and Social Affairs. The results show that the average age of healthcare workers in social care services for the elderly in the Czech Republic in 2017 was 46.7 years old, with a significant dominance of women (96.6%). The average monthly gross salary for these workers was CZK 30,404. In light of these figures and the context of international comparison, it is evident that in the field of social care it is necessary to consider not only the financial needs but also the effort to support workforce development.

Keywords: social care; healthcare worker; personnel capacity; age structure; regional analysis

JEL Classification: H75; J14; J24

1. Introduction

The Czech population is aging. According to the Czech Statistical Office (2020), the proportion of seniors aged 65 and over in the population in the Czech Republic was 18.8% in 2017, 20.0% in 2020, and the estimate for 2050 is 28.6%. An essential challenge related to demographic aging is elderly care, both in residential facilities and in-home (field) services (Duvall & Andrews, 2010; Průša, 2015).

Direct relatives as informal caregivers at a time when the elderly need care are often employed full time. Family caregivers face not only a high workload but also a financial and psychological burden (Marešová et al., 2020b). This again contributes to the increased need for professional care provided by formal caregivers, as evidenced by a number of studies (e.g., Průša, 2015; Kubalčíková & Havlíková, 2016; Langhamrová et al., 2018; Marková et al., 2020).

The need for appropriate professional staff to ensure adequate long-term care for the elderly includes not only social care but also health care provided in social care services.

According to the Czech Social Services Act (Act No. 108/2006 Coll.), professional staff in social services are divided into social workers, social service workers, healthcare workers, pedagogical workers, and counselors. This paper focuses on the healthcare workers in social care services, including residential, ambulatory, and field services.

Many seniors come to residential social service facilities directly from hospitals. Especially in this case, healthcare professionals play a key role, but there is a shortage in the Czech Republic, namely in general nurses (Institute of Health Information and Statistics of the Czech Republic & Institute of Biostatistics and Analyses, 2018; Maresova et al., 2020c). General nurses are required to exercise a professional approach, expertise, and empathy, and to preserve human dignity, autonomy, and the highest possible degree of self-sufficiency of the elderly (Malíková, 2020). The responsibility of nurses in residential social services is significantly increased because a physician is not present in the facility throughout the day.

Neighboring Germany also suffers from a nursing shortage. According to Hackmann (2010), there will be about 4.4 million nursing cases by 2050, meaning an increase of 270%. In the future, care will be provided less frequently by family caregivers and increasingly by professional institutions such as home care services and nursing homes (Schönrock et al., 2015). Therefore, an additional half a million healthcare workers will be needed in the care sector (Harling et al., 2014).

High-quality nursing care contributes to improving the quality of life of seniors in residential facilities, with respect to their health and degree of self-sufficiency (Duvall & Andrews, 2010). In addition, the share of clients with higher degrees of dependence in residential social service facilities is growing in the Czech Republic (Komárková et al., 2020). Therefore, there is growing importance of the role of social service providers and the associated higher demands on public expenditures (Langhamrová et al., 2018; Maresova et al., 2020a) and vocational education in the related fields (Schönrock et al., 2015; Skela-Savič et al., 2020).

Průša (2015) points out that the provision of social services by the Czech regions varies considerably and that the structure of services is not optimal. Based on the spatial accessibility analysis, Vrabková et al. (2021) demonstrate that new social care services for the elderly are not set up in new places than existing ones, so implementing the National Action Plan Supporting Positive Aging for 2013–2017 (Ministry of Labor and Social Affairs, 2014) is not effective. Within the framework of the National Strategy of Social Services Development for 2016–2025 (Ministry of Labor and Social Affairs, 2016), there is an appeal to the need to interconnect the social and health systems for long-term care, the so-called socio-health borderline. This requires cooperation between the Ministry of Labor and Social Affairs and the Ministry of Health of the Czech Republic.

For a deeper understanding of the possibilities of connecting health and social care, this paper aims to describe the state of the personnel and financial needs to provide healthcare in the area of social care services for the elderly in the individual regions of the Czech Republic. In particular, the paper answers the following research questions:

RQ1: What is the qualification structure of healthcare workers in social care services for the elderly in the Czech Republic?

RQ2: What is the proportion of healthcare workers among formal caregivers in social care services?

RQ3: What is the gender structure of healthcare workers in social care services across the regions?

RQ4: What is the age structure of healthcare workers in social care services across the regions?

RQ5: What is the average salary of healthcare workers in social care services in the individual regions?

2. Methodology

The data source was the social services statements filed at the Ministry of Labor and Social Affairs of the Czech Republic. This provided us with selected data from 2017 for scientific and research purposes. Specifically, three data sets were included:

1. a list of registered social service providers, including their target groups,
2. anonymized data on all employees in social services,
3. total personnel costs per social service provider.

The Czech Social Services Act defines fourteen types of social care services. For this paper, the first data set was used to select social care services targeted at the elderly. In total, we identified 2,113 social care providers. Table 1 then shows both the numbers and percentages of these services in their total number. The services are listed according to their order of occurrence in the Czech Social Services Act. It is apparent that two-thirds of social care service providers list the elderly as the target group.

Table 1. The number and percentage share of social care services targeted at the elderly with respect to the total number of social care services (regardless of their target group).

Social Care Services	Type	Total Number	For the Elderly Number	Proportion (%)
Personal Assistance	F	230	174	75.7
Caregiving Service	A, F	710	707	99.6
Emergency Service	F	17	17	100.0
Guiding and Reading Services	A, F	16	6	37.5
Independent Living Support	F	60	1	1.7
Respite Care	A, F, R	300	227	75.7
Daily Service Centers	A	81	37	45.7
Day Care Centers	A	276	99	35.9
Weekly Care Centers	R	58	9	15.5
Homes for the Disabled	R	204	10	4.9
Retirement Homes	R	529	529	100.0
Extra Care Housing	R	326	200	61.3
Sheltered Housing	R	211	11	5.2
Social Services in Healthcare Institutions	R	107	86	80.4
Total		3,125	2,113	67.6

Note: A – ambulatory services, F – field services, R – residential services

For the selected elderly care services, the recalculated numbers of healthcare workers were analyzed based on their workload as set out in their employment contracts or contract agreements, which vary according to the type of social care service, as included in the second

data set. The analysis of the age and gender structure of healthcare workers also took their workload into account (1.0 for full-time employees; 0.5 for half-time employees etc.).

Based on the third data set, their average salaries were calculated according to the type of social service and the region. The average salary was calculated as a twelfth of the total annual cost of the employees with respect to their total workload by service and region. This result was then divided by 1.34 due to the adjustment of the amount from the statutory social and health insurance contributions by the employer.

3. Results

As the data should cover the whole population of employees in social care services in the given year, the analysis was based only on descriptive statistics. For clarity, the results are divided into five subsections according to the individual research questions.

3.1. Qualification Structure (RQ1)

Twelve different job categories (work roles) were identified for healthcare workers in social care services. Specifically, these were physicians, general nurses, assistive personnel, healthcare social workers, physical therapists, occupational therapists, nutritional therapists, addiction therapists, caregivers, emergency medical technicians, other professionals, and other unspecified personnel. Table 2 gives a basic overview of the full-time equivalents (FTEs) of healthcare workers, distinguishing the five most common work roles in social care services for the elderly.

Table 2. FTEs of healthcare workers in social care services for the elderly, separately for the most common work roles.

Social Care Services	Total	GN	AP	PT	EMT	OT
Personal Assistance	7.7	3.1	0.2	0.2	0.0	3.2
Caregiving Service	40.3	25.8	3.8	0.5	0.1	0.0
Respite Care	184.7	139.9	5.4	6.7	1.4	4.0
Daily Service Centers	0.4	0.0	0.0	0.1	0.0	0.0
Day Care Centers	4.8	2.4	0.1	0.7	0.0	1.0
Retirement Homes	3,382.7	2,895.8	117.3	161.2	20.7	52.4
Extra Care Housing	1,158.7	938.7	57.4	52.6	15.1	41.4
Social Services in Healthcare Institutions	294.9	159.6	14.6	7.0	67.5	1.5
Other	52.0	36.0	0.9	5.1	0.0	1.2
Total	5,126.1	4,201.3	199.7	134.2	104.8	104.7

Note: GN – general nurses, AP – assistive personnel, PT – physical therapists, EMT – emergency medical technicians, OT – occupational therapists

In 2017, a total of 5,126 healthcare workers were employed in social care services (Table 2). As expected, general nurses are the largest group, with a total of 4,201 FTEs, which represents 82% of all healthcare workers in social care services for the elderly. Furthermore, assistive personnel, physical therapists, emergency medical technicians, and occupational therapists were the most represented work roles among the twelve work roles considered, with more than 100 FTEs. To supplement, the workload of physicians in social care services reached 37.6 FTEs.

3.2. Proportional Representation (RQ2)

Social workers, social service workers, and healthcare workers are considered as formal caregivers in social services in the analysis. A comparison of the workload of these three groups of formal caregivers is shown in Table 3, including their percentage shares of the total number of FTEs for formal caregivers.

Table 3. FTEs of social workers, social service workers, and healthcare workers and their percentage share with respect to the total number of formal caregivers.

Social Care Services	SW		SSW		HW		Total FTE
	FTE	%	FTE	%	FTE	%	
Personal Assistance	123.3	8.9	1,250.2	90.5	7.7	0.6	1,381.1
Caregiving Service	501.5	9.1	4,975.1	90.2	40.3	0.7	5,516.9
Respite Care	97.2	9.3	768.2	73.2	184.7	17.6	1,050.2
Daily Service Centers	23.8	22.3	82.6	77.3	0.4	0.4	106.8
Day Care Centers	40.5	13.6	252.1	84.8	4.8	1.6	297.4
Retirement Homes	914.4	6.2	10,494.0	70.9	3,382.7	22.9	14,791.1
Extra Care Housing	276.5	5.1	3,965.0	73.4	1,158.7	21.5	5,400.2
Social Services in Healthcare Institutions	48.0	7.5	295.9	46.3	294.9	46.2	638.8
Other	44.7	11.3	299.3	75.6	52.0	13.1	396.0
Total	2,070.0	7.0	22,382.3	75.7	5,126.1	17.3	29,578.4

Note: SW – social workers, SSW – social service workers, HW – healthcare workers

Table 3 shows that every sixth position among formal caregivers is attributed to a healthcare worker. The highest number of healthcare workers was in retirement homes (3,383 FTEs), where the proportion was almost 23%. The second-highest number was reached in extra care housing (1,159 FTEs). Further, the figures in Table 3 demonstrate that the largest proportion of healthcare workers among formal caregivers is in social services provided to clients in healthcare institutions. Specifically, the ratio of healthcare professionals was 46:54 in 2017.

3.2. Gender Structure (RQ3)

As most healthcare workers work in retirement homes and extra care housing, only these two social care services will be distinguished separately in this analysis and further ones. Table 4 introduces the percentages of women among healthcare workers in social care services by region. The regions are sorted according to their CZ-NUTS 3 codes.

The figures in Table 4 demonstrate that the vast majority of healthcare workers in social care services for the elderly in 2017 were women. At the regional level, the proportion ranged from 94.1% (Prague) to 99.1% (Liberec Region). When comparing the national proportions in the last row in Table 4, the proportion of women was slightly higher for healthcare workers in retirement homes (97.1% vs 96.6%).

Table 4. The regional proportion of women among healthcare workers in social care services for the elderly, separately for retirement homes and extra care housing.

Constituency	Social care services	Retirement homes	Extra care housing
Prague	94.1	94.5	93.6
Central Bohemia Region	96.2	96.3	97.3
South Bohemia Region	95.4	96.5	98.0
Plzeň Region	96.9	97.4	94.6
Karlovy Vary Region	94.9	96.1	91.0
Ústí nad Labem Region	97.1	98.2	94.5
Liberec Region	99.1	99.8	97.7
Hradec Králové Region	99.0	99.0	98.9
Pardubice Region	98.4	98.4	98.1
Vysočina Region	98.1	98.2	99.9
South Moravia Region	96.9	97.5	97.2
Olomouc Region	97.4	97.0	98.8
Zlín Region	98.5	98.4	98.8
Moravian-Silesian Region	96.5	97.4	94.7
Czech Republic	96.6	97.1	96.3

3.3. Age Structure (RQ4)

Table 5 shows the average age of healthcare workers in social care services for the elderly by region. Table 6 presents the share of these workers aged 50 and over (50+) and aged 60 and over (60+). In both calculations, the workload of the individual employees was taken into account. The average age of healthcare workers in the Czech Republic in 2017 was 46.7 years old. Regional averages ranged from 44.9 years old (Pardubice Region) to 48.5 years old (Liberec Region) while 44.5% of healthcare workers in social care services for the elderly were 50+. In addition, 10.3% of healthcare workers were 60+. It is worth noting that in extra care housing, the age of the healthcare workers is slightly more favorable.

Table 5. The regional average age of healthcare workers in social care services for the elderly, separately for retirement homes and extra care housing.

Constituency	Social care services	Retirement homes	Extra care housing
Prague	46.6	48.0	42.1
Central Bohemia Region	46.6	47.8	43.3
South Bohemia Region	45.4	44.9	44.5
Plzeň Region	46.4	46.1	44.5
Karlovy Vary Region	48.4	49.7	45.5
Ústí nad Labem Region	45.7	46.0	47.0
Liberec Region	48.5	48.6	48.3
Hradec Králové Region	47.2	47.0	48.7
Pardubice Region	44.9	45.2	45.0
Vysočina Region	46.8	46.6	47.4
South Moravia Region	47.4	48.3	46.7
Olomouc Region	47.1	47.1	47.4
Zlín Region	45.9	46.0	46.2
Moravian-Silesian Region	47.5	48.1	46.8
Czech Republic	46.7	47.1	45.4

Table 6. Regional percentages of 50+ and 60+ healthcare workers in social care services for the elderly, both separately for retirement homes and extra care housing.

Constituency	Social care services		Retirement homes		Extra care housing	
	50+	60+	50+	60+	50+	60+
Prague	47.1	17.4	52.8	20.6	31.5	11.6
Central Bohemia Region	42.3	9.8	45.8	11.2	33.1	5.8
South Bohemia Region	39.7	6.0	36.5	5.9	42.1	3.7
Plzeň Region	43.7	17.1	44.1	17.0	34.4	15.1
Karlovy Vary Region	51.6	18.9	54.4	21.8	47.0	10.8
Ústí nad Labem Region	41.0	8.1	42.1	8.4	46.5	8.5
Liberec Region	51.4	5.4	48.0	6.4	57.6	3.5
Hradec Králové Region	46.0	9.7	45.3	9.2	51.4	12.2
Pardubice Region	42.6	5.3	43.5	5.9	43.8	3.6
Vysočina Region	44.0	8.7	43.6	9.3	44.0	4.5
South Moravia Region	46.4	9.0	48.9	10.7	46.0	7.1
Olomouc Region	47.0	7.5	47.1	7.9	47.8	5.1
Zlín Region	42.1	6.7	42.8	6.0	43.9	11.3
Moravian-Silesian Region	44.3	11.6	46.6	12.3	42.7	10.0
Czech Republic	44.5	10.3	45.7	10.8	41.5	8.0

3.4. Average Monthly Salary (RQ5)

Based on the acquired data, the average gross monthly salary of healthcare workers in social care services for the elderly was CZK 30,404 in 2017, more specifically CZK 31,837 in retirement homes, and CZK 30,600 in extra care housing. Regional differences are illustrated in Table 7, which shows that the average monthly salary of healthcare workers in social care services for the elderly ranged from CZK 20,573 (Plzeň Region) to CZK 33,262 (Olomouc Region).

Table 7. The regional average monthly salary (in CZK) of healthcare workers in social care services (separately for retirement homes and extra care housing) and healthcare services.

Constituency	Social care services	Retirement homes	Extra care housing	Healthcare services
Prague	28,459	29,515	30,641	42,051
Central Bohemia Region	28,195	32,544	22,817	35,404
South Bohemia Region	31,462	33,500	34,661	31,208
Plzeň Region	20,573	23,436	24,658	40,292
Karlovy Vary Region	32,362	33,035	34,675	30,011
Ústí nad Labem Region	29,682	30,315	33,762	30,559
Liberec Region	31,958	31,127	33,521	34,774
Hradec Králové Region	32,297	32,615	33,702	37,124
Pardubice Region	29,738	29,065	29,856	31,132
Vysočina Region	32,221	31,386	38,969	33,449
South Moravia Region	32,383	34,413	32,134	35,685
Olomouc Region	33,262	33,794	30,751	37,164
Zlín Region	29,669	28,797	35,259	32,551
Moravian-Silesian Region	31,241	33,511	27,432	35,521
Czech Republic	30,404	31,837	30,600	37,260

For comparison, the last column in Table 7 shows the monthly salaries in health care published by the Institute of Health Information and Statistics of the Czech Republic (2018).

Regional salaries in social care services do not correlate positively with regional salaries in healthcare services ($r = -0.43$).

4. Discussion

To compare the Czech Republic with other European countries, we used section Q (ISIC Rev. 4 classification) of human health and social work activities. According to ILOSTAT (2020), section Q reached 7.2% of total employment in the Czech Republic in 2017 and 7.4% in 2019. These proportions are rather low in contrast to the European Union (28 countries), where it was 11.0% for 2017 and 11.2% for 2019. In neighboring Germany, the monitored proportions were 12.9% and 13.2%.

4.1. Qualification Structure

In the Czech Republic, the basic prerequisite for the reimbursement of healthcare services provided in residential social service facilities by insurance companies is the existence of a contract signed between these facilities and the insurance company. Nursing and medical care in residential social service facilities can be reimbursed only if provided by qualified staff and a general practitioner under the conditions stipulated in the list of medical interventions (Malíková, 2020). Ideally, this prerequisite should guarantee the quality of services received in the institutions, which is a positive regulatory aspect by the state. However, it also has a substantial financial impact because to be able to attract a qualified workforce, it needs to go hand in hand with appropriate salary bands.

Based on our analysis, a total of 5,126 FTEs provided healthcare in social care services in 2017, with 1,988,922 people aged 65 and over living in the Czech Republic (Czech Statistical Office, 2020). In 2050, 3,075,587 such old people are expected (Czech Statistical Office, 2020), which is 55% more. Thus, to ensure the same care as in 2017, this requires 2,801 more healthcare workers in social care services.

The highest number of full-time healthcare jobs within the total number of recalculated healthcare personnel workloads in social care services includes general nurses and physical therapists, which are highly specialized skill sets. In addition, there is a shortage of these non-medical health professionals in the Czech Republic (Marešová et al., 2020c). Kubalčíková and Havlíková (2016) also draw attention to the lack of qualified formal caregivers in the Czech Republic and the possible consequences in the form of the establishment of unregistered care homes, where the required quality of care is not guaranteed.

4.2 Demographic Structure

When examining the data from 2017, the average age of healthcare workers in social care services for the elderly in the Czech Republic was 46.7 years old. Regional averages ranged from 44.9 years old (Pardubice Region) to 48.5 years old (Liberec Region). In addition, 44.5% of healthcare workers in social care services for the elderly were 50 years or older and 10.3% of healthcare workers were 60 years or older. This illustrates that the changing demographic will not only influence the need for care but also a workforce that can provide it while an active employment policy will also be required.

From the gender perspective, it is interesting to note that the vast majority of the healthcare workers in social care services for the elderly are women ranged from 94.1% to 99.1% across the regions. Similar gender distribution was found for social service workers, although the profession of formal caregiver is not perceived by Czech society as gender-segregated (Marková et al., 2020). For comparison, Schulz (2013) demonstrated that the proportion of women in section Q of human health and social work activities is 4.6 percentage points (pp) lower in Germany than in the Czech Republic; for residential care activities, the difference is 10.8 pp.

4.3 Economic Situation

Based on the acquired data, the average gross monthly salary of healthcare workers in social care services for the elderly was CZK 30,404 in 2017. Despite the high demands on healthcare workers in social care services, their salaries do not correspond to this. The calculated average gross monthly salary was 3% above the national average across all economic activity sectors, which amounted to CZK 29,504 (Czech Statistical Office, 2018). Salaries in social services have risen in recent years, but this segment still lags behind others (Institute of Health Information and Statistics of the Czech Republic & Institute of Biostatistics and Analyses, 2018). One of the consequences is that Czech healthcare workers and other formal caregivers work abroad due to better financial conditions, namely in neighboring Germany and Austria (Mareckova, 2004; Drbohlav & Pavelková, 2018).

4.4 Limitations

The presented results have some limitations. Only those social care services that mentioned seniors as a target group were included in our study. However, this does not mean that other services cannot be used by the elderly. It should also be noted that the regions in the dataset indicated the official seat of the service provider; however, the service may be provided in another region.

The calculation of the average monthly salary must also be understood with some reserve. The total average monthly costs for all the considered healthcare workers in the region were divided by 1.34, which assumes the employer's statutory social and health insurance contributions for all employees. However, this may not have been the case for all workers, as some may have been employed on a contract basis or have had a small-scale job. Thus, the calculated averages may be slightly underestimated.

Finally, it should be noted that our results are only related to one year, namely 2017. Therefore, in the future, we plan to perform the data analysis over a longer period and also make a larger international comparison of our results.

5. Conclusions

Population projections in all European countries show that the population is aging and has an increased life expectancy. Nevertheless, each country is approaching this population change differently and at different speeds. Based on the available data, the Czech Republic still needs to work hard to adapt to this change to make sure the population receives the

necessary services provided by sufficiently professional staff. The Czech elderly care system needs fundamental structural change so the health and social care sectors cooperate more openly. There is also a need for a transparent financing model and to be able to attract the relevant workforce.

It is desirable for health and social care systems to make a joint effort to deliver support to the people in need promptly and, at the same time, leverage financial savings from synergy, which can be obtained from a better process overview, and eliminate redundancies in the infrastructure. In addition, open and interconnected data on the care provided would allow for faster research in this important area and, consequently, for more accurate estimates of the capacity needed and the financial burden of elderly care.

Acknowledgments: This work was supported by the Technology Agency of the Czech Republic (TAČR) under grant TL01000300.

References

- Act No. 108/2006 Coll., *On social services*. Czech Republic, The Parliament of the Czech Republic.
<https://www.mpsv.cz/pravni-predpisy-pro-socialni-sluzby>
- Czech Statistical Office. (2018). *Average wages - 4th quarter of 2017* [Data set]. Retrieved January 8, 2021, from <https://www.czso.cz/csu/czso/ari/average-wages-4-quarter-of-2017>
- Czech Statistical Office. (2020). *Population of the Czech Republic Prediction until 2101* [Data set]. Retrieved December 18, 2020, from https://www.czso.cz/staticke/animgraf/projekce_1950_2101/
- Drbohlav, D., & Pavelková, L. (2018). Intra-European Movement of Czechs with Special Regard to Austria and Care Givers (The “MICO” Type-Between Migration and COmmuting). In P. Scholten, & M. van Ostaijen (Eds.), *Between Mobility and Migration* (pp. 205–226). Springer Open.
- Duvall, J. J., & Andrews, D. R. (2010). Using a structured review of the literature to identify key factors associated with the current nursing shortage. *Journal of Professional Nursing*, 26(5), 309–317.
<https://doi.org/10.1016/j.profnurs.2010.02.002>
- Hackmann, T. (2010). Entwicklung der professionellen Pflege vor dem Hintergrund des demografischen Wandels. In A. Nienhaus (Ed.), *Gefährdungsprofile-Unfälle und arbeitsbedingte Erkrankungen im Gesundheitsdienst und Wohlfahrtspflege* (pp. 96–112). Ecomed MEDIZIN.
- Harling, M., Schablon, A., & Nienhaus, A. (2014). Validierung der Nurse-Work-Instability-Scale-Ergebnisse der Baseline – Befragung einer prospektiven Studie an einer Kohorte von Altenpflegekräften. In A. Nienhaus (Ed.), *RiRe - Risiken und Ressourcen in Gesundheitsdienst und Wohlfahrtspflege* (pp. 115–135). Ecomed MEDIZIN.
- ILOSTAT. (2020). *Employment Distribution by economic activity (by sex)* [Data set]. Retrieved January 8, 2020 from https://www.ilo.org/shinyapps/bulkexplorer34/?lang=en&segment=indicator&id=EMP_2EMP_SEX_ECO_DT_A
- Institute of Health Information and Statistics of the Czech Republic. (2018). *Zdravotnická ročenka České republiky 2017*. (Annual Report). Institute of Health Information and Statistics of the Czech Republic.
<https://www.uzis.cz/index-en.php?pg=record&id=8166>
- Institute of Health Information and Statistics of the Czech Republic & Institute of Biostatistics and Analyses. (2018). *Zdravotnictví ČR: Personální kapacita a odměňování 2017*. (Report). Institute of Health Information and Statistics of the Czech Republic. <https://www.uzis.cz/index.php?pg=record&id=8147>
- Komárková, L., Truhlářová, Z., & Marešová, P. (2020). Structure of Clients in Residential Social Services for the Elderly: A Regional Analysis. In P. Jedlička, P. Marešová, K. Firlej, & I. Soukal (Eds.), *Proceedings of the international scientific conference Hradec Economic Days 2020* (pp. 327–335). University of Hradec Králové.
<https://doi.org/10.36689/uhk/hed/2020-01-038>
- Kubalčíková, K., & Havlíková, J. (2016) Current Developments in Social Care Services for Older Adults in the Czech Republic: Trends Towards Deinstitutionalization and Marketization, *Journal of Social Service Research*, 42(2), 180–198. <https://doi.org/10.1080/01488376.2015.1129014>

- Langhamrová, J., Šimková, M., & Sixta, J. (2018). Makroekonomické dopady rozšiřování sociálních služeb pro stárnoucí populaci České republiky. *Politická ekonomie*, 66(2), 240–259. <https://doi.org/10.18267/j.polek.1186>
- Malíková, E. (2020). *Péče o seniory v pobytových zařízeních sociálních služeb* (2nd ed.). Grada Publishing.
- Mareckova, M. (2004). Exodus of Czech doctors leaves gaps in health care. *The Lancet*, 363(9419), 1443–1446. [https://doi.org/10.1016/S0140-6736\(04\)16137-0](https://doi.org/10.1016/S0140-6736(04)16137-0)
- Maresova, P., Komarkova, L., Kuhnova, J., Cimler, R., Pazitny, P., Kandilaki, D., Musilek, K., Truhlarova, Z., Zemek, F., & Kuca, K. (2020a). Anticipated Social and Healthcare Economic Burden of People with Alzheimer's Disease in Two Selected Regions of the Czech Republic. *Healthcare*, 8(4), 433. <https://doi.org/10.3390/healthcare8040433>
- Maresova, P., Lee, S., Fadeyi, O. O., & Kuca, K. (2020b). The social and economic burden on family caregivers for older adults in the Czech Republic. *BMC geriatrics*, 20, 171. <https://doi.org/10.1186/s12877-020-01571-2>
- Maresova, P., Prochazka, M., Barakovic, S., Baraković Husić, J., & Kuca, K. (2020c). A Shortage in the Number of Nurses—A Case Study from a Selected Region in the Czech Republic and International Context. *Healthcare*, 8(2), 152. <https://doi.org/10.3390/healthcare8020152>
- Marková, A., Komárková, L., & Truhlářová, Z. (2020). The Perception of the Care Work and Its Importance: A Pilot Study. *Czech and Slovak Social Work*, 20(1), 33–44.
- Ministry of Labor and Social Affairs. (2014). *Národní akční plán podporující pozitivní stárnutí pro období let 2013 až 2017: Aktualizovaná verze k 31. 12. 2014*. (Report). Ministry of Labor and Social Affairs. https://www.mpsv.cz/documents/20142/953091/NAP_CZ_web.pdf/26116d05-2319-aa67-831e-f5a33881dcb1
- Ministry of Labor and Social Affairs. (2016). *Národní strategie rozvoje sociálních služeb na období 2016–2025*. (Report). Ministry of Labor and Social Affairs. <https://www.mpsv.cz/documents/20142/577769/NSRSS.pdf/af89ab84-31ac-e08a-7233-c6662272bca0>
- Průša, L. (2015). Důsledky stárnutí populace na potřebu služeb sociální péče do roku 2030. *Demografie*, 57(3), 231–244.
- Schönrock, S., Schablon, A., Nienhaus, A., & Peters, C. (2015). What do healthcare workers in elderly care know about occupational health and safety? An explorative survey. *Journal of Occupational Medicine and Toxicology*, 10(1), 1–11. <https://doi.org/10.1186/s12995-015-0079-0>
- Schulz, E. (2013). *Employment in Health and Long-Term Care Sector in European Countries* (NEUJOBS Working Paper, No. D12.1, Suppl. A). Deutsches Institut für Wirtschaftsforschung, Berlin. http://www.neujobs.eu/sites/default/files/Health%20care%20workforce-EU-160913_final.pdf
- Skela-Savič, B., Gotlib, J., Panczyk, M., Patelarou, A. E., Bole, U., Ramos-Morcillo, A. J., Finotto, S., Mecugni, D., Jarosova, D., Patelarou, E., Dolezel, J., & Ruzafa-Martínez, M. (2020). Teaching evidence-based practice (EBP) in nursing curricula in six European countries—A descriptive study. *Nurse Education Today*, 94, 104561. <https://doi.org/10.1016/j.nedt.2020.104561>
- Vrabková, I., Ertingerová, I., & Kukulíáč, P. (2021). Determination of gaps in the spatial accessibility of nursing services for persons over the age of 65 with lowered self-sufficiency: Evidence from the Czech Republic. *Plos One*, 16(1), e0244991. <https://doi.org/10.1371/journal.pone.0244991>

Efficiency Comparison of Municipal Public Transport in the Selected Cities of the Czech Republic

Veronika KOMOROUSOVÁ and Jana HINKE*

University of West Bohemia, Pilsen, Czech Republic; vkomoro@kfu.zcu.cz; hinke@kfu.zcu.cz

* Corresponding author: hinke@kfu.zcu.cz

Abstract: The article compares the efficiency of municipal public transport in the cities of Pilsen and Ostrava. To compare the efficiency, a system of suitable ratios has been drawn up. The ratios were calculated from the underlying data in the time series from 2010 to 2019. First, the transport services in both cities were compared on the basis of the following indicators: density of the transport network, transport facilities, comparative transport capacity, the development of the average age of public transport vehicles in comparison with the development of investments in the vehicle fleet recalculated per unit of performance. Subsequently, the comparison of efficiency was drawn, with the parameter of capacity utilization of transport performance being chosen as the basic criterion. The analysis was complemented with a comparison of real sales per capita, a comparison of nominal sales per passenger transported and a comparison of the real value of compensation per capita. Based on the comparisons, the conclusions were drawn. They show that although the city of Ostrava has relatively better public transport facilities, the city of Pilsen uses its public transport more efficiently.

Keywords: efficiency; municipal public transport; comparison; transport performance

JEL Classification: L91; O18

1. Introduction

Increasingly frequent traffic congestions and the growing interest in environmental issues make public transport the preferred mode of transport in cities. Therefore, national and local authorities should determine operating conditions that will enable the efficient use of public funds (Fitzova & Matulova, 2020). However, the question is how to evaluate the efficiency of municipal public transport, and thus the effectiveness of the use of public funds.

To assess the efficiency of priorities of public transport, the authors (Zhang et al., 2019) designed an index system using the difference coefficient of the CRITIC-TOPSIS model. The obstacle factor model is used to diagnose factors influencing the priority performance of municipal public transport. Lupták et al. (2019) propose a new uniform methodology for the assessment of passenger transport timetables in terms of transport connectivity, the purpose of which is to propose a methodological procedure for assessing the quality of transport connections in the transport network, thus heading towards a more efficient evaluation of integrated transport systems. The study (Hirschhorn et al., 2019) on the organization and performance of public transport focused on the selected metropolitan areas in Europe, Australia and Canada uses the qualitative comparative analysis (QCA). The QCA uses a

combination of multiple explanatory conditions, examines the relations between the conditions and evaluates their necessity and adequacy. The return on costs depends on the combined effects of several conditions and finds out that different ways can lead to similar results. Other authors (Anila et al., 2019) used the AHP technique (Analytical Hierarchical Process) to evaluate performance indicators. The methodology of model construction begins with the selection of various performance indicators. Twelve variables were selected for the model. They were then divided into user-oriented and provider-oriented indicators. A worldwide survey by the Dephi technique was used in another study (Hirschhorn et al., 2018) to evaluate the performance indicators and organizational elements in public transport. This is a three-phase iterative process of interweaving questionnaires and controlled feedback. In relation to the performance indicators, system-wide metrics are selected as the preferred measures for the strategic evaluation of public transport. Alonso et al. (2018) assesses the efficiency of public transport in times of financial/economic crisis. Their results show that especially the growth of transport integration can improve the efficiency and quality of public transport, and thus contribute to increasing the competitiveness of public transport (even in adverse contexts). In any case, Campos-Alba et al. (2020) highlight the need to analyze the long-term effectiveness of various forms of public transport management, as this is the only way to obtain a stable, homogeneous, and comparable estimate of the efficiency of municipal public transport.

Matulova and Fitzova (2018) conducted research in this area within the Czech Republic. They examined the efficiency of municipal public transport using three external inputs (employees, rolling stock, and energy), one final output (passengers), and two intermediate products (vehicle-kilometers and seat-kilometers). One of their main findings was that the efficiency of smaller transport systems which had a difficult access to funding sources was systematically less efficient. In other research, Fitzova et al. (2018) identified factors influencing the efficiency of municipal public transport systems and compared Czech municipal public transport systems according to their efficiency. This analysis was performed on a sample of 19 systems in the Czech Republic for the period from 2010 to 2015. According to their results, Pilsen had one of the most efficient transport systems, in contrast to the least efficient cities: Chomutov-Jirkov, Ostrava and Dein. This paper will verify the results of their study and further determine whether the position of the selected cities of Pilsen and Ostrava has changed since the time of the research to the present.

The purpose of the paper is to examine the often-ignored area of public transport, which can significantly affect the growing density of traffic in cities and the efficiency of transport networks. The municipal public transport system has its own specifics, it is an area with imperfect competition, which is often regulated by the state. Hence, the measurability of the effectiveness and efficiency of this activity has its limitations, and it is difficult to use general criteria and metrics to evaluate performance.

In this paper, the authors aim to determine which of the selected cities has better public transport facilities and which city uses public transport more efficiently.

2. Methodology

The efficiency comparison of municipal public transport was made between two cities of the Czech Republic, namely Pilsen and Ostrava. The main criterion for selection was primarily comparability in the mode of transport services by public transport, with three transport modes being represented in both cities, i.e., trams, trolleybuses, and buses. The selected cities are also comparable in terms of area and population.

The data collection for the analysis was made from the period of 2010-2019 (Table 1). We used data from the annual reports of the Association of Public Transport Companies, data published by the Czech Statistical Office and data from the Ministry of Transport. After that we defined a system of suitable indicators for comparison, both for the evaluation of transport services and then for the evaluation of transport efficiency. We calculated the indicators in the monitored time series and added average values as well. We compared the values of the indicators, subsequently drew partial conclusions, and summarized them overall.

3. Results

First, the transport services in both cities were compared within the efficiency comparison of municipal public transport. The following criteria were chosen to evaluate the transport services: density of the transport network, transport facilities, comparative transport capacity, the development of the average age of public transport vehicles in comparison with the development of investments in the vehicle fleet. Subsequently, the efficiency comparison was performed, with the parameter of capacity utilization of transport performance being chosen as the basic criterion. The analysis was complemented by the comparison of sales per capita and per passenger transported as well as by the comparison of the real value of compensation per capita.

3.1. Comparison of Transport Services Provided by Municipal Public Transport

We have defined the following parameters for the basic comparison of transport services:

- Density of the public transport network (the network in km/the area in km²) was determined as the quotient of the length of public transport lines in km and the area of the city in km².
- The parameter of transport facilities per thousand of inhabitants (the transport network in km/the number of inhabitants) was determined as the quotient of the length of public transport lines and the number of inhabitants (× 1,000).
- Comparative transport capacity (in thousands of seat-kilometers per capita) was determined as the quotient of performance in thousands of seat-kilometers and the number of inhabitants.
- The parameter of capital expenditures per unit of performance (in millions of CZK/performance in vehicle-kilometers) was determined as the quotient of capital expenditures in millions of CZK and transport performance in vehicle-kilometers.

- The parameter of the development of the average age of vehicles in total was quantified as the average age of vehicles by individual modes of transport (tractions). The average value was calculated as a simple average, in 2019 the average value was specified by a weighted average, where the weights were the number of vehicles of individual modes of transport (tractions) (the data in the result table are given in brackets).

Based on the development of individual parameters and their comparison (Table 2), the following conclusions have been drawn:

- The city of Ostrava has better public transport services in terms of the density of the transport network, with an average of 5 km of lines per one km² of the city area. In Pilsen, there is an average of 4 km of lines per km² of the city area.
- When comparing the ratio of the length of the public transport network to the number of inhabitants, Ostrava has also slightly better public transport network, with 3.54 km of lines per 1,000 inhabitants compared to 3.23 km of lines per 1,000 inhabitants in Pilsen.
- The comparison of recalculated transport capacity is also better for Ostrava, which has the annual average of 11.5 thousand of seat-kilometers per capita. In Pilsen, there is on average 8.6 thousand of seat-kilometers per capita per year.
- As for the equipment of the vehicle fleet concerning its innovation, then Pilsen invests more in the purchase and modernization of public transport, with investing an average of CZK 15.61 per vehicle-kilometer of transport performance per year. In Ostrava, it is on average CZK 12.17 per vehicle-kilometer of transport performance. The comparison result of capital expenditures also corresponds to the development of the average age of vehicles, when Pilsen uses a newer vehicle fleet for transport services (the average age of vehicles is approx. 9 years), while Ostrava has slightly older vehicles for public transport services (approx. 13 years).

3.2. Comparison of Efficiency of Municipal Public Transport

To compare the efficiency of municipal public transport, we have defined the following parameters:

- The number of rides per capita was determined as the ratio of transport performance in the number of passengers transported to the number of inhabitants. This is a parameter indicating the number of rides (passengers transported) per inhabitant of the city per year.
- The indicator of transport performance in passenger-kilometers (determined by multiplying the performance of passengers transported and the average transport distance) is commonly used to evaluate transport performance, with this parameter indicating the transport of one passenger over the distance of one kilometer. The transport performance of municipal public transport in passenger-kilometers is published by the Ministry of Transport for the entire Czech Republic, not for individual transport companies. The indicator of transport performance in passenger-kilometers for the selected transport companies was recalculated from the data on passengers

transported and from the data on the average transport distance according to the statistics of the Ministry of Transport (Table 3).

- The efficiency of transport performance - the so-called utilization of transport capacity (in %) - was determined as the ratio of transport performance in passenger-kilometers to transport performance in seat-kilometers. This indicator gives us the percentage utilization of transport capacity.
- The value of real sales from public transport per capita was determined as the ratio of the real value of sales to the number of inhabitants. To recalculate the nominal value of sales to real value, the accumulated inflation indices (Table 4) related to the base year of 2010 were used. The inflation indices were determined based on the development of the annual inflation rate according to the Czech Statistical Office (2021a).
- The value of nominal sales from public transport per passenger transported was determined as the ratio of the nominal value of sales to the value of transported passengers. This indicator is a certain approximate identifier of the fare price.
- The real value of compensation per capita (in CZK) was determined as the ratio of the real value of compensation for public transport to the number of inhabitants. To recalculate the nominal value of compensation to real value, basic inflation indices were used again. This indicator shows the degree of social costs of operating municipal public transport (the value of subsidies per capita).

Based on the development of individual parameters and their comparison (Table 5), the following conclusions were drawn:

- When comparing the indicator of the number of rides per capita, it was found that the city of Ostrava falls behind Pilsen by almost half, with an average of 322 passengers transported per one inhabitant in Ostrava, in contrast to Pilsen, where there are 625 passengers transported per one inhabitant.
- The indicator of the transport performance efficiency points to the fact that the capacity of public transport in Ostrava is used at 21% on average, while in Pilsen the average use of public transport capacity is at 55%.
- The indicator of real value of sales per capita also points to the fact that public transport is used more efficiently in Pilsen, where there is an average of CZK 1,592 of real sales per capita, while it is a slightly lower value in Ostrava on average (CZK 1,536 of sales per capita); although there is a 33% higher capacity of transport performance per capita (in passenger-kilometers) in Ostrava.
- The indicator of the nominal value of sales per passenger transported is a certain complementary indicator for evaluating the efficiency. It determines the average price of rides excluded VAT in general. This indicator provides some generalizing information about the pricing strategy of the compared cities. It may be deduced from the indicator that travelling by municipal public transport is generally cheaper in Pilsen than in Ostrava. When comparing the passenger fare rates, in addition to comparing the price of basic passenger fare rates, it would also be necessary to compare the system of discounts

and options when passenger fares are free, and to take into account the structure of passengers, which is not the subject of this article.

- A certain degree of social costs per capita can be deduced from the indicator of the real value of compensation per capita. The results clearly show that in Pilsen there is a share of CZK 4,361 per capita on average per year, which is by 22% higher subsidies from public budgets to municipal public transport per capita than in Ostrava, where the average amount is CZK 3,563.

4. Discussion and Conclusions

The research concerning the assessment of the efficiency of municipal public transport focused on the comparison of transport services and subsequently on the comparison of the efficiency of municipal public transport in the cities of Pilsen and Ostrava. Based on the analysis of the defined system of indicators from the time series of 2010-2019, the following conclusions have been drawn:

- In this comparison, the city of Ostrava has a higher transport capacity and better public transport facilities than Pilsen (a higher density of the public transport network, a higher calculated length of the network per capita and a higher transport capacity per capita).
- On the other hand, the city of Pilsen has a higher quality of public transport in terms of fleet innovation indicators (a lower average age of vehicles, higher average investments in fleet modernization and renewal).
- The city of Pilsen uses its municipal public transport more efficiently (a higher value of transport performance in terms of transported passengers per capita, a higher use of transport performance capacity based on the efficiency parameter). In Pilsen, there is also a higher volume of real sales per capita, although it is possible to deduce that Pilsen provides public transport with a generally more favorable pricing strategy (a lower value of nominal sales per passenger transported). The analysis also points to the fact that the social costs expressed in the ratio of subsidies for municipal public transport per capita are higher in Pilsen than in Ostrava.

Based on the summary of partial conclusions, it can be stated that although the city of Ostrava has a higher density of the public transport network and better facilities than Pilsen, it uses its public transport with significantly lower efficiency. In Pilsen, on the other hand, there is a better equipped vehicle fleet in terms of its age and modernization, and a more favorable pricing strategy for passengers can be found as well. However, the population in Pilsen is burdened by higher social costs on average (subsidies from public budgets), which go to public transport.

In further research, we would like to focus on comparing the efficiency of municipal public transport in other cities of the Czech Republic, to gradually complement the research with analysis of other related indicators, to add a deeper analysis of pricing strategy, to examine the impact of public transport efficiency on transport sustainability (especially emissions, noise, and traffic density), and to evaluate the interdependence - correlation of individual variables in longer time series.

EFFICIENCY COMPARISON OF MUNICIPAL PUBLIC TRANSPORT

Table 1. The underlying data for the calculation of comparative indicators. (Own processing in accordance with Association of Transport Companies of the Czech Republic, 2021).

Municipal public transport - Ostrava	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Transport performance in thousands of km	34,054	34,008	33,773	32,214	31,820	32,168	32,546	32,751	32,703	31,814
Transport performance in thousands of seat-km	3,462,884	3,475,436	3,469,792	3,311,458	3,301,825	3,298,709	3,331,316	3,353,975	3,348,643	3,336,729
Passengers transported (in thousands of passengers)	102,600	101,924	96,389	93,476	91,000	88,159	88,518	91,150	97,648	96,129
The length of lines (in km)	1,068	1,068	1,059	1,000	1,025	1,027	1,014	1,014	1,057	1,069
Sales from municipal public transport in mil. of CZK	514	516	520	531	511	481	452	435	429	441
Compensation (public transport subsidies) in mil. of CZK	1,022	1,025	1,083	1,070	1,062	1,033	1,064	1,177	1,306	1,409
Compensation (percentage of costs)	66	66	67	66	67	67	69	75	77	78
Investments in vehicle fleet in mil. of CZK	303.6	280.2	316.0	170.7	277.3	847.7	0.0	41.5	1,178.8	556.9
Average age – buses		9.4	8.8	8.8	10.0	5.8	6.6	7.6	6.7	6.9
Average age – trolleybuses		12.0	11.9	12.6	13.6	11.5	11.6	11.9	9.7	10.6
Average age – trams		15.7	15.7	20.0	19.5	21.5	22.0	23.0	20.1	19.6
Number of inhabitants	303,609	299,622	297,421	295,653	294,200	292,681	291,634	290,450	289,128	287,968
Area of the city in km ²	214.2	214.2	214.2	214.2	214.2	214.2	214.2	214.2	214.2	214.2

Municipal public transport - Pilsen	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Transport performance in thousands of km	15,036	15,078	15,102	15,071	15,077	15,099	15,238	15,283	15,065	15,460
Transport performance in thousands of seat-km	1,381,428	1,360,527	1,371,334	1,415,689	1,437,851	1,486,124	1,494,694	1,585,469	1,479,127	1,535,859
Passengers transported (in thousands of passengers)	100,885	101,900	99,154	100,593	101,115	101,986	107,581	109,984	115,473	124,977
The length of lines (in km)	487	487	472	541	581	582	583	587	586	593
Sales from municipal public transport in mil. of CZK	273	267	300	296	292	290	292	292	293	303
Compensation (public transport subsidies) in mil. of CZK	690	742	743	766	798	816	777	824	872	930
Compensation (percentage of costs)	65	63	63	60	61	63	63	62	63	38
Investments in vehicle fleet in mil. of CZK	232.8	273.2	309.0	209.2	175.0	188.6	83.5	247.0	44.5	610.7
Average age – buses		10.1	9.0	7.1	8.1	7.3	6.9	8.2	9.1	7.5
Average age – trolleybuses		10.9	12.0	5.4	8.5	8.6	8.5	6.7	7.4	7.8
Average age – trams		8.3	8.3	6.6	9.1	9.0	9.0	10.8	11.8	11.8
Number of inhabitants	168,808	167,302	167,472	168,034	169,033	169,858	170,548	170,936	172,441	174,842
Area of the city in km ²	137.7	137.7	137.7	137.7	137.7	137.7	137.7	137.7	137.7	137.7

EFFICIENCY COMPARISON OF MUNICIPAL PUBLIC TRANSPORT

Table 2. Parameters for the comparison of transport services by public transport for the period of 2010-2019. (own processing)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
Network density (km of lines/area in km²)											
Ostrava	4.99	4.99	4.94	4.67	4.79	4.79	4.73	4.73	4.93	4.99	4.86
Pilsen	3.53	3.53	3.43	3.93	4.22	4.23	4.23	4.26	4.26	4.31	3.99
Transport facilities (in km of lines per thousand of inhabitants)											
Ostrava	3.52	3.56	3.56	3.38	3.48	3.51	3.48	3.49	3.66	3.71	3.54
Pilsen	2.88	2.91	2.82	3.22	3.44	3.43	3.42	3.43	3.40	3.39	3.23
Transport capacity (in thousands of seat-km per the number of inhabitants)											
Ostrava	11,405.74	11,599.40	11,666.26	11,200.49	11,223.06	11,270.66	11,422.93	11,547.51	11,581.87	11,587.15	11,450.51
Pilsen	8,183.43	8,132.16	8,188.44	8,425.02	8,506.33	8,749.21	8,764.07	9,275.22	8,577.58	8,784.27	8,558.57
Capital expenditures per unit of performance (in CZK/km)											
Ostrava	8.92	8.24	9.36	5.30	8.71	26.35	0.00	1.27	36.05	17.50	12.17
Pilsen	15.48	18.12	20.46	13.88	11.61	12.49	5.48	16.16	2.95	39.50	15.61
Average age of vehicles (in years)											
Ostrava		12.37	12.13	13.80	14.37	12.93	13.40	14.17	12.17	12.37 (12.7)	13.08
Pilsen		9.77	9.77	6.37	8.57	8.30	8.13	8.57	9.43	9.03 (9.0)	8.66

Table 3. Average transport distance from 2010 to 2019. (Sydos, 2021)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Average transport distance	6.9	7.1	7.1	7.5	7.6	7.4	7.6	7.7	8.2	8.3

Table 4. Basic inflation index from 2010 to 2019. (Czech Statistical Office, 2021b)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Basic inflation index	100	101.8	104.9	106.3	106.7	107	107.7	110.1	112.3	115.1

EFFICIENCY COMPARISON OF MUNICIPAL PUBLIC TRANSPORT

Table 5. Parameters for comparing the efficiency of municipal public transport for the period of 2010-2019. (own processing)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
Number of rides per capita											
Ostrava	338	340	324	316	309	301	304	314	338	334	322
Pilsen	598	609	592	599	598	600	631	643	670	715	625
Transport performance (in thousands of passenger-kilometers)											
Ostrava	707,940	723,660	684,362	701,070	691,600	652,377	672,737	701,855	800,714	797,871	713,419
Pilsen	696,107	723,490	703,993	754,448	768,474	754,696	817,616	846,877	946,879	1,037,309	804,989
Transport performance efficiency (in %)											
Ostrava	20%	21%	20%	21%	21%	20%	20%	21%	24%	24%	21%
Pilsen	50%	53%	51%	53%	53%	51%	55%	53%	64%	68%	55%
Real value of sales per capita (in CZK)											
Ostrava	1,693	1,692	1,666	1,690	1,629	1,537	1,439	1,360	1,320	1,331	1,536
Pilsen	1,616	1,567	1,708	1,656	1,620	1,596	1,588	1,552	1,513	1,507	1,592
Nominal value of sales per passenger transported (in CZK)											
Ostrava	5.0	5.1	5.4	5.7	5.6	5.5	5.1	4.8	4.4	4.6	5.1
Pilsen	2.7	2.6	3.0	2.9	2.9	2.8	2.7	2.7	2.5	2.4	2.7
Real value of compensation calculated per capita (in CZK)											
Ostrava	3,366	3,360	3,471	3,405	3,383	3,299	3,388	3,681	4,022	4,251	3,563
Pilsen	4,087	4,357	4,229	4,288	4,425	4,490	4,230	4,378	4,503	4,621	4,361

Acknowledgements: This paper is a partial result of the SGS-2020-026 project titled "Economic and Financial Transformation in the Context of the Digital Society" of the Faculty of Economics, University of West Bohemia in Pilsen.

References

- Alonso, A., Monzón, A., & Cascajo, R. (2018). Measuring negative synergies of urban sprawl and economic crisis over public transport efficiency: the case of Spain. *International Regional Science Review*, 41(5), 540-576. <https://doi.org/10.1177/0160017616687361>
- Anila, C., Raviraj, M., & Varghese, G. (2019). Performance Optimization of Public Transport Using Integrated AHP-GP Methodology. *Urban Rail Transit*, 5(2), 133-144. <https://doi.org/10.1007/s40864-019-0103-2>
- Association of Transport Companies of the Czech Republic. (2021). About us – Annual reports. Retrieved January 2, 2021 from <http://www.sdp-cr.cz/o-nas/vyrocní-zpravy/>
- Campos-Alba, C. M., Prior, D., Pérez-López, G., & Zafra-Gómez, J. L. (2020). Long-term cost efficiency of alternative management forms for urban public transport from the public sector perspective. *Transport Policy*, 88, 16-23. <https://doi.org/10.1016/j.tranpol.2020.01.014>
- Czech Statistical Office. (2021a). *Public database - own choice*. Retrieved January 10, 2021, from <https://vdb.czso.cz/vdbvo2/faces/cs/index.jsf?page=uziv-dotaz#>.
- Czech Statistical Office. (2021b). *Inflation - types, definitions, tables*. (n.d.). *Inflation - Types, Definitions, Tables*. Retrieved January 8, 2021, from https://www.czso.cz/csu/czso/mira_inflace
- Fitzova, H., & Matulova, M. (2020). Comparison of urban public transport systems in the Czech Republic and Slovakia: Factors underpinning efficiency. *Research in Transportation Economics*, 81(SI). <https://doi.org/10.1016/j.retrec.2020.100824>
- Fitzova, H., Matulova, M., & Tomes, Z. (2018). Determinants of urban public transport efficiency: case study of the Czech Republic. *European Transport Research Review*, 10(2). <https://doi.org/10.1186/s12544-018-0311-y>.
- Hirschhorn, F., Veeneman, W., & van de Velde, D. (2018). Inventory and rating of performance indicators and organisational features in metropolitan public transport: A worldwide Delphi survey. *Research in Transportation Economics*, 69(SI), 144-156. <https://doi.org/10.1016/j.retrec.2018.02.003>
- Hirschhorn, F., Veeneman, W., & van de Velde, D. (2019). Organisation and performance of public transport: A systematic cross-case comparison of metropolitan areas in Europe, Australia, and Canada. *Transportation Research Part A: Policy and Practice*, 124, 419-432. <https://doi.org/10.1016/j.tra.2019.04.008>
- Ľupták, V., Drożdziel, P., Stopka, O., Stopková, M., & Rybicka, I. (2019). Approach Methodology for Comprehensive Assessing the Public Passenger Transport Timetable Performances at a Regional Scale. *Sustainability*, 11(13), 3532. <https://doi.org/10.3390/su11133532>
- Matulova, M., & Fitzova, H. (2018). Transformation of urban public transport financing and its effect on operators' efficiency: evidence from the Czech Republic. *Central European Journal of Operations Research*, 26(4:SI), 967-983. <https://doi.org/10.1007/s10100-018-0565-4>
- Sydos. (2021). *Transport yearbooks*. Retrieved January 5, 2021, from <https://www.sydos.cz/cs/rocniky.htm>
- Zhang, X., Zhang, Q., & Sun, T. (2019). Performance evaluation and obstacle factors analysis of urban public transport priority. *Transportation Planning and Technology*, 42(7), 696-713. <https://doi.org/10.1080/03081060.2019.1650433>

What is the Real Tax Burden in Slovakia?

Zlatica KONÔPKOVÁ

Masaryk University, Brno, Czech Republic; konopkova.zlatica@mail.muni.cz

Abstract: Taxes are the main fiscal instrument and essential part of economy. Every government needs to collect them to fund its spending, but also needs to find the right balance to minimize their negative distortion effects. This paper investigates the real tax burden in Slovakia using modified World Tax Index (WTI). It is a multi-criteria indicator measuring overall tax burden in OECD countries. WTI is constructed as a combination of hard tax data weighted based on factor analysis by soft data, which are gathered through an online questionnaire among tax specialists. WTI eliminates the influence of GDP and does not overestimate the tax burden as other indicators. Results for Slovakia suggest that personal income taxes have the greatest impact, followed by corporate income taxes, property taxes and other taxes on consumption/excise taxes. The lowest tax burden is created by the value-added tax. The results recommend a decrease in labor income taxes that had increasing trend over investigated period.

Keywords: tax burden; tax quota; World Tax Index (WTI); factor analysis; PCA; Slovakia

JEL Classification: H21; C38

1. Introduction

Economies and their governments are currently dealing with the consequences and uncertainty caused by the pandemic of novel coronavirus, which highlights the role of the government in economy. Restrictive measures were put in place in order to prevent the spread of the virus and caused reduction of economic activity all over the sectors. Economic subjects now turn their attention to the government and ask for help and compensation for limiting their activities. Therefore, huge pressure is expected on government budgets in next years. Especially on those, who have not recovered completely from the latest global financial crisis. It would be a real challenge for policy makers to set up right mixture of taxes to cover their increased spending and at the same time does not have significant negative impact on economic activity. Taxes can slow down the economic growth, as they create distortions and burden part of the activity in economy.

Due to the negative impact of taxation on economy, it is important to measure the size of impact on economy. The mostly used indicators of tax burden are tax quota and implicit tax rates. Tax quota relates the tax revenues to nominal GDP, or in compound form, tax revenues together with social security contributions to nominal GDP. It is available for many countries, frequently used in models of economic growth and for countries comparison. Implicit tax rate represents also the ratio of tax revenues, but only to the tax related activities or commodities in GDP instead of the whole nominal GDP. The implicit tax rates are calculated for labour, capital

and consumption, but only for countries in European Union and therefore comparison is possible only within EU.

There are also alternative indicators of tax burden created in order to eliminate some disadvantages of the mentioned standard measurements. Usually, they are not as simple as the standard ones, but might better reflect the phenomenon. Raimondos-Møller and Woodland (2006) introduce an intuitive, non-money metric index of optimality, which measures the distance of a current tax structure from the optimal one, but it says nothing about how costly it is to be away from the optimal level of taxes. Polito (2009) focuses on specific field of taxes and investigate the tax burden by calculating effective tax rates. He argues that effective marginal and average tax rates (as forward-looking indices of the effective tax burden on income from capital) are negatively biased because traditional models overlook dividend constraints associated with financial tax incentives, such as accelerated depreciation. According to De Laet and Wöhlbier (2008), tax is as a compulsory unrequired payment to the government. Tax types are assigned various economic function (work, business, consumption) and differentiated according to the national account. Kiss et al. (2009) criticize the structure of tax quota and eliminate the influence of government.

According to Kotlán and Machová (2012), the tax quota does not reflect the level of the tax burden, but only the redistribution of GDP percentage through the public budgets. A higher tax quota can indicate only more efficient tax collection than higher tax burden. Another disadvantage is connected to GDP, because of its different methodology in different countries. The same is valid also for the implicit tax rates. Therefore, they have introduced their own alternative indicator for OECD countries called World Tax Index (WTI), which is not limited only to the tax revenues and nominal GDP. As presented by Kotlán and Machová (2013), WTI more significantly address the negative effect of taxation for particular taxes types, which is not possible using the tax quota. In Konôpková and Buček (2016), a new methodology for WTI based on applying factor analysis was introduced. The new tax burden indicator is actually a unique single weighted average tax rate for the country. As shown by pilot project results for the Czech Republic in Konôpková and Buček (2018a), modified WTI eliminates the influence of GDP and does not overestimate the tax burden as other indicators.

The goal of this paper is to investigate the tax burden in Slovakia. It follows and extends previously mentioned research and presents the results of applying newly designed WTI for Slovakia. Next section describes methodology and data, then the results are presented and discussed.

2. Methodology and Data

WTI is an overall multi-criteria indicator incorporating information from different areas, that might affect the tax burden, e.g. progressivity of the tax system, incentives, deductions, administration, etc. It is structured into 5 main groups according to OECD taxes classification – Personal Income Tax (PIT), Corporate Income Tax (CIT), Value Added Tax (VAT), Individual Property Taxes (PRO) and Other Taxes on Consumption/Excises (OTC). It is calculated as a combination of available hard tax data and soft data (qualified expert opinions - QEO) gained from questionnaires, which are distributed among tax specialists.

In its original design, WTI methodology was assuming that tax experts can evaluate directly the tax burden in their countries. Therefore, such experts were asked to share their expert judgements about the tax burden in their country, and the mean tax burden was calculated for each tax category based on their answers. Only academic experts were included. New methodology extends the research also to public and private sector and changes from direct to indirect approach. As stated by Borsboom, Mellenbergh, and van Heerden (2003), the values of representing variables are hidden, because human behaviour cannot be observed directly, but they can be estimated through mathematical methods.

A new questionnaire was introduced in Konôpková and Buček (2016) and is available online at <http://goo.gl/forms/kWCsMvKO2tWUirIk2>. It is built on several “Do you think...?” questions to be answered using a standard Likert scale of Strongly disagree (1) – Strongly agree (5). They represent different components of taxation in order to discover the unobserved underlying factors for every main tax category. Applying the factor analysis, five factors are received and the obtained individual score is then used for calculation of the tax categories weights for each individual respondent. The average value of all respondents is then the final weight for the tax category. Final WTI is calculated as a combination of the standardized weights and representing tax rates for every category. The indicator defined in this way is a unique single weighted average tax rate for the country. It was shown in Konôpková and Buček (2018b) that three different methods of factorization obtain similar effects for the five tax categories and therefore calculation of the WTI is independent of the chosen method of factorization.

This paper presents the results of the Principal Component Analysis (PCA) built in *psych* library and performed in *R-Studio*. The Principal Component Analysis (PCA) is a statistical procedure that transforms a number of correlated variables into a (smaller) number of uncorrelated variables. The PCA can be done using the singular value decomposition (SVD):

$$X = U\Sigma V^T \quad (1)$$

where, U is a $n \times n$ matrix with eigenvectors of XX^T , Σ is a $n \times p$ diagonal matrix containing the square roots of eigenvalues of U or V in descending order and V^T is a $p \times p$ matrix with eigenvectors of X^TX . For more details, check Brown (2009).

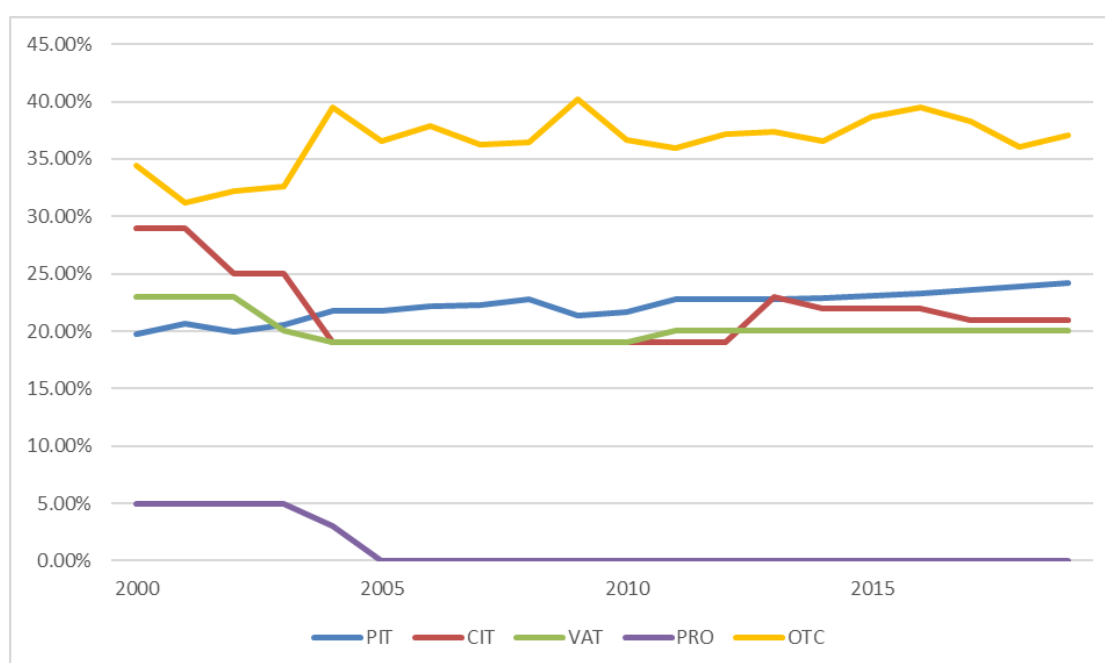
2.1. Data

To calculate the final WTI for Slovakia, a representative ad valorem tax rate for each category must be selected. Unfortunately, there is no single tax rate that would represent Excises (OTC). They are mostly per unit taxes defined by law and in Slovakia cover fuel (diesel, petrol), alcohol (hard liquor, wine, and beer), and tobacco (cigarettes). An equivalent ad valorem tax was calculated for every good as a percentage of excise on the average annual price. The final representative tax rate for the OTC category was then calculated as the weighted average of the mentioned equivalent ad valorem taxes. The weights were taken from Harmonised index of consumer prices published by Eurostat (2020). Table 1 displays the names of selected representative tax rates and their source.

Table 1. Representative tax rates for Slovakia and their source

Category	Description	Source
PIT	Average personal income tax & social security contribution rates to gross labour income (100% of the mean wage)	OECD (2020), Table I.5
CIT	Statutory corporate income tax rate	OECD (2020), Table II.1
VAT	Basic tax rate	OECD (2020), Table 2.A2.1
PRO	Tax on the acquisition of real property/property transfer tax	Zakonypreludi.sk
OTC	The average rate of excise taxes weighted by HICP weights	calculation

Figure 1 shows the representative tax rates and their changes over time. The most important is year 2004, when Slovakia has joined European Union and also big tax reform was implemented. All property tax rates were cancelled and one basic flat rate at 19% was introduced for personal, corporate income and value added taxes. The flat tax rate was cancelled in 2012 and the CIT rate has been significantly increased. In WTI, PIT category covers also social security contributions as special type of tax and therefore it was above flat tax rate. Overall, the PIT rate has increasing trend over time. The increase in OTC was caused by the tax harmonization after the entry of Slovakia into the European Union.

**Figure 1.** Representative tax rates over time.

3. Results

The responses were collected from October 2016 till April 2017 and then mainly in the period from August 2020. Questionnaire was sent to academic researchers, public national institutions, and to the private sector represented by the Big Four accounting firms. It was also shared to tax specialist in cooperation with Slovenská komora daňových poradcov and in the biggest accounting discussion group on social network Facebook.

Together 30 respondents filled the questionnaire, mostly from private sector (83%). More than 56% of respondents strongly agreed or agreed with the statement that they consider themselves experts on taxes, only 6% strongly disagreed or disagreed with it, and the

remaining 38% were neutral. Thanks to the high expertness of respondents, we can consider their answers relevant for our research. Applying the methodology described in previous section, the weights of individual tax categories on the overall tax burden were calculated and are displayed in Table 2.

Table 2. Calculated weights and order of the WTI categories

	PIT	CIT	VAT	PRO	OTC
Weight	0.3505	0.1927	0.0730	0.1912	0.1926
Order	1	2	5	4	3

The most important category in WTI for Slovakia is Personal Income Tax with contribution of 35.5%. It is then followed by Corporate Income Tax, Excises and Property Taxes with the similar contribution around 19%. The least important is Value Added Tax with contribution only 7.3%. It is in line with expectation, that direct taxes are the ones, that bothers economic subjects the most. Overall, direct taxes contribute by 73.58% to tax burden, while indirect taxes only by 26.42%. Therefore, policy makers should carefully prepare reforms of direct taxes. In Slovakia, the government should definitely think about reversing the trend in PIT, which is the most important category in tax burden. In case of need for increasing tax revenues, the politicians might consider firstly value added tax, which is stable over the period and the least bothering at the same time.

Table 3 displays the value of WTI for Slovakia for years 2000-2019. It is a unique single weighted average tax rate for the country, which can be simply incorporated into models of economic growth. The rate is quite stable over time, but in average, the tax burden in Slovakia is higher in the second decade of the examined period.

Table 3. WTI for Slovakia in period 2000-2019

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
21.79%	21.48%	20.64%	20.71%	20.87%	19.73%	20.09%	19.85%	20.07%	20.29%
2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
19.71%	20.03%	20.28%	21.07%	20.78%	21.25%	21.47%	21.16%	20.84%	21.13%

4. Discussion

Now, let's compare the newly designed World Tax Index for Slovakia with Tax quota. Figure 2 displays their values for last 20 years. World Tax Index was more stable, which might suggest it was not affected by decline in GDP caused by the latest global financial crisis and therefore the problem commented by Kotlán and Machová (2012) might be removed with new methodology. The tax rates during period of 2004-2012 was quite stable due to flat tax rate and therefore we might expect the tax burden be the same, but the tax quota was declining which suggests it was affected by the changes in GDP. The results of this research are limited by number of respondents and it would be interesting to estimate the tax burden with more observation.

Overall, the results are in line with the study prepared by the OECD (2011). The study suggests the moving from direct to indirect taxation, which is the main trend in fiscal policy.

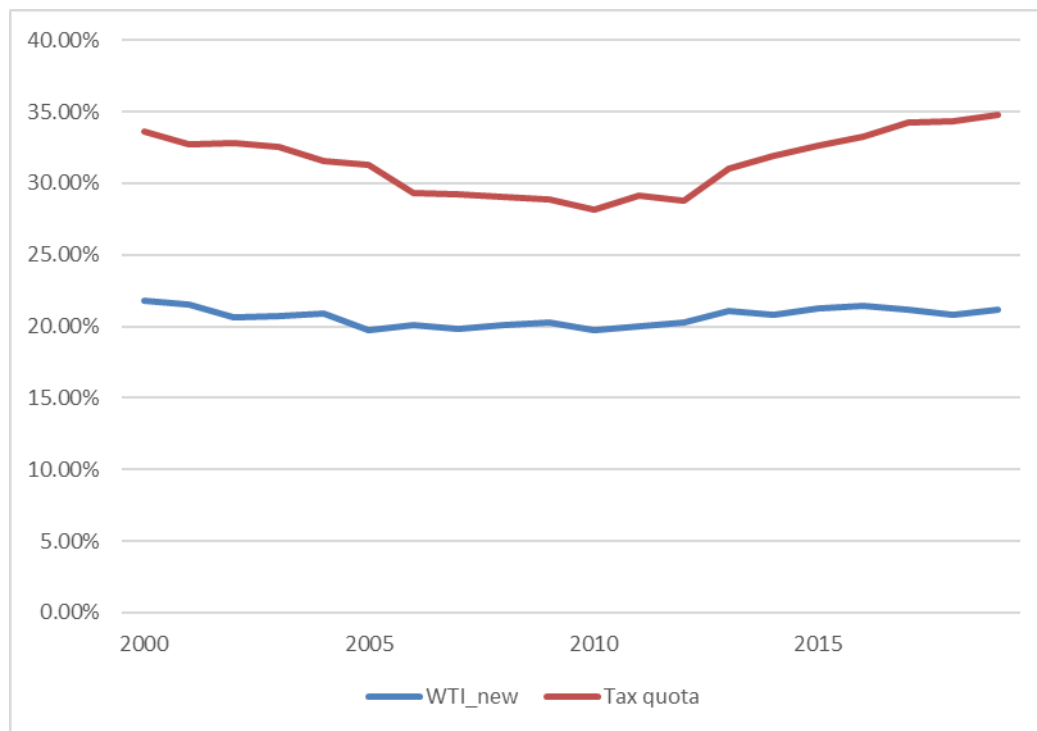


Figure 2. World Tax Index and Tax quota for Slovakia

Direct taxes bother economic subjects much more than indirect. Policy makers should follow it in order to collect taxes efficiently and reduce tax burdens. In more detail, the study stated that corporate and personal income taxes had the largest negative effects on the economy, while in contrast consumption and property taxes had the smallest negative effects, same as our results. Corporate and personal income taxes are the most important categories and consumption and property taxes are on the opposite side.

Acknowledgments: Supported by funding of specific research at Faculty of Economics and Administration, project MUNI/A/0906/2019. This support is gratefully acknowledged.

References

- Borsboom, D., Mellenbergh, G. J., & van Heerden, J. (2003). The theoretical status of latent variables. *Psychological Review*, 110(2), 203–219. <https://doi.org/10.1037/0033-295X.110.2.203>
- Brown, J. D. (2009). Principal components analysis and exploratory factor analysis – Definitions, differences and choices. *Shiken: JALT Testing & Evaluation SIG Newsletter*, 13(1), 26–30. <http://jalt.org/test/PDF/Brown29.pdf>
- De Laet, J. P., & Wöhlbier, F. (2008). *Tax burden by economic function: A comparison for the EU member states*. (MPRA Paper 14761). Munich Personal RePEc Archive. https://mpa.ub.uni-muenchen.de/14761/1/MPRA_paper_14761.pdf
- Eurostat. (2020). *Harmonised index of consumer prices (HICP)* [Data set]. Retrieved November 30, 2020, from <https://ec.europa.eu/eurostat/web/hicp/data/database>
- Kiss, G. P., Jedrzejowicz, T., & Jirsáková, J. (2009). *How to measure tax burden in an internationally comparable way?* (NBP Working Paper 56). National Bank of Poland. https://www.nbp.pl/publikacje/materialy_i_studia/56_en.pdf
- Kiss, G. P., Jedrzejowicz, T., & Jirsakova, J. (2009). How to Measure Tax Burden in an Internationally Comparable Way? *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1752229>
- Kotlán, I., & Machová, Z. (2012). World Tax Index: Methodology and data. *DANUBE: Law and Economics Review*, 2(2), 19–33. https://www.eaco.eu/wp-content/uploads/2015/04/kotlan_machova2.pdf

- Kotlán, I., & Machová, Z. (2013). The impact of the tax burden on the living standard in OECD countries. *Ekonomický časopis*, 61(9), 951–962. <https://www.sav.sk/journals/uploads/0621141609%2013%20Kotlan-Machova-RS.pdf>
- Kotlán, I., Machová, Z., & Janíčková, L. (2011). Vliv zdanění na dlouhodobý ekonomický růst. *Politická ekonomie*, 59(5), 638–658. <https://polek.vse.cz/pdfs/pol/2011/05/04.pdf>
- Konôpková, Z., & Buček, J. (2016). World Tax Index: Methodology for 2017. In Z. Machová (Ed.), *6th International Scientific Conference TAXES IN THE WORLD* (pp. 77–87). European Association Comenius EACO and VSEO.
- Konôpková, Z., & Buček, J. (2018a). World Tax Index: Measuring tax burden in the Czech Republic. In M. Reiff, & P. Gežík (Eds.), *Quantitative methods in economics; Multiple criteria decision making XIX* (pp. 186–192). University of Economics. <http://fhi.sk/files/katedry/kove/ssov/proceedings/Zbornik2018.pdf>
- Konôpková, Z., & Buček, J. (2018b). World Tax Index: Results of the pilot project. In L. Váchová, & V. Kratochvíl (Eds.), *The 36th International Conference Mathematical Methods in Economics, Conference Proceedings* (pp. 240–245). MatfyzPress. https://mme2018.fm.vse.cz/wp-content/uploads/2018/09/MME2018-Electronic_proceedings.pdf
- OECD. (2011). *Tax Policy Reform and Economic Growth*. OECD Publishing. <https://doi.org/10.1787/9789264091085-en>
- OECD. (2020). *Database OECD* [Data set]. Retrieved November 30, 2020, from <https://www.oecd.org/tax/tax-policy/tax-database/>
- Polito, V. (2009). Measuring the Effective Tax Burden in the Real World. *Fiscal Studies*, 30(2), 247–278. <https://doi.org/10.1111/j.1475-5890.2009.00095.x>
- Raimondos-Møller, P., & Woodland, A. D. (2006). Measuring Tax Efficiency: A tax optimality index. *Journal of Public Economics*, 90(12), 1903–1922. <https://doi.org/10.1016/j.jpubeco.2005.12.003>
- Zákonypreludi.sk. (2020, August 31). *Zákony pre ľudí*. <https://www.zakonypreludi.sk/zz/1992-318#cast3>

Integrative Estimation of Region Economic Stability as in the Case of the Russian Federation

Stanislava KONTSEVAYA^{1*}, Aleksander METLYAHIN², Lyubov YARYGINA²,
Elvira ORLOVA², Nadezhda NIKITINA² and Lubos SMUTKA¹

¹ Czech University of Life Sciences, Prague, Czech Republic; s.konsevaya@mail.ru; smutka@pef.czu.cz

² Vologda State University, Vologda, Russia, a.metlyahin@mail.ru; iaryginalv@vogu35.ru; orlovaao@mail.ru; nikitina.vologda@list.ru

* Corresponding author: s.kontsevaya@mail.ru

Abstract: Economic stability of a region is an important object of control and analysis for the government. However, it is complex indicator and assessable complicatedly. The goal of the paper is a development of a methodology of region economic stability integrative estimation resistant to short dramatic fluctuations of definite years. The research is based on the data about 10 regions of the Russian Federation over the period of 2000-2018. Suggested methodology includes 12 components of economic stability based on 67 indicators. These indicators were chosen and subdivided into groups by three courses of threats i.e. social and demographical threat, production and economic threat, and infrastructural and supporting threat. Smoothing of coefficients is made by arithmetic progression with smoothing width equal to 5 years in order to obtain estimations resistant to short fluctuations. Integrative estimation helps compare indicators completely different by quality and quantity, to range regions and estimate influence extent of some actions or external shocks on economic stability dynamics, and to forecast further development of the scenario in the region. The integrative estimation was tested in the Vologda Region of the Russian Federation. The result of this test proves significant decrease of the economic stability over 18 years.

Keywords: regional analysis, agrifood, agriculture, methodology

JEL Classification: F52; Q18

1. Introduction

The economic stability is a material basis of national safety. The objects of the economic stability comprise a government, regions, enterprises and a household sector. Economic stability estimation allows providing forthcoming support of regions being lower than a threshold level. This research deals with economic stability estimation at the regional level.

The economic stability can be described as a process when a human being or a society tends to reach tranquility and an ability to counteract threats within geographical or cultural space where they feel some kind of confidence that they have enough resources for satisfaction both present and future needs, and the threat potentially able to take up these resources never appears (Wiraszka & Karpinska, 2020).

The key problem of economic stability estimation is multidimensional concept so it is complicated for measuring (Böhringer & Jochem, 2007). The vast majority of scientists

consider it as a combination of some aspects of physical and biotical environment, social and economic well-being (Efroymson et al., 2013). As an increasing of living standards is the main goal of region development, a safety matter is to be decided in this context too (Soltes, et al., 2020).

Modern approaches to economic stability estimation utilize environmental, social and economic conditions known as three key pillars of stability (Mori & Christodoulou, 2012; Hacking & Guthrie, 2008; Mayer, 2008). Some authors utilize more than 2600 indicators (Grooten et al., 2012). In order to increase complexity each input variable has often associated dataset comprising some observations. These huge amounts of data about different stability components are complicated in control, and their visualization is almost impossible without compression or reduction of the size.

Aggregative functions are one of methods to precise and simplify the data. Aggregating theory is a mathematical area which investigates shape and properties of an aggregative function. In environmental economics aggregating topic is presented in aggregating special relation (Su & Ang, 2010), and combination of information in separate sectors (Lenzen, 2007; Marinetal., 2012).

Indicators, composite indicators or aggregated indicators are used for simplification of multiple and complicated data sets and elaboration of estimation results. Though the choice of aggregative function is the key component of estimation development, in scientific works there are few patterns, which could work as examples of choosing appropriate aggregative function. The most explicit review of aggregative functions is presented in the research «Applications of aggregation theory to sustainability assessment» (Pollesch & Dale, 2015).

Economic stability estimation differs from common social and economic development analysis by utilization of special methods of transformation of initial indicators and use of threshold values for qualitative analysis (Averina & Buyanova, 2019).

Currently there are different approaches to estimation of economic stability level (Khasanov & Korableva 2019; Mutchler et al., 2019; Dragojlovic et al., 2020; Akberdina & Smirnova 2018, Korableva & Karpov, 2017). As a rule, they are based upon indicative analysis that is quantitative and qualitative values identifying state and change of economic stability, and they are defined by combination of economic stability indicators.

Economic stability indicators have the following characteristic features:

- Identification of threats for economic stability in terms of quantity;
- Highly variable and sensitive, hence, they have high warning ability to warn of possible threats due to changed conditions of economic system functioning;
- they perform indicating functions only being altogether but not separated.

It should be noted that the most important characteristic of economic stability indicators is the specificity of their collaboration, which always exists but the only definite extent of threat reveals this collaboration and it starts alerting threat to the society (Senchagov, 2005).

Huge economic systems are stable and stagnant enough, so short time fluctuation should be neglected while making estimation, and only distorting properties of the economic system in the region should be taken into account.

The goal of the paper is a development of a methodology of region economic stability integrative estimation resistant to short dramatic fluctuations of definite components.

The following tasks were set in order to reach the goal:

- Analysis of the key components of economic stability;
- Development of an algorithm for integrative estimation;
- Development of the method to obtain estimations resistant to short time fluctuations;
- Estimation economic stability dynamics as in the case of the Vologda Region of the Russian Federation.

The research is based on the information about 10 regions in the North-Western Federal District. Estimation was made by 12 components of economic stability based on 67 indicators. The data was taken over the period of 2000-2018. The source of the data is web-site Russian Federal State Statistic Service. Calculations were made in Microsoft Excel.

2. Methodology

2.1. The Key Components of Economic Stability

The methodology of estimation of economic stability level was built upon the classification of threats by areas combined into three main groups (Table 1).

Table 1. Subdivision of indicators into groups by economic stability courses

Threat	Courses of stability
Social and demographical	Demographical, migration, social, foodbased, environmental
Production and economic	Production, investment, innovation, financial
Infrastructural and supporting	Power-producing, infrastructural, foreign economic

Each of groups is characterized by the set of specific indicators and totally 67 indicators. The list of base indicators is presented in Appendix 1.

The following criteria, used as a base for choosing indicators, should be utilized for estimation of economic stability of the region:

- The ability of the population to expanded reproduction and to save its headcount;
- The ability of social and economic system of the region to hold out-migration of the regular population having high labor potential;
- The ability of social and economic system of the region to assimilate migrants;
- The conformity of the social standard of living to institutionally fixed standardized demands and improvement of this standard;
- The ability of nature resource potential of the terrain to withstand anthropogenic and industry-related stresses;
- Provision of the economy with strategic resources;
- Resource potential efficiency;
- The ability of the economy to function under expanded reproduction;
- Financial system stability;

- Dependence of economy on import of the most important products, which can be manufactured in the region at the required level;
- Rationality of the foreign trade structure;
- Scientific potential support;
- Efficiency of the main schools of science in the region;
- Existence of the single economic area and inter-regional economic relations, respecting federal interests eliminating development of recessionist sentiments;
- Existence of economic and legal conditions eliminating criminal trends in the society;
- Efficiency of government regulation of economical processes.

Estimation of the level of economic stability of the region by specified criteria helps reveal threats in each of three abovementioned groups of economic stability. However, some of these criteria reveal status of stability courses belonging to different groups. For instance, provision of economy with strategic resources impacts production, investment, innovation and power-producing stability. Dependence of economy on import of the most important products, which can be manufactured in the region at the required level, proclaims challenges and threats of food and foreign economic security. It should be noted that in terms of the present research food security is the basis for economic stability analysis of the region. Keeping and increasing headcount of the stable population, improvement of living standards and provision with high quality food generate the basis for stable development of the region of the Russian Federation; hence, firstly these indicators provide security of regional economic system.

2.2. Algorithm of Integrative Estimation

Each course of economic stability has aggregated indicator which is calculated on the basis of some relative indicators by each specific course, and the total integrative indicator of the region is defined on the basis of aggregated indicators by each specific course.

Calculation of aggregated indicators supposes operating by relative specific indicator. In real case scenario the vast majority of specific indicators is calculated on different bases and can't be summed directly. Hence, all specific indicators by economic stability courses are rated in the following way.

Relative j-indicator of i-course of economic stability is calculated by the following equation:

$$X_{ij} = 1 \pm \frac{2}{\pi} \operatorname{atan} \left(\frac{x_{ij} - \bar{x}_{ij}}{\sigma_{ij}} \right) \quad (1)$$

Where x_{ij} – value of j-indicator of i-course of economic stability;

\bar{x}_{ij} – Average value of j-indicator of i-course of economic stability (threshold value);

σ_{ij} – Standard deviation of the value x_{ij} for comparable group of objects (neighboring regions).

The sign “+” is used when favorable value of the specific indicator exceeds the threshold value, otherwise the sign “-” should be put in the equation.

If the calculation of aggregated indicators is made in terms of dynamic, appropriate values of relative indicators may be rated by average value of the current or the last year.

Such transformation helps guarantee satisfaction of the indicator X_{ij} to the following conditions:

- $0 < X_{ij} < 2$ for any initial value of the specific value x_{ij} ;
- $X_{ij} = 1$ only in that case when the value of the specific indicator completely identical to the threshold value.

Both abovementioned conditions together with the way to obtain indicator proclaim existence of possible threats or challenges in decided course of economic stability if $X_{ij} < 1$. Definite limits are to be defined a posteriori, and crossing of these limits by definite indicators signalizes threat with more or less extent of risk.

2.3. The Method to Obtain Estimations Stable to Short Time Fluctuation

Weighting coefficients in terms of time, presenting importance of the data of some year for effective indicator, should be assigned in order to calculate aggregated indicator with regard to dynamics. There are some methods of calculation weighting coefficients in terms of time δ_t . Let us decide harmonic factor methods, modified exponential mean and arithmetic progression (Equation 2,3,4) with regard to calculate weighted mean for T years.

Harmonic factor method.

According to this method the weights in terms of time are defined by the following equation:

$$\delta_t = \frac{1}{T} \sum_{\tau=1}^t \frac{1}{T - \tau + 1} \quad (2)$$

Modified exponential mean.

Initially the parameter of smoothing λ (initially it can be taken $\lambda = 2/T$) is chosen. Then the weights of each year are calculated by the equation:

$$\delta_t = \frac{\lambda(1 - \lambda)^{T-t}}{1 - (1 - \lambda)^T} \quad (3)$$

Arithmetic progression method.

This method is utilized in case of condition of constant difference between neighboring weighting coefficients. In this case coefficients in terms of time generate arithmetic progression. Assigning first term of the progression $\delta_1 = a_0$, the progression difference d is derived from the condition $\sum_{\tau=0}^{T-1} a_\tau = 1$:

$$\frac{(2a_0 + d(T-1))}{2} T = 1, \quad \text{then} \quad d = \frac{2}{T-1} \left(\frac{1}{T} - a_0 \right), \quad (4)$$

To satisfy the condition $0 < \delta_t < 1$ it is necessary $0 < a_0 < \frac{1}{T}$.

Then the weighting coefficients in terms of time are calculated by the following equation:

$$\delta_t = a_0 + 2 \frac{t-1}{T-1} \left(\frac{1}{T} - a_0 \right) \quad (5)$$

Choice of the method of calculation of weighting coefficients in terms of time δ_t depends of the goals of the research and variation of indicators afrom year to year.

Integrative indicator of economic stability of the region is defined on the basis of aggregated indicators calculated for course of economic stability by means of arithmetic or geometrical mean:

$$X = \sum_{i=1}^n X_i \alpha_i; \quad X = \prod_{i=1}^n X_i^{\alpha_i}; \quad \sum_{i=1}^n \alpha_i = 1 \quad (6)$$

where X_i – aggregated indicator of i-course of economic stability belonging to the interval $(0, 2)$, relative units;

$i = 1, \dots, n$ – number of courses representing economic stability of the region; α_i – the weighting coefficients of influence of indicators of i-course on the total level of economic stability in the region, relative units.

3. Results

Dynamics of economic stability level in the regions of the North-Western Federal District of the Russian Federation (including 10 regions i.e. the Karelia Republic, the Komi Republic, the Arkhangelsk Region, the Vologda Region, the Kaliningrad Region, the Leningrad Region, the Murmansk Region, the Novgorod Region, the Pskov Region, St. Petersburg) is estimated in order to test decided methodology. The estimation is made by 12 abovementioned components of economic stability based upon 67 indicators. The data belongs to the period of 19 years from 2000 till 2018. Smoothing period of 5 years was chosen in order to obtain more stable estimation. Consequent weighting coefficients calculated by different methods are presented in Table 2.

Table 2. Values of weighting coefficients for chronological mean of integrative indicators at T=5

Method of obtaining of the weighting coefficients	Period				
	1	2	3	4	5
Harmonic weights method	0.040	0.090	0.157	0.257	0.457
Method of modified exponential mean	0.056	0.094	0.156	0.260	0.434
Method of arithmetic progression	0.150	0.175	0.200	0.225	0.250

Application of three decided methods of selecting weighting coefficients to the most economically developed region is presented in Figure 1.

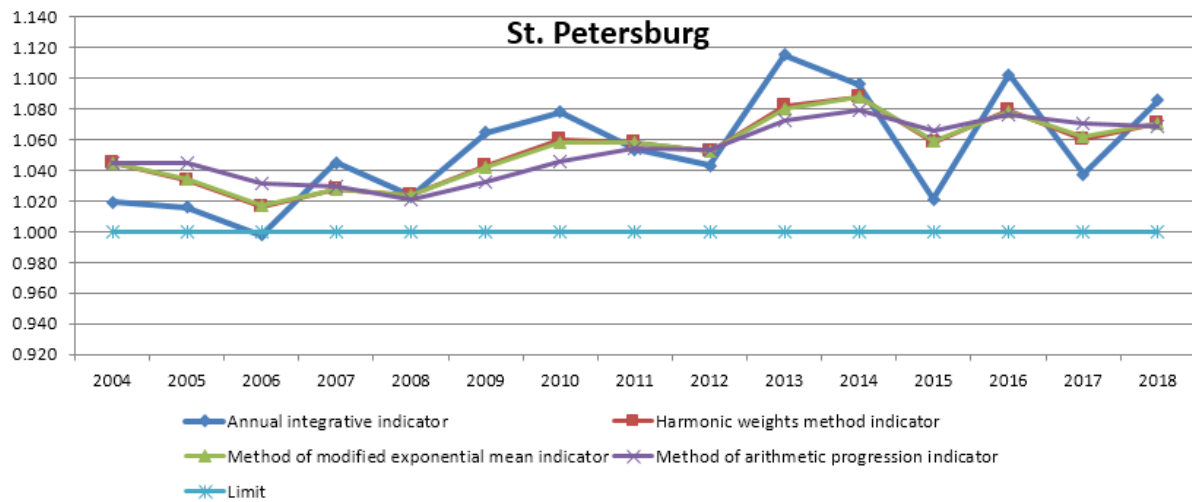


Figure 1. Integrative indicator of economic stability level, represented by different types of the weighting coefficients, in case of St. Petersburg

Obviously, the coefficients obtained by arithmetic progression provide the best smoothing. The same conclusion can be done by Figure 2 in case of the Vologda Region.

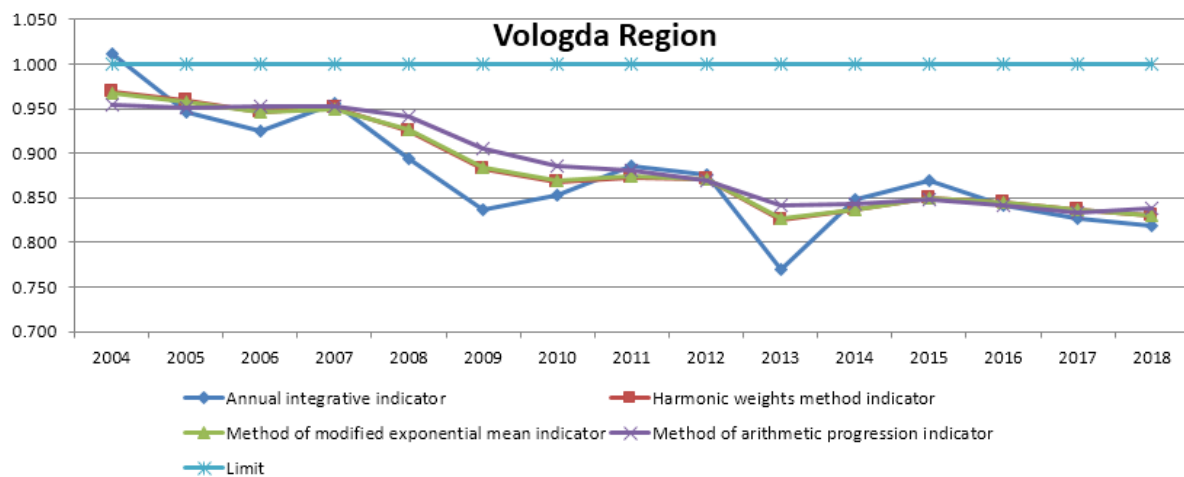


Figure 2. Integrative indicator of economic stability level, represented by different types of the weighting coefficients, in case of the Vologda Region

Annual consumption of food (meat, milk, sugar, vegetable oil, bread in kg and eggs in pcs.) per one person over 19 years represented by indicators for comparison is presented in Figure 3. Critical level of stability is 1, less than 1 value means threat, and more than 1 value – consumption indicator is normal.

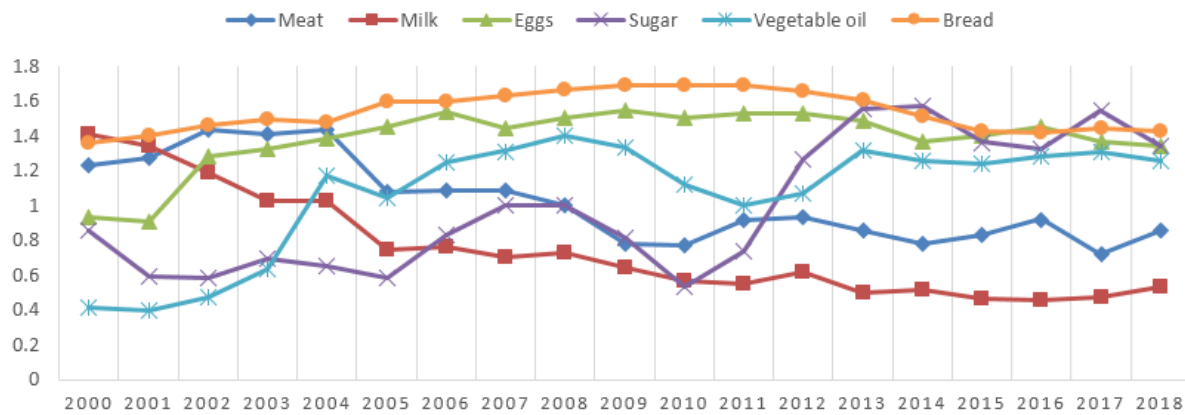


Figure 3. Annual consumption of main food products per 1 person in case of the Vologda Region – integrative indicator

Obviously, provision with such main food products as meat and milk is steadily decreased.

Dynamics of integrative indicators represented by chronological means with weights obtained by arithmetic progression is presented on Figure 4 for 10 regions.

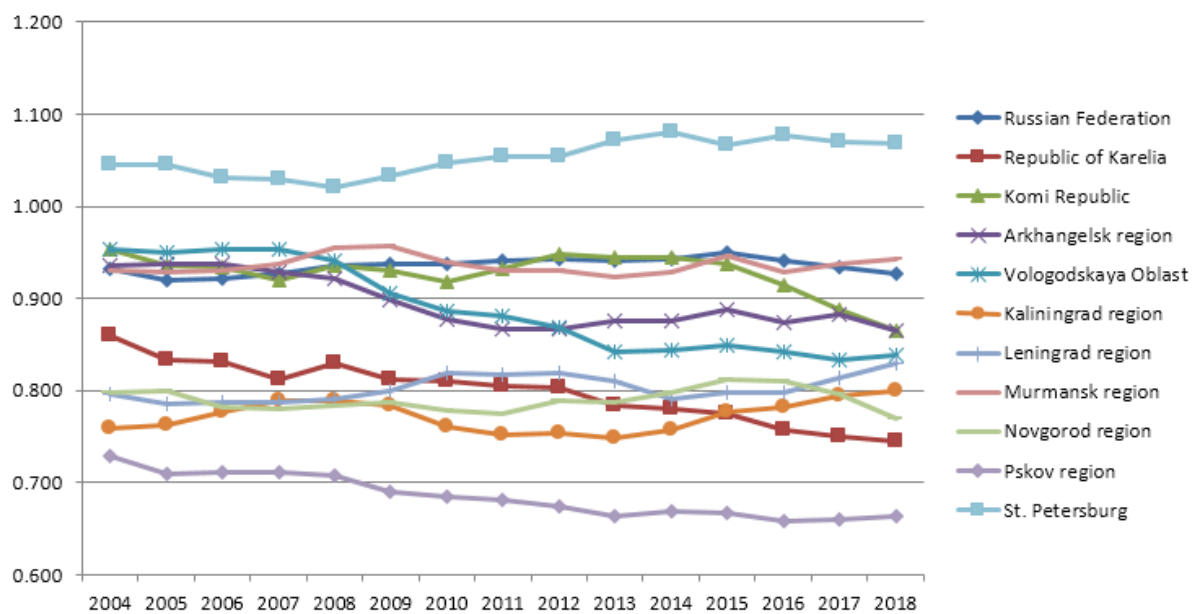


Figure4. Dynamics of integrative indicator of economic stability level over the period of 2000-2018

Value of integrative indicator for the decided regions proclaims steady economic stability in St. Peterburg only; at the same time other regions should determine actions to increase total economic stability and its courses that require some complex actions.

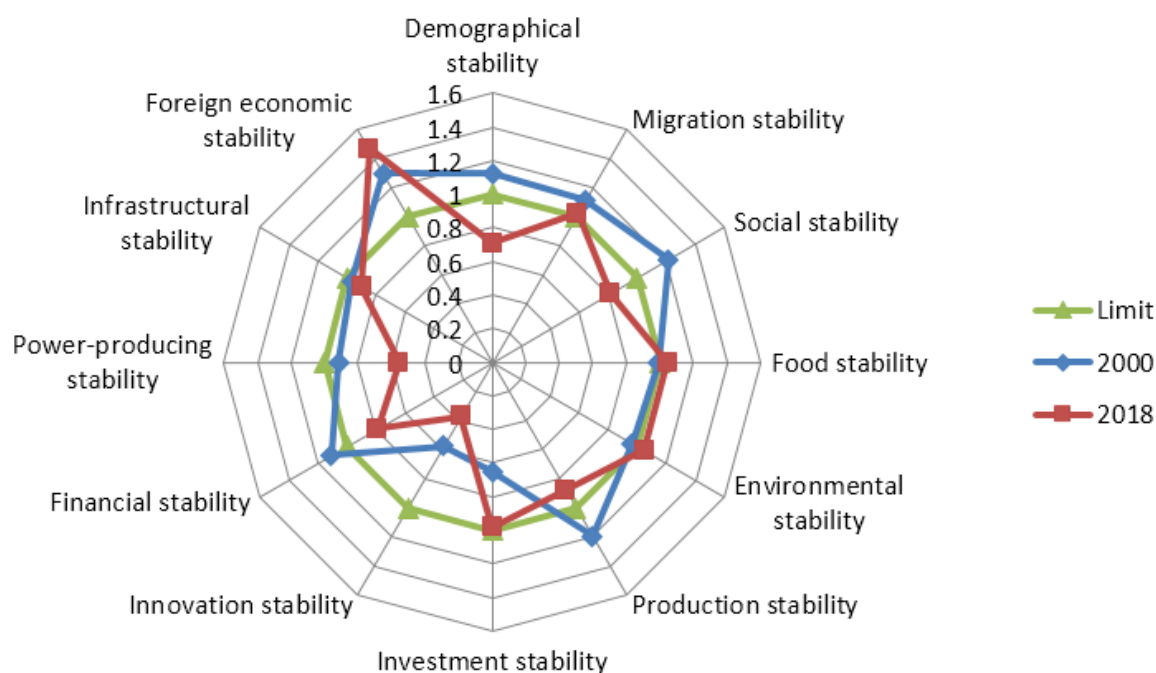


Figure 5. Aggregated indicators of economic stability represented by specific components for the Vologda Region

Analysis of phase-plane plot of the Vologda Region (Fig. 5) proclaims significant compression in almost each decided areas that obviously demonstrates threats in economic stability of the region.

Utilization of aggregated indicators helps reveal the most critical areas of economic stability and existence of challenges and threats for economic stability of the region. Level of economic stability was steadily decreasing within decided period in the Vologda Region.

Results obtained by this methodology coincide at a great extent with methodologies of other authors. Nevertheless, integrative estimation obtained by suggested methodology is less sensitive to short time and accidental fluctuations. This methodology clearly reveals critical components of economic stability which need careful attention of the government.

4. Discussion

Generation of a system of the indicators is the key objective for economic stability estimation of the region. Hence, there are some researches of Russian scientists on this topic. For instance, in 2014 specialists of Nizhny Novgorod State Technical University in the name of R. E. Alekseev together with Economics Institute of Russian Academy of Science suggested the system of indicators of economic stability of the region comprising 30 indicators (Senchagov, 2014). However, officially stated system of economic stability indicators on the regional level is still missing.

The basic level of economic stability is still a question for discussion too. In this research mean for 10 regions was taken as a minimum stability equal 1. However, in opinion of (Korableva & Karpov, 2017) utilization of official government data on minimum provision with each indicator is more correctly. For instance, according to the food security doctrine proper provision with milk and dairy products should be more than 90% of the total

consumption value (Garant, 2020). Amount of the weighting coefficients by the courses of economic stability is also set on the basis of scientific experts' opinion when the most preferable aspects of economic stability are revealed. From one side, it brings definite extent of subjectivity, but, from another side, it takes into account experts' opinion for impartial assessment of economic stability.

Analysis of economic stability of the region with officially stated minimums and opinion of experts may be the topic of future researches.

5. Conclusions

Suggested integrative methodology, identifying economic stability, helps range regions by assigning definite range (number) in descending order of this indicator. Variation of the integrative indicator in dynamics provides estimation of the extent of influence of some actions or external shocking impacts on economic stability dynamics, and helps forecast further development of the situation in the region.

Acknowledgments: This research was supported by the grant of Internal Grant Agency (IGA) of Faculty of Economics and Management, Czech University of Life Sciences, project 2020A0015 entitled "Price changes on agrifood markets in post-Soviet countries under Russian import ban and sanctions".

References

- Akberdina, V. V., & Smirnova, O. P. (2018). Economic security of the region: assessment and prospects. *Regional economy: theory and practice*, 16(8), 1506–1517. <https://doi.org/10.24891/re.16.8.1506>
- Averina, I. S., & Buyanova, M. E. (2019). Problems and measures of innovative activity support in the system of economic security of the Volgograd region. In *Proceedings of the Volgograd State University International Scientific Conference "Competitive, Sustainable and Safe Development of the Regional Economy"*. <https://doi.org/10.2991/cssdre-19.2019.14>
- Böhringer, C., & Jochem, P. E. (2007). Measuring the immeasurable — A survey of sustainability indices. *Ecological Economics*, 63(1), 1–8. <https://doi.org/10.1016/j.ecolecon.2007.03.008>
- Dragojlovic, N., Michaux, K. D., Moumin, N. A., Li K. H., Talukder, Z., Hou, K., Mundy G., Stormer, A., Ngik, R., Green, T. J., & Lynd, L. D. (2020). Economic Evaluation of an Enhanced Homestead Food Production Intervention for Undernutrition in Women and Children in Rural Cambodia. *Global Food Security*, 24. <https://doi.org/10.1016/j.gfs.2019.100335>
- Efroymsen, R. A., Dale, V. H., Kline, K. L., McBride, A. C., Bielicki, J. M., Smith, R. L., Parish, E. S., Schweizer, P. E., & Shaw, D. M. (2013). Environmental Indicators of Biofuel Sustainability: What About Context? *Environmental Management*, 51(2), 291–306. <https://doi.org/10.1007/s00267-012-9907-5>
- Garant (2020, January 21). *Food security doctrine*. Garant.ru. <https://www.garant.ru/products/ipo/prime/doc/73338425/>
- Grooten, M., Almond, R., McLellan, R., & World Wide Fund for Nature. (2012). *Living planet report 2012: biodiversity, biocapacity and better choices*. World Wide Fund for Nature. http://wwf.panda.org/about_our_earth/all_publications/living_planet_report/2012_lpr/
- Hacking, T., & Guthrie, P. (2008). A framework for clarifying the meaning of Triple Bottom-Line, Integrated, and Sustainability Assessment. *Environmental Impact Assessment Review*, 28(2), 73–89. <https://doi.org/10.1016/j.eiar.2007.03.002>
- Khasanov, R. K., & Korableva, A. A. (2019). Economic Security Index as a Tool to Assess the Development of Agroindustrial Regions. *Ekonomicheskaya Politika*, 14(6), 82–101. <https://doi.org/10.18288/1994-5124-2019-6-82-101>
- Korableva, A. A., & Karpov, V. V. (2017). Indicators of economic security of the region. *Bulletin of the Siberian Institute of Business and Information Technologies*, 3(23), 36–42.
- Lenzen, M. (2007). Aggregation (in-)variance of shared responsibility: A case study of Australia. *Ecological Economics*, 64(1), 19–24. <https://doi.org/10.1016/j.ecolecon.2007.06.025>

- Marin, G., Mazzanti, M., & Montini, A. (2012). Linking NAMEA and Input output for 'consumption vs. production perspective' analyses: Evidence on emission efficiency and aggregation biases using the Italian and Spanish environmental accounts. *Ecological Economics*, 74, 71–84.
<https://doi.org/10.1016/j.ecolecon.2011.11.005>
- Mayer, A. L. (2008). Strengths and weaknesses of common sustainability indices for multidimensional systems. *Environment International*, 34(2), 277–291. <https://doi.org/10.1016/j.envint.2007.09.004>
- Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental Impact Assessment Review*, 32(1), 94–106.
<https://doi.org/10.1016/j.eiar.2011.06.001>
- Mutchler, J. E., Li, Y., & Xu, P. (2019). How strong is the Social Security safety net? Using the Elder Index to assess gaps in economic security. *Journal of Aging & Social Policy*, 31(2), 123–137.
<https://doi.org/10.1080/08959420.2018.1465798>
- Pollesch, N., & Dale, V. H. (2015). Applications of aggregation theory to sustainability assessment. *Ecological Economics*, 114, 117–127. <https://doi.org/10.1016/j.ecolecon.2015.03.011>
- Russian Federal statistical website (2020) *Russia in figures*. Retrieved January 01, 2021, from <https://rosstat.gov.ru/>
- Senchagova, V. K. (2005). *Economic security of Russia: General course textbook* (2nd ed.). Delo.
- Senchagova, V. K. (2014). *Economic security of Russian regions: monograph*. Rastr-NN.
- Soltes, V., Repkova Stofkova, K., & Lenko, F. (2020). Socio-economic consequences of globalization on the economic development of regions in the context of security. *SHS Web of Conferences*, 74, 4–26.
<https://doi.org/10.1051/shsconf/20207404026>
- Su, B., & Ang, B. W. (2010). Input–output analysis of CO2 emissions embodied in trade: The effects of spatial aggregation. *Ecological Economics*, 70(1), 10–18. <https://doi.org/10.1016/j.ecolecon.2010.08.016>
- Wiraszka, P., & Karpinska, U. (2020). Economic security as an element of the region's development process on the example of communes of the Swietokrzyskie Voivodship. *Baltic Journal of Economic Studies*, 6(3) 67–75.
<https://doi.org/10.30525/2256-0742/2020-6-3-67-75>

Appendix 1. Indicators divided by courses of economic stability (Part 1)

I Social and demographical threats
<p>1 Demographical: Crude birth rate (a number of newborns per 1,000 persons); Rate of natural increase per 1,000 persons; Dependency ratio (number of disabled persons per 1,000 persons of able-bodied persons); Expectation of life at birth (years); Total fertility rate (number of children per 1 woman)</p> <p>2 Migration: Net migration rate per 10,000 persons; Distribution of incomers by moving directions from other regions (percent from total number of incomers); Distribution of incomers by moving directions from abroad (percent from total number of incomers); Distribution of emigrants by moving directions from other regions (percent from total number of emigrants); Migration ratio per 10,000 persons.</p> <p>3 Social: Real earnings of the population (in percent from previous year); Ratio of per capita population income to subsistence level, %; Population with incomes less than subsistence level (in % from total population of the region); Average floor area per one person (m²); Number of persons died in traffic accidents per 100,000 persons; Number of registered murders or assault to murder per 100,000 persons.</p> <p>4 Food: Consumption of meat and meat products per 1 person in kg; Consumption of milk and dairy products per 1 person in kg; Consumption of eggs per 1 person, pcs.; Consumption of sugar per 1 person, kg; Consumption of vegetable oil per 1 person, kg; Consumption of bread per 1 person, kg;</p> <p>5 Environmental: Air pollution from stationary source, t/km²; Surface water pollution, t/km²; Share of recovered and incapacitated air pollutants in the total amount of air pollutants emitted by stationary sources, %</p>

Appendix 1. Indicators divided by courses of economic stability (Part 2)

II Production and economic threats	
6 Production:	Share of GRP in GDP of the Russian Federation, %; GRP per 1 person, RUB; Production Increase Index; Wear of fixed assets, %; the unemployment rate, %; the occupational level, %
7 Investment:	Share of investment into fixed assets in GRP; Investments into fixed assets per 1 person; Index of investment physical volume in fixed assets
8 Innovation:	Share of science and scientific service costs in GRP, %; Number of patents per 100,000 persons; Volume of innovation goods, works and services in % from shipped goods, completed works and services; Technical innovation share in % from the total volume of shipped goods, completed works and services.
9 Financial:	Consolidated budget surplus of the region in GRP, %; Consolidated surplus cost in GRP per 1 person, thou. RUB; Overdue accounts payable in GRP, %; Provisional credentials in the GRP, %; Loss-maker share; Indebtedness under credits, given to legal entities by credit companies in RUB in GRP, %; Indebtedness under credits, given to physical persons per 1 person, thou. RUB; Ratio of deposits of legal entities and physical persons, raised by credit companies in GRP, %; Consumer price index, %
III Infrastructural and supporting threats	
10 Power-producing:	Capacity of power plants, kW/person; Electrical power generation 1,000 kWh/person; GDP (GRP) energy intensity (kg of oil equivalent/10,000 RUB) in constant prices of 2012
11 Infrastructural:	Early childhood education gross coverage ratio; Number of students per 10,000 persons; Number of trainees per 1 teacher; Number of hospital beds per 10,000 persons; Number of doctors per 10,000 persons; Number of nursing staff per 10,000 persons; Number of online mobile gadgets per 1,000 persons; number of companies using Internet
12 Foreign economic:	Export/Import ratio; Share of import in GRP, %; Export growth rate, %

Methodology of Estimation of Agro-Industrial Capacity and Food Consumption (As in the Case of the Region of North-Western Federal District of the Russian Federation)

Stanislava KONTSEVAYA^{1*}, Oksana MORONOVA², Aleksander METLYAHIN²
and Lubos SMUTKA¹

¹ Czech University of Life Sciences, Prague, Czech Republic; s.konsevaya@mail.ru; smutka@pef.czu.cz

² Vologda State University, Vologda, Russia; metlyahin.ai@yandex.ru; moronova@mail.ru

* Corresponding author: s.konsevaya@mail.ru

Abstract: The key factor for food self-provisioning is efficient utilization of agricultural capacity. The goal of the paper is development of integral assessment of food consumption level and agro-industrial capacity in a region. This methodology was tested in the regions of North-Western Federal District of the Russian Federation. Suggested methodology helps estimate producing production and consumption of food, and compare regions with similar social and economic environment. Assessment of food consumption involved such food products as meat, milk, eggs, bread, sugar, vegetable oil and medically recommended rates of consumption of basic food products. In accordance with the suggested methodology assessment of agro-industrial capacity comprised such indicators as cultivated land, stock of cattle and pigs, quantity of drilled fertilizers, growth rate of agricultural production and production volumes of livestock breeding per 1 person. Ranking score of the regions was made by comparing actual data with standard object or scientifically proved indicators. Suggested methodology revealed that all regions of North-Western Federal District suffered from stable decrease of production capacity of agricultural sector, but actual food consumption was growing simultaneously. This growth is provided by import of agricultural products from other regions of the Russian Federation and from abroad.

Keywords: regional analysis, agrifood, agriculture, methodology, food security

JELClassification:F52; Q18

1. Introduction

Food security is an integral part of national security of a state. First of all estimation of national food security level is intended for recognition of ability of a country to provide for internal needs of the population in main food products, and to develop national food facility. In the process of analyzing national security of regions food security is transformed into the element of living standards of the definite terrain and estimated mostly by the indicators of food availability (physical and economic), and the indicators of consumption of main food products and conformance of this consumption to reasonable rates. Estimation of efficiency of utilization of agricultural capacity of the terrain and ability of food self-provisioning with

main products (with regard to agricultural specificity) are integral parts of the methodology of estimation of food security reasonable level.

Different indicators (Davis et al., 2014; Eckert & Shetty, 2011; Lin et al., 2014; Ma et al., 2013; Sohi et al., 2014; Widener, 2013). are utilized in order to estimate economic food availability at micro- and macro-level. Such indicators as inflation rate, exchange rate, customs duties on food and agricultural products, price index numbers and their dynamics are used at macro-level analysis.

An attention should be paid to difference in approaches to determine regional food security. Currently there are two basically different positions on this issue. Some authors (Vermel, 1997; Ostaev, 2020) consider food security of a region as an integral part of national food security only and prove this point of view by absence of limits on transfer of goods and services, and unreasonable course of regional food system on complete self-provisioning. Openness of a region as a social and economic system paves the way to stable cooperation with other regions and in terms of national food security estimation the place of product manufacturing is not of principal importance but conformance with national standards and requirements on quantitative availability and quality characteristics of consumed food is of great importance.

Second approach paves the way to establishing regional food security system completely similar with national ones (Lilov, 2008). In this case the priority is definitely transferred from food self-provisioning to estimation of physical and economic availability of food, but the key element of regional food security system is reasonable utilization of agro-industrial capacity as it provides the basis for development of premises to create proper food security. Some authors consider issues of food self-provisioning important at any level of food security system establishing (Kostiaev, 2012).

In authors' opinion, analysis of food security level in the region should involve estimation of agricultural capacity of a terrain, its relevance and efficiency of its utilization. Research of relations between scale of agricultural production and assurance of regional food security is of definite interest.

Food consumption level is significantly defined by physical and economic availability of food which depends on production cost and production volumes in the region and costs of import of food resources (Gumerov, 2018). Correlation of prices of imported food and in-house production costs regulates scales of regional food sector, but potential ability of production of food resources limited by natural and climate potential of the terrain and established production capacity is as important as abovementioned correlation. As a rule, limiting impact is identified by base material sector and it is shortage of the local food base material which holds potential development of regional food sector. This is why estimation of production capacity of agricultural sector of a region helps reveal trends of alteration of regional food security and forecast alterations in self-provisioning with main food products in a region.

The goal of this research is development of a methodology of ranking regions by the size and efficiency of agricultural capacity utilization and revealing correlation between food

self-provisioning of a region and actual consumption of food conforming to medically recommended rates.

The objects of the research are:

1. Development of the methodology of integral assessment of agro-industrial capacity of a region and integral assessment of food consumption by population of a region.
2. Test of suggested methodology as in the case of the regions of North-Western Federal District and research of impact of efficiency of agro-industrial capacity utilization in a region on conformance of actual food consumption with medically recommended consumption rates.

The object of the research is level of regional food security, and the subject is the regions of North-Western Federal District.

2. Methodology

Traditionally the process of food security level estimation involves conformance of actual food consumption with standard values, which can be equal to medically recommended rates of consumption (or social rates of minimum commodity bundle if terrain is in critical state) (Uskov, 2014). In this case obtained individual indexes are quite disparate and intended for estimation of satisfaction in definite groups of products without making total review, which helps assess common trend of actual consumption of main food products by population.

Suggested methodology provides solution of the problem of integral assessment of conformance of actual food consumption with established standards and comparison of regions with similar social and economic environment and suffering from similar negative or positive impacts of both internal and external factors that provides reasonable estimation of ability of a region to withstand threats to food security. Application of the methodology in dynamics reveals variation of the region's rank that provides reasonable characteristic of food security level of the region by one of criteria.

The main groups of food comprise those products which satisfy need in proteins (meat and meat products, milk and dairy products and eggs), in carbohydrates (bread and cereal products and sugar), and vegetable oils.

In the process of agro-industrial capacity estimation the system of indicators was focused on two main indicators i.e. the size of capacity and effectiveness of capacity utilization. Such indicators as area under crops (with regard to quality of plough lands which is indirectly characterized by volume of applied fertilizers), stock of cattle and pigs, which characterize availability of production units, were used for estimation of potential food production capacities in the region. Estimation of efficiency of utilization of agro-industrial capacities was made on the basis of indicators identifying growth rates of agricultural production and volume of livestock production per 1 person. These indicators were chosen due to specialty of agricultural companies which were traditionally intended for livestock production.

Ranking score is based upon comparison of objects by each indicator with relative prototype object, which is artificial object having the best characteristics by comparison with other objects or scientifically recommended ones.

Incoming information is a matrix with elements equal to values of chosen indicators. Each j-indicator on i-object is defined by the value x_{ij} , that helps generate information matrix for compared objects:

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

It should be taken into account that considered objects can be characterized by incentive indicators, which increase improves overall estimation of the object's state (for example, production volume), and disincentive indicators, which increase deteriorates overall estimation (for example, production cost per 1 unit of a product). Moreover, utilized indicators might be of different measurement units or measurement scales so preliminary standardization is to be done.

$$x_{0j} = \max_{1 \leq i \leq m} x_{ij}, \text{ если } X_j - \text{incentive indicator}; \quad (2)$$

$$x_{0j} = \min_{1 \leq i \leq m} x_{ij}, \text{ если } X_j - \text{disincentive indicator}. \quad (3)$$

Deviation of the indicator in positive or negative side from scientifically recommended value signifies deterioration of the situation, and initial value of the indicator can be used as standard value.

Standardized characteristics are calculated on the base of initial values of the matrix X and standard values:

$$y_{ij} = \frac{x_{ij}}{x_{0j}}, \text{ если } X_j - \text{incentive indicator}; \quad (4)$$

$$y_{ij} = \frac{x_{0j}}{x_{ij}}, \text{ если } X_j - \text{disincentive indicator}. \quad (5)$$

Estimation d_i is calculated as weighted distance between two points in n-dimensional space, where coordinates of the first point are standard values of the indicator and coordinates of the second point are indicators of i-object:

$$d_i = \sqrt{\sum_{j=1}^m (y_{ij} - y_{0j})^2 w_j} \quad (6)$$

The object which value of d_i is minimum should be considered the best one, however, in order to improve demonstrativeness and interpretability of obtained assessments the following value can be decided:

$$R_i = (1 - d_i) \times 100\% \quad (7)$$

This value identifies extent of conformance to possible standard in given specific conditions.

In this research disincentive indicator is consumption of sugar. Scientifically recommended rates of consumption should be used in case of consumption of sugar, bread and bread products and vegetable oils per 1 person. Standard values for other indicators should be taken from obtained values.

3. Results

During research work basic matrixes including the system of indicators, weighting estimation of an indicator and standard values were generated for each analyzed period. The matrix for 2018 is presented as an example (Table 1).

Table 1. Production capacity of agricultural sector of the regions of North-Western Federal District of the Russian Federation (without St. Petersburg) and efficiency of production capacity utilization in 2018

Region	Indicators								
	Agricultural production index	Area under crops, thou. ha	Applied mineral fertilizers, kg of primary nutrient per ha	Applied organic fertilizers, t per ha	Cattle stock, thou. heads	Pigs stock, thou. heads	Production of milk, t/person	Production of eggs, pcs/person	Meat production, dead weight, t/person
Standard	110.9	355.8	121.4	10.6	165.8	204.4	0.454	438.65	0.311
Weighting of the indicator	0.113	0.101	0.069	0.069	0.094	0.094	0.153	0.153	0.153
The Karelian Republic	102.9	30.0	18.8	4.2	22.6	7.4	0.101	12.7	0.005
The Komi Republic	103.3	37.2	12.7	4.0	31.6	51.8	0.066	150.4	0.029
The Arkhangelsk Region	109.0	69.4	33.4	5.6	44.0	204.4	0.112	41.1	0.005
The Vologda Region	104.5	355.8	45.2	4.2	165.8	7.4	0.454	426.3	0.023
The Kalinigrad Region	110.0	249.5	121.4	3.2	137.2	51.8	0.177	265.5	0.063
The Leningrad Region	103.9	240.0	41.1	9.8	179.8	204.4	0.087	438.6	0.038
The Murmansk Region	102.6	7.1	31.7	10.6	7.1	176.5	0.026	12.1	0.002
The Novgorod Region	102.4	156.0	23.6	2.7	30.6	8.0	0.109	372.2	0.202
The Pskov Region	110.9	238.2	19.3	3.2	71.6	165.8	0.314	129.5	0.311

Values of indicators were taken from Federal State Statistics Service (Russian Federal statistical website, 2020). The best obtained value of some analyzed region in appropriate period was taken as standard value. The matrix does not involve St. Petersburg for the reason of absence of agricultural production though there is big production capacity of food industry. The Leningrad Region is the main source of basic materials for St. Petersburg.

Estimation of weighting of the indicator was made on the basis of paired comparison method (Table 2). In the process of generating matrix of paired comparison utilization efficiency of production capacity was more considerable than availability of resources needed for establishing of production process.

Table 2. The matrix of paired comparison of significance of indicators of scale and utilization efficiency of agro-industrial capacity of a terrain

Indicator	Indicators								
	Agricultural production index	Area under crops thou. ha	Applied mineral fertilizers, kg of primary nutrient per ha	Applied organic fertilizers, t per ha	Cattle stock, thou. heads	Pigs stock, thou. heads	Production of milk, t/person	Production of eggs, pcs/person	Meat prod., dead weight, t/person
Agricultural production index	=	=	>	>	>	>	<	<	<
Area under crops, thou. ha	=	=	>	>	=	=	<	<	<
Applied mineral fertilizers, kg of primary nutrient per ha	<	<	=	=	<	<	<	<	<
Applied organic fertilizers, t per ha	<	<	=	=	<	<	<	<	<
Cattle stock, thou. heads	<	=	>	>	=	=	<	<	<
Pig stock, thou. heads	<	=	>	>	=	=	<	<	<
Production of milk, t/person	>	>	>	>	>	>	=	=	=
Production of eggs, pcs/person	>	>	>	>	>	>	=	=	=
Meat production, dead weight, t/person	>	>	>	>	>	>	=	=	=

Consequently, the indicators of production of milk, meat, and eggs per 1 person are of maximum significance, agricultural production index is less significant that can be explained by unequal importance of some agricultural products from regional provision's point of view. The indicators of applied fertilizer volume are of minimum importance as they do not influence current food consumption. They impact consumption through soil fertility support and growth of yield of food and fodder crops

Stable trend to decrease of production capacity and efficiency of its utilization in agricultural sector of the regions was observed in the researched period (Fig.1). The Vologda Region had officially leading position till 2014, then its place was taken by The Pskov Region. The Leningrad Region and The Kaliningrad Region have stable high position (3-4 line). The most Northern regions (The Murmansk Region and The Karelian Republic) have expectedly low positions in the rank.

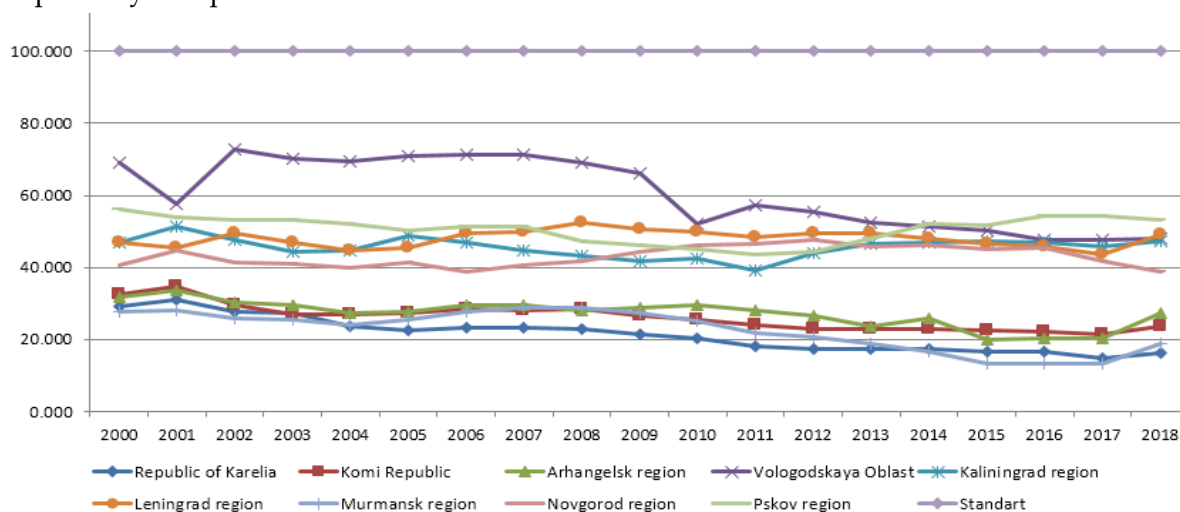


Figure 1. Integral indicator of rate and level of agro-industrial capacity utilization of North-Western Federal District

Graphic representation of obtained results clearly demonstrates increased deviation of integral indicator of estimation of agro-industrial capacity of a region from standard value. By the end of research period the leader of 2018 The Pskov Region has 1.5 times stronger deviation by comparison with the leader 2000 The Vologda Region (0.466 and 0.310 consequently).

It should be noted that selective growth of agricultural production efficiency in some farms was observed in almost all regions of North-Western Federal District. Special attention should be paid to stability and trend to growth of meat production in The Leningrad Region, The Novgorod Region, The Pskov Region and The Komi Republic (mostly due to pork and poultry production) and milk production in The Vologda Region and The Leningrad Region. Growth of these indicators helped keep leading position in the rank inspite of decreased rate of capacity.

Similar methodology was applied to range regions by conformance of actual food consumption with medically recommended rates (Table 3 and 4). Maximum significance belongs to conformance with threshold values in the group of animal origin food i.e. meat and meat products, milk and dairy products and eggs. This group provides balance of proteins and fats of animal origin which deficit negatively impacts quality and lifetime of the population.

Table 3. Conformance with actual food consumption rates of the population in the regions of North-Western Federal District (except for St. Petersburg) in 2018

Region	Indicators					
	Conformance of meat and meat products consumption with reasonable consumption rates, %	Conformance of milk and dairy products consumption with reasonable consumption rates, %	Conformance of eggs consumption with reasonable consumption rates, %	Conformance of sugar consumption with reasonable consumption rates, %	Conformance of vegetable oils consumption with reasonable consumption rates, %	Conformance of bread and bread products consumption with reasonable consumption rates, %
Standard value	125.3	84.5	114.6	100	100	100
Weighting of the indicator	0.212	0.212	0.212	0.110	0.132	0.122
The Karelian Republic	96.0	66.1	95.0	150.0	96.7	115.2
The Komi Republic	109.3	77.3	107.7	121.4	98.3	100.0
The Arkhangelsk Region	85.3	55.8	92.3	139.3	108.3	100.0
The Vologda Region	98.7	69.7	121.5	142.9	103.3	102.9
The Kaliningrad Region	116.0	68.2	109.2	160.7	117.5	101.9
The Leningrad Region	104.0	84.5	114.6	139.3	85.0	108.6
The Murmansk Region	102.7	70.0	78.5	121.4	114.2	78.1
The Novgorod Region	100.0	69.7	104.2	139.3	122.5	106.7
The Pskov Region	125.3	83.9	88.5	132.1	95.8	92.4

Consumption of food providing carbohydrates part of allowance significantly influences energy content. Nonconformance of indicators almost 2 times lower than in previous group can be explained by better availability and by redundant consumption of

some products, in particular sugar. Significance of fats presented by vegetable oils takes average position.

Table 4. The matrix of paired comparison of conformance of actual food consumption

Region	Indicators					
	Conformance of meat and meat products consumption with reasonable consumption rates, %	Conformance of milk and dairy products consumption with reasonable consumption rates, %	Conformance of eggs consumption with reasonable consumption rates, %	Conformance of sugar consumption with reasonable consumption rates, %	Conformance of vegetable oils consumption with reasonable consumption rates, %	Conformance of bread and bread products consumption with reasonable consumption rates, %
Conformance of meat and meat products consumption with reasonable consumption rates, %	=	=	=	>	>	>
Conformance of milk and dairy products consumption with reasonable consumption rates, %	=	=	=	>	>	>
Conformance of eggs consumption with reasonable consumption rates, %	=	=	=	>	>	>
Conformance of sugar consumption with reasonable consumption rates, %	<	<	<	=	<	=
Conformance of vegetable oils consumption with reasonable consumption rates, %	<	<	<	<	=	=
Conformance of bread and bread products consumption with reasonable consumption rates, %	<	<	<	<	=	=

Integral indicator signifies stable trend of actual food consumption to approach to recommended one, though no regions obtained this standard within researched period.

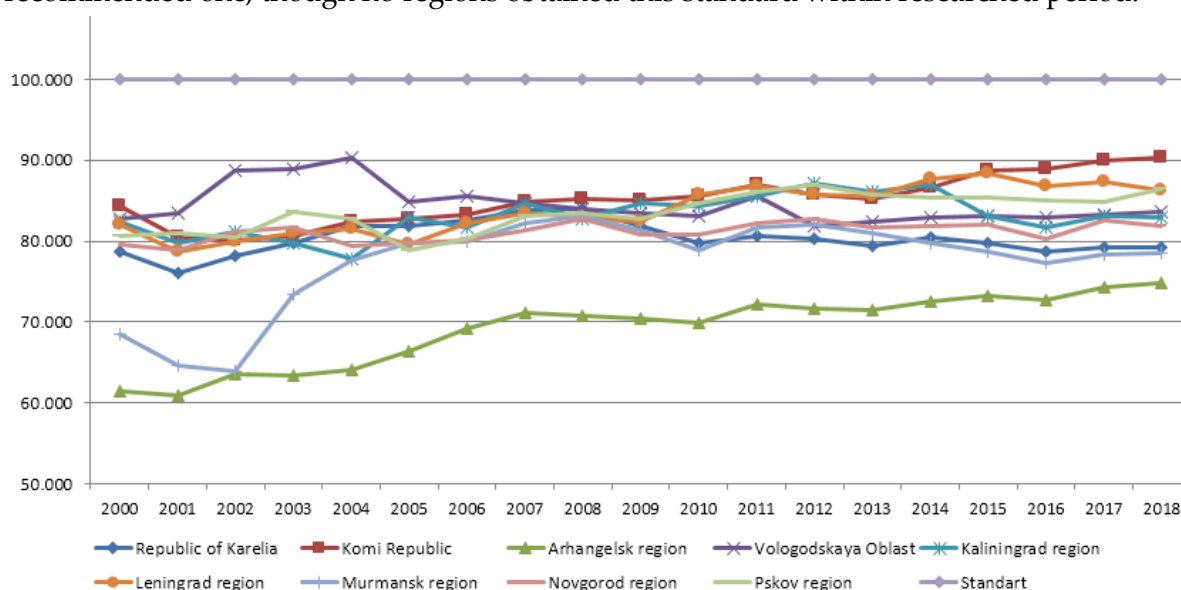


Figure 2. Integral indicator of conformance of actual food consumption with medically recommended consumption rates

In spite of visual multidirectionality of curves of integral indicators of scale and utilization of agro-industrial capacity of the regions in North-Western Federal District, and integral indicators of conformance of actual food consumption with medically recommended consumption rates there is stable relation between these indicators. Regions with leading position on the first indicator, as a rule, keep high positions on consumption ranking too. Outsiders in self-provisioning with minor exceptions demonstrate maximum deviation from standard values of food consumption. Deficit food products are compensated by import of agricultural products. Import is subdivided into internal one from other Russian regions with better conditions for agriculture and foreign import from Turkey, China and EU (Smutka, et al., 2015) which compensates shortage of agricultural products too.

4. Discussion

The term food security is still the question for discussion. Hence, Food Security Doctrine of the Russian Federation (Act no.20, 2020) is based on the concept of food self-provisioning. At the same time self-provisioning with main groups of food products can't be the single criterion of food security level, and in case of meso- and micro-levels this group of indicators needs some addition.

Approaches to identification of food security are different among Russian scientists. (Nazarenko, 2011) defines food security as a complex of sub-systems including food independency, social stability, demographic stability and food production branch. (Ushachev, 2008) distinguished two parts of food security: provision of physical and economic availability of food for each person in conformance with reasonable rates of consumption and in volumes available to support active mode of life, and high quality and safety of consumed food products. Both parts should not depend on variation of external and internal conditions and should not influence government food stocks. Here the main factor of food security provision is increase of food production scale in the country.

In opinion of authors of this research the most complete definition of food security is that one, which was given by (Gumerov, 2003), who considered that food security is "constantly supported state of protection of national food systems from internal and external risks and threats, which provides trouble free provision of all social groups of population with main food products in accordance with right of each person on relevant food conforming to standards of healthy and ultimate nutrition acting in given period of time". This approach helps take into account dynamics of rates and standards which are modified due to social and economic transformations of the society and development of regulatory environment of national food system.

5. Conclusions

In other words, the results of the research provide the following main conclusions:

1. Stable relation was revealed between efficiency of functioning of agricultural and food sector in the region and consumption of main food products.

2. Suggested methodology has such specific features as complexity and universalism which provide an opportunity for comparison analysis of definite criteria of food security by regions, and corrective actions within agricultural and food policy with regard to specific features of terrain's development and revealed risks and threats.
3. Recommended set of indicators and assessment criteria may be transformed by introducing additional indicators and criteria or excluding less efficient ones depending on the goals of the research and significance of representation of agricultural specificity of the region and development of agricultural production.

In modern conditions agricultural and food policy of the country should be formed with regard to the fact that the Russian Federation is under sanctions by some economically developed countries that makes questions of food capacity development in the regions and in the whole country especially actual. So systematic assessment of efficiency of current regulation and support measures by assessment of changes in scale and efficiency of agro-industrial capacity utilization as well is necessary for development of regional agricultural and food policy.

Acknowledgments: This research was supported by the grant of Internal Grant Agency (IGA) of Faculty of Economics and Management, Czech University of Life Sciences, project 2020A0015 entitled "Price changes on agrifood markets in post-Soviet countries under Russian import ban and sanctions".

References

- Act no.20, *On approval of the Food Security Doctrine of the Russian Federation*. Decree of the President of the Russian Federation 2020. <http://docs.cntd.ru/document/564161398>
- Davis, L., Sengul, O., Ivy, J., Brock, L., & Miles, L. (2014). Scheduling Food Bank Collections and Deliveries to Ensure Food Safety and Improve Access. *Socio-Economic Planning Sciences*, 48(3), 175-178. <https://doi.org/10.1016/j.seps.2014.04.001>
- Eckert, J., & Shetty, S. (2011). Food systems, planning and quantifying access: Using GIS to plan for food retail. *Applied Geography*, 31, 1216-1223. <https://doi.org/10.1016/j.apgeog.2011.01.011>
- Gumerov, R. (2018). *Food security of the Russian Federation (theory and practice)*. Bukvalno.
- Kosiaev, A., & Kotusenko, I. (2012). Ensuring food security in Russia: a regional aspect. *Economy of agricultural and processing enterprises*, 5, 4-7.
- Lilov, A. (2008). Regional food security problems in Siberia. In *Scientific basis for the development and implementation of regional programs for stabilization and development of the agro-industrial complex, systems for conducting agro-industrial production and ensuring food security of the Russian Federation*, SibNIIESH (pp. 152-153).
- Lin, B., Ver, P., Kasteridis, P., & Yen, S. (2014). The roles of food prices and food access in determining food purchases of low-income households. *Journal of Policy Modeling*, 36, 938-952. <https://doi.org/10.1016/j.jpolmod.2014.07.002>
- Ma, X., Battersby, S., Bell, B., Hibbert, J., Barnes, T., & Liese, A. (2013). Variation in low food access areas due to data source inaccuracies. *Applied Geography*, 45, 131-137. <https://doi.org/10.1016/j.apgeog.2013.08.014>
- Nazarenko, V. (2011). *Food security (in the world and in Russia)*. Monuments of historical thought.
- Ostae, G., Frantsisko, O., Ternavshchenko, K., Molchan, A., Ovcharenko, N., & Balashova, I. (2020). Formation of an integrated system for monitoring the food security of the region. *Amazonia Investiga*, 9(25), 59-70.
- Russian Federal statistical website. (2020). *Regions of Russia. Socio-economic indicators*. Retrieved January 1, 2021 from <https://rosstat.gov.ru/>
- Smutka, L., Spicka, J., Ishchukova, N., & Selby, R. (2016). Agrarian import ban and its impact on the Russian and European Union agrarian trade performance. *Agricultural Economics*, 62(11), 493-506. <https://doi.org/10.17221/294/2015-AGRICECON>
- Sohi, I., Bell, B., Liu, J., Battersby, S., & Liese, A. (2014). Differences in Food Environment Perceptions and Spatial Attributes of Food Shopping Between Residents of Low and High Food Access Areas. *Journal of Nutrition Education and Behavior*, 46(4), 241-249. <https://doi.org/10.1016/j.jneb.2013.12.006>

- Ushachev, I. (2008). Ensuring food security is a top priority for the Russian economy. *OrelGAU Bulletin*, 5(8), 5-10.
- Uskov, T., Selimenkov, A., & Anishenko, A. (2014). *Food security of the region*. ISERT Russian Academy of Science.
- Vermel, D., & Hromov, U. (1997). Problems of food security in Russia. International and internal aspects. *Agro-industrial complex: economics, management*, 1, 5-12.
- Widener, M., Metcalf, S., & Bar-Yam, Y. (2013). Agent-based Modeling of Policies to Improve Urban Food Access for Low-income Populations. *Applied Geography*, 40, 1-10. <https://doi.org/10.1016/j.apgeog.2013.01.003>

CSR Web Communication by Controversial Companies: The Example of Chemical Companies Operating in Norway

Jan KOPRIVA* and Libena TETREVOVA

University of Pardubice, Pardubice, Czech Republic; jankopriva96@gmail.com; libena.tetrevoval@upce.cz

* Corresponding author: jankopriva96@gmail.com

Abstract: Communication of socially responsible activities by companies is a fundamental condition allowing companies to share the benefits of their social responsibility. The need for effective communication of socially responsible activities which are performed exhibits itself in a particularly significant manner in the case of companies in controversial industries, such as companies in the chemical industry. The aim of the article is to analyze and evaluate the scope and structure of CSR activities communicated by chemical companies operating in Norway. Primary data was obtained on the basis of content analysis of the websites of the TOP 100 chemical companies operating in Norway. This was processed using tools for descriptive statistics. The study which was performed shows that the scope of communication by the monitored chemical companies operating in Norway is low (43% of the monitored activities are communicated). Activities in the field of environmental responsibility are communicated to the greatest extent, followed by activities in the field of economic responsibility. Comparison of the scope in which individual socially responsible activities are communicated is evident from the findings presented, including international comparison.

Keywords: corporate social responsibility; web communication; chemical companies; Norway

JEL Classification: M14; L65; M39

1. Introduction

Communication of socially responsible activities which companies perform is crucial from the point of view of sharing the benefits of socially responsible behavior which is applied (Tetrevoval et al., 2020). It is not enough merely to perform interesting, socially beneficially activities. A company must also know how to communicate effectively regarding these activities (Kim & Ferguson, 2018; Tetrevoval, 2017). If a business is able to inform its stakeholders about the CSR (corporate social responsibility) activities which it performs in an appropriate manner, it can also share the benefits of its social responsibility. In this context, Lim and Greenwood (2017) distinguish three key dimensions of CSR communication. This concerns the business dimension focused on provision of information to customers, the employee dimension focused on provision of information to employees and the community dimension focused on provision of information to the community. The above-mentioned dimensions

include the key stakeholders in the business in the context of the stakeholder theory (Nikolova & Arsić, 2017; Ranängen, 2016).

The primary focus of attention within the framework of CSR communication must be communication in relation to end customers and corporate customers. This is to say that a lot of customers nowadays judge whether a producer acts in a socially responsible manner when they are shopping (Kim, 2019; Tetrevova, 2017). As is evident, for example from the study performed by IPSOS (IPSOS, 2020), 49% of Czechs think that it is important whether a company acts in a socially responsible manner when deciding about making a purchase. 70% of customers are willing to pay extra for a product which is environmentally friendly or if a certain amount of money from its sale will be used to fund a socially beneficial project. The results of this study also show that socially responsible activity is a reason for more than half of the respondents to purchase or recommend a particular brand. Social responsibility is in general important, in particular for the purchasing decisions of generations Z and Y. The importance of this decreases with age (IPSOS, 2020). However, it is not only the customers who judge the social responsibility of companies. Employees also do so (Lim & Greenwood, 2017) and should therefore be adequately provided with information about CSR activities which are performed. This is to say that, according to the IPSOS study, it is important for 78% of employees whether the employer acts in a socially responsible manner, in particular employees with a university education (IPSOS, 2019). A sufficient amount of high-quality and relevant information about CSR activities performed must also be provided to the community, in particular in the place where the respective company operates, including provision of information to the political representation there. This is to say that CSR communication can help a company to gain the required moral legitimacy (Seele & Lock, 2015). Thanks to effective CSR communication, a company can also share benefits such as an increase in customer satisfaction and organizational attractiveness (Latif et al., 2020; Zhang et al., 2020), increase in employee satisfaction and loyalty (Barakat et al., 2016; Schoeneborn et al., 2020), strengthening of its corporate reputation (Jelinkova & Vancova, 2020; Zhang et al., 2020) or increase in the value of the company (Chung et al., 2018; Hu et al., 2018).

Despite the fact that several studies have proven the positive benefits of CSR communication mentioned above, not enough studies are available which are devoted to the practical aspects of CSR communication (Kim & Ferguson, 2018). According to Seele and Lock (2015), CSR communication by companies is incomparable and inconsistent, this being the reason why it is frequently the subject of skepticism and criticism by stakeholders. In this context, Andreu et al. (2015) state that “understanding how to effectively communicate socially responsible initiatives is an important challenge for both researchers and managers, who invest considerable resources in CSR initiatives”.

Our purpose is thus to fill in the gap in investigation of this issue, specifically, the issue of evaluation of the level of CSR web communication by companies in controversial industries. The reason for this focus on the issue of CSR web communication is the fact that, together with social networks, corporate websites are the preferred channels of CSR communication, as is for example illustrated by Cortado et al. (2016), Da Giau et al. (2016) or Tetřevová et al. (2020). The reason for the focus on the issue of companies in controversial industries is then the fact that

CSR communication plays a much greater role as regards the need for them to defend the legitimacy of their operations than is the case with companies in non-controversial industries (Kilian & Hennigs, 2014; Song et al., 2020).

The aim of the article is to analyze and evaluate the scope and structure of CSR activities communicated by chemical companies operating in Norway. The submitted study presents findings gained on the basis of content analysis of the websites of the TOP 100 chemical companies operating in Norway, this using the CE3SPA method (Method of communication of economic, environmental, ethical, social and philanthropic activities).

The further text of the article explains the applied methodology – the research procedure and data sample are characterized; the methodological framework is presented and the method of data analysis is explained. The findings of the study are subsequently presented, this being from the point of view of the scope and structure of CSR activities communicated by the monitored chemical companies operating in Norway. The last section of the text offers discussion of the findings of the study and comparison in an international context.

From the point of view of theory, the presented study contributes towards enhancement of knowledge regarding the issue of evaluation of the level of CSR communication by companies in controversial industries. From the point of view of the company managers, but also the policy makers, it provides a guide to improving the level of CSR communication, on the one hand, by identifying preferred and neglected activities from the point of view of CSR communication and, on the other hand, by creating a basis for benchmarking.

2. Methodology

Elaboration of the presented study is based on systematic literary research (Kraus et al., 2020; Speldekamp et al., 2019), the subject of which was articles published on the topic of CSR communication in journals registered in the databases of the Web of Science and Scopus. In relation to this, backward snowballing was then applied (Wohlin, 2014). The full texts of the relevant publications were searched using the Google Scholar tool.

Collection of primary data then built on the literary research. Primary data was gained using content analysis. The reason for this is that the expedience of its use has been proven by several studies devoted to the issue of CSR communication, see more e.g. in McDaniel et al. (2016), Palazzo et al. (2020), or Tetreanova et al. (2019). Latent content analysis was chosen. This is a type of content analysis which is based not only on searching for the defined keywords and their synonyms, but also searching for the defined subject on the basis of the meaning of the text (Dooley, 2016; Gaur & Kumar, 2018). From a technical point of view, recording of data was performed using the binary codes 1 (the monitored activity is communicated) and 0 (the monitored activity is not communicated) (Huffman, 2006). Collection of data was performed from December 2019 until May 2020 and subsequently supplemented to include additional data in August and September 2020.

The subject of content analysis was the websites of the TOP 100 chemical manufacturing companies based in Norway which are published in English. According to NACE Rev. 2 classification (European Commission, 2008), this concerned the websites of division 20 (Manufacture of chemicals and chemical products) companies. They were identified using

the Nordic Market Data AB database (Nordic Market Data AB, 2019). In view of the fact that nine of the given companies do not have functional websites and twenty-one of the companies do not have an English version of their website, the websites of 70 chemical manufacturing companies based in Norway were subsequently analyzed.

From a methodological point of view, the subject of the content analysis was determined using the CE3SPA method (Method of communication of economic, environmental, ethical, social and philanthropic activities) (Tetreanova, 2018; Tetreanova et al., 2020). In its basic form, the CE3SPA method is based on evaluation of 40 socially responsible activities (10 economic responsibility activities, 7 environmental responsibility activities, 7 ethical responsibility activities, 11 social responsibility activities and 5 philanthropic responsibility activities). The reason for its use was the fact that this is a user-friendly method as compared, for example, to the GRI (Global Reporting Initiative) framework (GRI, 2020), which provides specific practical instructions for application and which is intended primarily for companies in socially sensitive industries (Tetreanova & Patak, 2019). In addition to this, the expedience of its use has already been proven both for companies in the chemical industry (Tetreanova, 2018; Tetreanova et al., 2020), and also for sugar factories (Tetreanova, 2019), gambling operators (Tetreanova & Patak, 2019) or the TOP 100 companies (Tetreanova et al., 2019), not only in the Czech Republic, but also abroad (Ukraine, Slovakia or Germany).

Statistical processing of primary data was performed using MS Excel. Methods of descriptive statistics were applied. The scope in which CSR activities are communicated in individual areas of CSR and as a whole in all areas was measured with the aid of the average number of activities communicated. Differences in the scope of communication between individual areas of CSR were analyzed with the aid of the relative average number of activities. The scope in which individual CSR activities are communicated was analyzed with the aid of multiple response analysis (the frequency of companies in which the activity was identified).

3. Results

The study performed shows that chemical companies operating in Norway communicate an average of 17 of the 40 assessed socially responsible activities on their corporate websites, i.e. 43%. They communicate environmental responsibility activities in the greatest scope (58%), followed by economic responsibility activities (56%). On the contrary, they communicate philanthropic responsibility activities (22%) and ethical responsibility activities (26%) in the least scope. More details about the scope of socially responsible activities communicate by Norwegian chemical companies on their websites can be found in Table 1.

The overall scope in which CSR activities are communicated and also the overall scope in which activities are communicated in the individual areas of social responsibility, i.e. in the economic, environmental, ethical, social and philanthropical fields, is determined by the scope in which the individually assessed activities are communicated, i.e. the structure of communication.

Table 1. Scope of CSR activities communicated

Area	Number of possible activities in the given area	Average number of activities	Relative average number of activities	Median number of activities	Minimum number of activities	Maximum number of activities
Economic responsibility	10	5.6	56%	5	0	10
Environmental responsibility	7	4.1	58%	4	0	7
Ethical responsibility	7	1.8	26%	1	0	6
Social responsibility	11	4.5	41%	3	0	10
Philanthropic responsibility	5	1.1	22%	0	0	5
Total	40	17	43%	16	0	35

Table 2. Scope of communication of individual economically responsible activities

Code	Communicated activities	Percent of cases (%)
EC1	Good governance practices	46
EC2	Care for the quality and safety of products	81
EC3	Product innovation	66
EC4	Strengthening relations with customers	89
EC5	Strengthening relations with owners and investors	51
EC6	Strengthening relations with suppliers and purchasers	57
EC7	Development of relations with public institutions	33
EC8	Membership in professional associations	51
EC9	Partnership with educational institutions	39
EC10	Development of relations with the public	51

Table 3. Scope of communication of individual environmentally responsible activities

Code	Communicated activities	Percent of cases (%)
EN1	Ensuring compliance with environmental legislation	67
EN2	Saving energy and other resources	60
EN3	Minimization of waste and support for recycling	63
EN4	Investment into clean technologies	57
EN5	Support for preservation of resources and biodiversity	29
EN6	Prevention and remedy of negative impacts of activities on the environment and community	71
EN7	Encouraging initiatives promoting a responsible approach to the environment	59

The study performed shows that seven of the ten assessed activities are communicated by more than half of the companies in the field of economic responsibility (Table 2). Here, strengthening relations with customers and care for the quality and safety of products are communicated by more than three quarters of chemical companies operating in Norway on their websites. On the contrary, activity in the field of economic responsibility in the form of development of relations with public institutions is communicated by only a third of the monitored companies.

In the field of environmental responsibility (Table 3), in which the greatest scope of CSR communication was proven, six of the seven assessed activities are communicated by more

Table 4. Scope of communication of individual ethically responsible activities

Code	Communicated activities	Percent of cases (%)
ET1	Installation of a code of ethics	59
ET2	Education and training of employees to act ethically	19
ET3	Ethical reporting	21
ET4	Ethical audit	20
ET5	Creation of an ombudsman's office	9
ET6	Creation of an ethics committee	11
ET7	Whistleblowing hotline	39

Table 5. Scope of communication of individual socially responsible activities

Code	Communicated activities	Percent of cases (%)
SC1	Ensuring occupational health and safety	61
SC2	High-quality working environment	46
SC3	Care for education and development of employees	51
SC4	Application of measures eliminating any form of discrimination at work	46
SC5	Ensuring freedom of association in trade unions and the right to collective bargaining	17
SC6	Implementation of a high-quality process of recruiting employees and terminating employment	36
SC7	Involvement of employees in the decision-making process	41
SC8	Employee care	47
SC9	Ensuring work-life balance	24
SC10	Action to combat mobbing and harassment	39
SC11	Ensuring a healthy corporate culture	41

than half of the monitored chemical companies operating in Norway. Prevention and remedy of negative impacts of activities on the environment and community is communicated in the greatest scope (71%). On the contrary, the activity in this area, which is communicated the least, which is not communicated by even a third of the monitored companies, is support for preservation of resources and biodiversity (29%).

From the point of view of the monitored chemical companies operating in Norway, a relatively neglected area of CSR communication is the field of ethical responsibility. Only one ethically responsible activity of the seven activities assessed in this field is communicated by more than half of the companies, this being installation of a code of ethics. Ethical responsibility activity in the form of creation of an ombudsman's office then ranks among the least communicated activities, not only from the point of view of ethical responsibility activities, but also from the point of view of all CSR activities communicated by chemical companies operating in Norway. See Table 4 for more details.

From the point of view of CSR web communication by chemical companies operating in Norway, the field of social responsibility does not rank among those areas with a high level of communication or those with a low level of communication (Table 5). The level of communication in this field corresponds to the overall level of CSR communication by the monitored chemical companies. In this field, the monitored chemical companies communicate ensuring occupational health and safety (61%) and care for education and development of employees (51%) in the greatest scope. On the contrary, they communicate

ensuring freedom of association in trade unions and the right to collective bargaining (17%) in the least scope.

As regards the field of philanthropic responsibility (Table 6), the survey we performed showed that this was one of the fields of CSR in which the monitored chemical companies operating in Norway communicate the least. The given finding is determined by the fact that less than half of the companies communicate each of the assessed activities in this area. Corporate giving is communicated by the largest number of chemical companies monitored (47%). On the contrary, support for donation activities among employees is communicated by the least of them (9%). Together with activity in the form of creation of an ombudsman's office, this activity ranks among the least communicated CSR activities performed by the monitored chemical companies.

Table 6. Scope of communication of individual philanthropically responsible activities

Code	Communicated activities	Percent of cases (%)
PH1	Corporate giving	47
PH2	Support for donation activities among employees	9
PH3	Corporate volunteering	13
PH4	Support for individual employee volunteering	14
PH5	Collaboration with non-profit organizations	24

4. Discussion

The study performed shows that chemical companies operating in Norway communicate an average of 43% of the monitored activities on their corporate websites. In view of the fact that the TOP 100 companies operating in Norway communicate 89% of CSR activities (KPMG, 2020) and in view of the fact that a higher level of CSR communication can be expected among companies in the chemical industry (Kilian & Hennigs, 2014; Song et al., 2020), we regard the scope of CSR activities communicated by chemical companies operating in Norway as being relatively low. The given scope is comparable with the scope of CSR activities communicated by chemical companies operating in the Czech Republic (40%) (Tetreva et al., 2020), one of the post-communist countries, in which a lower level of CSR communication has been exhibited over the long term (Háček, 2017; Háček & Wolniak, 2015; Tetreva, 2019). The truth is that the scope of CSR communication by chemical companies operating, for example, in Ukraine or Slovakia is significantly lower – 36% and 29% respectively (Tetreva et al., 2020).

As regards the scope in which CSR activities are communicated in the individual areas of CSR communication, environmental responsibility activities (58%) and economic responsibility activities (56%) are communicated in the greatest scope. These two fields of responsibility dominate CSR communication as a whole. In general, in the context of the stakeholder theory (Nikolova & Arsić, 2017; Ranängen, 2016), the field of economic responsibility is the preferred area, both from the point of view of controversial and also non-controversial companies. We can, for example, document this fact using the example of the TOP 100 companies operating in the Czech Republic or Ukraine (Tetreva et al., 2019). The field of environmental responsibility comes to the forefront, specifically in the case of

controversial companies, the activities of which are associated with environmental risks (Peters et al., 2019). We can document this fact, not only using the example of chemical companies operating in Norway, but also that of chemical companies operating in the Czech Republic (Tetreva, 2018; Tetreva et al., 2020) or sugar factories operating in Germany and Ukraine (Tetreva, 2019). The area in which activities are on the contrary communicated in the least scope is the field of philanthropic responsibility. In general, however, it is usually the field of ethical responsibility which is communicated the least (Tetreva et al., 2019, 2020).

From the point of view of the structure of communicated CSR activities in the individual fields of CSR, the activity communicated most in the field of economic responsibility by the monitored chemical companies operating in Norway is strengthening relations with customers. The given finding seems logical in the context of the stakeholder theory and the concept of customers as key stakeholders. This activity is one of the most communicated activities, not only in the case of Norwegian chemical companies, but also among chemical companies (Tetreva et al., 2020) and the TOP 100 companies (Tetreva et al., 2019) operating in the Czech Republic and Ukraine. In the field of environmental responsibility, prevention and remedy of negative impacts of activities on the environment and community is the activity which is communicated the most. This activity also ranks among the TOP environmentally responsible activities communicated in the case of chemical companies operating in the Czech Republic, Slovakia and Ukraine (Tetreva et al., 2020) or the TOP 100 companies operating in the Czech Republic (Tetreva et al., 2019). In the field of ethical responsibility, the TOP activity is installation of a code of ethics. This activity is also the TOP ethical activity communicated by chemical companies operating in the Czech Republic, Slovakia and Ukraine (Tetreva et al., 2020), the TOP 100 companies operating in the Czech Republic and Ukraine (Tetreva et al., 2019) or sugar factories operating in Germany and Slovakia (Tetreva, 2019). As regards the field of social responsibility, the monitored chemical companies operating in Norway communicate ensuring occupational health and safety in the greatest scope. This is also the case with chemical companies operating in Slovakia and Ukraine (Tetreva et al., 2020) and the TOP 100 companies operating in Ukraine (Tetreva et al., 2019). In the field of philanthropic responsibility, the monitored chemical companies operating in Norway communicate corporate giving in the greatest scope. This activity also ranks among the TOP philanthropic activities in the case of chemical companies operating in the Czech Republic, Slovakia and Ukraine (Tetreva et al., 2020), the TOP 100 companies operating in the Czech Republic and Ukraine (Tetreva et al., 2019) or gambling operators in the Czech Republic (Tetreva & Patak, 2019).

Acknowledgments: This study was partly supported by a grant from the Fund for Bilateral Relations within the framework of the EEA and Norway Grants 2014-2021 (EHP-BFNU-OVNKM-3-134-01-2020) and by a grant from the University of Pardubice within the framework of the Specific Science Projects (SGS_2021_003).

References

- Andreu, L., Casado-Díaz, A. B., & Mattila, A. S. (2015). Effects of message appeal and service type in CSR communication strategies. *Journal of Business Research*, 68(7), 1488–1495.
<https://doi.org/10.1016/j.jbusres.2015.01.039>

- Barakat, S. R., Isabella, G., Boaventura, J. M. G., & Mazzon, J. A. (2016). The influence of corporate social responsibility on employee satisfaction. *Management Decision*, 54(9), 2325–2339. <https://doi.org/10.1108/md-05-2016-0308>
- Chung, C. Y., Jung, S., & Young, J. (2018). Do CSR activities increase firm value? Evidence from the Korean market. *Sustainability*, 10(9), 3164. <https://doi.org/10.3390/su10093164>
- Cortado, F.-J., Chalmeta, R., & Ntim, C. G. (2016). Use of social networks as a CSR communication tool. *Cogent Business & Management*, 3(1), 1187783. <https://doi.org/10.1080/23311975.2016.1187783>
- Da Giau, A., Macchion, L., Caniato, F., Caridi, M., Danese, P., Rinaldi, R., & Vinelli, A. (2016). Sustainability practices and web-based communication. *Journal of Fashion Marketing and Management: An International Journal*, 20(1), 72–88. <https://doi.org/10.1108/jfmm-07-2015-0061>
- Dooley, K. J. (2016). Using manifest content analysis in purchasing and supply management research. *Journal of Purchasing and Supply Management*, 22(4), 244–246. <https://doi.org/10.1016/j.pursup.2016.08.004>
- European Commission. (2008). NACE Rev. 2 – Statistical classification of economic activities in the European Community. Office for Official Publications of the European Communities. <https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF/dd5443f5-b886-40e4-920d-9df03590ff91>
- Gaur, A., & Kumar, M. (2018). A systematic approach to conducting review studies: An assessment of content analysis in 25 years of IB research. *Journal of World Business*, 53(2), 280–289. <https://doi.org/10.1016/j.jwb.2017.11.003>
- GRI. (2020, November 20). Consolidated set of GRI sustainability reporting standards 2020. GRI. <https://www.globalreporting.org/standards/>
- Hąbek, P. (2017). CSR reporting practices in Visegrad group countries and the quality of disclosure. *Sustainability*, 9(12), 1–18. <https://doi.org/10.3390/su9122322>
- Hąbek, P., & Wolniak, R. (2015). Assessing the quality of corporate social responsibility reports: The case of reporting practices in selected European Union member states. *Quality & Quantity*, 50(1), 399–420. <https://doi.org/10.1007/s11135-014-0155-z>
- Hu, Y., Chen, S., Shao, Y., & Gao, S. (2018). CSR and firm value: Evidence from China. *Sustainability*, 10(12), 4597. <https://doi.org/10.3390/su10124597>
- Huffman, D. A. (2006). A method for the construction of minimum-redundancy codes. *Resonance*, 11(2), 91–99. <https://doi.org/10.1007/bf02837279>
- IPSOS. (2019, May 28). The public expects environmental protection from CSR activities of companies and fair treatment of employees. https://www.ipsos.com/sites/default/files/ct/news/documents/2019-05/tiskova_zprava_ipsos_28_05_2019_csr.pdf
- IPSOS. (2020, November 26). Corporate social responsibility: there is growing pressure to treat employees fairly. https://www.ipsos.com/cs-cz/spolecenska-odpovednost-firem-roste-tlak-na-ferove-chovani-kzamestnancum.ipsos.com/sites/default/files/ct/news/documents/2019-05/tiskova_zprava_ipsos_28_05_2019_csr.pdf
- Jelinkova, M., & Vancova, A. (2020). Criteria for assessing the reputation of chemical companies in the eyes of customers. *Chemické listy*, 114(8), 559–564.
- Kim, S. (2019). The process model of corporate social responsibility (CSR) communication: CSR communication and its relationship with consumers' CSR knowledge, trust, and corporate reputation perception. *Journal of Business Ethics*, 154(4), 1143–1159. <https://doi.org/10.1007/s10551-017-3433-6>
- Kim, S., & Ferguson, M. A. T. (2018). Dimensions of effective CSR communication based on public expectations. *Journal of Marketing Communications*, 24(6), 549–567. <https://doi.org/10.1080/13527266.2015.1118143>
- Kilian, T., & Hennigs, N. (2014). Corporate social responsibility and environmental reporting in controversial industries. *European Business Review*, 26(1), 79–101. <https://doi.org/10.1108/eb-04-2013-0080>
- KPMG. (2020, November 30). The road ahead: The KPMG survey of corporate responsibility reporting 2017. KPMG. <https://home.kpmg.com/xx/en/home/insights/2017/10/the-kpmg-survey-of-corporate-responsibility-reporting-2017.html>
- Kraus, S., Breier, M., & Dasí-Rodríguez, S. (2020). The art of crafting a systematic literature review in entrepreneurship research. *International Entrepreneurship and Management Journal*, 16(3), 1023–1042. <https://doi.org/10.1007/s11365-020-00635-4>
- Latif, K. F., Pérez, A., & Sahibzada, U. F. (2020). Corporate social responsibility (CSR) and customer loyalty in the hotel industry: A cross-country study. *International Journal of Hospitality Management*, 89, 102565. <https://doi.org/10.1016/j.ijhm.2020.102565>

- Lim, J. S., & Greenwood, C. A. (2017). Communicating corporate social responsibility (CSR): Stakeholder responsiveness and engagement strategy to achieve CSR goals. *Public Relations Review*, 43(4), 768–776. <https://doi.org/10.1016/j.pubrev.2017.06.007>
- McDaniel, P. A., Cadman, B., & Malone, R. E. (2016). Shared vision, shared vulnerability: A content analysis of corporate social responsibility information on tobacco industry websites. *Preventive Medicine*, 89, 337–344. <https://doi.org/10.1016/j.ypmed.2016.05.033>
- Nikolova, V., & Arsić, S. (2017). The stakeholder approach in corporate social responsibility. *Engineering management*, 3(1), 24–35.
- Nordic Market Data AB. (2019, December 1). *The largest companies in the Nordics*. Nordic Market Data AB. <https://www.largestcompanies.com/>
- Palazzo, M., Vollero, A., & Siano, A. (2020). From strategic corporate social responsibility to value creation: an analysis of corporate website communication in the banking sector. *International Journal of Bank Marketing*, 38(7), 1529–1552. <https://doi.org/10.1108/ijbm-04-2020-0168>
- Petera, P., Wagner, J., Pakšiová, R., & Křehnáčová, A. (2019). Sustainability information in annual reports of companies domiciled in the Czech Republic and the Slovak Republic. *Engineering Economics*, 30(4), 483–495. <https://doi.org/10.5755/j01.ee.30.4.22481>
- Ranängen, H. (2016). Stakeholder management theory meets CSR practice in Swedish mining. *Mineral Economics*, 30(1), 15–29. <https://doi.org/10.1007/s13563-016-0098-z>
- Schoeneborn, D., Morsing, M., & Crane, A. (2020). Formative perspectives on the relation between CSR communication and CSR practices: Pathways for walking, talking, and t(w)alking. *Business & Society*, 59(1), 5–33. <https://doi.org/10.1177/0007650319845091>
- Seele, P., & Lock, I. (2015). Instrumental and/or deliberative? A typology of CSR communication tools. *Journal of Business Ethics*, 131(2), 401–414. <https://doi.org/10.1007/s10551-014-2282-9>
- Song, B., Wen, J., & Ferguson, M. A. (2020). Toward effective CSR communication in controversial industry sectors. *Journal of Marketing Communications*, 26(3), 243–267. <https://doi.org/10.1080/13527266.2018.1536887>
- Speldekamp, D., Saka-Helmhout, A., & Knoben, J. (2019). Reconciling perspectives on clusters: An integrative review and research agenda. *International Journal of Management Reviews*, 22(1), 75–98. <https://doi.org/10.1111/ijmr.12216>
- Tetreova, L. (2017). Communication of socially responsible activities by sugar-producing companies. *Listy cukrovarnické a řepářské*, 133(12), 394–396.
- Tetreova, L. (2018). Communicating CSR in high profile industries: Case study of Czech chemical industry. *Engineering Economics*, 29(4), 478–487. <https://doi.org/10.5755/j01.ee.29.4.19199>
- Tetreova, L. (2019). Communication of socially responsible behaviour by sugar producers in Germany, Czech Republic and Slovak Republic. *Listy cukrovarnické a řepářské*, 135(9-10), 322–325.
- Tetreova, L., & Patak, M. (2019). Web-based communication of socially responsible activities by gambling operators. *Journal of Gambling Studies*, 35(4), 1441–1455. <https://doi.org/10.1007/s10899-019-09842-3>
- Tetreova, L., Patak, M., & Kyrylenko, I. (2019). Web-based CSR communication in post-communist countries. *Applied Economics Letters*, 26(10), 866–871. <https://doi.org/10.1080/13504851.2018.1508866>
- Tetreova, L., Patak, M., & Kyrylenko, I. (2020). CSR web communication in controversial industries: The example of chemical companies based in post-communist countries. *Journal of Promotion Management*. <https://doi.org/10.1080/10496491.2020.1851849>
- Wohlin, C. (2014). Guidelines for snowballing in systematic literature studies and a replication in software engineering. In M. Shepperd (Ed.), *18th International Conference on Evaluation and Assessment in Software Engineering* (pp. 1–10). Association for Computing Machinery. <https://doi.org/10.1145/2601248.2601268>
- Zhang, Q., Cao, M., Zhang, F., Liu, J., & Li, X. (2020). Effects of corporate social responsibility on customer satisfaction and organizational attractiveness: A signaling perspective. *Business Ethics: A European Review*, 29(1), 20–34. <https://doi.org/10.1111/beer.12243>

Higher Education Institution in the 21st Century – Key Factors for Prospective Students

Enikő KORCSMÁROS, Szilvia T. KOSÁR and Bence CSINGER*

J. Selye University, Komarno, Slovakia, korcsmarose@uj.s.sk; kosars@uj.s.sk; csinger.bence@gmail.com

* Corresponding author: csinger.bence@gmail.com

Abstract: In our study, we examine the most important key factors that play an important role in the lives of students about to enter higher education. Higher education institutions contribute career preparation by providing a wide range of internship opportunities for students. In addition, it contributes greatly to personal development. The aim of our research is to provide a comprehensive picture of the most significant influencing factors for students in 21st century Hungary that determine the choice of a higher education institution. In the course of our study, we conducted a quantitative survey among secondary schools in Hungary, which was implemented in the form of a direct mail questionnaire survey. Our results prove that the most important factor for students nowadays is to get a suitable job opportunity after their studies. In the case of students with a good and excellent academic average, the professionalism of their future teachers and the quality of instruction are decisive for their further education.

Keywords: higher education; key factors; further learning

JEL Classification: I20; I21; I23

1. Introduction

The 21st century brought drastic social and economic changes. This period is the century of the knowledge-based society, where human knowledge, which becomes an almost direct productive force, is of unprecedented importance in the life of mankind. As a result, the knowledge economy has emerged, putting the economic structures of the 21st century on a new footing. The most important institutions of the knowledge society deal with the production, distribution and reproduction of knowledge. This role is now played by educational institutions, including higher education. Today, the most important thing is to develop relationships, communication and cooperation, and through its potential, to approach a given problem from different perspectives. In addition, it is important to mention a kind of technological and social paradigm shift, as nowadays ideas, concepts, and solutions are the main parameters. (Hudson, 2006)

Modern education systems form a complex structure consisting of several interconnected levels. The ensemble of these forms the school system itself, which is divided into subsystems with more or less institutional characteristics. (Halász, 2001)

Each country has its own individual higher education system, but each is part of the European Higher Education Area (EHEA). The system is the result of a unique international collaboration in higher education and the political will of 49 countries with different political,

cultural and academic traditions, which has created a step-by-step area of shared commitment over the past twenty years. The 49 countries fully agree and accept the reform of higher education based on common key values such as free expression, autonomy of institutions, independent student unions, academic freedom, and free movement of students and faculty. In order to sustain this process, the countries, institutions and stakeholders in the European region are constantly transforming their higher education systems. The aim is to make them compatible, thus strengthening their quality assurance mechanisms. The main goal of these countries is to increase the mobility of teachers and students and to facilitate employability. (Ehea, 2021)

Hungary has an advanced higher education system consisting of 38 universities and 29 colleges. With regard to universities, it can be said that there are 27 public, 9 private and ecclesiastical institutions in the country (Derényi, 2018).

An article in Eduline in 2019 shows that the Hungarian government has waived the compulsory secondary language exam for higher education. However, the advanced level of graduation, also required as an admission requirement, remains. Tamás Schanda, Parliamentary Secretary of State at the Ministry of Innovation and Technology, said last year that students who enroll in a higher education institution in 2020 and already have a language exam will have a significant advantage in admission, as this knowledge is extra points. He added that students who passed the language exam before applying would not be short of it either, as it would still be needed to obtain a degree, and would be a huge advantage during higher education, as it would make it easier for them to learn about the latest research findings. (Eduline, 2019)

In the 2019/2020 academic year, 64 higher education institutions conducted training in Hungary. The number of applicants for full-time bachelor's and master's degrees increased by 3.7 thousand in 2019. With regard to bachelor education, it can be said that, based on the current year's calculation, the number of applicants increased by 6.2% in 2019, and it can be said that the proportion of students admitted was 70% of first-place applicants. In the 2019/2020 academic year, 204 thousand students continued their studies in the full-time courses of Hungarian higher education institutions, which also meant an increase of 1.7% based on the current year's calculation. (Hungarian Central Statistical Office, 2019)

Figure 1 clearly shows that over the years, the number of people in tertiary education is unfortunately declining. Based on the data, we examined the development of the population between 1992 and 2001, as this age group was facing the choice of a higher education institution between 2010 and 2019. The gray part of the chart shows the number of students in higher professional training, the purple part in bachelor's education, the orange part in master's education and the blue part in doctoral education.

Student decisions can be divided into two groups: individual and group decisions. The choice of institution as well as further education is typically considered a group decision among high school students, as it is a major decision that will determine the future, within which the family has an extremely important role to play. In later stages of life, this decision is already passed on to the individual, but at the same time the role of group influence remains. (Rámháp, 2017)

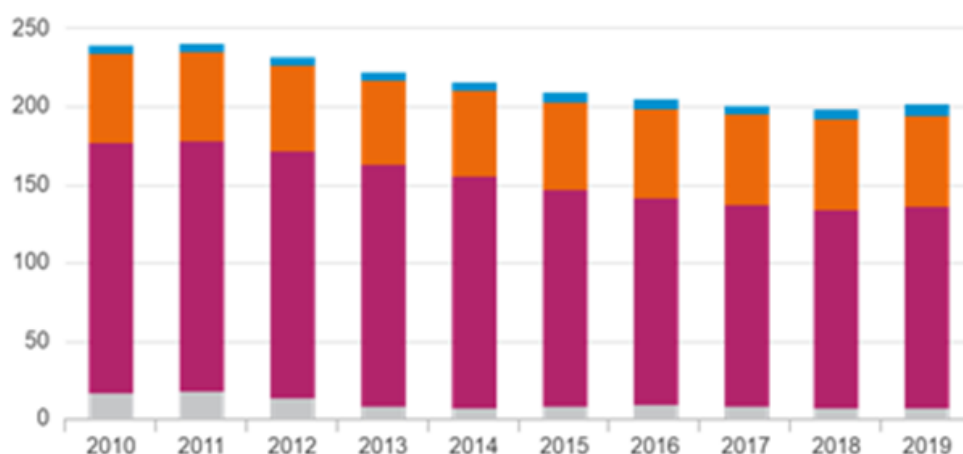


Figure 1. Changes in the number of students studying full-time in higher education institutions between 2010-2019. Source: Hungarian Central Statistical Office (2019)

We distinguish five different decision roles, which are: initiator, influencer, decision maker, purchaser, and user. With regard to higher education, the initiator is the student or parent who wishes to continue his or her studies, who wants his or her child to continue his or her studies, and at a later stage in life, the workplace where higher education is expected. The influencing category in this case is extremely wide-ranging. Parents, family, friends, acquaintances, society and the workplace also influence the decision. In terms of consumer behavior, we distinguish between individual (motivation, values, lifestyle, personality) and environmental (culture, reference groups, family) influencing factors. When choosing a higher education institution, the individual, the family or even the workplace can play a decision-making role. The opinion of the prospective student is dominant in the selection of the major as well as the admission strategy, but the parent is competent in financial matters. Parents leave room for individual goals, professional interest and attitudes, but since they finance the studies or, in other cases, the additional costs, they have the final say. The decision is often influenced by the opinions of peers, and financial issues are influenced by the family situation. We can also talk about mutual decisions, which are typically present in the case of settlement choice and housing issues. Parents can also provide students with good advice and experience in assessing the value of a degree as well as future employment opportunities. (Rámháp, 2017; Császár – Németh, 2011)

In the education system, therefore, we can talk about decisions made more or less freely, which are formed by weighing the expected benefits and expenses. Every decision has the consequence that market-like processes are present in the education system and competition also appears. Individual decisions that can be seen as consumer decisions related to education can be described as the relationship between the demand for forms of education and different institutional options as supply and demand. (Halász, 2001)

Table 1 provides a comprehensive overview of the changes in key factors that play a key role among students in selecting a higher education institution. In order to expand this literature review, we decided to examine these motivational factors in relation to Hungary.

Higher education institutions need to have a well-developed marketing strategy that provides ongoing information to their own target group.

Table 1. The most important factors in choosing a higher education institution

Hooley & Lynch, 1981	Lin, 1997	Soutar & Turner, 2002
Suitability of the course, place of university, academic reputation, type of university (old or modern), family opinion, job opportunities, quality of teaching, university atmosphere.	Quality of education, career opportunities, reputation, curriculum, level of study, faculty qualifications.	Suitability of the course, reputation, job opportunities, quality of teaching.

Higher education institutions need to have a well-developed marketing strategy that provides ongoing information to their own target group.

The decisions that students make when choosing a higher education institution are often related to the obvious and hidden costs of college or university visits, in a word, the resources needed for attendance (attendance collage). Researchers find that high school graduates who want to enroll in four-year institutions and their family members consider a number of variables before making their final decision. Students usually consider whether a particular institution offers some form of financial incentive support. Institutional characteristics are also taken into account. Several researchers have examined how the geographical location of students influences their application to a higher education institution. They concluded that students living in zones where college and university opportunities are available are more likely to apply to these institutions. Based on these, it was stated that the local accessibility of higher education institutions contributes significantly to the increase in the education of local students. (Canché, 2018)

2. Methodology

After reviewing the theoretical part of our analysis, the next important part of our research was the presentation of the results of our study.

We considered it an important factor to present our results to the reader in an appropriate way after answering the central question. As a result, we illustrate the results of the research using various graphic solutions. Based on the order of importance of the motivational factors encountered in graduating high school students, the first step was to create a preference order. In addition, we aimed to make a step-by-step representation of the elements of the pyramid we created on which higher education institutions have an influential power. A total of 311 high school students joined our primary data collection. When filling in the questionnaires, we placed great emphasis on the recipients, is the leaders and teachers of secondary schools and grammar schools, asking for the help of students who want to study further, and strengthening the camp of students with excellent or good grades. Taking these factors into account, 270 of the 311 responses received were evaluable for us.

With the help of the hypothesis formulated in connection with the topic, we wanted to research what motivational factors are present among Hungarian secondary school students when choosing a higher education institution. Prior to the statistical analysis of the data, our hypothesis was as follows:

H1: There is a linear relationship between the reputation of higher education institutions and other factors considered important by the authors.

In our hypothesis analysis, we examined variables that were measured on a five-point Likert scale. Based on the concepts defined by the Sajtos-Mitev (2007) pair of authors, the variables measured on the Likert scale are metric. As a result, in our case, we will test the formulated hypothesis with correlation analysis.

To examine the closeness of the data, the Pearson correlation coefficient (r), has been chosen, which can be determined:

$$r = \frac{\sum_{i=1}^N (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^N (x_i - \bar{x})^2 \sum_{i=1}^N (y_i - \bar{y})^2}} \quad (1)$$

where \bar{x} is the mean of x_i and \bar{y} is the mean of y_i . The value of the correlation coefficient can range from -1 to +1, where the absolute value of the pointer indicates the closeness of the relationships and its sign indicates the intensity of the relationship.

3. Results

Based on our research results, we created a preference order, which is shown in Figure 2. During the preparation of our order of preference, we divided each motivational factor into three categories, which were marked with three different colors in the figure. The section marked in the bottom gray contains the influencing factors that have the least impact on students in making decision. Above this are the factors that already greater influence, but they are not the most important. At the top of the pyramid, we placed the variables that can be defined as the most influential factors based on our research.

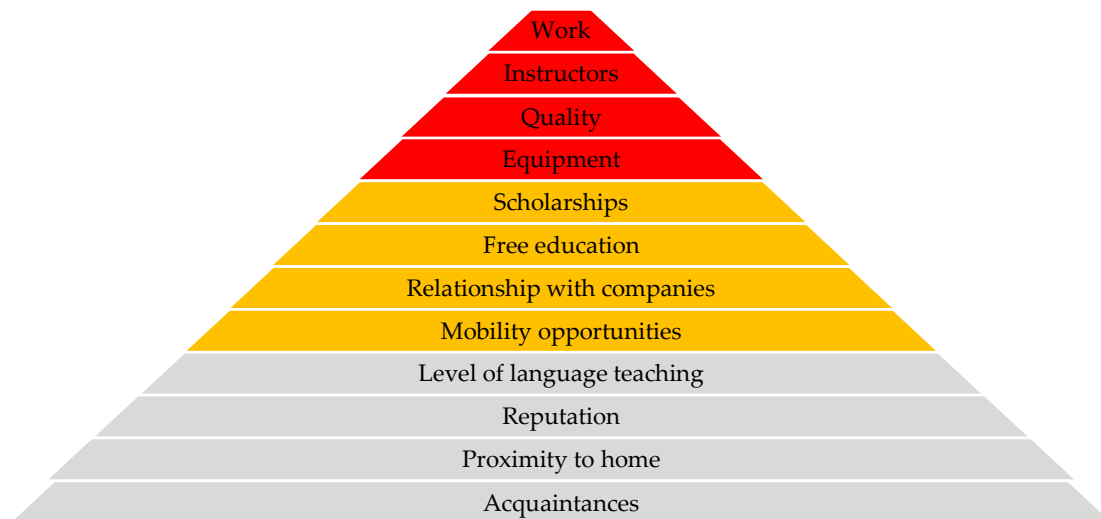


Figure 2. Order of preference for the most important factors when selecting a Hungarian higher education institution

The least important variable for students is that their acquaintances also visit (2.36) the higher education institution. Furthermore, the proximity of the university to their home is not relevant (2.79). The next level of preference order is the reputation of the university (3.60), which is more than 0.8 points ahead of the other two levels. However, reputation cannot be separated from several higher levels, as good equipment, quality, and the professionalism of

the lecturers will sooner or later entail an increase in the reputation of a university. The level of language teaching (3.81), mobility opportunities (3.84) and contact with companies (3.89) are not negligible aspects either. At the next two levels, there are material-related factors: free education (4.02) and scholarship opportunities (4.05), which have already been rated above four. Suppose a particular student is admitted to a cost-effective course and is not eligible for scholarships because of his or her position. This can have a significant impact on your choice of a foreign but free higher education institution. At the highest levels of the pyramid are the elements that are a basic expectation in a reputable higher education institution. The fourth most important factor is the equipment of the university (4.20), here we can think of the technical equipment, the classrooms, but even the library. Above this is the quality of the university (4.28), which is most often found in the rankings of the various higher education institutions. Students involved in the research identified two factors as the most important, as the difference between them is only one-tenth.

Since all variables were measured on a Likert scale for the statement under study, a correlation analysis was performed to study their relationship, the results of which are illustrated in Table 2.

Table 2. Examination of the H1 hypothesis by correlation analysis

	Pearson Correlation	Sig.	N.
University standard	0.397	0	270
Professionalism of trainers	0.006	0.919	270
University equipment	0.127	0.037	270
Level of language teaching	0.082	0.181	270
Mobility opportunities	0.163	0.007	270
Proximity to home	0.066	0.281	270
Influence of acquaintances	0.190	0.002	270
Free education	0.033	0.590	270
Scholarship opportunities	0.042	0.496	270
University-company relations	0.098	0.110	270
Future well-paying job opportunities	0.063	0.304	270

Observing the Pearson correlation coefficient, we can only identify one variable that correlates with the reputation of the university. This variable is the standard. Based on these, it can be stated that the more important the reputation of the higher education institution is for the students involved in the research, the more important it is that the quality of the institution is good. The relationship can also be said to be positive and moderately strong. In addition to the formulated hypothesis, the authors also outlined two assumptions in the second chapter.

4. Discussion

In the first part of our study, we provided an insight into the 21st century higher education system. As a next step we outlined the methodology of the study and finally review the results of the research. Our questionnaire was created using Survio and Google Form Building software. After conducting our quantitative questionnaire survey, we formulated

our hypotheses on the topic. After that we sent our survey many secondary schools in Hungary with the aim of examining the motivation of graduate students for further education and to get an answer to the question of which factors influence them the most when deciding on the choice of institution. The feedback results were coded using Microsoft Excel, and then the validity of our hypotheses was examined using the SPSS program. In the course of our analysis, we obtained the result that nowadays the future job opportunities, the professionalism of the instructors, the quality of the education, and the equipment of the institution are the most important factors that are taken into account when they choose a higher education institution. In our hypothesis analysis, we formulated the assumption that there is a linear relationship between the reputation of the institution and other factors that we consider important. We obtained the result that only one variable correlates with the reputation of the university, and that is the standard of the university.

5. Conclusions

Taking into account Table 1 based on the literature review and our own results, it can be said that the factors which influencing graduate students in Hungary have not changed much in the last 40 years. Based on our results, the primary task of a higher education institution is to provide the right teaching background, to pay great attention to the quality of education, and to consider the equipment of the institution. In our opinion, if these factors are given a strong emphasis by higher education institutions, it will contribute to the good placement of graduates in the labor market. As a limitation of our research, it is definitely important to mention the ongoing health crisis situation, which has forced high schools to switch to online education, which greatly reduced the willingness to fill. There are so many opportunities for research. Our goal is to expand the scope of research for the future, as well as to conduct an international comparative analysis. In addition, we would like to repeat our research in the future, which provides an opportunity to examine how the influencing factors are changing over the years, which are essential to further learning.

Acknowledgments: The scientific article is a partial output from the KEGA project 005UJS-4/2019 entitled "Streamlining Managerial Skills of the generations Z and Y by gamification on the context of linking science and practice", which is solved at the Faculty of Economics and Informatics of the J. Selye University in Komárno.

References

- Canché, G. S. M. (2018). Nearby collage enrollment and geographical skills mismatch: (Re)conceptualizing student out-migration in the American Higher Education System. *The Journal of Higher Education*, 89(6), 892-934. <https://doi.org/10.1080/00221546.2018.1442637>
- Császár, M. Z., & Németh, J. (2011). Some aspects of human capital production in hungarian higher education. *Central European Regional Policy and Human Geography*, 1(1), 27-35. https://www.researchgate.net/profile/Zsuzsa_M_Csaszar/publication/266874625_SOME_ASPECTS_OF_HUMAN_CAPITAL_PRODUCTION_IN_HUNGARIAN_HIGHER_EDUCATION/links/56c1a05708aee5caccf7cc3b.pdf
- Derényi, A. (2018). A felsőoktatás rendszere Magyarországon. *Tempus Közalapítvány*. <https://tka.hu/nemzetkozi/9518/a-felsooktat-as-rendszere-magyarorszagon>
- EduLine. (2019). Milliók nézik ezt a videót: így kampányolnak a Harvard hallgatói. https://eduline.hu/campus_life/20191122_kulonleges_video_egyetemistak
- Ehea. (2021). *Info*. European Higher Education Area and Bologna Process. <http://www.ehea.info/>

- Halász, G. (2001). *Az oktatási rendszer*. Műszaki Könyvkiadó.
- Hooley, G. J., & Lynch, J. E. (1981). Modeling the student university choice process through the use of conjoint measurement techniques. *European Research* 9(4) 158-170.
- Hudson, C. (2006). Regional development partnerships in Sweden: a way for higher education institutions to develop their role in the processes. *Higher Education: The International Journal of Higher Education and Educational Planning*, 51(3), 387-410. <https://doi.org/10.1007/s10734-004-6416-3>
- Hungarian Central Statistical Office. (2019). *Oktatási adatok, 2019/2020* (Educational data 2019/2020). <https://www.ksh.hu/docs/hun/xftp/idoszaki/oktat/oktatas1920/index.html>
- Lin, L. (1997). What are student education and educational related needs? *Marketing and Research Today*, 25(3), 199-212.
- Rámháp, S. (2017). *Felsőoktatási továbbtanulási motivációk Magyarországon. A változó ifjúság és a piacosodó felsőoktatás tükrében*. Doktori értekezés tervezet. (Motivations for further education in higher education in Hungary. In the light of changing youth and marketable higher education. Doctoral dissertation draft.) Széchenyi István Egyetem. Regionális- és Gazdaságtudományi Doktori Iskola. https://rgdi.sze.hu/images/RGDI/honlapелеmei/fokozatszerzesi_anyagok/Ramhap_Szabolcs_doktori_disszertacio.pdf
- Sajtos, L., & Mitev, A. (2007). SPSS Kutatási és adatelemzési kézikönyv. Budapest: Alinea Kiadó.
- Soutar, G. N., & Turner, J. P. (2002). Students' preferences for university: A conjoint analysis. *The International Journal of Educational Management*, 16(1), 40-45. <https://doi.org/10.1108/09513540210415523>

An Innovative Teaching Method and Its Practical Applicability – Focus on the Playful Interaction Among the Students

Enikő KORCSMÁROS*, Renáta MACHOVÁ, Lilla FEHÉR and Zsuzsanna TÓTH

J. Selye University, Komárno, Slovakia, korcsmarose@ujss.sk; machovar@ujss.sk; feherl@ujss.sk; tothz@ujss.sk

* Corresponding author: korcsmarose@ujss.sk

Abstract: The research related to innovation has been in a focus of academics for a long time. In the current study, the authors present the positive benefits of applying an innovative teaching method, based on primary research, applying a questionnaire-based survey. The innovative teaching methods may significantly change the traditional lessons. The questionnaire was completed anonymously in October 2019 and February 2020. Evaluated sampling as a form of non-random sampling was applied. There were 236 questionnaires evaluated after the application of the simulation software. We used SPSS to analyze the obtained data. The defined research question was: Is it possible to form different groups based on playful interaction among students? The Ward-method, as a hierarchical method was used for cluster analysis. We finally decided on two-cluster solution: cluster 1 called as a cluster of playful learning students and cluster 2 as a cluster of “uninterested negatives”. Novel methods in education play an essential role in the Slovak education system.

Keywords: innovation; playful learning; education; teaching method

JEL Classification: I21; I29; J24

1. Introduction

Currently we are being faced by constant change, which is accompanied with innovation in different fields of our life. The term „innovation“ is associated with the name of Schumpeter in historical context. He defined innovation as a process, which starts with a creative idea that can be implemented into practice. Since our research is focusing on innovation applied in education, we will introduce the theoretical background of the issue in this context. Our study will present the difference between the generations and their characteristics, as well as their position on the labour market. One of the biggest challenges of the corporate sector is the coordination of cooperation and working methods of these generations. The focus shifts on online activity of the younger generation and their commitment to IT tools. In contrast to emphasizing the negative impact of the above mentioned tools, the authors will introduce the positive, labour market enhancing use of innovative teaching methods. (Werbach & Hunter, 2012)

Innovation is also present in the education, which contributes to efficiency of education, supports the teacher in work and enables them to apply different methods of knowledge transfer, as well as provides students with an opportunity to try new methods of acquiring

knowledge. Since the students participating in education process are different, the use of different methods in the education process can lead to selection of the most effective methods to be applied in the education process (Szőköl, 2018; Zelenková & Hanesová, 2019).

The specific professional knowledge that is associated with competitiveness is based on high level of general knowledge. The technological progress is accelerating, which makes it difficult to determine the future of professions. However, there are certain competencies and attitudes that can be attributed to certain profession. Different competencies can be assigned to different fields, but there are certain competencies e.g. problem-solving ability, motivation, creativity, which can be listed as universal competencies. (Makó, 2015)

The interactive education will enable the students to become equal participants in a research-based education, and thus to be involved in the process of discovery, innovation and learning from mistakes. One of the main benefits of this new approach is that they learn to think, act, and make decisions professionally, thus developing their professional identity. (Holmes, Wieman, & Bonn, 2015)

These interactive techniques make the education process more attractive, authentic and satisfying – full of challenges that need to be addressed and lead to better education results. The active engagement can include several „provocations“, which are carefully planned by instructors, as well as will enable understanding and engagement in the educational process. Interactive teaching provides a possibility for the lecturer to persuade the students to participate in the process of online learning by using online materials, quizzes and other methods before entering the traditional classroom. Collecting data via responses can provide information for the lecturer, who can tailor the presentation and progress with the curriculum based on the collected data. The transition to active form of education leads to replacement of traditional didactics, where students will progress based on predetermined set of steps. The active methods of teaching are designed to help students solving problems while asking questions. As a result of this, the students will share their „experimental proposal“. It can be described that the previous traditional methods are like recipes used for cooking and baking. (Zelenková & Hanesová, 2019) In contrast, innovative teaching methods are more authentic, require teamwork and higher level of awareness. Students can be prepared not only for specific „textbook“ problems, but also for situations where the answer is not known in advance. This approach makes students to recognize that conclusions can rarely be recognized final, they need to be modified and finalized. (Zichermann & Linder, 2013) Active education requires a high level of interaction between the students and the teacher, as well as the student and the curriculum. The strategy of education should include the following aspects:

- Guided preparation for lessons – students should be prepared for interactions that might occur on the lessons. Therefore, not only the teachers, but also the students have to prepare for the lecture. It will increase the quality and frequency of the interactions.
- Time for reflection – following the interactions, students should be given a time for thinking and discussion in order to place the acquired learning material into further context.
- Applying mixed teaching techniques – the teacher should not insist on a specific technique, but use different techniques in different combinations and alternately.

- Increased emphasis on applying knowledge – interactions put increased emphasis on the application of new and existing concepts and knowledge in new and existing contexts.
- The „importance“ of incorrect answer – accepting that the „incorrect“ answer is also a necessary and positive step towards the sustainable education.
- The need for different measurement methods – help students to realize what they already know and what they are capable of. (Talbot et al., 2016)

The nature of innovative education offers more opportunities to correct misconceptions, to provide feedback in time, and integration of perspectives through discussions and discovery. As responsibility shifts towards the student, these methods are able to adapt to the educational abilities of the individuals, different professional directions and diversity of student aspirations (Deslauriers, Schelew, & Wieman, 2011; Freeman et al., 2014; Rózsa, 2018).

According to the following scheme below, we can assume that each individual expression is interpreted in two dimensions. One of the dimensions focuses on distinction between the concept of play (n) and play (v). Deterding (2011) explains the difference between them clearly. While the game is played, it can also have a broader meaning. As for the definition of „game“, he can agree with the classical definitions of the term, according to which individuals are trying to achieve a certain goal or results during the game, while the whole process is characterized by rules, competition and possible disputes as well.

The second dimension differentiates the „serious game „ and „gamification“ on the basis of the elements of the game and based on the game as an entire activity. As it was earlier mentioned in the text, we use game elements in a playful environment also during gamification, but the limits of applying game elements are unclear, so it is often difficult to distinguish serious game from gamification. (Deterding et al., 2011; Blšáková, Piwowar-Sulej, 2019)

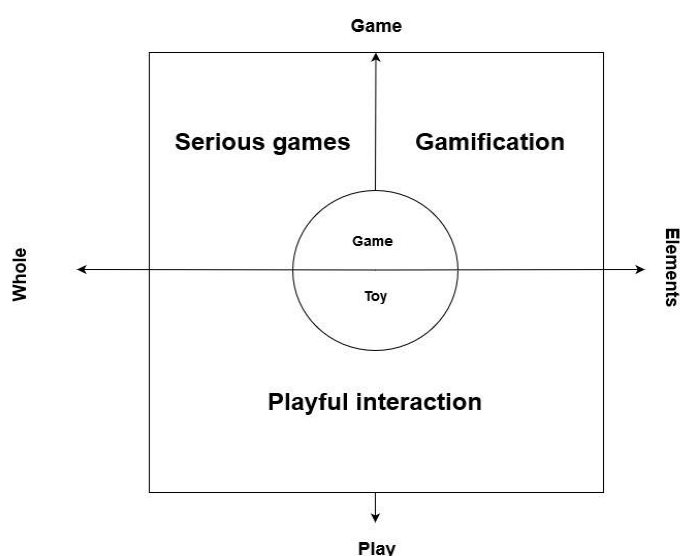


Figure 1. Difference between game, serious game and gamification (Deterding et al., 2011, p. 2)

2. Methodology

The aim of the research is to map the experience related to practical use of the simulation software as an innovative teaching method. To achieve our goal, we conducted a

primary research in form of a questionnaire survey. The questionnaire was completed anonymously in October 2019 and February 2020. Evaluating sampling as a form of non-random sampling was applied, the selection of elements is based on the researcher's decision. There were collected 236 questionnaires after the application of the software. We used SPSS to analyze the obtained data.

In order to achieve the research goals, the research questions were outlined:

Is it possible to form different groups based on playful interaction among the students? In addition to univariate analyzes, e.g. mean, mode, standard deviation, which provide an insight into the opinion of the respondents, we also applied multivariate analysis for deeper analysis of the obtained data. In this research the cluster analysis will be highlighted. The main objective was to obtain detailed information about the individuals forming certain groups. The Ward-method, as a hierarchical method was used for cluster analysis.

$$d_{Ward}(C_i, C_j) = \sum_{u,v \in C_i \cup C_j} d^2(u, v) - \left(\sum_{u,v \in C_i} d^2(u, v) + \sum_{u,v \in C_j} d^2(u, v) \right) \quad (1)$$

Using the Ward's method, we can minimize the squares within the clusters, and merge the two clusters that cause the lowest square error increase (Fogaras & Lukács, 2005). Within the clusters we conducted the cluster table analysis related to gender, place of residence and generation group of the respondents. The further relationship between the factors was examined using a Chi-Square test and Cramer V.

The research question focused on creating different groups of students based on the assessment of playful learning. In order to answer the question, a cluster analysis was used in the SPSS system. The aim of the method is to arrange the observation units into a homogeneous group based on the variables involved in the analysis. The cluster analysis is successful if the individuals forming a group share similarities, but relevant deviation can be detected among the different groups. The cluster analysis is trying to create groups of observed individuals. The process of cluster analysis was started by defining the problem and formulating the research question. The last question of the questionnaire was relevant following the application of the software, as we wanted to organize our students into groups based on these 14 statements. Before running the cluster analysis, it is necessary to examine the conditions of the analysis. There was no need to standardize the data, as our variables were measured on a five-point metric scale, and no flagrant elements were detected. The correlation between the variables was not too high either, so clustering was made possible. Since our variables are measured on a metric scale, two observation units can be considered similar, when the distance between them is small, and they are the same if the distance between them equals to zero. The Euclidean distance was used to measure the distance. The next step of the cluster analysis is to select the cluster method to be applied. There are two methods of clustering. We can differentiate the hierarchical and non-hierarchical cluster formation. Decision about which method is more appropriate is not an easy task. According to professional recommendation, it is advisable to use the methods together. The ideal number of clusters was determined by using the Ward-technique as a hierarchical method.

3. Results

To determine the number of clusters, we examined the aggregation algorithm and the dendrogram, based on which both the two- and three-cluster solutions required further examination. The following step of the examination was the interpretation and characterization of the clusters, which can be conducted based on the cluster centroids (average). The first analysis included only those factors that contributed to forming the clusters, and later the characterization of each group was performed with the help of variables not included in the clusterization. To make decision about the number of clusters, we also examined the standard deviation of the clusters, which contributed to deduction of homogeneity. The three-cluster and two-cluster solutions resulted in groups of almost the same homogeneity, but in the case of the two-cluster solution the standard deviation of our first cluster improved, so finally decided on two-cluster solution. 66% of the students were classified to Cluster 1, while 34% were classified to Cluster 2. The clusters were named and characterized based on the answers of respondents provided for statements about playful learning.

Table 1. Cluster 1

	Cluster 1	Average
I enjoy competition.	3.60	3.86
New tasks are equal to new challenges, which are inspiring.	3.31	3.60
Integrated usage of knowledge.	3.31	3.66
I get to know new skills about myself.	3.18	3.51
Reward after solving a certain amount of tasks.	3.15	3.51
I solve more and more difficult tasks.	3.13	3.42
Tasks to be solved evoke unexpected positive emotions.	3.10	3.37
I can try and prove my desires.	3.03	3.46
The new tasks generate desire.	2.92	3.31
As the best part, I can try and fulfill different roles.	2.90	3.24
The roles helped me re-evaluate my out-of-game options.	2.90	3.36
I can get easily angry if cannot solve a task.	2.82	2.71
After completing a task, the reward is a new task.	2.46	2.85
Tasks to be solved trigger unexpected negative feelings.	2.08	2.17

The first cluster is formed by 156 students, who do not really enjoy the opportunity of competition provided by game. Regarding the brief demographic characteristics of the representatives of the first cluster, we consider it important to indicate that from an age point of view, the cluster is represented in most of the representative of generation Y. Although members of generation Y are characterized by the fact that technology makes their everyday lives easier, the use of simulation software has not won their favor. The reward is not really motivating for them, and they get angry easily, when they cannot solve the task. Their negative and positive emotions during the game are not outrageous either. Based on the values presented in the table above, this group enjoyed the application of simulation

software less, the game rather brought negative attitudes to the surface, so this group is called the „uninterested negatives“. The teacher has a key role to play raising the students' awareness on playful learning, motivating them to compete, and applying tools to raise interest of the students in playful learning.

Table 2. Cluster 2

	Cluster 2	Average
I enjoy competition.	4.40	3.86
Integrated usage of knowledge.	4.35	3.66
I can try and prove my desires.	4.30	3.46
The roles helped re-evaluate my out-of-game opportunities.	4.25	3.36
Reward after solving certain amount of tasks.	4.20	3.51
New tasks are equal to new challenges, which is inspiring.	4.15	3.60
I get to know new skills about myself.	4.15	3.51
The new tasks generate desire.	4.05	3.31
I solve more and more difficult tasks.	4.00	3.42
The tasks to be solved evoke unexpected positive emotions.	3.90	3.37
As the best part, I can try and fulfill different roles.	3.90	3.24
After completing a task, the reward is a new task.	3.60	2.85
I can easily get angry if cannot solve the task.	2.50	2.71
The tasks to be solved trigger unexpected negative feelings.	2.35	2.17

Cluster 2 is formed by a smaller group of students. The cluster is represented in most of the representative of generation Z. Members of generation Z are already born into a world of digital technologies where it is unthinkable for them to live without the use of mobile phones, computers and other digital and communication devices. Members of generation Z, as they grew up in a new world, have completely changed their learning habits. This also raises problems in the education system, especially in the area of teaching methods. It is difficult for teachers to pass on their knowledge to young people who are accustomed to the rapid flow of information and its reception. There are 80 students in the cluster, which forms 34% of the sample. They enjoy competition, the opportunity to integrate their knowledge gained by studying different subjects, and they want to prove their abilities. They will not get angry if cannot solve tasks as well as the tasks to be solved do not generate negative feelings. It is benefiting to focus the attention of students on competition, reward and new challenges. This cluster is formed by the „competing positives“. Statistical testing of average differences is essential. An independent sample t-test was used for testing. After performing the independent sample t-test, we found that the opinion of our two clusters differs significantly for all statements.

4. Discussion and Conclusions

The aim of the research is to map the experience related to practical use of the simulation software as an innovative teaching method. In the following, we will provide the characterization of each cluster on the basis of three demographic variables (gender, place of

residence, generational categorization) not included in clustering. Since all three of our demographic questions are not measured on a metric scale, nor clustering is measured on a metric scale, so we chose the cross-tab analysis. Considering the distribution by gender and the place of residence, both of our clusters are mainly formed by women and rural residents. It is not surprising since female respondents and respondents with the place of rural residence are over-represented in the sample. There is a significant ($\chi^2 = 0.008$), but weak relationship (Cramer's $V = 0.171$) between the gender and the clustering factors. There is no significant relationship between the place of residence and clustering ($\chi^2 = 0.066$). There is a weak (Cramer's $V = 0.131$), significant ($\chi^2 = 0.044$) relationship between the generation categorization and clustering. The group of „uninterested negatives” is formed by the representatives of Generation Y (54%), while the group of „competitive positives” is formed by the representatives of Generation Z (60%). The research results suggest that the novel method of playful learning can be adopted much faster by younger generation, so it is worth to introduce applications supporting playful learning and simulation softwares to younger generation.

The most important conclusions of our cluster analysis is that it is more difficult for the older generation respondents to open to technological challenges. They were more skeptical about application of the software in the education process, so the role of the teacher is to motivate them to accept the new methods of teaching. In contrast, the representatives of younger generation are open to new methods applied in the education process, it is worth to put emphasis on competition, which can be defined as a strong labour market competence. Based on the obtained research results, we can assume that the novel methods in education play an essential role in the Slovak education system, as they result in strengthening labour market competencies among the members of young generation.

Acknowledgments: The scientific article is a partial output from the KEGA project 005UJS-4/2019 entitled “Streamlining Managerial Skills of the generations Z and Y by gamification on the context of linking science and practice”, which is solved at the Faculty of Economics and Informatics of the J. Selye University in Komárno.

References

- Blišťáková, J., & Piwowski-Sulej, K. (2019). Gamification as an innovative idea within human resources management. In P. Jedlička, P. Marešová, & I. Soukal (Eds.), *Hradec Economic Days* (Vol. 9, pp. 77–88). University of Hradec Králové. https://uni.uhk.cz/hed/site/assets/files/1073/proceedings_2019_1-1.pdf
- Deslauriers, L., Schelew, E., & Wieman, C. (2011). Improved Learning in a Large-Enrollment Physics Class. *Science*, 332(6031), 862–864. <https://doi.org/10.1126/science.1201783>
- Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification. Using game-design elements in non-gaming contexts. In *Proceedings of the 2011 Annual Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '11*, 2425. <https://doi.org/10.1145/1979742.1979575>
- Fogaras, D., & Lukács, A. (2005) Klaszterezés (Clustering). In *Informatikai algoritmusok II. 29. Fejezet.* (pp. 1395–1435). ELTE, Budapest. <http://web.cs.elte.hu/~lukacs/Papers/klaszterezes.pdf>
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America*, 111(23), 8410–8415.
- Holmes, N. G., Wieman, C. E., & Bonn, D. A. (2015). Teaching critical thinking. *Proceedings of the National Academy of Sciences of the United States of America*, 112(36), 11199–11204. <https://doi.org/10.1073/pnas.1505329112>
- Makó, Á. (2015). A szakképzett pályakezdekők munkaerő-piaci helyzete és elhelyezkedési esélyei. *Közgazdasági Szemle*, 62(5), 502–524.

- Rózsa, Z. (2018). Ghostwriting among business management students. *Acta Oeconomica Universitatis Selye*, 7(2), 151–161.
- Szőkö, I. (2018). Continuous Improvement of the Teaching Process in Primary Education. *Journal of Language and Cultural Education*, 6(1), 53–64. <https://doi.org/10.2478/jolace-2018-0004>
- Talbot, R. M. I., Doughty, L., Nasim, A., Hartley, L., Le, P., Kramer, L. H., Kornreich-Leshem, H., & Boyer, J. (2016). Theoretically Framing a Complex Phenomenon: Student Success in Large Enrollment Active Learning Courses. *Physics Education*, 344-347. <https://doi.org/10.1119/perc.2016.pr.081>
- Werbach, K., & Hunter, D. (2012) *For the win: How Game Thinking Can Revolutionize Your Business*. Wharton, Philadelphia.
- Zelenková, A., & Hanesová, D. (2019) Intercultural competence of university teachers: a challenge of internationalization. *Journal of Language and Cultural Education*, 7(1), 1-18, <https://doi.org/10.2478/jolace-2019-0001>
- Zichermann, G., & Linder, J. (2013). *The Gamification Revolution: How Leaders Leverage Game Mechanics to Crush the Competition*. McGraw-Hill.

Digital Twin Models: BIM Meets NetLogo

Milan KOŘÍNEK*, Ondřej TÁZLAR and Kamila ŠTEKEROVÁ

¹ University of Hradec Králové, Hradec Králové, Czech Republic; milan.korinek@uhk.cz; Ondrej.tazlar@uhk.cz; kamila.stekeroва@uhk.cz

* Corresponding author: milan.korinek@uhk.cz

Abstract: Digital twin is a computerized model of a physical device or system. Digital twins open new opportunities for operative decision making. Agent-Based Models (ABM) and simulations are core part of digital twins, especially in case of modelling humans in the spaces they act in. Microscopic simulations at the individual level have to be integrated with realistic models of environments. Here digital twins benefit from Building Information Models (BIM) but importing of BIM files into ABM platforms is not common. This problem is addressed in our paper. Principles of BIM are presented briefly. We suggest enhancing NetLogo modelling platform with BIM as the first step towards the development of digital twins models within NetLogo. The first part of the paper describes BIM formats and 3D visualization, including extraction of 3D model parts from IFC format. Parsing an IFC file using python is proposed, with recalculations of coordinates. It is also shown how the content of IFC can be reused in ABM and how simulations can affect BIM backwards.

Keywords: agent-based model; building information models; digital twin; IFC; NetLogo; simulation

JEL Classification: C63; C88

1. Introduction

A digital twin (DT) is a computerized model of a physical device or system that represents all functional features and links with the working elements (Chen, 2017). Three main counterparts of DT are a physical artefact, a digital counterpart, and data that connects them. The principles of DT modelling were initially applied in the aerospace sector and product manufacturing, recent applications are into smart cities, system engineering, robotics, healthcare, and medicine (Barricelli et al., 2019; Boje et al., 2020).

According Yokogawa (2019), DT technology can benefit multiple levels of the organization including enterprise insight (such as part of an enterprise-wide balanced scorecard), capability assurance with real-time monitoring and control of work processes, value chain optimization or integration of automation and control. Briefly, DTs open new opportunities for operative decision making.

Technologically, DTs build on artificial intelligence, Big Data processing techniques, cloud computing, high dimensional data coding, sensor technologies, and Internet of Things (Barricelli et al., 2019). Agent-Based Models (ABM) are core part of DTs, especially in case of modelling humans in the spaces they act in. Microscopic simulation at the individual level has to be integrated with a realistic model of the environment. This approach was successfully

applied in urban digital twins, a novel method in urban planning, see e.g. (Dembski et al., 2020) for a prototype of an urban digital twin for the town of Herrenberg in Germany. Virtual Singapore project (2021) offers four main capabilities to stakeholders (i.e. government, citizens, businesses and researchers). These capabilities are virtual experimentation, test-bedding, decision-making and research and development. A Digital Twin Helsinki (2021) was developed as a testing tool open to the public, also for mitigating climate change and improving energy efficiency, nowadays it also becomes leader in virtual tourism.

Building Information Modelling (BIM) is a set of technologies, processes and policies enabling multiple stakeholders to collaboratively design, construct and operate a facility in virtual space (BIM Dictionary, 2021). BIM is generally understood as an overarching term to describe a variety of activities in object-oriented Computer Aided Design, which supports the representation of building elements in terms of their 3D geometric and functional attributes and relationships (Ghaffarianhoseini, 2017). Recent trend is a representation of 4th and 5th dimension within BIM by adding temporal perspective and cost estimation (Boje et al. 2020).

Thanks to accurate information about the structure of buildings, it is desirable to directly use BIM for various simulations (Teo, 2016) which can result in process optimization. The question is how to integrate BIM within Agent-Based Models (ABM) such as models of visitors' flow in public spaces or evacuation models where parameters of buildings would be extracted from BIM. For synthesis of ABM platforms and resources, see e.g. (Abar, 2017).

The aim of the article is to propose procedures by which it would be possible to apply BIM information in ABM. The first part describes BIM formats and 3D visualization. Then parsing an IFC file using python is proposed, with recalculations of coordinates. It is also shown how the content of IFC can be reused in ABM and how simulations can affect BIM backwards.

2. Methodology

In the field of infrastructure planning, different modelling approaches are applicable such as Geographic Information System (GIS), Building information models (BIM) or City Information models (CIM). Although they can be used separately, it is possible to combine them together in planning: GIS is used for analyze and work with geographic data and solve spatial problems. GIS coordinates can be used for building location. BIM is a system that primarily focuses on life cycle of a building. BIM also includes 3D models of building and its equipment. Information on multiple buildings can be managed using CIM which is focused on a city infrastructure. CIM includes tools for description and analysis of roads, streets and public spaces (Tah, 2017).

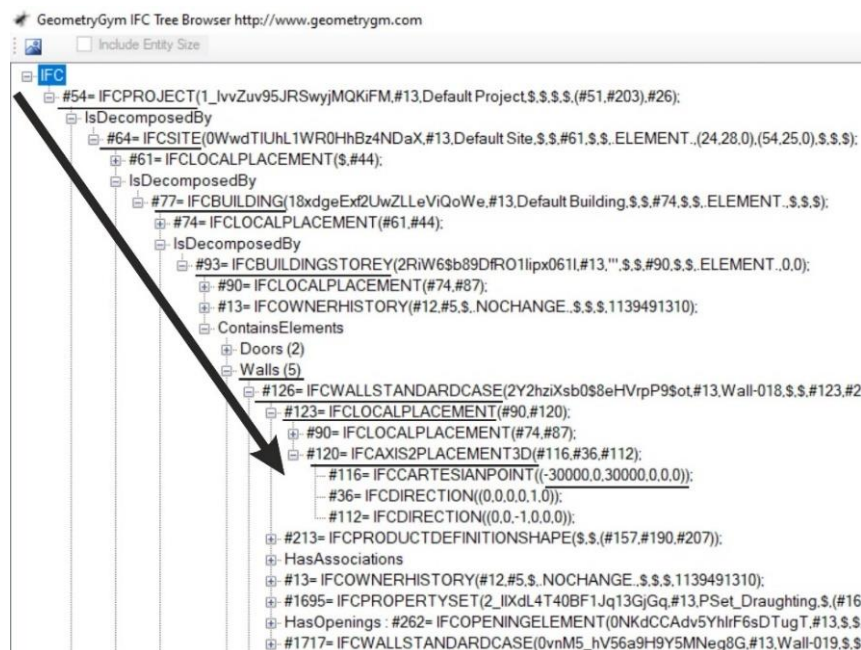
2.1. Building Information Model (BIM)

Building information model is not only a 3D model of the building, but this format also includes information needed for the creation of new buildings and their management, including information on the entire life cycle of the building (Bryde, 2013). The ISO 19650 standardization has made it possible to use and share BIM across sectors.

A part of the information model is also a visual representation of the building, which can be stored in various proprietary formats (RVT, NVD, DWG) and non-proprietary formats (IFC,

IFC is standardized (ISO 167391), open format, which can be used to transfer information between applications. However, it is still only an intermediary between applications, and some information may be lost when exporting BIM to *IFC* (Solihin, 2015). *COBie* is a human readable subset of the *IFC* format.

The IFC file contains information in a hierarchical arrangement (see Figure 1). The GIS location of the object is presented on the first level, subsequent levels are used for location of the building, its floors, components of each floor (such as walls, windows, doors, or columns). These components are also broken into smaller parts. Each individual object contains a reference to the parent element and its parameters, including location and rotation. Here comes the first problem when reading IFC file: information on location and rotation is local only, related to the direct predecessor, which can also be described by local information. For this reason, it is necessary to search the entire hierarchy to extract object information from the lowest levels.



As mentioned earlier, not all ABM platforms can work with the IFC format. Moreover, it is not always necessary to transform the whole BIM model: only relevant parts can be

processed with respect to the aim of ABM, game engine or other engine (e.g. floor plans of the buildings for the purpose of simplified pedestrian movement models). It is possible to perform a one-way conversion of IFC file into a 2D or 3D model for ABM. This process may be sufficient, but if some of information and links from the IFC file is lost, it will not be possible, for example, to retroactively modify IFC data based on the simulation outputs.

3. IFC Parser

The reason for the need to create an IFC format parser was to create ABM working with BIM, it means to import environmental information which contains a description of real buildings. 3D model data was stored in IFC format. The obtained data were used for simulations in the *NetLogo* tool, but thanks to the export to CSV and the definition of a simple and readable structure, other tools can also benefit from this procedure.

For the needs of ABM, it is practical to extract information on individual rooms and corridors from IFC file. Walls, windows, and doors are basic building elements which are included in IFC file. The problem is the relative relationships between the objects. For our experimental purpose, the floor of the building is considered the highest level of IFC file.

Because the IFC format is a text format, it is possible to create a parser from scratch by reading individual lines. However, it was easier to use one of the already existing libraries, such as *IFCOpenShell* for the python programming language. Thanks to the references between objects, it is possible to proceed in both directions. The library allows to get a list of superior objects, as well as a list of subordinate objects. In this way, it is possible to navigate hierarchical dependencies between objects. The following section describes the most important parameters needed to develop a simple environment for ABM. The aim is to create the space of two rooms with windows and doors. Rooms are composed of walls. All walls can be extracted using a function *by_type('IfcWall')* from *IFCOpenShell* library.

3.1. Position of Object

The first parameter that needs to be read is the position. This is stored in the *IfcLocalPlacement* structure. In this structure, there is a reference to the position of the parent element, which would have to be considered, and to the local transformation of the current element. The transformation includes the local position and directions of the X and Z axes (the Y axis is calculated). The position is represented by Cartesian coordinates in the *IfcCartesianPoint* structure. These are the coordinates of the center of the wall at its beginning. The directions of the X and Z axes determine in which direction the wall is rotated. A parameter named *Axis* specifies the Z axis, and a parameter named *RefDirection* specifies the direction of the X axis. Both parameters are of type *IfcDirection*. For example, *RefDirection: IFCDirection(-1.0,0.0,0.0)* says that the wall faces left when viewed from above (provided it is not affected by the parent hierarchy). For better precision is good to calculate transition matrix and then use dot product to get global coordinates. The wall size, endpoint, or wall shape is not the part of the *IfcLocalPlacement* structure and these values needs to be read from the *IfcProductDefinitionShape* structure, which specifies the shape of the wall.

3.2. Shape of Object

IfcProductDefinitionShape provides all the important information needed to build the shape of an object. An important parameter is the representation with the *SweptSolid* parameter. Part of this representation is information about the extraction of the object in a certain direction, the length of the extraction and also the shape by which the extraction is intended. The inclusion of the *IfcRectangleProfileDef* parameter says that the shape is of the rectangle type, and its *XDim* and *YDim* parameters determine the width and length of the rectangles. It is also possible to obtain the coordinates of the center of this extracted object. The appearance of the wall does not have to be defined by a geometric shape. It can arise, for example, from a curve that is specified by several points of type *IfcCartesianPoint*. It depends on the shape and method of creating the model.

3.3. Other Parameters

Many parameters are a part of the IFC forma, including the definition of units of measure within *IfcUnitAssignment* structure. These parameters must be considered, because for individual objects the values are only as a decimal number without units.

Objects contain *GUID* – parameter important for their identification. It is a unique identifier of the type *IfcGloballyUniqueID*, which is unique for the whole model. With this identifier, it is possible to uniquely identify an element and it is also possible to search for it in the hierarchy.

3.4. From IFC to CSV

If all the information about the objects is known, it can be exported to any format and structure that is needed. In the case of the *NetLogo* tool, it is advisable to use the csv format for input. Therefore, a simple structure was designed for a specific case, containing the GUID, object name, start position, end position, width, and reference to the parent object. Depending on the situation, it would be possible to extend the structure by, for example, the Z coordinate. In this way, information about the height of the rooms, the location of the windows or, for example, the height of the door could be stored. Thanks to this, it would be possible to create simple 2.5D or 3D simulations dealing with, for example, the volume of gases at different heights depending on the parameters of the space.

4. Results and Discussion

Part of the 3D model of BIM was converted to *NetLogo* using IFC file (Figure 2). With information about objects, it was possible to create corresponding 2D representation of two rooms with doors and windows. The final CSV file can be imported to other simulations platforms too. The main disadvantage of the method is that it is not a full 1:1 conversion of IFC file to CSV file. Missing information has to be added by python script. The complete logic of the IFC format is not considered, nor is it the way 3D models should be created.

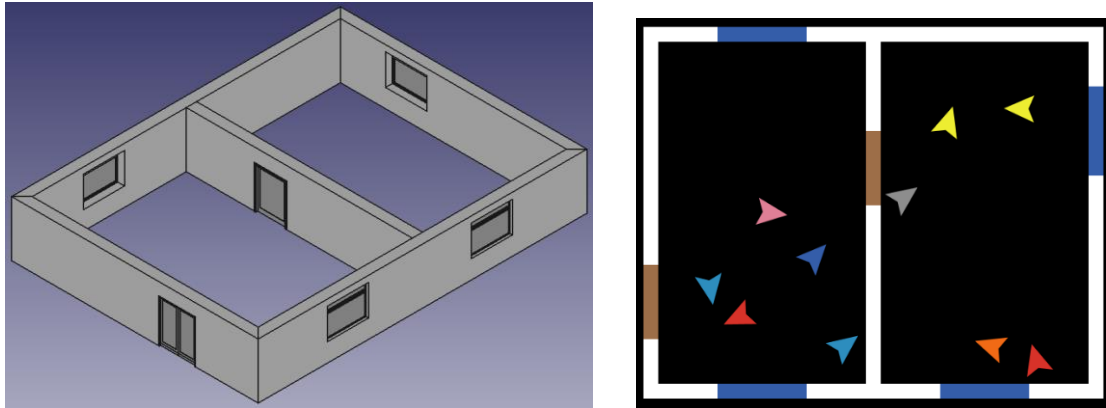


Figure 2. Example of 3D visualization from IFC file (left) and its transformation to NetLogo 2D visualization with agents (right). Source: authors

5. Conclusions

Authors of review (Fuller et al., 2020) noticed that the number of papers on Digital Twins in manufacturing is significantly higher compared to papers on Digital Twins for smart cities and they identify it as the research gap. We agree and to contribute to this area, we propose to enhance NetLogo with BIM as the first step towards the development of DT models within NetLogo. We explained how it is possible convert IFC files into the specification of the environment for ABM. It was described how to get building object information and how to manage parameters that are not explicitly defined in IFC file. The creation of environment in NetLogo from IFC files was presented.

Acknowledgments: The financial support of the Specific Research Project Information and knowledge management and cognitive science in tourism 5. Prepared on the basis of consultations with the researchers of the BEST project (www.bestsim.eu).

References

- Abar, S., Theodoropoulos, G. K., Lemarinier, P., & O'Hare, G. M. P. (2017). Agent Based Modelling and Simulation tools: A review of the state-of-art software. *Computer Science Review*, 24, 13–33.
<https://doi.org/10.1016/j.cosrev.2017.03.001>
- Barricelli, B. R., Casiraghi, E., & Fogli, D. (2019). A Survey on Digital Twin: Definitions, Characteristics, Applications, and Design Implications. *IEEE Access*, 7, 167653-167671.
<https://doi.org/10.1109/ACCESS.2019.2953499>
- BIM Dictionary. (2021). *Building Information Modelling*. <https://bimdictionary.com/en/building-information-modelling>
- Boje, C., Guerriero, A., Kubicki, S., & Rezgui, Y. (2020). Towards a semantic Construction Digital Twin: Directions for future research. *Automation in Construction*, 114, 103179.
<https://doi.org/10.1016/j.autcon.2020.103179>
- Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of Building Information Modelling (BIM). *International Journal of Project Management*, 31(7), 971-980. <https://doi.org/10.1016/j.ijproman.2012.12.001>
- Chen, Y. (2017). Integrated and Intelligent Manufacturing: Perspectives and Enablers. *Engineering*, 3, 588–595.
<https://doi.org/10.1016/J.ENG.2017.04.009>
- Dembski, F., Wössner, U., Letzgus, M., Ruddat, M., & Yamu, C. (2020). Urban Digital Twins for Smart Cities and Citizens: The Case Study of Herrenberg, Germany. *Sustainability*, 12(6), 2307.
<https://doi.org/10.3390/su12062307>
- Fuller, A., Fan, Z., Day, C., & Barlow, C. (2020). Digital Twin: Enabling Technologies, Challenges and Open Research. *IEEE Access*, 8, 108952-108971. <https://doi.org/10.1109/ACCESS.2020.299>

- Ghaffarianhoseini, A., Tookey, J., Ghaffarianhoseini, A., Naismith, N., Azhar, S., Efimova, O., & Raahemifar, K. (2017). Building Information Modelling (BIM) uptake: Clear benefits, understanding its implementation, risks and challenges. *Renewable and Sustainable Energy Reviews*, 75, 1046-1053. <https://doi.org/10.1016/j.rser.2016.11.083>
- Solihin, W., Eastman, C., & Lee, Y. C. (2015). Toward robust and quantifiable automated IFC quality validation. *Advanced Engineering Informatics*, 29(3), 739-756. <https://doi.org/10.1016/j.aei.2015.07.006>
- Tah, J. H. M., Oti, A. H., & Abanda, F. H. (2017). A state-of-the-art review of built environment information modelling (BeIM). *Organization, Technology and Management in Construction: an International Journal*, 9(1), 1638-1654. <https://www.doi.org/10.1515/otmcj-2016-0030>
- Teo, T. A., & Cho, K. H. (2016). BIM-oriented indoor network model for indoor and outdoor combined route planning. *Advanced Engineering Informatics*, 30(3), 268-282. <https://www.doi.org/10.1016/j.aei.2016.04.007>
- Virtual Helsinki. (2021). <https://www.virtualhelsinki.fi/>
- Virtual Singapore. (2021). <https://www.nrf.gov.sg/programmes/virtual-singapore>
- Yokogawa. (2019). *Digital Twin: The Key to Effective Decision-Making How a Digital Twin Delivers Superior and Sustainable Business Value*. White paper. <https://web-material3.yokogawa.com/>

Sustainability in Project Management: Two Sides of the Same Coin or Poles Apart?

Jana KOSTALOVA^{1*} and John McGRATH²

¹ University of Pardubice, Pardubice, Czech Republic; jana.kostalova@upce.cz

² Technological University Dublin, Ireland; John.Mcgrath@TUDublin.ie

* Corresponding author: jana.kostalova@upce.cz

Abstract: Project management maturity influences the success of project management and project implementation. Based on project management international standards and other project management methodologies, various project management maturity models have developed. These models evaluate the level of project management maturity from many lenses; holistically, or in specific project management capabilities or specific to certain industry sectors. Projects are implemented in all human endeavors. Research and development, innovation initiatives, new ventures all harness projects as tool of change. Sustainability has three dimensions – social, economic and environmental. Project management is as much as life skill as it is a management science, relevant to business and society. It is therefore fundamental that sustainability is interwoven into project management tools, techniques and practices. Consequently, project management maturity models have to also evaluate how sustainability is included and applied in project management. The article defines a framework to assess sustainable project management in the form of the most important indicators based on the three pillars of sustainability: People, Planet and Profit. This approach could be used for evaluation of sustainability in project management generally or for the evaluation of a specific project management maturity model.

Keywords: project management maturity; project management maturity model; sustainable project management

JEL Classification: O22; Q01

1. Introduction

Societal attitudes regarding sustainability has changed in recent decades. Sustainability is just as relevant to ethics as it is to the environment and fundamental to tackling the greatest threat to humanity: Climate Change. It is concerned with limited natural resources, safeguarding the planet for future generations and unequivocal evidence that it is not possible to build society on endless growth and reduction of natural resources. Sustainability is the change of paradigm, which transforms human behavior and look for the way of life which could continue without dramatic and irreversible impact on society. There are many diverse views on this problem, but generally from 1992 the Rio de Janeiro World Summit it is the seriously presented and applicable attitude. (United Nations, 1992).

Development of society is connected and concerned with research and innovation activities. These activities are mainly managed as projects. Based on theory and practice along with reflections on lessons learnt from past projects a suite of project management methodologies has been developed. There are currently three international standards of project management: available – Project Management Institute (PMI), International Project Management Association (IPMA) in the form of IPMA Competence Baseline and Project IN Controlled Environment (PRINCE2) and many other methodologies (Project Management Institute, 2017; International Project Management Association, 2020; Association for Project Management, 2019).

The success in implementing projects is very closely connected to project management maturity. The positive influence of project management methods and tools usage have been confirmed by number of studies such as Lappe and Spang (2014), Patanakul et al. (2010) or Meredith and Mantel (2012). As a tool to measure project management maturity the Project Management Maturity Models (PMMMs) have been developed (Kostalova & Tetreova, 2018; Spalek, 2015; Kwak et al., 2015).

There is an increasing swell from society demanding a more environmentally responsible approach in all project activities, there is increasing pressure to include a sustainable element in project management approaches (Silvius et al., 2012; McGrath & Kostalova, 2020).

It is no longer realistic to measure Project success performance indicators that exclude sustainability and social responsibility. Lin et al. (2017) evaluated the social responsibility consideration in megaprojects, which by their very nature have a major impact on society and the environment. Silvius et al. (2012), Martens and Carvalho (2016) recommended the inclusion of sustainable considerations in project management as an integral component and evaluate the activities managed in project management from this point of view. There are available two Project Management Maturity Models/Standards focused on evaluation of the sustainability in project management: Sustainable Project Management Maturity Model (Silvius et al., 2012; Silvius & Schipper, 2015) and 5P Standard in Sustainability in Project Management (Carboni et al., 2018; GPM, 2019).

The question is how to evaluate the presence of sustainable and socially responsible attitude in project implementation generally. One option is to assess the sustainability of project outputs, the other is to evaluate the project management procedures themselves and their contribution to sustainability i.e. via PMMMs. If PMMMs are the tools for measuring project management maturity, indicators that assess sustainable and socially responsible attitude should also be part of the assessed items within PMMMs.

The aim of the article is to select suitable indicators, based on the most relevant general sustainability assessment tools, identifying sustainable and socially responsible attitude in project environment. Via such list of sustainable indicators, it will be possible to evaluate project management in organization generally or available PMMMs.

1.1. Project Management

The Project Management Institute (2017) defines project management as applying knowledge, skills, tools and techniques to project activities to achieve project requirements. According to this standard, project management is accomplished through the application and integration of project management processes in the form of project initiation, planning, implementation, monitoring, verification and completion (Project Management Institute, 2017). So, via the project management methods, tools and recommended processes is possible to manage projects during the whole life cycle. To achieve success in all implemented projects it is suitable to specify appropriate processes in the form of methodology. This was the reason the international project management standards have been developed.

Based on the activities of project managers, practitioners and theorists under the support of the most important project management associations have been formed a conceptual theoretical framework for project management in the form of project management international standards. There are available three the most important standards - the Standard of the Project Management Institute, in the form of A Guide to the Project Management Body of Knowledge (Project Management Institute, 2017). The second important standard is Projects IN Controlled Environments² (PRINCE2). It is a British standard managed by the Association for Project Management Group Ltd. (Association for Project Management, 2019). The third, mostly widespread standard mainly in European countries, is the IPMA Competence Baseline standard of the International Project Management Association, which is modify in national competence baselines standards (International Project Management Association, 2020). All standards offer methodology of project management, associations initiate research and development of their standards, education of project managers and certifications of their knowledge.

1.2. Project Management Maturity Models

To evaluate project management maturity – level of development at which an organization project management processes are – Project Management Maturity Models (PMMMs) have been developed (Albrecht & Spang, 2014; Souza & Gomez, 2015; Brokes & Clark, 2009). PMMMs are mainly based on international project management standards. Currently authors of the article identify 48 PMMMs worldwide. Many authors analyse PMMMs from different point of view, the structure of the models, but do not consider sustainability as an indicator of project management maturity (Farrokh & Mansur 2013; Souza & Gomes, 2015; Spalek, 2015; Albrecht & Spang, 2016; Khoshgoftar & Osman, 2009; Nenni et al., 2014).

Models are possible to structure from many points of view. Görög (2016) recommends evaluation the project management maturity at the project portfolio, program and individual project levels. There is a plethora of PMMMs available that focus on all levels – project portfolio, program and projects and PMMMs which evaluate only project level. Spalek (2015) divided PMMMs into process-oriented and organizational-oriented. Backlund et al. (2014) states that the characteristic focus of some PMMMs is to focus on assessing the capabilities or competencies of project managers, project team members, or top management so these

models are competency-oriented PMMMs. Another point of view on PMMMs is based on specific areas which is via PMMM evaluated (construction projects, software development projects, risk project management etc.). Author structured PMMMs as follows:

- General PMMMs:
 - Based on international project management standards (i.e. Organizational Project Management Maturity Model, based on PMI (Project Management Institute, 2013); Portfolio Management Maturity Model, based on PRINCE2 (Axelos, 2010); IPMA Delta Standard, based on IPMA (International Project Management Association, 2016))
 - Based on project management methodologies (i.e. POC Competence Model (Gareis & Huemann, 2000))
- Models focus on specific area of project management (i.e. Project Risk Maturity Model (Hopkinson, 2010); Conceptual Model for Assessing Project Management Maturity (Spalek, 2015); Sustainable Project Management Maturity Model (Silvius et al., 2012))
- Local project management models (i.e. Project management reference model in organizations from the Czech Republic (Adamek et al., 2013)).

1.3. Sustainability and Project Management

As a tool to respond to social change, environmental challenges and the impact of human activity on the environment and society, sustainable development can be considered as a model which offers the possibility of long-term sustainable existence of society without destructive interventions and changes in the environment. The sustainable development is the balance between economic growth, social wellbeing and wise use of natural resources (Keating, 1993).

Sustainable development means meeting the needs of the present whilst ensuring future generations can meet their own needs. It has three pillars: economic, environmental and social, known as Triple-Bottom Line. To achieve sustainable development, policies in these three areas have to work together and support each other. (European Commission, 2020; Elkington, 1998).

The term of sustainability in business environment is very closed to Sustainable Development (Martens & Carvalho, 2016), Corporate Social Responsibility (European Commission, 2001) or Corporate Sustainable Management (Baumgartner & Rauter, 2017), Corporate Sustainability (Baumgartner and Ebner 2010) and Business Ethics (Carroll, 1991; Baumgartner & Rauter, 2017).

The assessment of sustainability or corporate socially responsible behavior of organizations in public or private sector is possible via many available tools. There are declared sustainable development goals in the form of Agenda 2030 by United Nations (2015) and Local Agenda 21 by United Nations (1992), international standards like Global Reporting Initiative (GRI) (GRI, 2016), UN Global Compact (2014), AA 1000 Accountability (2018), the OECD Guidelines for Multinational Enterprises (2011), SA 8000 (Social Accountability International, 2014), or ISO 26000 (ISO 26000, 2010). There are also available sustainability

maturity models like Business Sustainability Maturity Model (Cagnin, Loveridge, & Butler, 2005), Maturity Model for Sustainability in New Product Development (Hynds et al, 2014), model measured Business Sustainability Maturity Levels (Meza-Ruiz et al. 2017).

Sustainability must be made operational in each specific context, at scales relevant for its achievement, and appropriate methods must be designed for its long-term measurement (Heinen, 1994). Sustainability is reflected in all areas, and therefore it has to be included also in the project management.

Traditionally the project management success was measured by many criteria, methods, indicators, tools. Silvius and Schipper (2016) present the overview of success criteria and they also connect the area of projects, project success and sustainability. The Martens and Carvalho (2016) summarized the overview of articles focused on relationship of sustainability and project management and declared the sustainability has got positive impact on project success. Carvalho and Rabechini (2017) presented sustainability from other point of view as the new dimension of project success, which is necessary to evaluate. Many other authors also discussed the mutual relationship of sustainability and project management and the benefits that can be gained by including of sustainability in project management (Silvius & Schipper, 2016; Silvius et al. 2012, Martens & Carvalho, 2016, Wang, Wei & Sun, 2014; Carboni et al., 2018; GPM, 2019).

1.4. Indicators of Sustainability

Sustainability Assessment can be powerful tool to analyze how the sustainability in all three pillar dimensions is implemented (Waas et al., 2014; Ali, 2013). Specification of indicators of sustainability as the tools to evaluate the level of sustainability, was made by many authors (Waas et al., 2014, Bell & Morse, 2008; Matravers, Moldan, Billharz, & Robyn, 1998; Hak, Moldan & Dahl, 2007). The structured sustainable indicators in form of dimensions or criteria are presented in the international standards of sustainability (see chapt. 1.3).

Agenda 2030 (United Nations, 2015) defined 17 goals in area of sustainable development, these goals are important, and widely accepted as criteria for detailed assessment of sustainability. GRI structured the indicators for assessment in three areas - economic, social and environmental (GRI, 2016) and in each of them specify the detail indicators. UN Global Compact (2014) structured the indicators in four areas – human rights, working conditions, environment and anti-corruption activity.

AA 1000 Accountability (2018) specify recommendations for public and private companies in area of sustainability, they presented mainly principles of sustainable attitude – principle of inclusivity, principle of materiality, principle of responsiveness and principle of impact. The OECD Guidelines for Multinational Enterprises (2011) focus mainly on global companies and specify recommendation in areas: human rights, employment, environment, combating bribery, consumer interests, competition, taxation. SA 8000 (Social Accountability International, 2014) focuses mainly on corporate ethics, in this standard the detail areas of ethics, work conditions and labour rights are specified. ISO 26000 (ISO 26000, 2010) as the base of the standard presents the core subjects of social responsibility and sustainability –

organization governance, labour practices, the environment, fair operating practices, consumer issues and community involvement and development.

Sustainable indicators based on international initiatives and standards offer general sustainable indicators. Lin et al. (2017) presented sustainability indicators suitable to evaluate the megaprojects social responsibility, the indicators are structured in five groups economic, legal, ethical and environmental, political and social responsibility, they are used for responsibility assessment on project or organizational level. Banishashemi et al. (2017) specify the critical success factors for integration of sustainability into construction project management, the factors correspond with the project environment, but they focus mainly on large infrastructure projects.

2. Methodology

The purpose of this paper is to develop a framework to support the integration of sustainability into project management maturity assessment. In order to identify the links between sustainability and project management a review of the literature was conducted specifically focused on sustainable project management and the integration of sustainability into project management methodologies and maturity assessments. As the most important resources focused generally on indicators of sustainability have been chosen general standard indicators (GRI, 2016), which presents the overview of indicators of sustainability. These indicators have been evaluated and modified from the point of relevance to project management. The list of project management indicators has been extended based on the most suitable analysis of sustainability in project management, which are presented mainly in resources (Martens and Carvalho, 2016; Lin et al., 2017; Banishashemi et al., 2017) and the recommended way of evaluation of sustainability in business activities (Meza-Ruiz et al., 2017). The final list of indicators of sustainability is usable to evaluate the sustainable attitude in organization project management attitude or available project management maturity models.

The literature provides evidence of a direct correlation between project performance and project management maturity but also exposes the integration of sustainability into project management maturity is a relatively new phenomenon that is relatively unexplored. Indisputably, there is a lack of frameworks in the context of integrating sustainability into project management maturity. This paper and the proposed framework contribute to this emerging research topic that is relevant to both practitioners and academics.

3. Results

To analyse the involvement of sustainable attitude in PMMMs based on literature review the indicators of sustainability which are relevant in context of PMMM evaluation were specified. As the source mainly the GRI standard (2016), Meza-Ruiz et al. (2017), Martens and Carvalho (2016), Lin et al. (2017) and Banishashemi et al. (2017) have been used. The sustainability indicators are structured in accordance with Triple-bottom line in three main areas and the additional area for general indicators. The list of indicators of sustainability is presented in Table 1.

Table 1. Sustainability Indicators for PMMMs assessment.

General Sustainability Indicators	Managerial Approach
	Business Ethics
	Innovation Management
	Organizational Culture Management
	Responsibility for Product and Services
	Assessment of Technological Feasibility of Project
	Improvement
	Obey Law and observe disciplines
	Ensure Quality and Safety
	Philanthropy
	Transparent Information and Reporting
	Green Designing and Construction
	Collaboration
	Implementing an Effective Quality Control
	Implementing an Effective Project Risk Management
	Strategic Management
	Knowledge Management
	Awareness of Sustainability
	No Conflict of Interest
	Effective Project Control
Economic Sustainability Indicators	Lessons Learned Focused on Sustainability
	Assessment of Economic Feasibility of Project
	Financial and Economic Performance
	Financial Benefits from Good Social and Environmental Practices
	Ensure Shareholders Economic Interest
	Market Presence
	Indirect Economic Impacts
	Transparent and competitive procurement processes
	Anti-corruption
	Anti-competitive Behavior
	Tax
	Cost Management
	Increase in Profitability
	Reasonable Return on Investment
	Perpetuation of Environmental Benefit of the Project
	Efficiency Utilize Resources
Environmental Sustainability Indicators	Recycling of Resources
	Nature Resources Minimization
	Materials Minimization
	Energy Minimization
	Water and Effluents Minimization
	Ground, Ground Pollution
	Air, Air Pollution
	Biodiversity
	Emissions
	Waste Management
	Environmental Compliance
	Supplier Environmental Assessment
	Eco-efficiency
	Management of Environmental Impacts
	Environmental Policy Management

Social Sustainability Indicators	Environmental Commitment and Responsibility
	Protect Environment
	Employment
	Labor/Management Relations
	Occupational Health and Safety
	Training and Education
	Support and cooperation of Project Management Team in delivering a sustainable project
	Diversity and Equal Opportunity
	Non-discrimination
	Freedom of Association and Collective Bargaining
	Child Labor Forced or Compulsory Labor
	Security Practices
	Rights of Indigenous People
	Human Rights Assessment
	Local Communities/Relationship with Society
	Relationship with Stakeholders
	Relationship with Suppliers and Contractors
	Supplier Social Assessment
	Public Policy
	Community involvement
	Customer Health and Safety
	Customer Relationship Management
	Marketing and Labeling
	Customer Privacy
	Socioeconomic Compliance
	Participation and Involvement of Stakeholders
	Impact on the Professional Life of the Team Members
	Satisfaction and Productivity of the Team
	Perpetuation of Social Benefit of the Project
	Motivation
	Human Capital Development
	Corporate Citizenship

Authors based on the GRI standard (2016), Meza-Ruiz et al. (2017), Martens and Carvalho (2016), Lin et al. (2017) and Banishashemi et al. (2017)

4. Conclusions

Project management trends are driven by business trends and the development of the society. In this new world era, sustainable development is recognized as a pillar of high performance, ethics and a contributor to bottom-line profitability and return of investment (ROI). The project management community can no longer ignore this reality and must pivot to recognize sustainability as a building block of project management maturity. Project management maturity and sustainability are relatively new concepts but both, along with the planet prosper by a mutual recognition of their symbiotic relationship.

This study has planted a seed for further research into the concept of sustainability as a building block of project management maturity and sustainable attitudes within the project management community and project-oriented organizations.

References

- AccountAbility. (2018). *AA1000 Accountability Principles*. https://www.accountability.org/wp-content/uploads/2018/05/AA1000_ACCOUNTABILITY_PRINCIPLES_2018_Single_Pages.pdf
- Adamek, M., Bartoš, D., Buchbauerová, M., Doležal, J., & Motal, M. (2013). *Project management reference model in organizations*. Společnost pro projektové řízení.
- Albrecht, J. C., & Spang, K. (2014). Linking the benefits of project management maturity to project complexity. *International Journal of Managing Projects in Business*, 7, 285–301. <https://doi.org/10.1108/IJMPB-08-2013-0040>
- Albrecht, J. C., & Spang, K. (2016). Disassembling and reassembling project management maturity. *Project Management Journal*, 47(5), 18–35. <https://doi.org/10.1177/875697281604700503>
- Ali, M. (2013). *Sustainability Assessment*. Academic Press.
- Association for Project Management. (2019). *APM Body of Knowledge* (7th ed.). Association for Project Management.
- Axelos Limited. (2010). *P3M3 project management self – assessment*. https://www.axelos.com/Corporate/media/Files/P3M3%20Model/P3M3_Self_Assess_Project.pdf
- Backlund, F., Chronéer, D., & Sundqvist, E. (2014). Project Management Maturity Models – a Critical Review a Case Study within Swedish Engineering and Construction organizations. *Procedia – Social and Behavioral Sciences*, 119, 837–846. <https://doi.org/10.1016/j.sbspro.2014.03.094>
- Banishashemi, S., Hosseini, M. R., Golizadeh, H., & Sankaran, S. (2017). Critical success factors (CSFs) for integration of sustainability into construction project management practices in developing countries. *International Journal of Project Management*, 35(6), 1103–1119. <https://doi.org/10.1016/j.ijproman.2017.01.014>
- Baumgartner, R. J., & Rauter, R. (2017). Strategic perspectives of corporate sustainability management to develop a sustainable organization. *Journal of Cleaner Production*, 140, 81–92. <https://doi.org/10.1016/j.jclepro.2016.04.146>
- Baumgartner, R. J., & Ebner, D. (2010). Corporate sustainability strategies: sustainability profiles and maturity levels. *Sustainable Development*, 18, 76–89. <https://doi.org/10.1002/sd.447>
- Bell, S., & Morse, S. (2008). *Sustainability Indicators Measuring the Immeasurable?* (2nd ed.). Earthscan.
- Brokes, N., & Clark, R. (2009). Using Maturity Models to Improve Project Management Practice. In *POMS 20th Annual Conference*. 011-0288 (pomsmeetings.org)
- Cagnin, C. H., Loveridge, D., & Butler, J. (2005). Business sustainability maturity model. In *Business Strategy and the Environment Conference* (pp. 4–6). Microsoft Word - Cagnin.doc (crrconference.org)
- Carboni, J., Duncan, W., Gonzalez, M., Milsom, P., & Young, M. (2018). *Sustainable Project Management: The GPM Reference Guide* (2nd ed.). GPM Global.
- Carroll, A. B. (1991). The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. *Business Horizons*, 34, 39–48.
- Carvalho, M. M., & Rabechini, R. (2017). Can project sustainability management impact project success? An empirical study applying a contingent approach. *International Journal of Project Management*, 35(6), 1120–1132. <https://doi.org/10.1016/j.ijproman.2017.02.018>
- Elkington, J. (1999). *Cannibals with Forks: the Triple-Bottom Line of 21st Century Business*. New Society Publishers. John Wiley & Son.
- European Commission. (2020). *What is sustainable development?* <https://ec.europa.eu/trade/policy/policy-making/sustainable-development/>
- European Commission. (2001). *Green Paper: Promoting a European Framework for Corporate Social Responsibility*. Luxembourg: Office for Official Publications of the European Communities. COM (2001).
- Farrokh, J., & Mansur, A. K. (2013). Project management maturity models and organizational project management maturity model (OPM3): A critical morphological evaluation. *International Scholarly and Scientific Research & Innovation*, 7(5), 68–71.
- Gareis, R., & Huemann, M. (2000). Project management competencies in the project-oriented organization. In J. R. Turner, & S. J. Simister (Eds.), *Gower Handbook of Project Management* (3rd ed., pp. 709–722) Gower.
- GRI. (2016). *GRI: 2016*. <https://www.globalreporting.org/standards/gri-standards-download-center/?g=e10f8b5a-6775-40da-afbf-4b3cdc1df635>
- Görög, M. (2016). A Broader Approach to Organizational Project Management Maturity Assessment. *International Journal of Project Management*, 34(8), 1658–1669. <https://doi.org/10.1016/j.ijproman.2016.08.011>
- GPM. (2019). *The GPM P5™ Standard for Sustainability in Project Management GPM Global Version 2.0*. GPM Global.
- Hak, T., Moldan, B., & Dahl, A. L. (2007). *Sustainability indicators: a scientific assessment*. Island Press.

- Heinen, J. T. (1994). Emerging, diverging and converging paradigms on sustainable development. *International Journal of Sustainable Development and World Ecology*, 1, 22–33. <https://doi.org/10.1080/13504509409469857>
- Hopkinson, M. (2010). *The project risk maturity model*. Routledge. <https://doi.org/10.4324/9781315237572>
- Hynds, E. J., Brandt, V., Burek, S., Jager, W., Knox, P., Parker, J. P., Schwartz, L., Taylor, J., & Zietlow, M. A. (2014). Maturity Model for Sustainability in New Product Development. *Research-Technology Management*, 57(1), 50–57. <https://doi.org/10.5437/08956308X5701143>
- International Project Management Association. (2020). *IPMA Standards*. <https://www.ipma.world/individuals/standard/>
- International Project Management Association. (2016). *Reference model for IPMA Delta*. <http://www.ipma.world/certification/certify-organisations/delta-reference-model/>
- ISO. (2010). *ISO 26 000:2010 Guidance on social responsibility*. <https://www.iso.org/obp/ui/#iso:std:iso:26000:ed-1:v1:en>
- Keating, M. (1993). *The Earth Summit's Agenda for Change*. Centre for our Common Future.
- Khoshgoftar, M., & Osman, O. (2009). Comparison of maturity models. *2nd IEEE International Conference on Computer Science and Information Technology*. IEEE. <https://doi.org/10.1109/ICCSIT.2009.5234402>
- Kostalova, J., & Tetrevova, L. (2018). Proposal and Verification of Project Management Methods and Tools Oriented Maturity Model, *Revista de Gestão e Projetos Journal of Business and Projects*, 9(1), 1–23. <https://doi.org/10.5585/gep.v9i1.595>
- Kwak, Y. H., Sadatsafavi, H., Walewski, J., & Williams, N. L. (2015) Evolution of project based organization: A case study. *International Journal of Project Management*, 33(8), 1652–1664. <https://doi.org/10.1016/j.ijproman.2015.05.004>
- Lappe, M., & Spang, K. (2014). Investment in project management are profitable: A case study-based analysis of the relationship between the costs and benefits of project management. *International Journal of Project Management*, 32(4), 603–612. <https://doi.org/10.1016/j.ijproman.2013.10.005>
- Lin H., Zeng, S., Ma, H., Zeng, R., & Tam, V. W. T. (2017). An indicator system for evaluating megaproject social responsibility. *International Project Management Journal*, 35, 1415–1425. <https://doi.org/10.1016/j.ijproman.2017.04.009>
- Martens, M. L., & Carvalho, M. M. (2016). The challenge of introducing sustainability into project management function: multiple-case studies. *Journal of Cleaner Production*, 117, 29–40. <https://doi.org/10.1016/j.jclepro.2015.12.039>
- Matravers, R., Moldan, B., & Billharz, S. (1998). *Sustainability Indicators: Report of the Project on Indicators of Sustainable Development*. John Wiley.
- McGrath, J., & Kostalova, J. (2020). Project management trends 2020+. In *Hradec Economic Days* (pp. 534–542). <https://doi.org/10.36689/uhk/hed/2020-01-061>
- Meredith, J. R., & Mantel, S. J. (2012). *Project management a managerial approach* (8th ed.). John Wiley & Sons.
- Meza-Ruiz, I. D., Rocha-Lona, L., Soto-Flores, M. R., Garza-Reyes, J. A., Kumar, V., & Lopez-Torres, G. C. (2017). Measuring Business Sustainability Maturity-levels and Best Practices. *Procedia Manufacturing*, 11, 751–759. <https://doi.org/10.1016/j.promfg.2017.07.176>
- Nenni, M. E., Arnone, V., Boccardeli, P., & Napolitano, I. (2014). How to Increase the Value of the Project Management Maturity Model as a Business-oriented Framework. *International Journal of Engineering Business Management*, 6(8), 1–7, <https://doi.org/10.5772/58292>
- OECD. (2011). *OECD Guidelines for Multinational Enterprises*. OECD Publishing. <https://doi.org/10.1787/9789264115415-en>
- Patanakul, P., lewongcharoen, B., & Milosevic, D. (2010). An empirical study on the use of project management tools and techniques across project life-cycle and their impact on project success. *Journal of General Management*, 35(3), 41–65. <https://doi.org/10.1177/030630701003500304>
- Project Management Institute. (2017). *A Guide to the Project Management Body of Knowledge* (6th ed.). PMI.
- Project Management Institute. (2013). *Organizational project management maturity model (OPM3)* (3rd ed.). PMI. <https://doi.org/10.1201/9781420028942.axa>
- Silvius, A. J. G., & Schipper, R. (2015). Developing a maturity model for assessing sustainable project management. *Journal of Modern Project Management*, 3(1), 16–27.
- Silvius, G., & Schipper, R. (2016). Exploring the relationship between sustainability and project success – conceptual model and expected relationships. *International Journal of Information Systems and Project Management*, 4(3), 5–22. <https://doi.org/10.12821/ijispm040301>

- Silvius, G., Schipper, R., Planko, J., Brink, J., & Köhler, A. (2012). *Sustainability in Project Management*. Gower Publishing Limited.
- Spalek, S. (2015). Establishing a conceptual model for assessing project management maturity in industrial companies. *International Journal of Industrial Engineering*, 22(2), 301–313.
- Social Accountability International. (2014). *Social Accountability 8000: International standard. (SA8000: 2014)*. [http://www.sa-intl.org/_data/global/files/SA8000Standard2014\(3\).pdf](http://www.sa-intl.org/_data/global/files/SA8000Standard2014(3).pdf)
- Souza, T. F., & Gomes, C. F. S. (2015). Assessment of maturity in project management: a bibliometric study of main models. *Procedia Computer Science*, 55, 92–101. <https://doi.org/10.1016/j.procs.2015.07.012>
- UN Global Compact. (2014). *Guide to Corporate Sustainability*. https://www.unglobalcompact.org/docs/publications/UN_Global_Compact_Guide_to_Corporate_Sustainability.pdf
- United Nations. (1992). *Earth Summit Agenda 21*. United Nations.
- United Nations. (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*. United Nations Official Document.
- Waas, T., Hugé, J., Block, T., Wright, T., Benitez-Capistros, F., & Verbruggen, A. (2014). A Sustainability Assessment and Indicators: Tools in a Decision-Making Strategy for Sustainable Development. *Sustainability*, 6(9), 5512–5534. <https://doi.org/10.3390/su6095512>
- Wang, N., Wei, K., & Sun. H. (2014). Whole life project management approach to sustainability. *Journal of Management in Engineering*, 30(2), 246–255. [https://doi.org/10.1061/\(ASCE\)ME.1943-5479.0000185](https://doi.org/10.1061/(ASCE)ME.1943-5479.0000185)

The COVID-19 Pandemic and the Professional Situation on the Real Estate Market in Poland

Maciej KOSZEL

Poznań University of Economics and Business, Poznań, Poland, maciej.koszel@ue.poznan.pl

Abstract: The article deals with the impact of the COVID-19 pandemic on the professional situation of people working on the real estate market in Poland. After the introduction of the pandemic state in Poland, the further restrictions had been implemented and Polish economy, including real estate market deteriorated. In 2019, 468.3 thousand transactions were recorded in Poland – the total value exceeds 121.7 billion PLN and has tripled over the last 10 years. (NBP, 2020) The following research question was formulated: how the professional situation on the real estate market has changed in the 2nd quarter of the 2020 in comparison to the previous period. The main objective of the paper is to identify current and future (expected) professional situation on selected market. For the purposes of the research a survey was conducted among 247 representatives of the professions connected with the real estate market: real estate agents, property managers and property valuers and other. Article describes the detailed research outcomes and focuses on such as aspects as collaboration with clients, operating mode, remote work during pandemic. Due to the specific scope of the studies mainly indigenous, Polish sources were used – Polish National Bank (NBP) and Statistics Poland reports and analysis.

Keywords: real estate market; professional situation; coronavirus; pandemic

JEL Classification: I10; R31

1. Introduction

The COVID-19 pandemic caused by the SARS-CoV-2 coronavirus (WHO, 2020), which began in the mid November 2019 in the city of Wuhan in central China (Ma, 2020) and had spread dynamically all around the world has contributed to the deterioration of the worldwide economic growth and economic crisis. (NBP, 2020; Nicola et al., 2020; Statistics Poland, 2020; PAP, 2020; The Economist, 2020) The very first case of the coronavirus infection in Poland was confirmed on March 4th, 2020. (Barteczko & Florkiewicz, 2020; Ministerstwo Zdrowia, 2020) Since then different form of restrictions has been implemented – mostly related with the economic activity of companies and social life of citizens. (Ministerstwo Rodziny, Pracy i Polityki Społecznej, 2020; Ministerstwo Zdrowia, 2020) On the March 20th, 2020 state of pandemic was introduced in Poland (Health Minister, 2020), which has been followed with further difficulties for both companies and citizens, and forced changes and the need to accommodate to the new environment and conditions. Many entrepreneurs decided to limit their economic activity or to start working remotely. (Serwis Rzeczypospolitej Polskiej, 2020) Unfortunately, it was not possible for all the industries and branches of the economy. (Infor Kadry, 2020; Matłacz, 2020; Wróbel, 2020) Similar situation

could have been observed in other countries as well. (Del Giudice et al., 2020; Hoesli & Malle, 2020; Tanrıvermiş, 2020; Yoruk, 2020)

The real estate market is one of the branches of the economy that is acutely affected by the COVID-19 pandemic. (Dobrowolski, 2020; Musiał & Boroń, 2020; Nosal, 2020; Otto, 2020; PFRN, 2020; PFSRM, 2020; Zhao, 2020) Ongoing public debate and lack of clear conclusions (Business Insider, 2020; Gazeta Next, 2020; Głowacki, 2020; Interia Biznes, 2020; Money, 2020; PFRN, 2020) has contributed to the decision to prepare research connected with the functioning of the professionals on the real estate market. So called “new economic reality” (Serwis Rzeczypospolitej Polskiej, 2020) has created previously unknown conditions for real estate entrepreneurs and companies. (PFRN, 2020) It was decided to form the following research questions: 1) what is the current situation of professionals working on the real estate market, 2) what is the current characteristics of the real estate market in general, 3) what are the future perspectives for the real estate professionals and the market itself?

Due to the wide scope of the presented problem, it was decided to focus on the professional situation of people working in the real estate market only. That is because they are the first to be exposed to the negative outcomes of the ongoing changes, including restrictions related to the professional work. The aim of the article is to evaluate the current and future professional situation of people who work in the real estate market. Due to the practical aspect of the research, the article emphasizes on presenting the empirical results.

2. Methodology

The main research was conducted in the April, 2020. Qualitative and quantitative data was collected anonymously and voluntarily. The target group were representatives of professions on the real estate market. The survey was targeted at potential respondents through direct channels and through professional organizations. According to the official data set, the current number of property valuers in Poland is 7,694, the total number of real estate agents is 5,029 and property managers – 2,136. (Ministerstwo Rozwoju, 2020; PFRN, 2020; PFSRM, 2020) It is estimated, that only half of the property valuers are professionally active, and not all of the real estate agents and property managers are registered in the regional associations. This problem is a consequence of the deregulation of the status of real estate agents and property managers in Poland. (AMRON, 2014) 247 correctly completed surveys were received, and it means that the hypothetical percentage return of questionnaires is 1.643%. However, taking into consideration earlier doubts concerning the number of active professionals, the real percentage of return might be significantly higher in this case.

The study used the indirect survey measurement method – an online survey and an electronic survey questionnaire as a measurement tool. (Patton, 1990) The questionnaire was developed using a generally available, free tool. The survey questionnaire was divided into four blocks of questions, i.e.:

1. Demographics (respondent's particulars),
2. The business profile,

3. The impact of the coronavirus pandemic on the current situation on the real estate market in Poland (March-April 2020),
4. The impact of the coronavirus pandemic on the future situation on the real estate market in Poland (next 12 months).

The third and fourth question blocks were additionally divided into sections, within which the following sections were distinguished:

1. The general situation on the real estate market,
2. The professional situation on the real estate market,
3. The situation in individual segments of the real estate market.

The choice of the scale and variants of the answers depends on the specificity of the question. Most of the detailed questions (block three and four) used a five- and six-point scale of answers (the six-point scale included the "not applicable" option). For the purposes of the article, the results obtained in the section demographics, business profile and the professional situation (present and future) on the real estate market will be discussed.

3. Results

3.1. Respondents Characteristics – Demographics and Business Profile

This chapter presents the basic demographics and business profile of respondents. The main objective of this chapter is to characterize the respondents. The total of 247 respondents took part in the survey. Figures 1 – 9 shows the structure of the respondents according to the following criteria:

- Sex and age (Figure 1),
- Position held in the company (Figure 2),
- Voivodeship, which represents the regions in Poland (Figure 3),
- Size of the population of the city in which the respondent operates (Figure 4),
- Geographical scope of professional activity (Figure 5),
- Type of business (specialty) and market type (Figure 6),
- Held professional licenses or certificates (Figure 7),
- Experience in years (Figure 8),
- Financial situation in the last three years (Figure 9).

The structure of the respondents by gender is balanced, with a slight advantage of women (51%) over men (49%) – Figure 1 (left diagram). The respondents were dominated by people between 30 and 39 years of age (42.1%), the next group are people under the age of 30 (26%), and the third group in terms of the number of people is "40-year-olds" (20%) – Figure 1 (right diagram). The vast majority of the respondents have higher education (96.4%).

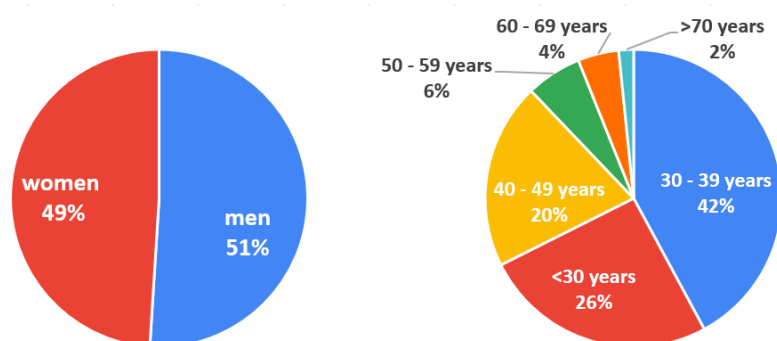


Figure 1. Structure of the respondents by sex (left diagram) and by age (right diagram)

The largest group among the respondents are people who indicated the "owner" as their company position (46%), then people holding the position of a specialist (21%), then a manager (12%) and a senior specialist (9%) - Figure 2.

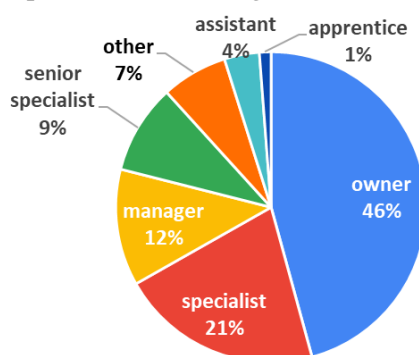


Figure 2. Structure of the respondents by position held in the company

The largest percentage of respondents conducts business / works in the Greater Poland Voivodeship (36%), Mazowieckie Voivodeship (17%) and Łódzkie Voivodeship (9%). The least represented in the survey are the Świętokrzyskie and Warmińsko-Mazurskie Voivodships (one respondent each). There were no representatives of the Podlaskie Voivodeship among the respondents – Figure 3.

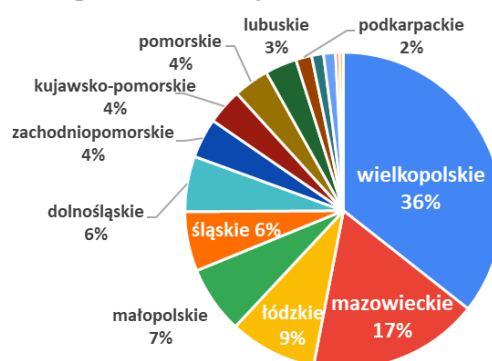


Figure 3. Structure of the respondents by voivodeship.

Nearly half of the respondents (48.6%) conduct their business in the largest cities in terms of population (over 500,000 inhabitants), 24.3% of the respondents work in very large cities (100,000-500,000 inhabitants), while 10.5 % in cities between 50,000-100,000 residents –

Figure 4. This reflects the spatial distribution of real estate transactions (Statistics Poland, 2020) – the vast majority of which are concluded in the largest Polish agglomerations.

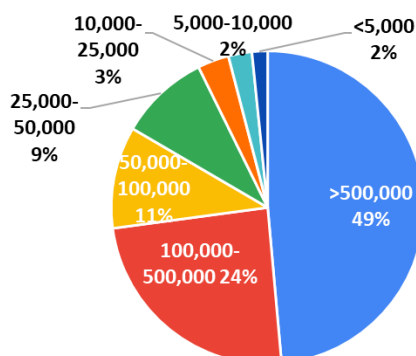


Figure 4. Structure of the respondents according to the size of the population of the city in which they operate.

According to the survey results the largest percentage of the respondents conducts business activities / works in enterprises with a national range of influence (34%), followed by regional or voivodeship (32%) and local or poviats (15%) geographical range. It should be noted that in the case of the largest cities, the poviats self-government is the same as the town / commune (urban poviats). Detailed results concerning the geographical range of business activity are presented in Figure 5.

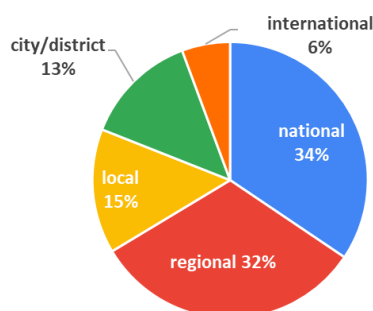


Figure 5. Structure of the respondents according to the geographical scope of professional activity

The largest number of respondents is involved in property valuation (72 respondents; 29%), real estate brokerage (65 respondents; 26%), property management and investing in the real estate market (50 respondents each; 20%). A significant proportion of the respondents conduct business activities in which they deal with more than one specialty - 135 people (55%). A detailed distribution of responses is shown in Figure 6 (left diagram). The vast majority of respondents conduct business / work serving the residential segment of the real estate market (199 respondents, 81%). This is the dominant profile of professional activity among most real estate agents, property valuers and property managers, and the largest segment in terms of volume and value of turnover. (Statistics Poland, 2020) Residential market is also the most essential due to the fact that 1) an apartment is a product that satisfies numerous needs and performs various functions (Twardoch, 2019; Górska, 2017), 2) an apartment is a product on the real estate market important from a socio-economic perspective (Centrum AMRON, 2019; Ministry of Development, 2020). 77 respondents (31%) deal with land trading, 64 respondents (26%) with the commercial market, and 50 respondents (20%)

with the office market. As in the previous case, a significant part of the survey participants serve more than one segment of the real estate market - 178 respondents (72%). The most frequently combined activity is providing services on the residential market and the land trading, which concerns 37 respondents (15%). The number of respondents who deal only with the residential market stands for 23% (56 people) of all surveyed. Figure 6 (right diagram) shows the results for each segment (isolated responses).

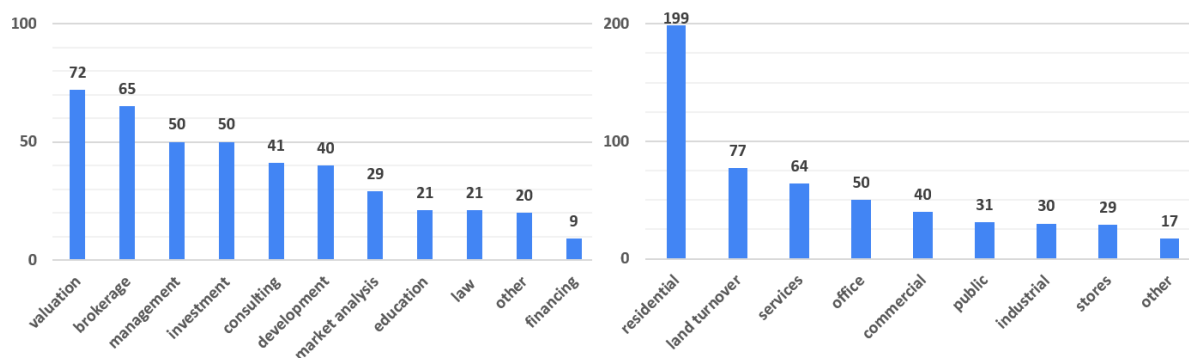


Figure 6. Number of respondents by type of business (specialty) (left diagram) and the real estate market type (right diagram)

The respondents were also asked to indicate their licenses and professional certificates. The amendment to The Property Management Act, which entered into force on January 1st, 2014, deregulated the professions of real estate agent and real estate manager. The role of entities granting professional licenses has been taken over by regional organizations. 39% of all respondents do not have a license / professional certificate. They are mainly people operating on the residential market. 27% of all respondents have professional qualifications in the field of property valuation, 18% a professional license of a real estate agent, and 13% of a property manager – Figure 7. On the basis of the obtained answers, it can also be stated that:

- 93% of the respondents operating as property valuator own a professional license,
- 69% of respondents operating as real estate agents own a professional license,
- 44% of respondents operating as real estate manager own a professional license.

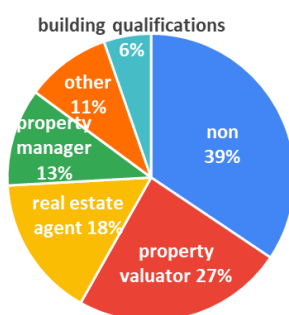


Figure 7. Respondents by held professional licenses / certificates

In the following question, the respondents indicated their professional experience expressed in the number of years of running a business or work related to the real estate

market. The largest number of respondents (79 respondents; 32%) indicates experience between 6 and 10 years, then experience up to 5 years (76 respondents; 31%) and between 11 and 15 years (42 respondents; 17%) – Figure 8 (left diagram). Assuming that the previous crisis on the real estate market covered the years 2008-2011, it can be assumed that a total of 38% of the respondents were already working in the real estate profession at that time and can make a comparison between the then and the current situation (causes, course, effects).

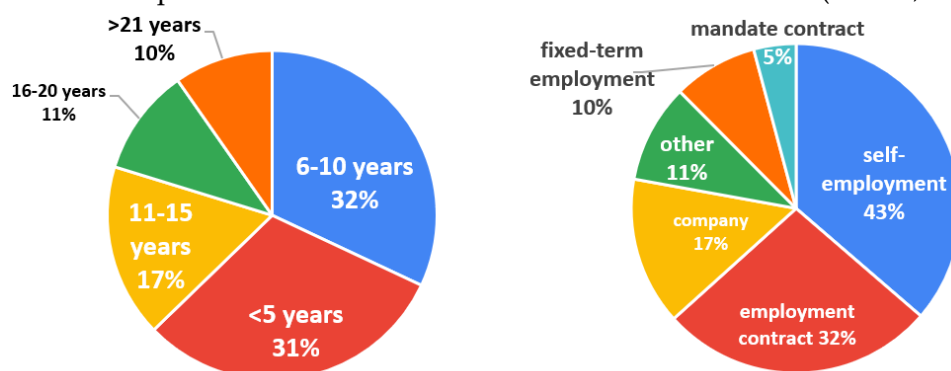


Figure 8. Respondents by their experience in years (left diagram) and by the form of employment (right diagram)

The respondents were also asked to define their current form of employment (professional status). In the question discussed, the respondents could indicate more than one answer variant. The highest percentage of respondents indicates that they are running a sole proprietorship (43%), followed by an employment contract for an indefinite period (32%) and running a company employing employees (17%) - Figure 8 (right diagram). It should be emphasized that some of the professions related to the real estate market can be treated as freelancer profession (property valuator, architect).

In the last question the respondents were asked to define their professional situation in the proceeded three years (before the pandemic), taking into account changes in this area: improvement or deterioration of the professional situation. 40% of the respondents indicated an improvement in their professional situation, while 28% indicated a significant improvement in this situation – Figure 9. Therefore, the vast majority of them felt the positive effects of the economic situation on the real estate market in recent years. 30% of the respondents indicated that the professional situation was maintained, and only 2% (in total) of respondents declared a deterioration or significant deterioration of the professional situation in the last three years.

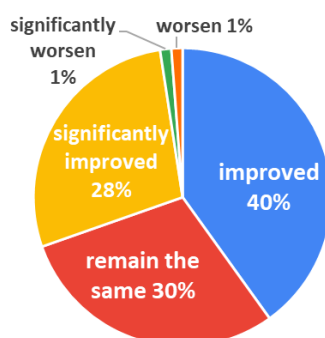


Figure 9. The financial situation of the respondents in the last three years

To sum up this part of the obtained results it can be stated that:

- The study was attended by representatives of major professional groups dealing with real estate services,
- Most of the respondents operate in very large cities (over 500,000 inhabitants) and large cities (100,000-500,000 inhabitants), which reflects the specificity of the real estate market in Poland and the concentration of potential in the largest cities and their agglomerations,
- The spatial differentiation of the results obtained (in terms of voivodeships) is disturbed - a greater percentage of respondents from Greater Poland Voivodeship and Mazowieckie Voivodeship.

3.2. Professional Dituition – Results

The second and the main section of the questions included issues related to the assessment of the current professional situation as compared to the pre-pandemic. Detailed questions concerned:

- Revenues,
- Number of face-to-face meetings with clients,
- Number of contracts signed / concluded transactions,
- Number of phone calls made,
- Number of on-line conversations (chat, videoconferences),
- General interest in real estate on the part of clients,
- Time devoted to professional work (total),
- Time spent working remotely,
- Efficiency as a ratio of the number of concluded contracts to the finalized ones.

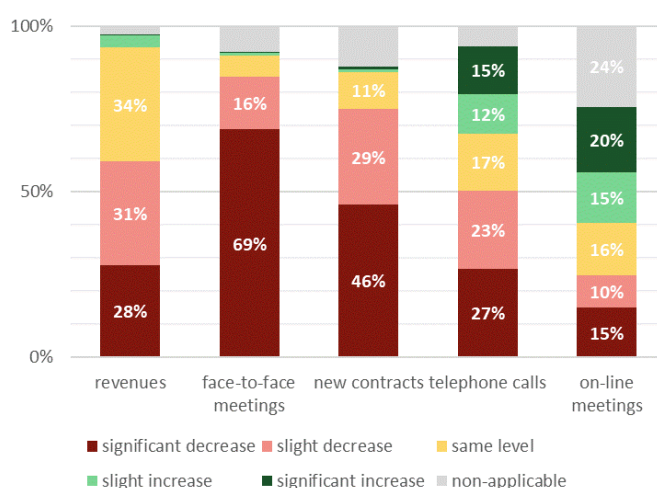


Figure 10. Assessment of the impact of the COVID-19 pandemic on the current professional situation in selected aspects

The overall professional situation of respondents over the last two months (March and April) had significantly worsened – Figure 10. Revenue in 59% of cases activity / professional work decreased, in 34% they remained at the same level 85% of respondents struggle with the problem of a decrease in face-to-face meetings with clients, which also contributes to a

much smaller number of new contracts signed – Figure 10. The above-mentioned problems mostly concern real estate agents (nearly 90% of respondents), property valuers (every second respondent) and representatives of real estate developers who provide services to the residential market (based on the answers given in the "business profile" block). The number of telephone calls, which are often the first form of contact, also decreased significantly. This mainly concerns the profession of a real estate agents, sales specialists in development companies, and property valuers serving the residential segment. Remote work and the number of on-line meetings (chat, videoconferences) mainly concern those professions in which direct meetings with clients are not required (analysts, managers, educational and training activities, investing in the real estate market and development activities). However, not all formalities and activities can be carried out using a remote form of work, which can only be used in selected cases.

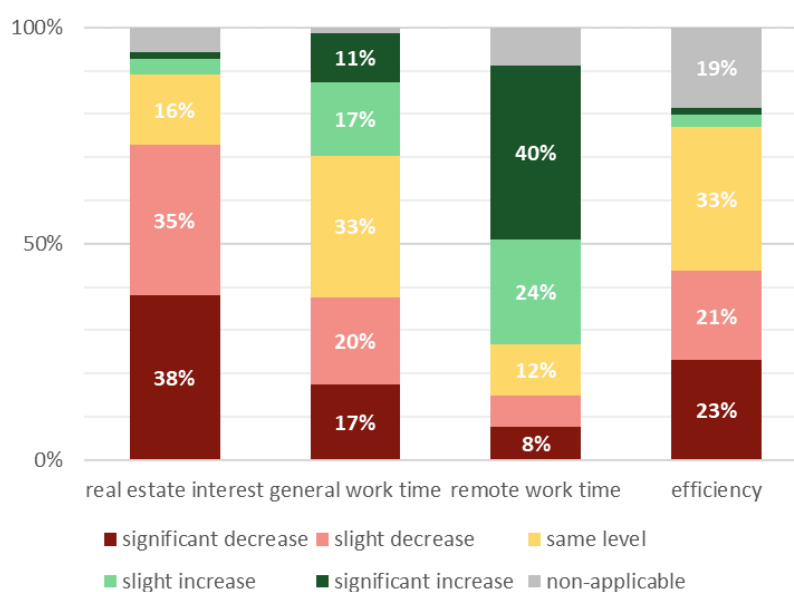


Figure 11. Assessment of the impact of the COVID-19 pandemic on the current professional situation in selected aspects.

73% of respondents indicate a decline in the general interest in real estate on the part of clients / buyers / contractors (depending on the profile of activity) – Figure 11. Only 28% of respondents indicate an increase in overall working time, every third respondent declares the same working time, while 37% of respondents experience a slight or significant decrease in this aspect – Figure 11. The most affected group are the respondents, who base their professional work on direct contact with their clients. Two-thirds of respondents indicate an increase in working time remotely, which reflects the general trend and response to the current realities of business and operations. Again, the profile of activity turns out to be key in this case - the greatest increase in remote work concerns people who can work in the so-called back office mode (back office, work that does not require direct contact). The last aspect of the assessment of the current professional situation is related to effectiveness, as a relation of succeeded to the concluded contracts. 44% of the respondents indicate a decrease, while in every third case the effectiveness remains at the same level.

The next section of questions was related to the assessment of the future (expected) of the professional situation. The layout of the questions used is the same as in the assessment of the present situation – the same elements as before.

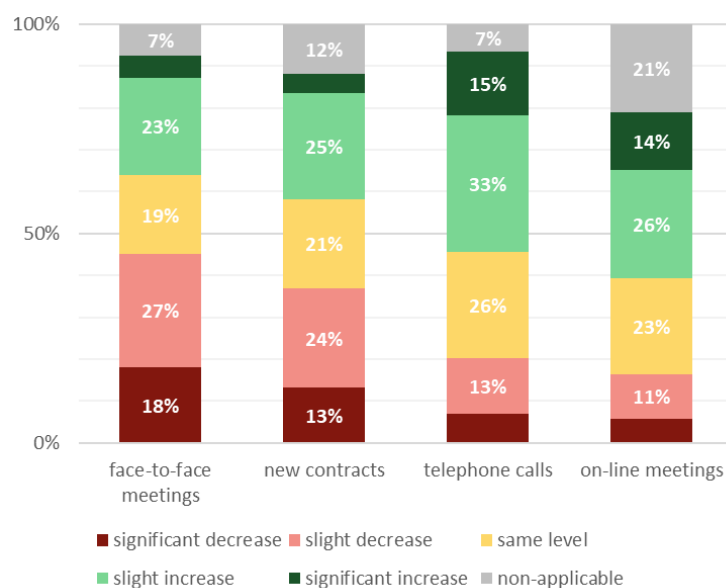


Figure 12. Assessment of the future professional situation in selected aspects

The respondents remain skeptical about their future professional situation – Figure 12. This again mainly applies to those respondents whose professional activity is based on direct contact and meetings with clients / contractors. Negative opinion (decreases and deterioration of the situation) prevails in terms of both expected meetings with clients and new signed contracts, even despite the expected increase in total working time, increase in remote work and improved interest in real estate as the subject of potential transactions.

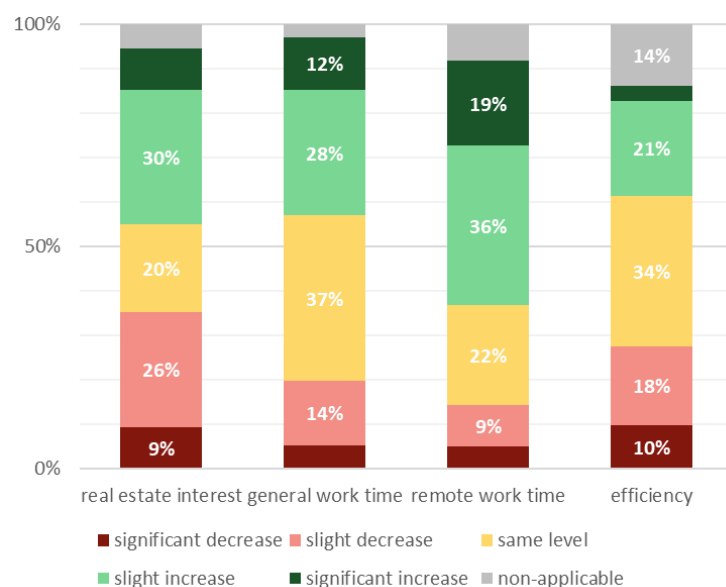


Figure 13. Assessment of the future professional situation in selected aspects

The role of remote work as a form of work, which will become more and more important, was assessed quite unanimously, even among those respondents who have not yet observed

(March and April) significant increases in this respect – Figure 13. This may prove, on the one hand, the limited possibilities of use in the present conditions and the need to adapt to the new approach, and on the other hand, the different pace of introducing changes among the respondents.

4. Discussion

The analysis of the results in terms of the current state of the real estate market gives a picture of a situation that has dramatically worsened in a very short time compared to the last few years, corresponding to the increase in the business cycle – Figures 10–13. This applies in particular to those surveyed who deal with real estate brokerage, sale of real estate (sales specialists in development companies), investing in the real estate market and real estate valuation in the residential segment. This contributes to an unequivocal and extremely negative assessment of the current general and professional situation in the real estate market. The common feature of the indicated groups is the work model based on direct contact with clients or contractors. The use of remote work in this case is possible only to a limited extent, which also does not give positive prospects.

The upcoming months on the real estate market, in the opinion of the respondents, despite many doubts and general uncertainty, are also assessed in a quite skeptical way. This applies both to the assessment of general market development prospects, the professional situation of the respondents and the situation in individual market segments. In terms of the parameters of key importance for the assessment of the future economic situation, the respondents expect further declines and deterioration of the situation.

5. Conclusions

To sum up the obtained results, it should be emphasized that the approach and tool used in the study were aimed at verifying the opinion expressed by people professionally involved in the real estate market. Assessments regarding the current situation are declarative, while the assessment of the future situation is the subjective opinion of the respondents.

The conducted research is a contribution to a further, in-depth analysis of changes taking place on the real estate market. The qualitative research on the condition of the market in question "here and now" will have to be supported by the verification of quantitative data, which is systematically collected, processed, analyzed and made public (e.g. by: national statistical offices, central banks or other national or commercial agencies and entities that deal with the real estate market and related industries and branches) (Deloitte, 2020; EY, 2020; JLL, 2020, KPMG, 2020). This approach will give a more complete and reliable picture of the state and the prospects of the real estate market - one of the most complex systems of the national economy. There is also a huge potential for further scientific exploration in identifying specific situation in each type of real estate market in different countries and comparing them showing the similarities and differences – cross comparison among economies and comparative analysis with previous crises. (Franckie & Korevaar, 2020)

References

- AMRON. (2014, March 10). *Deregulacja zawodu pośrednika w obrocie nieruchomościami i zarządcy nieruchomości*. <https://www.amron.pl/aktualnosc.php?tytul=deregulacja-zawodu-posrednika-w-obrocie-nieruchomosciami-i-zarzadcy-nieruchomosci>
- Barteczko, A., & Florkiewicz, P. (2020, March 4). *Poland reports first coronavirus case - health minister*. Reuters. <https://www.reuters.com/article/us-health-coronavirus-poland/poland-reports-first-coronavirus-case-health-minister-idUSKBN20R0U7>
- Business Insider. (2020, April 18). *Są tacy, którzy już polują na okazje na rynku mieszkaniowym*. <https://businessinsider.com.pl/finanse/inwestowanie/epidemia-koronawirusa-a-rynek-nieruchomosci-w-polsce/1zh1pkw>
- Deloitte. (2020, March 25). *Understanding the sector impact of COVID-19. Real estate*. <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/About-Deloitte/COVID-19/Covid-19-Global-Impacts-on-Real-estate-sector.pdf>
- Del Giudice, V., De Paola, P., & Del Giudice, F. P. (2020). COVID-19 Infects Real Estate Markets: Short and Mid-Run Effects on Housing Prices in Campania Region (Italy). *Social Sciences*, 9(7), 114. <https://doi.org/10.3390/socsci9070114>
- Dobrowolski, P. (2020, March 19). *Najem w czasach pandemii...* Polska Federacja Rynku Nieruchomości. <https://rejestr.pfrn.pl/porada,351,najem-w-czasach-pandemii>
- Dziennik Gazeta Prawna. (2020, April 20). *NBP łagodzi skutki pandemii i utrzymuje stabilność polskiego pieniądza*. (2020, 20 kwietnia). <https://gospodarka.dziennik.pl/news/artykuly/7386124,nbp-lagodzi-skutki-pandemii-i-utrzymuje-stabilnosc-polskiego-pieniadza.html>
- EY. (2020, October 5). *COVID-19. Industry Pulse Report: Real Estate*. https://www.ey.com/en_cy/covid-19-updates/pulse-report-realestate
- Franckie, M., & Korevaar, M. (2021). Housing Markets in a Pandemic: Evidence from Historical Outbreaks. *SSRN Electronic Journal*, 1–54. <https://doi.org/10.2139/ssrn.3566909>
- Gazeta Next. (2020, May 7). *Jak bardzo koronawirus uderza w rynek nieruchomości? "Sprzedaż zmalała, ale nie aż tak mocno"*. <https://next.gazeta.pl/next/7,151003,25923876,jak-bardzo-koronawirus-uderza-w-rynek-nieruchomosci-sprzedaz.html>
- Głowacki, J. (2020, March 4). *Koronawirus a rynek nieruchomości*. Puls Biznesu. <https://www.pb.pl/koronawirus-a-rynek-nieruchomosci-984156>
- Hoesli, M. E. R., & Malle, R. (2021). Commercial Real Estate Prices and Covid-19. *Swiss Finance Institute Research Paper*, 21–28. <http://dx.doi.org/10.2139/ssrn.3773532>
- Infor Kadry. (2020, March 23). *Praca zdalna podczas epidemii koronawirusa a dyskryminacja w zatrudnieniu*. https://kadry.infor.pl/kadry/indywidualne_prawo_pracy/odpowiedzialnosc_prawa_i_obowiazki/3632832,3_Pracu-zdalna-podczas-epidemii-koronawirusa-a-dyskryminacja-w-zatrudnieniu.html
- Interia Biznes. (2020, May 2). *Koronawirus odmienia rynek nieruchomości*. https://biznes.interia.pl/nieruchomosci/news-koronawirus-odmienia-rynek-nieruchomosci,nId,4465736#utm_source=paste&utm_medium=paste&utm_campaign=firefox
- JLL. (2020, March 12). *COVID-19. Global Real Estate Implications*. <https://www.jll.pl/pl/trendy-i-analizy/badanie/covid-19-global-real-estate-implications>
- KPMG. (2020). *The implications of COVID-19 for the real estate industry*. <https://assets.kpmg/content/dam/kpmg/im/pdf/COVID-19-and-Real-Estate-Impact-IOM.pdf>
- Ma, J. (2020, March 13). *Coronavirus: China's first confirmed Covid-19 case traced back to November 17*. <https://www.scmp.com/news/china/society/article/3074991/coronavirus-chinas-first-confirmed-covid-19-case-traced-back>
- Matłacz, A. (2020, March 29). *Po koronawirusie praca z domu może zyskać na popularności*. Prawo Kadry. <https://www.prawo.pl/kadry/czy-koronawirus-zmieni-na-stale-podejscie-pracodawcow-do-pracy,499057.html>
- Ministerstwo Rodziny, Pracy i Polityki Społecznej. (2020, March 13). *Pracownik i przedsiębiorca w obliczu koronawirusa - praktyczny poradnik*. <https://www.gov.pl/web/rodzina/pracownik-i-przedsiębiorca-w-obliczu-koronawirusa---praktyczny-poradnik>
- Ministerstwo Rozwoju. (2020). *Centralny Rejestr Rzeczoznawców Majątkowych* [Data set]. Retrieved May 5, 2020 from <https://www.gov.pl/web/rozwoj/centralny-rejestr-rzeczoznawcow-majatkowych>
- Ministerstwo Zdrowia. (2020). *COVID – informacje*. <https://www.gov.pl/web/zdrowie/covid>

- Ministerstwo Zdrowia. (2020, March 4). *Pierwszy przypadek koronawirusa w Polsce*. <https://www.gov.pl/web/zdrowie/pierwszy-przypadek-koronawirusa-w-polsce>
- Money. (2020, May 10). *Czy koronawirus zaraził rynek nieruchomości?* <https://www.money.pl/gospodarka/czy-koronawirus-zarazil-rynek-nieruchomosci-6508646776313985a.html>
- Musiał, M., & Boroń, M. (2020, March 4). *Glapiński: panika związana z koronawirusem niesie ryzyko osłabienia koniunktury*. <https://www.pap.pl/aktualnosci/news,598687,glapinski-panika-zwiazana-z-koronawirusem-niesie-ryzyko-oslabienia>
- NBP. Narodowy Bank Polski. (2020, March 13). *Wypowiedź Prezesa NBP, Prof. Adama Glapińskiego dla Polskiej Agencji Prasowej*. https://www.nbp.pl/home.aspx?f=aktualnosci/wiadomosci_2020/Prezes-NBP-dla-PAP.html
- NBP. Narodowy Bank Polski. (2020, March 16). *Komunikat Komitetu Stabilności Finansowej po posiedzeniu dotyczącym nadzoru makroostrożnościowego nad systemem finansowym* <https://www.nbp.pl/nadzormakroostroznościowy/komunikaty/2020-03-16.aspx>
- Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International Journal of Surgery*, 78, 185–193. <https://doi.org/10.1016/j.ijssu.2020.04.018>
- Nosal, B. (2020, March 21). *Jak koronawirus wpłynie na ceny mieszkań w Polsce? Ekspert: Nie ma paniki, aby nie było katastrofy*. *Gazeta Wyborcza*. <https://poznan.wyborcza.pl/poznan/7,36001,25808965,jak-koronawirus-wplynie-na-ceny-mieszkan-w-polsce-ekspert.html>
- Otto, P. (2020, April 29). *Deweloperzy będą rolować obligacje*. *Dziennik Gazeta Prawna*. <https://serwisy.gazetaprawna.pl/nieruchomosci/artykuly/1473142,koronawirus-a-rynek-deweloperski-rolowanie-obligacji.html>
- PAP. Polska Agencja Prasowa. (2020, March 13). *Glapiński: będę proponował Radzie Polityki Pieniężnej obniżenie stóp procentowych NBP*. <https://www.pap.pl/aktualnosci/news,605075,glapinski-bede-proponowal-radzie-polityki-pienieznej-obnizenie-stop>
- Patton, M. Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Sage Publications, Inc.
- PFRN. Polska Federacja Rynku Nieruchomości. (2020). *Centralny Rejestr Pośredników w Obrocie Nieruchomościami PFRN*. [Data set]. Retrieved May 9, 2020 from <https://rejestr.pfrn.pl/posrednicy>
- PFRN. Polska Federacja Stowarzyszeń Rzeczoznawców Majątkowych. (2020). *Członkowie PFSRM*. [Data set]. Retrieved May 9, 2020 from <http://www.pfsm.pl/czlonkowie>
- PFRN. Polska Federacja Rynku Nieruchomości. (2020). *Centralny Rejestr Zarządców Nieruchomości*. [Data set]. Retrieved May 9, 2020 from <https://rejestr.pfrn.pl/zarzadcy>
- PFRN. Polska Federacja Rynku Nieruchomości. (2020). *Lista stowarzyszeń*. [Data set] Retrieved May 9, 2020 from <https://rejestr.pfrn.pl/stowarzyszenia>
- PFSRM. Polska Federacja Stowarzyszeń Rzeczoznawców Majątkowych. (2020, March 25). *Komunikat TEGoVA w sprawie wyceny w czasie pandemii*. <https://pfsm.pl/aktualnosci/item/585-komunikat-tego-va-w-sprawie-wyceny-w-czasie-pandemii>
- PFSRM. Polska Federacja Stowarzyszeń Rzeczoznawców Majątkowych. (2020, April 1). *Nowe ograniczenia w związku z wystąpieniem stanu epidemii*. <https://pfsm.pl/aktualnosci/item/588-nowe-ograniczenia-w-zwiazku-z-wystapieniem-stanu-epidemii>
- PFSRM. Polska Federacja Stowarzyszeń Rzeczoznawców Majątkowych. (2020, March 25). *Nowe zasady bezpieczeństwa w związku z koronawirusem*. <https://pfsm.pl/aktualnosci/item/586-nowe-zasady-bezpieczenstwa-w-zwiazku-z-koronawirusem>
- PFSRM. Polska Federacja Stowarzyszeń Rzeczoznawców Majątkowych. (2020, April 17). *Rekomendacje dla rzeczoznawców majątkowych dotyczące wykonywania czynności zawodowych w okresie pandemii koronawirusa*. <https://pfsm.pl/aktualnosci/item/594-rekomendacje-dla-rzeczoznawcow-majatkowych-dotyczace-wykonywania-czynnosci-zawodowych-w-okresie-pandemii-koronawirusa>
- Regulation no. 2020/491, *The declaration of an epidemic state in Poland*. Health Minister. Republic of Poland. <https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU2020000491/O/D20200491.pdf>
- Serwis Rzeczypospolitej Polskiej. (2020, April 16). *W ramach nowej rzeczywistości gospodarczej proponujemy dzisiaj nowe zasady*. <https://www.premier.gov.pl/wydarzenia/aktualnosci/premier-w-ramach-nowej-rzeczywistosci-gospodarczej-proponujemy-dzisiaj-nowe.html>
- Serwis Rzeczypospolitej Polskiej. (2020, May 11). *Prawa i obowiązki pracownika podczas epidemii*. <https://www.gov.pl/web/koronawirus/prawa-i-obowiazki-pracownika-podczas-epidemii>

- Statistics Poland. (2020). *Real estate sales in 2019*. Statistics Poland, Trade and Services Department. <https://stat.gov.pl/obszary-tematyczne/infrastruktura-komunalna-nieruchomosci/nieruchomosci-budynki-infrastruktura-komunalna/obrot-nieruchomosciami-w-2019-roku,4,17.html>
- Statistic Poland. (2020). *Szybki szacunek produktu krajowego brutto za pierwszy kwartał 2020 roku*. Statistics Poland, National Accounts Department. <https://stat.gov.pl/obszary-tematyczne/rachunki-narodowe/kwartalne-rachunki-narodowe/szybki-szacunek-produktu-krajowego-brutto-za-pierwszy-kwartal-2020-roku,1,29.html>
- Statistics Poland. (2020). *Obroty towarowe handlu zagranicznego ogółem i według krajów w okresie styczeń-marzec 2020 roku*. Statistics Poland, Trade and Services Department. <https://stat.gov.pl/obszary-tematyczne/ceny-handel/handel/obroty-towarowe-handlu-zagranicznego-ogolem-i-wedlug-krajow-w-okresie-styczen-marzec-2020-roku,1,92.html>
- Tanrıvermiş, H. (2020). Possible impacts of COVID-19 outbreak on real estate sector and possible changes to adopt: A situation analysis and general assessment on Turkish perspective. *Journal of Urban Management*, 9(3), 263–269. <https://doi.org/10.1016/j.jum.2020.08.005>
- The Economist. (2020, April 16). *Is China winning?* <https://www.economist.com/leaders/2020/04/16/is-china-winning>
- World Health Organization. (2020). *Coronavirus disease (COVID-19) pandemic*. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>
- Wróbel, M. (2020, April 26). *Koronawirus: czy praca zdalna zostanie z nami na dobre*. Rzeczpospolita. <https://www.rp.pl/Kadry/304229972-Koronawirus-czy-praca-zdalna-zostanie-z-nami-na-dobre.html>
- Yoruk, B. (2020). Early Effects of the COVID-19 Pandemic on Housing Market in the United States, *SSRN Electronic Journal*, 1–28. <http://dx.doi.org/10.2139/ssrn.3607265>
- Zhao, Y. (2020). US Housing Market during COVID-19: Aggregate and Distributional Evidence. *COVID Economics*, 50, 113–154. <https://doi.org/10.2139/ssrn.3677651>

Group Factors of Voluntary Employee Turnover in Organizations from IT Sector

Anna KOSZELA

Wroclaw University of Science and Technology, Wroclaw, Poland; anna.koszela@pwr.edu.pl

Abstract: The research conducted so far on the phenomenon of voluntary employee turnover has still not achieved the desired method of keeping employees, especially in IT organizations. Therefore, it is important to expand the research by presenting new concepts that have not been developed so far, focusing on factors considered so far to be unclear in the context of voluntary employee turnover. This article aimed to present group factors relevant to mitigating voluntary employee turnover in IT organizations. In the context of factors related to the work on the team, identified the following factors: styles of leadership – inspiring and supporting leader like transformational or servant leadership, manager relationship, co-worker's relationship - emotional and instrumental support and internal communication, which cannot be ineffective and inefficient. A review of the literature considering group factors mitigating voluntary employee turnover shows that proper care for employees at the group level leads to measurable benefits for the whole organization.

Keywords: voluntary employee turnover; group factors; management

JEL Classification: D29; G30; M12

1. Introduction

The IT sector is one of the fastest-growing sectors due to growing technological needs (Henderson, 2012). The current crisis caused by the pandemic of COVID-19 shows that the technological need has become even higher every day, as almost all our lives have been moved online. During the previous crisis, wherein the IT industry, the decrease in turnover rate was not noticeable, although it is natural that during the crisis, the turnover rate is in recession (Lo, 2013). To meet the growing requirement for technology requirement, more and more IT companies are being established on the market, thus significantly increasing the demand for IT employees (Dohm & Shniper, 2007), whose deficit is constantly observed (Rong & Grover, 2009). The short-staffed causes that organizations have to compete strongly on the market for the interest of qualified and talented employees (McGee & Thyfault, 1998). Ensuring appropriate working conditions for employees will result in benefits for the organization because it is the employees who are key to maintaining the competitiveness of the organization (Bieńkowska & Ignacek - Kuźnicka, 2018). It can be concluded that the success of IT organizations can be determined by their strategy to manage voluntary employee turnover (VET) (Purohit, 2016; Lo, 2015). This strategy should primarily focus on finding the causes of employee dissatisfaction that may cause an intention to leave the organization. However, it is difficult to identify the causes of turnover and, because are strongly dependent on many conditions, so it seems reasonable to focus on the chosen sector

when studying rotation. In this article, the author identifies group factors influencing VET in the IT industry, which seem to be of significant importance in shaping it. The model of work in the IT industry is based primarily on working in teams, it is the team that directly affects the behavior and perception of the organization by the employees, and thus may contribute to their desire to leave the organization (Tarricone & Luca, 2002). Relationships with co-workers and relationships with supervisors, if based on conflict, are bound to result in intense dissatisfaction and negative feelings for the organization (Greene & Organ, 1973; Johnson & Graen, 1973; Johnson & Stinson, 1975). If a leader only requires an employee to be more efficient and effective, without supporting the employees in development and without giving them a sense of job security and trust, they may leave the organization (Bennis & Nanus, 1985; Fairholm, 1994; Zand, 1997). Therefore, in interpersonal relations, communication is also important, because it is the weakness of its process that can lead to a lot of misunderstandings, which will lead to conflicts and dissatisfaction. Although these factors have so far been considered individually in the literature in the context of an employees' behavior, their job satisfaction, or decreasing the intention to leave, the researchers have not so far grouped them as group factors influencing VET. Given the identified research gap, the article aims to present a literature review on factors influencing VET and justify their importance in preventing intention to leave, and to inspire further consideration and research.

2. Voluntary Employee Turnover

The review of the literature confirms that the aspect of employee turnover has been analyzed for a long time (Hom et al., 2017) due to the fact, that employee turnover is an integral part of Human Resources Management (HRM) in an organization (Listwan, 2010). Personnel fluctuation is defined as a kind of variability, lack of constancy, or periodical fluctuation - thus, it defines a certain exchange of employees or loss of personnel (Cybulski, 2008). Nevertheless, the concept is very heterogeneous, as it includes any restrictions on the number of employees, suspension of recruitment, disciplinary layoffs, or outplacement – i.e., controlled layoffs, but also natural leaves of employees from the organization, such as retirement or VET (Bar, 1994). The current trend in HRM indicates that the loss of experienced employees and the loss of their tacit knowledge, the so-called "loss of human capital", can cause a risk to the organization because the recruitment of new employees consumes significant financial resources and it will take a long time to rebuild the knowledge of an experienced employee (Thatcher et al., 2002). Currently, research shows that it is highly skilled, highly efficient employees, due to their specialized knowledge, who most often decide to leave the organization because they are aware of their skills, looking for new opportunities and new challenges (Pocztowski, 2007). So far, many concepts related to VET have been developed. Purohit (2016) considers turnover as a rate of the number of employees, who leave the organization voluntarily and the organization must replace in a given period to the average number of employees employed in the organization. Moreover, the author considers the turnover rate in many ways but especially notes that the main risk for organizations is especially the VET of high-skilled employees (Purohit, 2016). Porter and

Steers (1973) in their turnover model focused on "turnover intention" and "intention to leave", defined as the next step in the process of leaving after experiencing dissatisfaction in the organization (Aburumman et al., 2010), a step that can lead to actually leaving the organization. Matz and colleagues (2013) define intention to leave as an intentional and aware decision to leave an organization. Intention to leave an organization is a much better indication of an employee's actual turnover than job satisfaction or affective commitment (Rubenstein et al., 2017; Schaap & Olckers, 2020). For an organization, information about the intention to leave seems to be very helpful as it forces the organization to take steps to influence the employee's decision. However, it is also important to identify those factors that cause such a high degree of dissatisfaction among employees that they are more likely to leave the organization. This is a big challenge for modern HR managers.

2.1. Factors Related to the Employee Turnover

For many years, researchers have been developing models to explain the turnover phenomenon, but the number of such models may indicate that they are not globally applicable. March and Simon (1958) presented VET is a phenomenon that depends mainly on the ease of changing jobs - that is, the possibility of employment on the job market and the goal that employees have when changing jobs (March and Simon, 1958). However, the advisability of changing jobs depends to a certain extent on the financial benefits and rewards currently offered by the organization (Steers & Mowday, 1981; Dreher, 1982; Gerhart & Milkovich, 1992;). According to the March and Simon model (1958), this influence of the factors determining the intention to leave is not direct, as it mediates through job satisfaction. Steers and Mowday (1981), in addition to the market and economic conditions, pointed to the indirect cause of VET, employee expectations for work, and the values that directly affected job satisfaction and work engagement, and organizational commitment. However, many of the factors included in the model were directly related to the individual characteristics of the employee. On the other hand, Price and Mueller (1981) focused on their model only on work-related factors. The causes of indirect turnover were primarily seen in autonomy, fairness, pay levels, promotion opportunities, work routines, social support, and training opportunities. The analysis presented by Price and Mueller (1981) seems to be in line with Porter and Steers (1973), who saw an intention to leave the organization as an organizational factor for dissatisfaction. Today, it is still believed that as long as an employee is satisfied with their job, the organization provides them with a sense of stability and the relationship with their manager is satisfactory, the employee will not feel the need to search for a new job. Unfortunately, it is more and more often observed that the level of turnover is increasing among employees whose profession is in high demand in the job market. This group includes knowledge workers (Trevor et al., 1997) so employees of the IT industry, which is considered to be one of the more attractive sectors on the job market, still facing a much more dynamic increase in demand for IT specialists than they are available. The specificity of this sector and the heterogeneity and multiplicity of models indicate that it is necessary to conduct a separate analysis of the reasons for VET in terms of its characteristics.

2.2. Voluntary Employee Turnover in IT Organizations

Purohit (2016) noted that the current actual turnover rate is close to 25% because more and more IT organizations are moving into the Indian market due to the low cost of retention (Purohit, 2016). Studies conducted by Lacity et al. (2008) show that the problem of VET in India is even stronger and the rate often exceeds 30%. Research conducted in Sri Lanka also confirms the growing problem of VET. The results of these studies show that only 50% of employees declare their intention to stay in the current organization while as many as 80% of employees expect certain job changes, i.e., career development through promotion (Jinadasa & Wickramasinghe, 2005). A study conducted in China shows that the turnover rate can reach up to 50%, which significantly increases the cost of recruiting employees and also limits the development of the organization (Listwan, 2010). In turn, a study conducted by the Malaysian Federation of Employees showed that in recent years, IT organizations have achieved the highest turnover rates – up to 75% (Hassan, 2014). Also, statistical studies conducted by the U.S. Department of Job Market confirm that the rate of VET from IT organization only in 2005-2006 increased by 7.2% and this trend is continuing (Von Hagel, 2009). As can be seen, the problem is real and these trends present a challenge for the management of IT organizations, taking into account the costs necessary to replace IT specialists (Korsakienė et al., 2015). Nevertheless, there is still too little research that concentrate on VET from IT organizations. Until now, researchers have focused more on research on VET in the banking, nursing, or accounting sectors (Von Hagel, 2009).

3. Group Factors of Voluntary Employee Turnover in IT Organization

There are many factors in the literature on VET that directly or indirectly affect intention to leave (March & Simon, 1958; Steers & Mowday, 1981; Price & Mueller, 1981). In Table 1, the author presented the concept of dividing the factors influencing VET the IT sector directly related to work group.

Table 1. Group factors of IT employee turnover

Group factors of IT employee turnover	
Factor	Literature references
Leadership	Sun and Wang, 2017; Parris and Peachey, 2013; Jaramillo et al, 2009; Turgut et al., 2007
Manager relationship	Cotton et al., 1986; Lee, 2004; Thwala et al., 2012; Foong, 2008; Longenecker and Scazzero, 2003; McKnight et al. 2009
Co-workers relationship	Fisher, 1985; Uhl-Bien et al., 2000; Tews et al., 2013; Beehr et al., 2003; Viswesvaran et al., 1999
Internal communication	Kotter, 1996; Ballard and Seibold, 2006, Kotter, 2012; Kim et al., 2010; Adebayo and Ogunsina, 2011; Abdien, 2019

Group factors, by the author, are defined as the factors related to the employees' position in the team. Scarnati (2001) defines teamwork as a cooperation process that allows employees to achieve additional results (Tarricone & Luca, 2002). Each team has common goals or tasks in which team members can develop effective, building up a good relationship and sharing knowledge and skills (Johnson & Johnson, 1995, 1999; Fisher et al., 1997). Any conflict can disrupt the harmony of work in a team, reduce the employees' job satisfaction and

productivity, and thus reduce the performance of the whole team and also increase the intention to leave the most talented employees (Greene & Organ, 1973; Lyons, 1971; Johnson & Graen 1973; Johnson & Stinson; 1975). Often, among the reasons for conflict, there are some misunderstandings or communication problems within the team, in consequence, effective communication also has a significant role in team management (Spaho, 2013). Therefore, a leader should inspire his co-workers to perform and effectively solve problems and conflicts, because it can strengthen the effective synergy of the team (Bennis & Nanus, 1985; Fairholm, 1994; Zand, 1997). Teams are an integral part of the organization, the perception of the organization's employees is often based on the perception of work in a group (Tarricone & Luca, 2002). Based on the above considerations, the author has distinguished those factors, that will have a significant impact on VET as leadership style of team leader (Sun & Wang, 2017; Parris & Peachey, 2013), coworkers' relations (Fisher, 1985; Uhl-Bien et al., 2000; Tews et al., 2013), managers relationship (Cotton et al., 1986; Lee, 2004; Thwala et al., 2012), internal communication in the team (Kotter, 1996; Ballard & Seibold, 2006; Kotter, 2012).

3.1. Leadership

Leadership has a significant impact in the context of building relations between an employee and a leader. The leader behavior, i.e., the way decisions are made and implemented, their communication skills, as well as their approach to people, empathy, and understanding (Van Dierendonck et al., 2014; Kashyap & Rangnekar, 2016), influences an employees' behavior and attitudes - including their willingness to stay or leave the organization (Palanski et al., 2014; Wang et al., 2016; Turgut, 2017; Suifan et al., 2020). Mobley (1977) has long since recognized that employees will stay in their jobs if they receive adequate support from their manager. In the literature, one of the most effective styles of leadership indicated transformational leadership (Antonakis et al., 2003; Moynihan et al., 2012; Sun & Wang, 2017). Bass and Avalio (1994) define this type of leadership as a four-dimensional model consisting of ideal influence, inspiration, individual consensus, and intellectual stimulation. Transformational leaders are models to follow who gain the respect and trust of their employees, communicate important and attractive organizational goals to their employees, and effectively motivate employees to work (Sun & Wang, 2017). Such leaders are focused on supporting employee development, building strong relationships with them, and unconventionally resolving problems and conflicts (Bass 1998; Bass & Avalio, 1994). Studies conducted so far confirm the negative relationship between transformational leadership and VET (Wang & Sun, 2016; Khan, 2015; Lim et al., 2017). Another type of leadership that has been identified in the literature as supporting and positively influencing employee behavior is servant leadership (Dutta & Khatri, 2017). This leadership style has a positive impact on employee trust in the leader (Sendjaya & Pekerti, 2010) and as a consequence increasing loyalty to the organization (Kool & Van Dierendonck, 2012). Therefore, many researchers suggest that improving organizational loyalty has a positive impact on organizational commitment and weakens VET (Dutta & Khatri, 2017). Therefore, the above considerations, show that a leader who tends to support their employees is

effective in reducing their turnover (Parris & Peachey, 2013; Jaramillo et al., 2009; Turgut et al., 2007).

3.2. Manager Relationship

The relationship between the employees and the manager seems to be an important HRM aspect, due to the growing significance of the employees in the organization and their growing rights (Lo, 2015). A supervisor's relationship with employees should focus on the proper communication process, correcting, shaping, and improving employees' knowledge, attitudes and behaviors to improve their job performance rather than punishing them for making mistakes (Megginson et al., 2001). Considering the much closer relationship between management and employee, positive treatment of employees by the supervisor may increase positive perceptions of organizational support (Rhoades et al., 2001; Joarder et al., 2011). As a result, research indicates that VET decreases and the employee's productivity, efficiency, and job satisfaction increase (Cotton et al., 1986; Lee, 2004; Thwala et al., 2012). Employees aspire to professional success through positive relationships with their supervisor, which can help to achieve organizational commitment and job satisfaction, and this indirectly reduces VET (Foong, 2008). Research conducted by Thatcher (2006) shows that satisfaction with the relationship with the superior has a positive, direct impact on motivation to work, while a negative perception of the superior has a direct impact on increasing the desire to leave the organization (Longenecker & Scazzero, 2003). Other research conducted on a group of employees, also from the IT industry, indicated that employees' trust in leaders increases job satisfaction and lowers VET (McKnight et al. 2009). Therefore, support from superiors is necessary because it will keep the employees in the organization and motivate them to work (Bigliardi et al., 2005; Zhao & Zhou, 2008).

3.3. Coworkers Relationship

Employees' relationships can be defined as the keeping of normal working relationships between employees, which can contribute to achieving satisfactory job performance, work motivation, morale, and, consequently, meeting organizational goals (Long et al., 2012). Fisher (1985) describes employee relationships as friendly and caring relationships that provide employees with emotional confidence and support in solving stressful situations. The truth is that the style of work, especially in the IT sector, is more and more challenging for employees because they often have to perform difficult tasks and work many hours in project teams (Lee, 2004). As a consequence, employees will have more social requirements and emotional needs to motivate them to work. There are arguments in the literature that high-quality interpersonal contacts cause a positive impact on employees' behavior (Uhl-Bien et al., 2000). Moreover, when it comes to employee support, it should be considered in two respects as instrumental support – focused on tasks and problem solving (Mossholder et al., 2005) – and emotional – focused on the person, the foundation of friendship and personal care (Beehr et al. 2000). According to Zohar (1994), the workload is one of the most stressful factors, while instrumental support can reduce the stress by reducing the workload of the co-worker (Beehr et al., 2003; Viswesvaran et al., 1999) and reduce VET (Tews et al., 2013).

Emotional support also seems to be effective in mitigating VET, especially among young employees for whom human relationships are more relevant (Tews et al., 2013). Building friendship in the workplace increases the worker's commitment because leaving would require building new relationships (Tews et al., 2013). Instrumental support, similar to emotional support, can mitigate some of the negative emotions associated with work exhaustion or burnout caused by growing requirements and responsibility at work (Brotheridge & Grandey, 2002; Glomb & Tews, 2004). Therefore, it seems to be urgent for organizations to include employees' characteristics during formulating project teams.

3.4. Internal Communication

Communication is a crucial factor in HRM, above all, it is important in human relations management (Barrett, 2006). The role of internal communication in an organization is to analyze how is the process of people communication in the organization and to develop an effective communication system (Grunig & Dozier, 2002). It should also identify, create, and keep the connections that are beneficial for both the organization and its employees, on which the success of the organization will depend (Cutlip, 1985). Bevan and Bailey (1991) consider internal communication is the main factor in employee work motivation and job performance and has an important role in building an organization's competitive advantage (Tariszka-Semegine, 2012). Therefore, poor communication, can cause many risks in terms of HRM, such as lack of employee involvement, leadership problems, and even increased VET (Kotter, 1996; Ballard & Seibold, 2006; Kotter, 2012). Branham (2005) also suggests that poor communication between management and employees is one of the factors why employees decide to leave the organization. Effective managers listen to their employees, allow them to present their point of view, and involve them in the decision-making process - then the work proceeds smoothly and effectively (Mishra et al., 2014). Employees who describe communication as ineffective and inefficient show much more intention to leave the organization (Kim et al., 2010; Adebayo & Ogunsina, 2011; Abdien, 2019). Ballard and Seibold (2006) recognized the indirect impact of communication on VET. The organizations, which have a satisfactory communication process create a supportive work environment for the employees to successfully perform their tasks, increase job satisfaction, and consequently reduce education and job training (Naz & Gul, 2014).

4. Discussion

The considerations on VET in IT organizations, undertaken in the article, contributed to the identification of a specific group of factors that can significantly mitigate a VET of IT employees. The group factors included leadership, relationships with co-workers, relationships with managers, and internal communication. Transformational and servant leadership presented in the literature as the most effective in reducing VET was indicated as the most supportive style of leadership. Leaders who build trusting relationships and who inspire employees to develop their skills offer them a special learning environment, which results in increased employee loyalty to the organization, a higher sense of commitment to the organization, and consequently reduced VET (Wang & Sun, 2016; Khan, 2015; Lim et al.,

2017, Dutta & Khatri, 2017). The style of leadership thus influences the building of employee-manager relationships, as it is recognized that relationships do not necessarily have to be based on friendship, but trust and a sense of support are essential. Friendly relationships can be built with co-workers and it is precisely these relationships, largely among young employees, that have significantly reduced VET (Tews et al., 2013). Some employees expect emotional support from their co-workers, which will reduce the negative emotions caused by daily tasks, while others expect instrumental support, i.e., support in performing these daily tasks and reducing the employee's workload (Beehr et al., 2003). Internal communication seems to be complementary to teamwork relationships which, among the above factors, can support positive VET mitigation efforts (Iqbal, 2010). A literature review shows that it is possible to effectively mitigate VET already at the level of small groups in the organization. Therefore, managers should care for the best-qualified leaders who will inspire employees to develop and should select personnel to the team in that way to match not only the qualifications of other colleagues but also their character.

5. Conclusions

The article presents a literature review on a specific group of factors influencing employee turnover in IT organizations. This is an important phenomenon, given the ever-increasing demand for skilled IT employees and the continuing shortage of them. The concept of group factors that will reduce VET and prevent problems of organization with resources is presented. It is very important to conduct further considerations on VET and to develop a new concept of the turnover model because the models developed so far cannot be used universally. Of course, only a specific group of factors was taken into account in the considerations, which could be qualified as group factors - related to teamwork. Therefore, it seems necessary to repeat the review in the context of organizational factors and job-related factors. Besides, the considerations presented should also be verified in practice, and based on the research, a model for VET in an IT organization should be developed. Despite the limitations indicated, the presented considerations on VET in IT organizations may become an inspiration for further considerations on the significance of this phenomenon.

References

- Abdien, M. K. (2019). Impact of communication satisfaction and work-life balance on employee turnover intention. *Journal of Tourism Theory and Research*, 5(2), 228-238. <https://doi.org/10.24288/jtr.526678>
- Aburumman, O., Salleh, A., Omar, K., & Abadi, M. (2020). The impact of human resource management practices and career satisfaction on employee's turnover intention. *Management Science Letters*, 10(3), 641-652. <https://doi.org/10.5267/j.msl.2019.9.015>
- Adebayo, S. O., & Ogunsina, S. O. (2011). Influence of supervisory behaviour and job stress on job satisfaction and turnover intention of police personnel in Ekiti State. *Journal of Management and Strategy*, 2(3), 13. <https://doi.org/10.5430/jms.v2n3p13>
- Antonakis, J., Avolio, B. J., & Sivasubramaniam, N. (2003). Context and leadership: An examination of the nine-factor full-range leadership theory using the Multifactor Leadership Questionnaire. *The leadership quarterly*, 14(3), 261-295. [https://doi.org/10.1016/s1048-9843\(03\)00030-4](https://doi.org/10.1016/s1048-9843(03)00030-4)
- Ballard, D. I., & Seibold, D. R. (2006). The experience of time at work: Relationship to communication load, job satisfaction, and interdepartmental communication. *Communication Studies*, 57(3), 317-340. <https://doi.org/10.1080/10510970600845974>

- Barrett, D. J. (2006). Strong communication skills a must for today's leaders. *Handbook of business strategy*.
<https://doi.org/10.1108/10775730610619124>
- Bass, B. M., & Avolio, B. J. (Eds.). (1994). *Improving organizational effectiveness through transformational leadership*. Sage.
- Bass, B. M. 1998. *Transformational Leadership: Industry, Military, and Educational Impact*. Mahwah, NJ: Erlbaum Associates.
- Beehr, T. A., Jex, S. M., Stacy, B. A., & Murray, M. A. (2000). Work stressors and coworker support as predictors of individual strain and job performance. *Journal of Organizational Behavior*, 21(4), 391-405.
[https://doi.org/10.1002/\(sici\)1099-1379\(200006\)21:4<391::aid-job15>3.0.co;2-9](https://doi.org/10.1002/(sici)1099-1379(200006)21:4<391::aid-job15>3.0.co;2-9)
- Bennis, W. G., & Nanus, B. (1985). *Leaders: The Strategies for taking charge*. New York: Harper & Row, Publishers.
- Bevan, R., & Bailey, J. (1991). *Lesley's Handbook of Public Relations and Communication*.
- Bieńkowska, A., & Kuźnicka, B. I. (2018). Professional trainings of lawyers as an indication of their involvement in the performed work—results of empirical research. In *Edulearn 18. 10th International Conference on Education and New Learning Technology (Palma, 2nd-4th of July, 2018): conference proceedings* (pp. 7182-7190). IATED Academy. <https://doi.org/10.21125/edulearn.2018.1695>
- Bigliardi, B., Petroni, A., & Dormio, A. I. (2005). Organizational socialization, career aspirations and turnover intentions among design engineers. *Leadership & organization development journal*.
<https://doi.org/10.1108/01437730510617645>
- Branham, L. (2012). *The 7 hidden reasons employees leave: How to recognize the subtle signs and act before it's too late*. Amacom.
- Brotheridge, C. M., & Grandey, A. A. (2002). Emotional labor and burnout: Comparing two perspectives of "people work". *Journal of vocational behavior*, 60(1), 17-39. <https://doi.org/10.1006/jvbe.2001.1815>
- Cotton, J. L., & Tuttle, J. M. (1986). Employee turnover: A meta-analysis and review with implications for research. *Academy of management Review*, 11(1), 55-70. <https://doi.org/10.5465/amr.1986.4282625>
- Cutlip, S., Center, A., Broom, G. (1985). *Effective Public Relations*. Prentice Hall, Englewood Cliffs.
<https://doi.org/10.1080/00913367.1979.10717979>
- Cybulski, K. (2008). *Przyczyny i konsekwencje wysokiej fluktuacji personelu sprzedażowego*.
- Dohm, A., & Shniper, L. (2007). Occupational employment projection to 2016. *Monthly Lab. Rev.*, 130, 86.
- Dreher, G. F. (1982). The role of performance in the turnover process. *Academy of Management Journal*, 25(1), 137-147. <https://doi.org/10.5465/256029>
- Dutta, S., & Khatri, P. (2017). *Servant leadership and positive organizational behaviour: The road ahead to reduce employees' turnover intentions*. On the Horizon. <https://doi.org/10.1108/oth-06-2016-0029>
- Fairholm, G. (1994). *Leadership and the Culture of Trust*. Praeger Westport. https://doi.org/10.1007/978-0-387-84902-7_6
- Fisher, C. D. (1985). Social support and adjustment to work: A longitudinal study. *Journal of management*, 11(3), 39-53.
- Fisher, S. G., & Hunter, T. A. (1997). Team or group? Managers' perceptions of the differences. *Journal of Managerial Psychology*, 12(4), 232-242. <https://doi.org/10.1108/02683949710174838>
- Foong-ming, T. (2008). Linking Career development practices to turnover intention: The mediator of perceived organizational support. *Journal of Business and Public Affairs*, 2(1), 1-16.
<https://doi.org/10.1108/02683949710174838>
- Gerhart, B., Milkovich, G. T., & Murray, B. (1992). Pay, performance, and participation. *Research frontiers in industrial relations*, 193-238.
- Glomb, T. M., & Tews, M. J. (2004). Emotional labor: A conceptualization and scale development. *Journal of Vocational Behavior*, 64(1), 1-23. [https://doi.org/10.1016/s0001-8791\(03\)00038-1](https://doi.org/10.1016/s0001-8791(03)00038-1)
- Greene, C. N., & Organ, D. W. (1973). An evaluation of causal models linking the received role with job satisfaction. *Administrative Science Quarterly*, 95-103. <https://doi.org/10.2307/2391931>
- Grunig, J. E., & Dozier, D. M. (2003). *Excellent public relations and effective organizations: A study of communication management in three countries*. Routledge. <https://doi.org/10.4324/9781410606617>
- Hassan, R. (2014). Factors influencing turnover intention among technical employees in Information technology organization: A Case of XYZ (M) SDN. BHD. *International Journal of Arts and Commerce*, 3(9), 120-137.
- Henderson, R. (2012). Industry employment and output projections to 2020. *Monthly Lab. Rev.*, 135, 65.
<https://doi.org/10.21916/mlr.2013.39>
- Hom, P. W., Lee, T. W., Shaw, J. D., & Hausknecht, J. P. (2017). One hundred years of employee turnover theory and research. *Journal of Applied Psychology*, 102(3), 530. <https://doi.org/10.1037/apl0000103>

- Iqbal, A. (2010). Employee turnover: Causes, consequences and retention strategies in the Saudi organizations. *The Business Review*, 16(2), 275-281
- Jaramillo, F., Grisaffe, D. B., Chonko, L. B., & Roberts, J. A. (2009). Examining the impact of servant leadership on salesperson's turnover intention. *Journal of Personal Selling & Sales Management*, 29(4), 351-365. <https://doi.org/10.2753/pss0885-3134290404>
- Jinadasa, L., & Wickramasinghe, V. (2005, December). IT industry labour turnover: the reality. In *Proceedings of the 10th International Conference on Sri Lanka Studies, University of Kelaniya, Kelaniya, December 16* (Vol. 18).
- Joarder, M. H., Sharif, M. Y., & Ahmmed, K. (2011). Mediating role of affective commitment in HRM practices and turnover intention relationship: A study in a developing context. *Business & Economics Research Journal*, 2(4).
- Johnson, T. W., & Graen, G. (1973). Organizational assimilation and role rejection. *Organizational Behavior and Human Performance*, 10(1), 72-87. [https://doi.org/10.1016/0030-5073\(73\)90005-6](https://doi.org/10.1016/0030-5073(73)90005-6)
- Johnson, D. W., & Johnson, R. T. (1995). Social Interdependence - Cooperative Learning in Education. In B. Bunker, & J. Z. Rubin (Eds.), *Conflict, Cooperation, and Justice* (pp. 205-251). San Francisco: Jossey-Bass Publishers.
- Johnson, D. W., & Johnson, R. T. (1999). *Learning Together and Alone: Cooperative, competitive, and individualistic learning* (5th ed.). Needham Heights: Massachusetts: Allyn and Bacon.
- Johnson, T. W., & Stinson, J. E. (1975). Role ambiguity, role conflict, and satisfaction: moderating effects of individual differences. *Journal of Applied Psychology*, 60(3), 329. <https://doi.org/10.1037/h0076752>
- Lacity, M., Rudramuniyaiah, P., & Iyer, V. (2008). Understanding turnover among Indian IS professionals. In *Offshore Outsourcing of IT Work* (pp. 209-244). Palgrave Macmillan, London. https://doi.org/10.1057/9780230582965_7
- Lee, P. C. B. (2004). Social support and leaving intention among computer professionals. *Information & management*, 41(3), 323-334. [https://doi.org/10.1016/s0378-7206\(03\)00077-6](https://doi.org/10.1016/s0378-7206(03)00077-6)
- Lim, A. J. P., Loo, J. T. K., & Lee, P. H. (2017). The impact of leadership on turnover intention: The mediating role of organizational commitment and job satisfaction. *Journal of Applied Structural Equation Modeling*, 1(1), 27-41. [https://doi.org/10.47263/jasem.1\(1\)04](https://doi.org/10.47263/jasem.1(1)04)
- Listwan, T. (Ed.). (2010), *Zarządzanie kadrami*. CH Beck.
- Lo, J. (2015). The information technology workforce: A review and assessment of voluntary turnover research. *Information Systems Frontiers*, 17(2), 387-411. <https://doi.org/10.1007/s10796-013-9408-y>
- Long, C. S., Perumal, P., & Ajagbe, A. M. (2012). The impact of human resource management practices on employees' turnover intention: A conceptual model. *Interdisciplinary journal of contemporary research in business*, 4(2), 629-641.
- Longenecker, C. O., & Scazzero, J. A. (2003). The turnover and retention of IT managers in rapidly changing organizations. *Information Systems Management*, 19(4), 58-63. <https://doi.org/10.1201/1078/43203.20.1.20031201/40085.8>
- Lyons, T. F. (1971). Role clarity, need for clarity, satisfaction, tension, and withdrawal. *Organizational Behavior and Human Performance*, 6(1), 99-110. [https://doi.org/10.1016/0030-5073\(71\)90007-9](https://doi.org/10.1016/0030-5073(71)90007-9)
- Kashyap, V., & Rangnekar, S. (2016). Servant leadership, employer brand perception, trust in leaders and turnover intentions: a sequential mediation model. *Review of Managerial Science*, 10(3), 437-461. <https://doi.org/10.1007/s11846-014-0152-6>
- Khan, S. I. (2015). *Transformational leadership and turnover intention: The mediating effects of trust and job performance* (Doctoral dissertation, Bangkok University). <https://doi.org/10.1080/15332845.2016.1202730>
- Kim, B. P., Lee, G., & Carlson, K. D. (2010). An examination of the nature of the relationship between Leader-Member-Exchange (LMX) and turnover intent at different organizational levels. *International Journal of Hospitality Management*, 29(4), 591-597. <https://doi.org/10.1016/j.ijhm.2009.10.025>
- Kool, M., & van Dierendonck, D. (2012). Servant leadership and commitment to change, the mediating role of justice and optimism. *Journal of Organizational Change Management*. 25(3), 422-433. <https://doi.org/10.1108/09534811211228139>
- Korsakienė, R., Stankevičienė, A., Šimelytė, A., & Talačkienė, M. (2015). Factors driving turnover and retention of information technology professionals. *Journal of business economics and management*, 16(1), 1-17. <https://doi.org/10.3846/16111699.2015.984492>
- Kotter, J. P. (2012). *Leading change*. Harvard business press.
- Martin, G. (2009) Driving corporate reputations from the inside: a strategic role and strategic dilemmas for HR? *Asia Pacific J Human Res*, 47(2), 219-235. <https://doi.org/10.1177/1038411109105443>

- March, J. G., & Simon, H. A. (1958). *Organizations*. John Wiley & Sons. New York.
- Matz, A. K., Woo, Y., & Kim, B. (2014). A meta-analysis of the correlates of turnover intent in criminal justice organizations: Does agency type matter? *Journal of Criminal Justice*, 42(3), 233-243.
<https://doi.org/10.1016/j.jcrimjus.2014.02.004>
- McGee, M. K., & Thyfault, M. E. (1998). Congress mulls more foreign workers. *Information Week*, 694, 32-32.
- McKnight, D. H., Phillips, B., & Hardgrave, B. C. (2009). Which reduces IT turnover intention the most: Workplace characteristics or job characteristics? *Information & Management*, 46(3), 167-174.
<https://doi.org/10.1016/j.im.2009.01.002>
- Megginson, L. C., Mosley, D. C., & Pietri, P. H. (2001). *Supervisory management: The art of empowering and developing people*. South-Western College sPub.
- Mishra, K., Boynton, L., & Mishra, A. (2014). Driving employee engagement: The expanded role of internal communications. *International Journal of Business Communication*, 51(2), 183-202.
<https://doi.org/10.1177/2329488414525399>
- Mobley, W. H. (1977). Intermediate linkages in the relationship between job satisfaction and employee turnover. *Journal of applied psychology*, 62(2), 237.
- Mossholder, K. W., Settoon, R. P., & Henagan, S. C. (2005). A relational perspective on turnover: Examining structural, attitudinal, and behavioral predictors. *Academy of Management Journal*, 48(4), 607-618.
<https://doi.org/10.5465/amj.2005.17843941>
- Moynihan, D. P., Pandey, S. K., & Wright, B. E. (2012). Setting the table: How transformational leadership fosters performance information use. *Journal of Public Administration Research and Theory*, 22(1), 143-164.
<https://doi.org/10.1093/jopart/mur024>
- Naz, S., & Gul, S. (2014). Moderating role of organizational commitment between communication satisfaction and turnover intentions among nurses. *Pakistan Journal of Psychological Research*, 39-52.
- Palanski, M., Avey, J. B., & Jiraporn, N. (2014). The effects of ethical leadership and abusive supervision on job search behaviors in the turnover process. *Journal of Business Ethics*, 121, 135-146.
<https://doi.org/10.1007/s10551-013-1690-6>
- Parris, D. L., & Peachey, J. W. (2013). A systematic literature review of servant leadership theory in organizational contexts. *Journal of business ethics*, 113(3), 377-393. <https://doi.org/10.1007/s10551-012-1322-6>
- Pocztowski, A. (2007). *Zarządzanie zasobami ludzkimi. Strategie-procesy-metody* (pp. 176-177). PWE, Warszawa.
- Porter, L. W., & Steers, R. M. (1973). Organizational, work, and personal factors in employee turnover and absenteeism. *Psychological bulletin*, 80(2), 151. <https://doi.org/10.1037/h0034829>
- Price, J. L., & Mueller, C. W. (1981). A causal model of turnover for nurses. *Academy of management journal*, 24(3), 543-565. <https://doi.org/10.5465/255574>
- Purohit, M. (2016). A study on-employee turnover in IT sector with special emphasis on Wipro and Infosys. *IOSR Journal of Business and Management*, 18(4), 47-51.
- Rhoades, L., Eisenberger, R., & Armeli, S. (2001). Affective commitment to the organization: The contribution of perceived organizational support. *Journal of applied psychology*, 86(5), 825. <https://doi.org/10.1037/0021-9010.86.5.825>
- Rong, G., & Grover, V. (2009). Keeping up to date with information technology: Testing a model of technological knowledge renewal effectiveness for IT professionals. *Information & Management*, 46(7), 376-387.
<https://doi.org/10.1016/j.im.2009.07.002>
- Rubenstein, A. L., Eberly, M. B., Lee, T. W., & Mitchell, T. R. (2018). Surveying the forest: A meta-analysis, moderator investigation, and future-oriented discussion of the antecedents of voluntary employee turnover. *Personnel Psychology*, 71(1), 23-65. <https://doi.org/10.1111/peps.12226>
- Scarnati, J. T. (2001). On becoming a team player. *Team performance management: An International journal*. 7(1/2), 5-10 <https://doi.org/10.1108/13527590110389501>
- Schaap, P., & Olckers, C. (2020). Relationships between employee retention factors and attitudinal antecedents of voluntary turnover: An extended structural equation modelling approach. *SA Journal of Human Resource Management*, 18, 15. <https://doi.org/10.4102/sajhrm.v18i0.1358>
- Sendjaya, S., & Pekerti, A. (2010). Servant leadership as antecedent of trust in organizations. *Leadership & Organization Development Journal*. 31(7), 643-663 <https://doi.org/10.1108/01437731011079673>
- Spaho, K. (2013). Organizational communication and conflict management. *Management-Journal of Contemporary Management Issues*, 18(1), 103-118.

- Suifan, T. S., Diab, H., Alhyari, S., & Sweis, R. J. (2020). Does ethical leadership reduce turnover intention? The mediating effects of psychological empowerment and organizational identification. *Journal of Human Behavior in the Social Environment*, 30(4), 410-428. <https://doi.org/10.1080/10911359.2019.1690611>
- Sun, R., & Wang, W. (2017). Transformational leadership, employee turnover intention, and actual voluntary turnover in public organizations. *Public Management Review*, 19(8), 1124-1141. <https://doi.org/10.1080/14719037.2016.1257063>
- Steers, R., & Mowday, R. (1981). Employee turnover and post decision accommodation processes. In L. L. Cummings, & B. Staw (Eds.), *Research in organizational behavior* (Vol. 3., pp. 235-281) Greenwich, CT: JAI.
- Stovel, M., & Bontis, N. (2002). Voluntary turnover: knowledge management-friend or foe? *Journal of intellectual Capital*, 3(3), 303-322. <https://doi.org/10.1108/14691930210435633>
- Tariszka-Semegine, E. (2012). Organizational internal communication as a means of improving efficiency. *European Scientific Journal*, 8(15). <https://doi.org/10.14267/veztud.2015.02.07>
- Tarricone, P., & Luca, J. (2002). *Successful teamwork: A case study*.
- Tews, M. J., Michel, J. W., & Ellingson, J. E. (2013). The impact of coworker support on employee turnover in the hospitality industry. *Group & Organization Management*, 38(5), 630-653. <https://doi.org/10.1177/1059601113503039>
- Thatcher, J. B., Stepina, L. P., & Boyle, R. J. (2002). Turnover of information technology workers: Examining empirically the influence of attitudes, job characteristics, and external markets. *Journal of Management Information Systems*, 19(3), 231-261.
- Thatcher, J. B., Liu, Y., Stepina, L. P., Goodman, J. M., & Treadway, D. C. (2006). IT worker turnover: An empirical examination of intrinsic motivation. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems*, 37(2-3), 133-146. <https://doi.org/10.1145/1161345.1161361>
- Thwala, W. D., Ajagbe, A. M., Enegbuma, W. I., & Bilau, A. A. (2012). Sudanese small and medium sized construction firms: An empirical survey of job turnover. *Journal of Basic and Applied Scientific Research*, 2(8), 7414-7420.
- Trevor, C. O., Gerhart, B., & Boudreau, J. W. (1997). Voluntary turnover and job performance: Curvilinearity and the moderating influences of salary growth and promotions. *Journal of applied psychology*, 82(1), 44. <https://doi.org/10.1037/0021-9010.82.1.44>
- Turgut, H., Bekmezci, M., & Ateş, M. F. (2017). The moderating role of job satisfaction on the relationship between servant leadership and turnover intention. *Journal of Business Research Turk*, 9(2), 300-314. <https://doi.org/10.20491/isarder.2017.273>
- Uhl-Bien, M., Graen, G. B., & Scandura, T. A. (2000). Implications of leader-member exchange (LMX) for strategic human resource management systems: Relationships as social capital for competitive advantage. *Research in personnel and human resources management*, 18, 137-186.
- Van Dierendonck, D., Stam, D., Boersma, P., De Windt, N., & Alkema, J. (2014). Same difference? Exploring the differential mechanisms linking servant leadership and transformational leadership to follower outcomes. *Leadersh Q*, 25(3), 544-562. <https://doi.org/10.1016/j.leaqua.2013.11.014>
- Von Hagel, W. J. 2009. *Precipitating events leading to voluntary employee turnover among information technology professionals: a qualitative phenomenological study*. Doctor's dissertation. University of Phoenix.
- Viswesvaran, C., Sanchez, J. I., & Fisher, J. (1999). The role of social support in the process of work stress: A meta-analysis. *Journal of vocational behavior*, 54(2), 314-334. <https://doi.org/10.1006/jvbe.1998.1661>
- Wang, X., Sun, L., Sheeran, L. K., Sun, B. H., Zhang, Q. X., Zhang, D., ... & Li, J. H. (2016). Social rank versus affiliation: Which is more closely related to leadership of group movements in Tibetan macaques (*Macaca thibetana*)? *American journal of primatology*, 78(8), 816-824.
- Wang, Y. D., & Sung, W. C. (2016). Predictors of organizational citizenship behavior: Ethical leadership and workplace jealousy. *Journal of Business Ethics*, 135(1), 117-128. <https://doi.org/10.1002/ajp.22546>
- Zand, D. E. (1997). *The leadership triad: Knowledge, trust, and power*. Oxford University Press on Demand.
- Zhao, W., & Zhou, X. (2008). *Intraorganizational career advancement and voluntary turnover in a multinational bank in Taiwan*. Career Development International. <https://doi.org/10.1108/13620430810891446>

Comparison of Municipal Development Plans of Czech Cities

Adam KOVÁCS, Tibor ZSIGMOND and Renáta MACHOVÁ*

J. Selye University, Komárno, Slovakia; 119725@student.ujs.sk; zsigmondt@ujs.sk; machovar@ujs.sk

* Corresponding author: machovar@ujs.sk

Abstract: The aim of the article is to compare the municipal development plans of different cities. The research covered cities in the Czech Republic with more than 100,000 inhabitants – excluding the capital, Prague. Five cities met the set criteria: Liberec, Olomouc, Pilsen, Ostrava and Brno. A brief outline of these cities is followed by the presentation of development plans created and approved by the municipalities of each city. In connection with the field of research, we formulate several research questions in order to be able to establish the most relevant results during the analyzes. Based on these, the connections and differences in the perception and purpose of each city can be examined. After outlining the research on the defined objectives and criteria, the results obtained are summarized. In the remainder of the article, we draw the appropriate conclusions based on the results identified. Finally, our article concludes with an outline of possible future directions and plans.

Keywords: municipality; development plan; comparison

JEL Classification: 020; 021; P21; P25

1. Introduction

According to Rechnitzer (2019) the urban development issues have received increasing attention in recent times, while the direction and institutional framework of regional policy is constantly changing. The aim of the study is to compare the directions of modern municipal development plans of Czech cities. The study deals with cities which have more than 100,000 inhabitants. Rechnitzer (2019) states that in cities with 100 thousand and more inhabitants the urban system is definitely viable.

A municipal development plan is the basic development document of a city, which determines how the city should develop in the coming years. It is based on an assessment of the needs and potential of the city. The priority of a municipality plan is to solve the main problems of a city. Its aim is to create appropriate conditions for the inhabitants. Its main goal is to make the given city more attractive for all citizens, including the functioning of business and non-profit entities. It should make the municipality attractive for potential residents. The municipality plan is a local strategy with a societal impact. Every plan must have a professionally developed strategy which should make impact on all citizens, actors of the city's development and on the immediate surroundings of the city. The plans are based on the need for economic development. Municipality plans create conditions for new activities to ensure employment. Develop and implement strategic asset portfolios to ensure its development and optimizes the management of its assets. It has to develop a system for

preventing the consequences of crisis events – like the difficulties caused by the Covid-19 pandemic. (Ankers et al., 2020; Hastings, 2021)

In addition to the criteria and framework defined by us, we examine five Czech cities from the perspective of development plans, and through the implemented and planned developments of each municipality and specificities of the plans we seek answers to our research questions.

2. Methodology

A secondary research was conducted. In addition to the defined criteria, the subject of the research was the examination of the municipal development plans of the selected cities. In order to give the most relevant image, several research questions were identified.

- What are the goals of the development plans created by the municipalities of the researched cities?
- What are the top priorities of the development plan of the researched municipalities?
- What correlations or differences characterize the researched cities in relation to the development plans?
- To what extent does the location of each city have an influential role in the development plans?

In the present case, aligned with the objectives and criteria set out, the research is descriptive. Appropriate sources and relevant data are explored in the form of secondary data. In the following the paper presents the examined cities from a demographic point of view.

Liberec is situated in the northern part of the Czech Republic, 90 km from Prague. The city is located in the Liberec Valley on the Žitavský Plateau – between the Jizera Mountains and the Ještěd-Kozák Ridge. The town is crossed by the river Lužická Nisa, which has two tributaries in the town: the Černá Nisa and the Harcovský brook. It is currently an important center of the region, as the city is the center of the Liberec district and the Liberec borough as well. According to the latest data, it has a population of 103,997, making it the 5th largest city in the Czech Republic – ahead of Olomouc. The city covers an area of 106.1 km², but it is only the 11th largest in the country. Liberec is one of the most interesting and significant cities in the Czech Republic, thanks to its rich architectural history. The leaders wanted to create a city that resembled Vienna, Munich or Dresden at the time. This was also evident in public and residential buildings. Architecture was greatly influenced by the conservatism of local architects, who mostly followed classicism. Besides them, architects from abroad, mainly from neighboring Germany and Central Europe, had quite a high influence. The image of the city today actually evolved between 1880-1930. It was then that the city's sophisticated infrastructure was developed, and the suburban concept was created.

This sought to emphasize the harmony of nature and the city. However, the second half of the 20th century greatly changed the look of the city. During socialism, the construction of panel houses and residential areas began, so the “concrete sea” flooded the city. This

phenomenon was typical of almost all cities in the Czech Republic. (Čejka, 2009; Zeman, 2009; ČSÚ, 2018, 2019; Město Liberec, 2021)

The city of Olomouc is an important center of the Czech Republic. According to the latest data, it has 100,494 inhabitants, making it the 6th largest city in the Czech Republic. The city covers an area of 103.33 km². The city is located in the central part of Moravia, along the Moravian River (hence its name Moravia). It is one of the most important cities in Moravia. Based on the sociographic division of Hampl (2005), Olomouc and its surroundings can be considered as one of the regional centers of the Czech Republic. In addition to Olomouc, there are other important towns in the area, such as Hlubočky, Lutín, Šternberk, Velká Bystřice, Prostějov, Přerev and Lipník nad Bečvou. (Jiříčková, 2011; ČSÚ, 2018, 2019)

Pilsen is in the western part of Bohemia and is officially the biggest city in the Pilsen region. It is located at the confluence of the rivers Radbuza, Úhlavy, Úslava and Mže, from where the river Berounka starts. Today, Pilsen covers an area of 13,767 hectares, divided into ten districts. Pilsen, the fourth largest city in the Czech Republic, has a total population of 171,000. In western Bohemia, Pilsen is dominant as a strong industrial, commercial, cultural and administrative center. The high cultural and economic level is reflected in the individual building developments. Among the most valuable monuments is the gothic cathedral of St. Bartholomew, the Renaissance town hall, the Baroque renovation of the buildings of the Archdeacon and the Franciscan monastery, and the Jewish synagogue. During the 19th century industrialization, the famous industrial giants - the Škoda Engineering Complex and Plzeňský Prazdroj – were established. The construction of a modern industrial zone – Borská pole - is an extraordinary project throughout the Czech Republic. As a result of the efforts to improve the quality of education the University of West Bohemia in Pilsen was founded in 1991. The most valuable traditions of the cultural environment in Pilsen are the work of the J. K. Tyl Theater. Pilsen is a venue for cultural events and festivals of international significance. The year 2015 was a big turning point when Pilsen became the European Capital of Culture. The metropolis of West Bohemia is visited by 3-4 million tourists a year. In recent years, Pilsen has become a sports city, built an Olympic park in 2016 and continued the “Sportmanie Plzeň” project in the following years. (Sykora, 2002; ČSÚ, 2018, 2019)

The most important industrial region is the Ostrava region, focusing mainly on heavy industry. The city is located in the northeastern part of the country and is the largest city in the Moravian-Silesian region. It ranks third in the Czech Republic due to its size and population. The total area of the city is 214 km² and is divided into 23 urban districts. According to the Czech Statistical Office (CZSO), on 1 January 2018, the population was 291,000. The city is located 10 km south of the Polish border and 50 km west of the Slovak border. It is located in a geomorphological complex of the Ostrava Basin which comprises the Ostravice, Odra, Opava and Lučina rivers. Ostrava is a legitimate and cultural center at the intersection of two historical areas of the Czech Republic, namely Moravia and Silesia. The municipality has an extended jurisdiction consisting of a regional court and a regional office. Ostrava is also a major university city with two state universities: The University of Ostrava, located in the city center, and the Technical University of Ostrava, located in the Poruba district of Ostrava. Due to the Leoš Janáček International Airport on the D47 motorway,

Ostrava is one of the largest traffic hubs in the Czech Republic (ČSÚ, 2018, 2019; Faktografické listy Ostrava, 2019)

Brno is the second most important city in the Czech Republic in terms of both population and territory, the largest city in Moravia, the capital of the historic Margraviate of Moravia. Brno is the center of the South Moravian Region, within which it forms an independent district, the Brno City District. The city is located at the confluence of the Svitava and Svatka rivers, with a population of roughly 380,000 (2019 data). The population of its agglomeration is approximately 800,000. The permanent population of the area at the 2014 census was 730,000. The city is situated in the South Moravian Region, on the border of the Czech Drahaný Hills and the Moravian Lowlands, in the valley of the rivers Svitava and Svatka, next to the D1 and D2 motorways connecting Bratislava with Prague. To the north of the city lies the Moravian Karst, rich in ravines and caves. Brno is also a major center for road transport. The D1 motorway leads to Ostrava, the D2 motorway to Prague and Bratislava. The D52 motorway leads to Vienna, and the planned D43 road will connect Brno with the northern parts of Moravia. The city is also building a ring road around the city. Brno is served by two airports, one of which is the Brno International Airport, whose traffic has grown significantly in recent years. From here there are direct flights to London, Rome, Moscow and St. Petersburg, among others. This airport also serves as a hub for police helicopters. The other is a small grassy airport near Brno Medlánky, it is mainly used by hobby aviators and hot air balloons. Cycling is also very popular, there are 38 kilometers of cycle paths leading through the city. A long – approx. 130 kilometers – cycle path leads to Vienna. There are also many hiking trails crossing Brno. (ČSÚ, 2018, 2019)

3. Results

3.1. Liberec

The municipality of Liberec has created a complex development strategic plan for the period 2014-2020, which defined the future development directions of the city. It bases on the previous strategic plans of 2002 and 2007 and aims to fill the gaps in these plans. The document assesses the needs and opportunities of the city. The main goal is to make Liberec more attractive to all citizens, regarding the operation of business and non-profit organizations. The implemented strategy affects to some extent all citizens, participants of urban development, those who come to the city for various reasons, and the immediate surroundings of the city. (Jašková, 2019)

In addition to obsolescence, the 2007 strategy also showed some quality shortcomings. In the 2007 version, the measurability indicators were incorrectly set and not properly aligned with the budgetary outlook, actually with the budget. In addition, the municipality had an inadequate organizational structure to implement the strategy. There was a lack of proper monitoring and communication with the public throughout the creation and implementation process. Cooperation with the region was low, and analyses and future trends and forecasts were missing. The potential of the city had not been fully exploited and no concrete steps were taken to implement the medium-term development plans. In addition, there was a lack

of sustained commitment on the part of political leadership and staff to put the strategy into practice. The updated strategy aims to address these shortcomings.

The city has defined different visions. These are the following:

- Liberec is the heart of northern Bohemia, amidst unique mountainous nature near the Czech-German-Polish triple border.
- The friendly and open city offers outstanding secondary and tertiary education in a variety of disciplines that train well-trained professionals using the most up-to-date technology.
- The city offers a rich cultural and social life as well as sports opportunities and much more leisure activities for both locals and visitors.
- The quality-of-life conditions of the citizens were provided with a quality environment, plenty of workplaces, and a modern urban management style that is open to cooperation with all sectors.
- In addition to the vision, the city has set additional global goals:
- An attractive city for both residents and tourists, with a functional living center, a diverse natural environment in the immediate vicinity of the city, as well as suitable conditions for sports and other leisure activities.
- Balanced and sustainable economic development is based on the use of modern technologies and the cooperation of individual entities with universities and research centers.
- The high standard of living of city dwellers increases the attractiveness of the city in several areas, for the current inhabitants and for newcomers as well.
- A modernly managed city that cooperates with neighboring municipalities, cities, as well as the county of Liberec, the "Euroregion Nisa", the city's residents, the business community, the civil sector and other stakeholders.
- Based on these, the defined strategic goals focus on the following areas:
- Competitive economy and entrepreneurship (enterprise, science, research, innovation, labor market, tourism),
- Quality of life (education, health, social services, housing, security, culture, sport and leisure),
- Environment and public areas (urban vegetation, suburban landscape, nature and landscape protection, rivers, waste, sewage, air, public spaces, availability of free space),
- Sustainable mobility and technical infrastructure (transport planning, transport infrastructure, traffic safety, traffic signs and traffic management, barrier-free traffic, non-motorized transport, sustainable mobility, public utilities, energy management),
- Public administration and civil society, territorial cooperation (management of development, urban communication, control of partnership and cooperation, public services, crisis management, administrative staff). (Město Liberec, 2007; Město Liberec, 2014; Mura & Machyniak, 2014; Vlacseková, 2019)

3.2. Olomouc

The municipality of Olomouc has created a complex development strategic plan for the period 2017-2023 called “Strategický plán rozvoje města Olomouce”, which sets out the future development directions of the city. (Město Olomouc, 2017)

The structure of the goals is primarily based on the problem analysis of the problem tree, which summarizes the most important conclusions of the analytical work and identifies the most important issues and reasons. During the analysis, a further 6 key issues were identified within the main issues and divided into different columns. Subsequently, a total of two working sessions were held. At the first meeting, the objectives related to the topic were presented and the members of the working group discussed the formulation of the objectives, the objective focus and implementation of the objectives, and the proposals for the establishment of contact persons and relevant departments. Subsequently, an external consultant worked out the goals, creating so-called “goal descriptions”. The first version of the tender section was presented on 18 September 2017 at the second public debate on the city’s development strategy. Nearly forty active citizens attended the public hearing, vigorously discussing the proposals and other interesting suggestions were presented as well. Relevant suggestions from citizens were incorporated into the draft and this version of the draft was shared with the members of the working group for their further comments. After that, a second meeting of the working groups was held to finalize the content of each objective, including the definition of indicators to measure the achievement of the objectives. (Město Olomouc, 2017)

The final structure of the proposal was formulated as a result of the working groups, the strategic management committee and the public hearing. The proposed part of the strategic plan is divided into four pillars, representing the main thematic areas. These are the following:

- Pillar 1: Competitive and creative Olomouc,
- Pillar 2: Olomouc - the pearl of Europe,
- Pillar 3: Sustainable Olomouc,
- Pillar 4: Olomouc - the functional center of the region.

Within each pillar, 5-7 specific goals were set. The strategic plan contains a total of 23 objectives, within which a further 87 main activities have been identified. (Město Olomouc, 2017)

3.3. Plzeň

The city of Pilsen has been working for several years to improve the quality of life of citizens and visitors to the metropolis with smart and modern solutions that make prosperity easier and more enjoyable. So it was involved in the global concept of smart cities. In the future, Pilsen will not only be a city of culture, sports, industry and beer, but also a center of innovation, cybernetics, science and research. In addition, Pilsen has set the following goals for the next years:

- Improving the quality of life of generations,
- Providing a safe city for the visitors and Pilsen itself,
- Developing a forward-looking labor market and linking the education system to practice,
- Improving the urban environment and increasing preparedness for climate change,
- Revitalize the city center,
- Raising awareness in Pilsen outside the city. (Pecuch, 2018; Město Plzeň, 2020)

Pilsen wants to be an economically strong, modern and competitive city in Europe. Pilsen focuses on innovative industry and the localization of high value-added production in modern industries. (Smart City Plzen, 2019)

The city sees the development of education and increasing its level as a key factor in competitiveness, which ensures high employment and a precondition for the development of the city's economic base. Its purpose is the unique composition of the education offered. (Smart City Plzen, 2019)

It facilitates the transfer of know-how from universities and research to practice through direct and indirect support for modern tools such as technology parks, information technology centers, innovation centers, conferences and symposia. (Plzen, 2019)

Attractive housing supply with the aim of keeping school leavers in the city and attracting educated and professionally qualified people for whom Pilsen will no longer have a “black city” image. (Smart City Plzen, 2019)

The city of Pilsen will grow as a cultural and social center, not only within the region but also more widely. It develops the offer of services and leisure opportunities for the residents and visitors of the city. In the development of tourism, it focuses on supporting important cultural and sporting events as well as congress tourism. The city offers its center to people and makes the space attractive for leisure and thus an attractive space for business. Pilsen will find partners, visitors and customers in Europe and in return will offer cooperation as well as business and leisure. (Smart City Plzen, 2019)

The city area and its immediate surroundings will be perceived as works of art, emphasizing the balance of each component, connecting the center with its surroundings, connecting urban units, colors and their effects on residents, cleanliness and harmony of public spaces, consistent use of environmentally friendly technologies to protect the environment and uphold the principle of sustainable development in the further construction and management of urban development. (Smart City Plzen, 2019)

3.4. Ostrava

The development plan in Ostrava lists the innovation centers and illustrates the most important such facilities.

Firstly, there is the IT4Innovations center. The IT4Innovations is a research center with strong international connections. The central topics of IT4Innovations research are large data processing and analysis, machine learning, development of parallel scalable algorithms, demanding engineering solutions, tasks and modelling of nanotechnologies. Since its founding in 2011, the prestigious pan-European IT4Innovations research has been a member

of PRACE (European Advanced Computing Partnership) infrastructure, where it represents the Czech Republic. (IT4innovations, 2019)

The BIC Ostrava Business Innovation Center was established in 1993 and its mission is to support and consult in various areas of market activities. It offers comprehensive services for start-ups and developing companies.

In addition to consulting and training, it provides services in its own industrial application development center. It aims to create the conditions for research and development activities, especially for small and medium-sized enterprises that are interested in innovating their products and technologies, however do not have the necessary background and equipment for this activity. It focuses on hydraulics, pneumatics, tribotechnics and proactive diagnostics. Currently, BIC Ostrava s.r.o. provides comprehensive services in technology transfer, innovation, investment projects, project management, research and development. (Bic, 2019; Čapošová, 2015)

The Nanotechnology Center (CNT) was established on 1 February 2007 from the VÚCHEM (Vysokoškolský ústav chemie materiálů) as a university institute of the Technical University of Ostrava (VŠB-TUO) and the first science and technology center in the Czech Republic, the name of which contains nanotechnologies. The activities of the Nanotechnologies Center focus on the research, preparation and analysis of materials, especially those measuring nanometers (10⁻⁹ m). The Center's world-famous scientists and experts develop and participate in scientific research activities such as nanocomposites, nanomaterials with photo functional and antibacterial properties, friction composites or sorption materials, and the toxicity of nanoparticles and their effects on the environment and living organisms, etc. (Centrum nanotechnologií, 2019)

The ENET center aims to research and develop renewable energy sources without adverse effects on the environment, including new transport and energy raw material processing technologies, their efficient energy conversion and modern solutions for so-called micro-networks with electrical and thermal energy storage. ENET will also focus on the priorities set out in Horizont 2020 and will develop projects in the framework of calls for new renewable energy technologies as well as for clustering, energy, smart grids and smart cities. (Centrum Enet, 2019)

4Medical Innovations is a technologically advanced biomedical center. It focuses on the most effective use of the results of basic research in clinical practice. Specific areas include cell manipulation, biotechnology, bio pharmacy, and diagnostics in human cells and genetics. The Center offers a wide range of ready-to-use laboratory development and manufacturing facilities in accordance with GMP regulations; direct access to international cooperation with innovative trade organizations and investors; close liaison and collaboration with the clinical departments of the University Hospital during clinical examinations. (4Medical Innovations, 2019)

The city of Ostrava has clearly started to develop. In 2018, it again upgraded its Moodys' rating, in this case to A1 positive. The Concerns multimodal logistics center will soon be completed in its entirety. Environmental measures are also a priority: environmentally conscious living, green areas, bike paths, a bike-sharing system and, last but not least, the

creation of a new university once the city has received the necessary permits. In addition, there are a number of large-scale investments underway in the city and the city of Ostrava is increasingly moving towards the SMART CITY-based group of cities.

3.5. *Brno*

The land use plan is expected by the end of 2022, which will include wider housing construction and more effective land measures. Urban transport needs major improvements, so renovating the city center avenue is one of the primary goals. The entire tram sections in the direction of Bystrc will be renovated and built from September next year. This will also significantly speed up the completion of the Žabovřeská I. part. (Brno 2050, 2019)

The handover of the station is, of course, also linked to transport. Although this is a public investment, the government and the Ministry of Transport are currently taking the next steps, but this project is also under development. The city of Brno is preparing the infrastructure related to the necessary projects, including the availability of a new public transport station. (Program Strategy Strategy, 2019; Hanáčková & Bumbalová, 2016)

Both the Brno 2050 and the Smart City Brno projects will arrive at their important stations in the near future. The Brno iD project has certain preconditions for further development. The visions for the near future are wide-ranging. Through Brno iD, citizens will be able to book a book in the library or pay for things. In addition, important information about the city might be sent directly via email or to the app, ensuring that citizens are kept informed of the current situation in the city. Using an electronic card, you can enter various cultural events, such as a theater. (Brno 2050, 2019)

The creators of the smart city also see the vision of Brno in creating an application to track citizens. This means that the app calculates how long it takes to go from point A to point B by car, on foot, by public transport. It is important to recognize at this point that one leaves some ecological footprint and social impact when traveling from one place to another. (Brno 2050, 2019)

Špitálka district will also be an important destination in the near future. It is one of the neighborhoods in Brno that was chosen for repair by the Smart City project creators. A modern, low-energy district needs to be created, and it needs to be built in one of the heating plants on Brno Street. The inspiration came from various foreign cities visited by members of Smart City Brno. This district renewal is part of the RUGGEDISED program. In five years, the site will have to be converted to a low-energy environment with sustainable urban transportation. The project aims to change the city according to the needs of citizens using modern technologies and procedures. This project should be implemented in 2020. (Brno 2050, 2019; Smart City Brno, 2019)

4. Discussion

In conclusion, in almost all of the listed cities, the primary basic goal is to improve the quality of life of the residents of the city. Within this, the most important areas are the economy (mainly creating new job opportunities), safety (social, transport or risk management, etc.), transport (construction of new roads, renovation of existing ones,

reorganization of transport, etc.), social services (elderly, sick, improvement of care for people with disabilities), education (schools, research centers, developments, innovations, etc.), environment (environmental protection, pollution abatement, use of alternative environmentally friendly technologies, etc.), information and communication technologies (introduction and development of electronic information services, mobile applications, electronic rentals, etc.) and tourism (creating an attractive cityscape, expanding opportunities, creating hiking and cycling trails, etc.).

Of course, the areas of development listed receive an unequal, different emphasis in each city. In each case, the location of the city plays a big role. The opportunities offered by each natural endowment are important, but at the same time, for example, the role of transport hubs (motorways, railway junctions, airports, etc.) that determine the opportunities of the city. In addition to these, there are factors such as the history of the city and the neighboring area. These factors are (mostly) not affected by the city. One can only adapt to the natural conditions by noticing and taking advantage of the opportunities offered. And some disadvantages should be tried to be reduced or made insignificant - for example, by focusing on other areas.

Municipalities update and change each development plan at regular intervals (usually every 4-5 years) according to particular changes. It happens that some of the set goals have been achieved, in which case further development may be a future goal, resp. maintaining the current status quo. However, in some cases, the goal may not be achieved or may only be partially achieved. In such cases, it is necessary to analyze the situation and identify the individual obstacles that have hindered development. Once these have been identified, they need to be removed, and further work can begin to achieve the main goal. It is an unfortunate unique phenomenon that in many cases the body of representatives is replaced after the elections and the new mayor sets completely opposite goals in their new program, sweeping away the successful plans and insights of previous years. Of course, they are not the only ones to make such decisions, but they also hire various independent experts to assess the situation and develop new sub-plans. In this case, however, the actual independence of the professionals can also be questioned, and in general the principle of "new mayor and new professionals" is applied, thus previous plans become null and void.

In the course of our research, we encountered several limits that we had to deal with and hindered the most relevant results. One such constraint was the change in development plans after new leaders came to the helm of the city, with the result that in many cases they came up with completely new plans instead of the original ones. The next problem was caused by the collection of relevant data and the restrictions in place since the COVID-19 pandemic also hampered our research.

Future directions include the expansion of our research area to examine the development plans of several Central European countries along the defined criteria, and we would also like to include the effects of COVID-19 in the research questions. We would like to conduct interviews with mayors or municipality representatives responsible for development.

References

- 4Medical Innovations. (2019). *Základní informace*. <http://www.4medi.cz/o-biotech-parku.html>
- Ankers, S., Kaiserman, D., & Shepley, C. (2020). *Grotton Revisited: Planning in Crisis?* Routledge.
- BIC Ostrava, s. r. o. (2019). *BIC Ostrava*. <https://www.bicova.cz/>
- Brno 2050. (2019). *Programová část strategie #brno2050*.
https://brno2050.cz/pdf/Strategie_BRNO_2050_programova_cast_FINAL.pdf
- Čapošová, E. (2015). The importance of human resources in quality management in public administration. *Acta Oeconomica Universitatis Selye*, 4(1), 34-41.
- Čejka, M. (2009). *Město Liberec v kulturologické perspektivě*. Univerzita Karlova: Praha.
- Centrum Enet. (2019). <http://cenet.vsb.cz/cz/>
- Centrum Nanotechnologií. (2019). <http://www.cnt.vsb.cz/>
- ČSÚ. (2018). *Počet obyvatel v obcích České republiky k 1. 1. 2018*.
<https://www.czso.cz/documents/10180/61546986/1300721803.pdf/bcb6d91b-626f-41fd-a705-3f7a49265b4d?version=1.0>
- ČSÚ. (2019). *Veřejná databáze*. [Data set]. Retrieved February 04, 2021 from
https://vdb.czso.cz/vdbvo2/faces/cs/index.jsf?page=uziv-dotaz#_
- Faktografické listy Ostrava. (2019). *Město Ostrava ve faktech a číslech*. https://www.ostrava.cz/cs/podnikatel-investor/ekonomicky-profil-mesta/publikace/ke-stazeni/FL_2019_CZ_final.pdf
- Hanáčková, D., & Bumbalová, M. (2016). Innovations in self-government. *Acta Oeconomica Universitatis Selye*, 5(2), 88-96.
- Hastings, N. A. J. (2021). *Physical Asset Management*. Springer.
- IT4Innovations. (2019). <https://www.it4i.cz/>
- Jašková, D. (2019). Assessment of social development in Slovakia in the context of human resources. *Central European Journal of Labour Law and Personnel Management*, 2(2), 21-32.
- Jiříčková, T. (2011). *Faktické obyvatelstvo města Olomouce*. Univerzita Palackého v Olomouci.
- Město Liberec. (2007). *Strategie rozvoje Statutárního města Liberec 2007 – 2020*.
https://www.liberec.cz/files/dokumenty/odbory/odbor-strategickeho-rozvoje-dotaci/strategie_2007_2020.pdf
- Město Liberec (2014). *Aktualizace Strategie Rozvoje Statutárního Města Liberec 2014–2020*.
<https://www.liberec.cz/files/dokumenty/odbory/odbor-strategickeho-rozvoje-dotaci/aktualizace-strategie-rozvoje-statutarniho-mesta-liberec-2014-2020.pdf>
- Město Liberec (2021). *Geografické údaje*. <https://www.liberec.cz/cz/mesto-samosprava/profil-statut-mesta/geograficke-udaje/>
- Město Olomouc. (2017). *Strategický plán rozvoje města Olomouce. Zefektivnění procesu strategického řízení ve městě Olomouci včetně tvorby strategického plánu a optimalizace procesů na úřadě*.
https://www.dataplan.info/img_upload/7bdb1584e3b8a53d337518d988763f8d/sp-olomouc-navrhova-a-analytika-cast.pdf
- Město Plzeň. (2020). *Město příležitosti Plzeň*.
https://www.plzen.eu/Files/MestoPlzen/web2013/Obcan/o_meste/vize_mesta/170605_Plzen_profil_mesta_CZE.pdf
- Mura, L., & Machyniak, J. (2014). Ethical aspects of public administration. In *Hradec Economic Days 2014: Economic Development and Management of Regions*. (pp. 59-65).
- Pecuch, M. (2018). *Strategie města Plzně*. <https://www.plzen.eu/urad/verejne-dokumenty/strategie-mesta/strategie-mesta-plzne.aspx>
- Rechnitzer, J. (2019). Gondolatok, vélemények magyar településfejlesztési programokról. *Tér és Társadalom*, 3(1), 3-26. <https://doi.org/10.17649/TET.33.1.3069>
- Smart City Brno. (2019). <https://www.smartcitybrno.cz/ruggedised/>
- Smart City Plzeň. (2019). <https://smartcity.plzen.eu/o-smart-city-plzen/>
- Sykora, L. (2002). *Suburbanizace a její sociální, ekonomické a ekologické důsledky*. Ústav pro ekopolitiku.
- Vlacseková, D. (2019). Comparative analysis of motivation of civil servants and public servants in the local state administration – case study of Slovakia. *Central European Journal of Labour Law and Personnel Management*, 2(1), 74-93.
- Zeman, J. (2009). *Architektonický a urbanistický vývoj Liberce 1352-2006*. Univerzita Karlova.

Assessment of the Competitive Position of the V4 Group Countries in the Foreign Trade of Agri-food Industry Products

Anna S. KOWALSKA¹, Klaudia GURKOWA¹, Anna OLSZAŃSKA¹, Ivan SOUKAL^{2*}
and Martin MATEJICEK²

¹ Wrocław University of Economics and Business, Wrocław, Poland; anna.kowalska@ue.wroc.pl;
klaudia.gurkova@ue.wroc.pl; anna.olszanska@ue.wroc.pl

² University of Hradec Králové, Hradec Králové, Czech Republic; ivan.soukal@uhk.cz;
martin.matejcek@uhk.cz

* Corresponding author: ivan.soukal@uhk.cz

Abstract: The article is focused on the international competitive position of V4 countries in the foreign trade of agri-food industry products. The V4 countries' accession to the EU significantly changed exporters and importers' situation in these countries, providing them with better access to numerous markets. Integrating them into the single internal market area promoted trade and resulted in an increase of intra-EU exports and imports. The agri-food products market strongly benefited from such an opportunity, which was significantly limited before 2004 by duties and quotas. The article presents changes in international trade in agri-food products in the V4 countries and their competitiveness. We employ share of the analyzed country in global exports (EMS), import-export coverage (TC), revealed comparative advantages (RCA), and the intensity of intra-industry trade Grubel-Lloyd Index (GL) to assess the competitiveness. Our results show that Poland performed the best in international trade in agri-food products among the V4 countries. The result was confirmed by partial indicators and the total competitiveness index.

Keywords: trade; competitiveness; agri-food industry; export, import; V4 Group

JEL Classification: F10; F14; L66; Q17

1. Introduction

Over the years, the way of understanding the issue of competitiveness has significantly evolved. Thanks to the research conducted in this field, we know that the factors determining both the competitive potential and the competitive position of the country's economy have changed significantly with the overall global progress. From classical theories, where the basis for evaluation were factors of production, through neo-factor concepts and neotechnological hypotheses extended to include natural resources, in which knowledge was the reference point (Nosecka & Pawlak, 2014). Over time, the factors changed, and with them, the very definition of the concept under discussion transformed. (Olczyk, 2008). Most often, the competitiveness of the economy, along with all its sectors and entities, is characterized not only in multi-level, but also multithreaded perspective. However, it is worth noting that

despite its complexity, it has become one of the most important subjects of reflection for scientists in the fields of economics, politics, and even management.

As for the issues related to competitiveness analysis, they have been present in the literature for years; however, they do not lose their relevance. Observations at the international level prove that this aspect is important both from the point of view of the economy and economic policy, and even the country's business practice (Voinescu & Moisoiu, 2015). This can be directly related to one of the most important documents concerning the competitiveness of countries in the world, i.e., the World Competitiveness Yearbook. The report published by the Swiss International Institute for Management Development (IMD) every year since 1989 proves that detailed research in this field can provide solutions to important problems. They concern such pillars as macroeconomic stability, financial system, business dynamism, labor market, product market, innovation, skills, and abilities (Schwab, 2019). Moreover, the complexity of the issue and the multiplicity of determinants and measures characterizing the state's competitiveness are so important on the international arena level that it is subject to constant discussions by such units as: the World Bank, the European Commission or the Organization for Economic Cooperation and Development (OECD). The noticeable relationship between economic growth and the global socio-ecological system's capacity affects decisions concerning not only the authorities but also the inhabitants of each country (Hämäläinen, 2003). In the end, it is the society that reacts to top-down decisions with its behaviour.

It is important to note that the state's adjustment as a whole, along with its economy, entities, sectors, power, and society, to subsequent projects is aimed at ensuring the best position among other rivals. International competitiveness is most often defined as the state's general ability to effectively grow, and therefore to build wealth that is proportionately larger than its competitors on the world market (Mróz, 2016). Its particular attractiveness for the scientific sphere comes from the close connection with such aspects as, for example, the high standard of living and country's food policy. The relationship with the demand, supply, structure, and competition strategy strongly influences the ongoing research in this area (Trail & Pitts, 1998). Thanks to this, it is certain that the literature and the theories it contains are constantly updated and expanded with new achievements.

Everything points to a multidirectional tendency in considering competitiveness. Thanks to the specification of three factors such as growth, integration, and sustainable development, it becomes easier to understand competitiveness through the prism of dynamic changes that surround us from everywhere. It has been suggested that attention should be paid to non-price factors such as the impact of government intervention. Moreover, growing attention is paid to the agri-food sector's role and the fact that its impact on countries' competitiveness is increasing (Latruffe, 2010). This proves that the world population is growing. Therefore, new problems and challenges arise in the category of food policy, i.e., issues underlying the state's governing and management.

The current situation, although changeable and unstable, is also subject to evaluation and discernment. Issues related to the globalization of economic systems, advances in communication and transport technologies, reduction of logistics costs, and a very significant

evolution of demand patterns require a detailed settlement (Carraresi & Banterle, 2008). There are so-called ex-post and ex-ante group of factors. They are helpful when a researcher or a policy-maker intends to assess the position and the chances of progress in the long term (Misala, 2011). Therefore, for the purposes of this study, four indicators from this group were selected and used in the data compilation process.

The research area, not without reason, covers the countries of the Visegrad (V4) Group. The group called the V4 Four, or V-4 for short, is a regional form of cooperation between four countries of Central and Eastern Europe: Poland, Slovakia, Hungary, and the Czech Republic. These neighbouring countries are similar in terms of such features as, for example, tradition, culture, social values, geopolitical conditions, and, not infrequently, common history and therefore constitute an interesting research object (Kowalska & Gurkova, 2020). These countries underwent gradual liberalization of trade and economic integration at the global and regional levels (Molendowski, 2014). They opened their economies from the beginning of the transformation process in the 1990s. However, the process flow was not uniform. The most important issues were included in this study.

This article aims to assess the competitive position in the foreign trade of agri-food industry products among the V4 Group member states.

2. Methodology

In the article, selected indicators of ex-post competitiveness were used to assess the international competitiveness of the agri-food industry. Ex post competitive position indicators can be divided into three groups: comparative advantage measures, measures of market shares or international trade, and measures of price-cost competitiveness (Krasiński, 2018). In order to assess changes in the global trade in agri-food products of the V4 countries, basic methods of statistical analysis of data and selected quantitative measures were used, including mainly the results of foreign trade, i.e., the balance of trade in products of a given industry, Export Market Share (EMS) (1), Trade Coverage (TC) (2), Revealed Comparative Advantage (RCA) (3), Grubel-Lloyd's intra-industry trade indicators (GL) (4).

Following factors were used to measure the competitive position of agri-food products exported from the V4 countries to the global market:

1. Index of the share of the analysed country in world exports (EMS), which is expressed by the formula (Poland Statistical Office, 2018):

$$EMS = E_{ij} / E_{iN} \quad (1)$$

where:

E - exports in terms of value (USD/EUR),

i - analysed group of goods,

j - analysed country,

N - all countries.

This indicator is one of the simplest indicators measuring the competitive position. The increase in the share in exports of a given country in a specific group of goods is interpreted as an improvement in its competitive position (Zawiślińska, 2003).

2. Import-export coverage ratio (TC), calculated according to the formula (Olszańska, 2016):

$$TC_i = E_i / I_i \times 100 \quad (2)$$

where:

E - exports in terms of value (USD/EUR),

I - import in terms of value (USD/EUR),

i - analysed group of goods.

The TC index level above 1 means that the country generates a surplus in trade in agri-food products and, as a result, has a competitive advantage in the exchange of products of this group. The value of the index below 1 means a deficit in trade turnover, which proves a weak competitive position in foreign markets (Kowalska, 2017).

3. Revealed Comparative Advantage Index (RCA), which measures, for example, the share of the agri-food industry in a country's total exports in relation to the share of this industry in total global exports. The indicator is expressed by the formula (Balassa, Noland, 1989):

$$RCA_i = E_{ij} / E_{Tj} : E_{iN} \quad (3)$$

where:

E - export in terms of value (USD/EUR),

i - analysed group of goods,

j - analysed country,

N - all countries,

T - all goods.

The indicator takes values from 0 to infinity. If $RCA > 1$, the agri-food industry of a given country has revealed comparative advantages, and therefore it is competitive. If, on the other hand, $0 < RCA < 1$, the analysed country has no revealed comparative advantages in global exports (Szczepaniak, 2017).

4. The Grubel-Lloyd Index (GL) measures the intensity of intra-industry trade. It is calculated according to the formula (Grubel & Lloyd, 1975):

$$GL = 1 - |E_{ij} - I_{ij}| : (E_{ij} + I_{ij}) \quad (4)$$

where:

E - export in terms of value (USD/EUR),

i - analysed group of goods,

j - analysed country.

The indicator takes values in the range (0.1). Level 0 means that all exchange has the nature of an inter-industry exchange (only exports or only imports of food products occur). Level 1 means that the entire exchange is of an intra-industry nature (the value of exports equals the value of imports) (Kowalska et al., 2017).

To determine the ranking of the V4 countries with the highest competitiveness in international trade in agri-food products, the partial indicators, i.e., EMS, TC, RCA, GL, were

standardized (using a program), on the basis of which the so-called summary index of competitiveness (i.e., the arithmetic mean of the four partial indices).

The agri-food industry has been defined on the basis of the international nomenclature of the uniform classification of products, i.e., the Harmonized Commodity Description and Coding System, or HS for short. This nomenclature is used by over 200 countries worldwide, including the European Union, China, the United States, and Japan. The analysed data concerned the value of exports, imports, and the agri-food industry's trade balance in the V4 Group countries in 2001-2019. The source of all data was the International Trade Statistics TRADE MAP - ITC.

3. Results and Discussion

3.1. Value of Trade in the V4 Countries with Products of the Agri-food Industry

The data analysis showed that the exports of agri-food industry products in individual V4 countries in the years 2001-2019 varied (Fig. 1). Among the V4 countries, the highest value of exports, both in the last year and in the entire analysed period, was achieved by Poland while the lowest values were recorded in Slovakia. The value of exports of agri-food products in individual countries of the V4 Group in 2019 amounted to Poland (EUR 30.84 billion), Hungary (EUR 9.35 billion), the Czech Republic (EUR 7.71 billion), and Slovakia (EUR 2.91 billion). The value of exports of agri-food products of these countries increased in relation to the exports carried out in 2001, respectively: Poland - almost 8.4-fold, Slovakia - more than 4.6-fold, the Czech Republic - over 4.3-fold and Hungary - 3.2-fold. The average annual increase in the value of exports of agri-food industry products in the years 2001-2019 in individual V4 countries was, respectively: Poland on average by EUR 1.568 billion, Hungary by EUR 0.4097 billion, the Czech Republic on average by EUR 0.399 billion and Slovakia by on average EUR 0.156 billion. In the case of all V4 countries, the fit of the trend line was at a very good level - above 0.8, which may indicate a further possible increase in the value of exports of agri-food industry products from these countries to international markets.

Import of agri-food products has also been growing in the countries discussed, although not as fast as exports. In 2019, agri-food industry products with a total value of over EUR 41.2 billion were imported to the V4 countries. The largest amounts of products were imported to Poland; these were commodities with a total value of almost EUR 20.6 billion, while the smallest quantity of goods, worth EUR 4.79 billion - were imported to Slovakia. In 2019, the value of imported agri-food products, compared to 2001, increased in all V4 countries. The most significant upturn showed Poland (more than 4.5-fold), then Hungary (almost 4-fold), and Slovakia (nearly 3.9-fold). The smallest one was found in the Czech Republic (approximately 3.7 times). The average annual increase in the value of imports of agri-food industry products in the years 2001-2019 in individual V4 countries was, respectively: in Poland by an average of EUR 0.979 billion, in the Czech Republic by an average of EUR 0.432 billion, in Hungary by an average of EUR 0.274 billion, and in Slovakia by an average of EUR 0.227 billion.

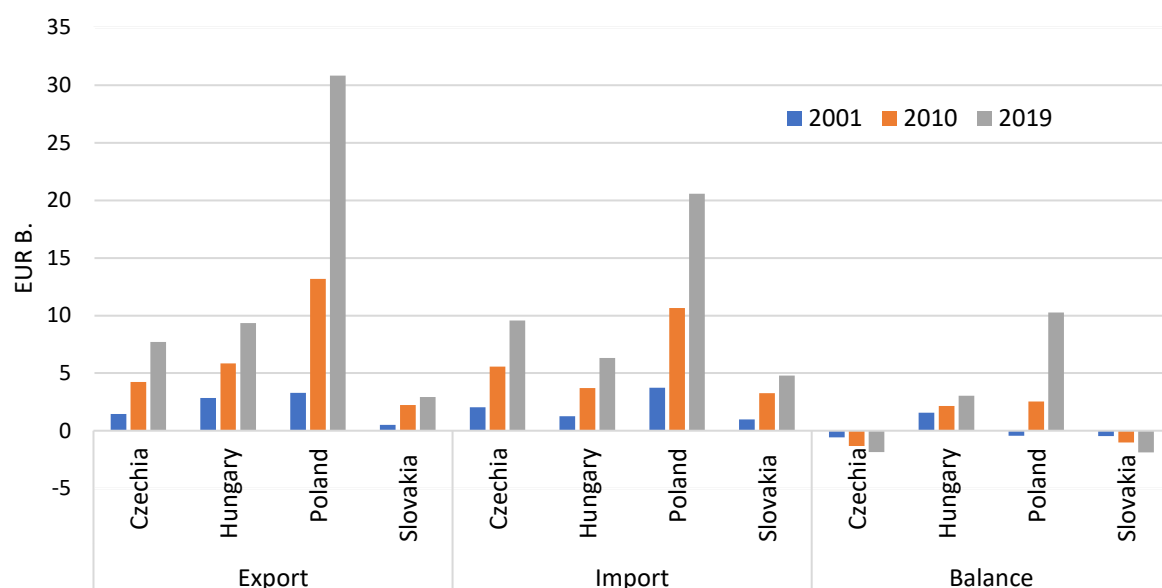


Figure 1. Exports, imports and the balance of trade in agri-food products in the V4 countries in 2001-2019. (International Trade Centre, 2020).

The exchange balance assessment showed that only Hungary in the discussed countries showed a positive balance of turnover. Poland started to achieve a positive trade balance after 2002, while the Czech Republic and Slovakia showed a negative turnover balance throughout the analysed period, proving that these countries were net importers of agri-food products throughout the analysed period.

3.2. Assessment of the International Competitiveness of the Agri-food Industry of Individual V4 Countries

One of the most frequently used international competitiveness measures is the share in the export market (Doryń, 2019). In the years 2001-2019, Poland was of the greatest importance in the global export of agri-food products among the V4 group countries (Fig. 2). In 2019, the share of agri-food products exported from Poland to the world market amounted to 2.17% of the total agri-food exports, while the share of agri-food exports from other V4 Group countries in the global export of these products did not exceed 0.7%. In the analysed period, the share of Polish agri-food exports in global exports increased in relation to its value in 2001 by 1.53 pp. The share of other countries of the V4 Group in the global structure of exports of agri-food products also increased in the analysed period, but it was lower than in Poland, and in relation to the value of 2001, it increased by 0.26 pp in the Czech Republic and by 0.1 pp - in both Hungary and Slovakia. Annually, this share in the years 2001-2019 increased on average in the case of Poland by 0.078 pp, and the fit of the trend line was at the level of $R^2 = 0.92$. The Czech Republic also showed a good fit ($R^2 = 0.72$), however, the average annual increase in the export share structure in the analysed period was only 0.014pp in the Czech Republic case. A linear trendline's R^2 0.7 is high, which means that both countries' upward trend should continue in the coming years.

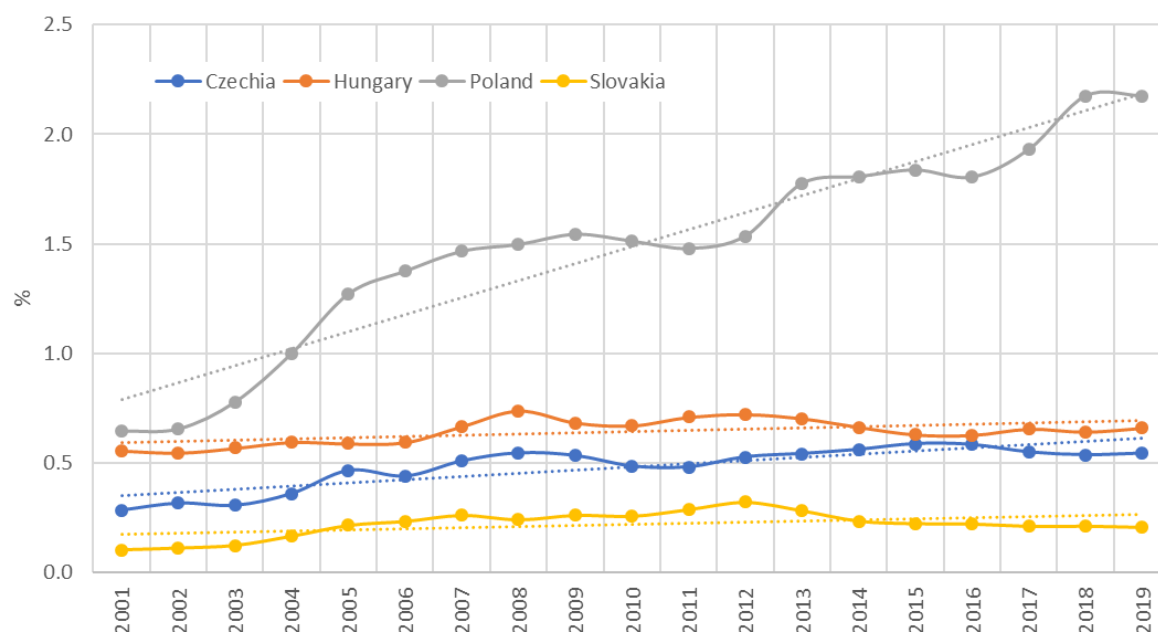


Figure 2. Indicators of the exports share of the V4 countries in the total exports of food industry products in 2001-2019. (International Trade Centre, 2020).

An important indicator to assess international competitiveness is the TC indicator, which shows the relationship between the value of exports and the value of imports (Rubaj, 2019). The values of this coefficient exceeding 1 mean the specialization of the studied country, which allows for the conclusion that it has a relative advantage over its partners (Lubiński et al., 1995; Pawlak et al., 2010). A trade deficit, i.e., a value below 1, indicates a weak position on international markets. A positive trade balance throughout the analysed period was shown by Hungary, while Poland reached the value of the indicator above 1 from 2003 (Fig. 3), and therefore it can be assumed that these countries are net exporters of agri-food products. The highest relative trade surplus among the surveyed countries was recorded in Hungary, especially in 2001, when the TC index was 2.24. In the following years, the value of TC index in Hungary's case showed a downward trend (a decrease of the index by 0.34 compared to 2001). The opposite situation was observed in the case of Poland, wherein the years 2001-2019, the TC index showed an upward trend, which means that the net surplus in this country was increasing year by year (the growth of the ratio by 0.7 compared to 2001). In 2019, both Poland and Hungary recorded a similar value of the TC indicator (at the level of 1.5). In three out of the four analysed countries, i.e., in the case of Poland, the Czech Republic, and Slovakia, the improvement in the international trade balance was related to an increase in exports. At the same time, there was also a systematic but much slower increase in the import of agri-food products in these countries. In the case of Hungary, the decrease in the coverage of imports with exports was due to a greater increase in the value of imports than the value of exports.

Countries from the V4 group, which were net importers of agri-food products throughout the examined period, i.e., showed a negative balance in foreign trade in the analysed products, are the Czech Republic and Slovakia. The net importer with an increase in import-export coverage was Slovakia. The value of TC index for Slovakia increased by

15.6% compared to 2001. In 2012, Slovakia showed the highest value of the TC index (0.9) in the analysed years. On the other hand, the Czech Republic is one of the net importers with a decrease in the coverage of imports with exports in the research period. In 2019, the Czech Republic recorded a 7% decrease in the value of the TC index compared to 2001. In the case of the Czech Republic, the highest TC value of 0.82 was recorded in 2015.

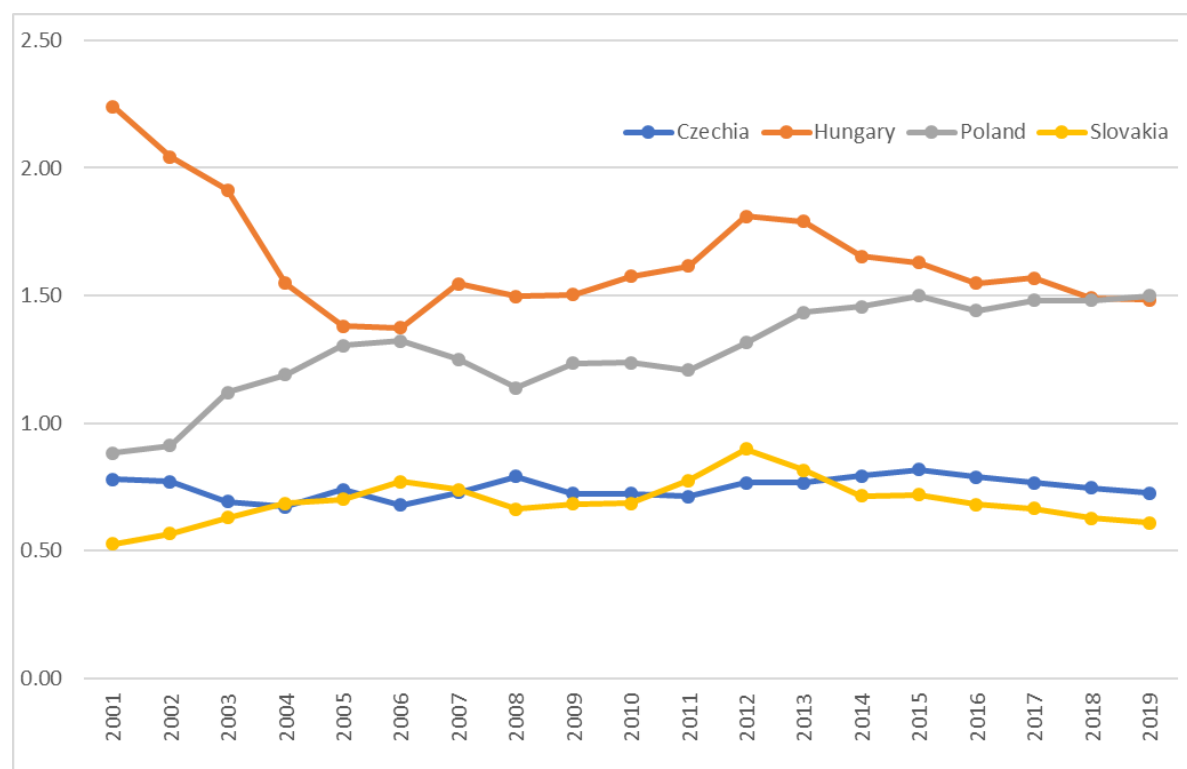


Figure 3. TC indicators in the global export of agri-food industry products of the V4 Group countries in 2001-2019. (International Trade Centre, 2020).

Another important indicator evaluating countries' competitiveness is the assessment of the revealed comparative advantages (Szczepaniak & Wigier, 2020). It is assumed that the agri-food industry is competitive if the country has revealed comparative advantages. This means that the share of agri-food products in a given country's total exports is higher than the share of these products in global exports.

The RCA index level above 1 and the revealed comparative advantages were achieved in the entire period under study in only one country belonging to the V4 Group - Poland. On the other hand, in Hungary, the value of this indicator fluctuated in the analysed period, and in most years of the research period, it exceeded the value of 1 (Fig. 4). In Poland, in the years 2001-2019, the RCA level ranged from 1.05 in 2002 to 1.64 in 2013. On the other hand, in Hungary, comparative advantages (ranging from 1.01 to 1.29) were achieved in the years 2001-2002; 2008-2015, 2017 and 2019. The RCA level below 1 in the entire analysed period was recorded in the other 2 countries of the V4 Group. The Czech Republic and Slovakia did not achieve comparative advantages. It was only Poland which, among the countries of the V4 Group, strengthened its competitive position compared to 2001. The value of the indicator

increased by almost 45%. In other countries, the value of the indicator decreased compared to 2001.

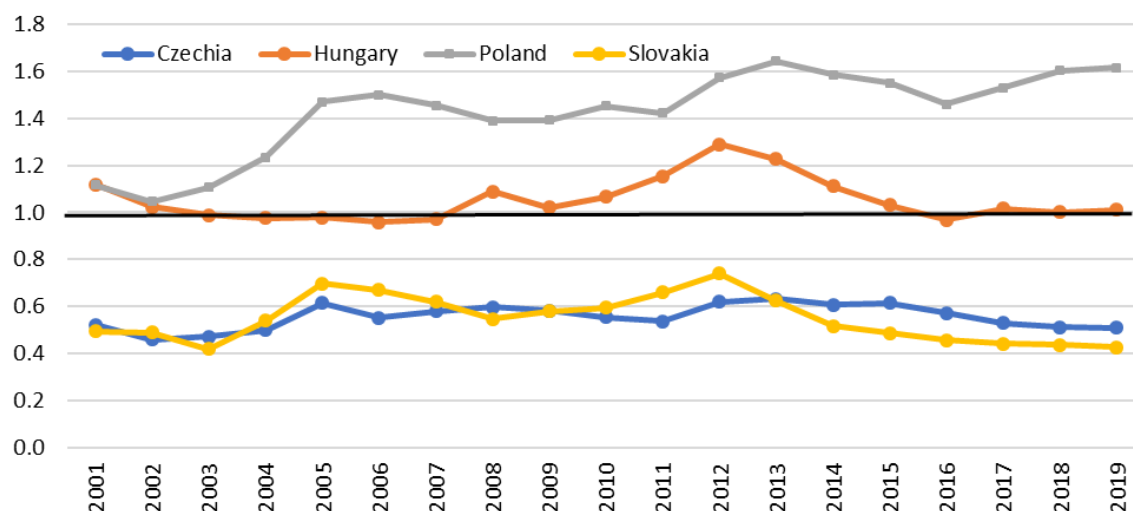


Figure 4. RCA indicators in the global export of agri-food products from the V4 Group countries to the world market in the period 2001-2019. (International Trade Centre, 2020).

The analysis of the intensity of intra-industry trade in products of the agri-food industry in individual V4 Group countries showed that in the analysed years, the volume of intra-industry exchange fluctuated. However, in all examined countries, at least 60% of the exchange was intra-industrial (Fig. 5).

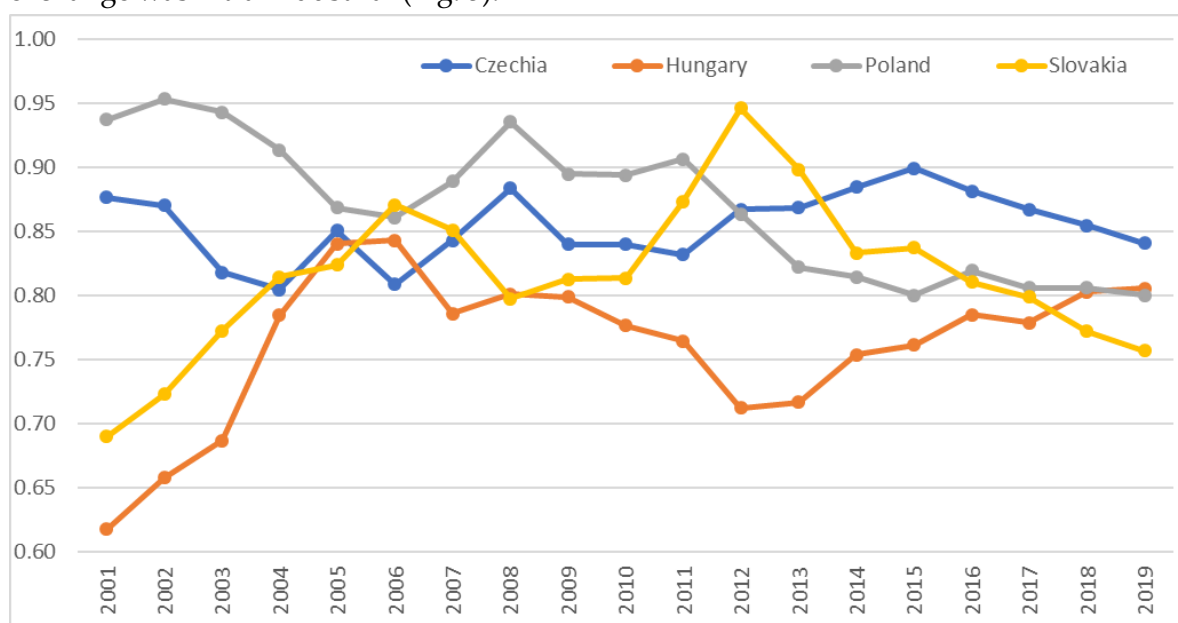


Figure 5. Grubel-Lloyd indicators in the world exports of agri-food products of the V4 Group countries in 2001-2019. (International Trade Centre, 2020).

In 2019, the Czech Republic had the highest level of intra-industry trade among the V4 countries (84%). In 2001-2019, the intra-industry trade level in the Czech Republic was high, ranging from 80% in 2004 to 90% in 2015.

Among the V4 countries, Poland had the highest level of intra-industry trade in 2001-2011 (excluding 2006, when Slovakia overtook it). However, since 2008, there has been a systematic decrease in the intensity of intra-industry trade in Poland's case. A similar trend has also occurred in Slovakia since 2012. The share of intra-industry trade in Hungary in the analysed period was relatively low, although increasing again since 2012.

The calculated partial indices (EMS, TC, RCA, GL), obtained by individual countries of the V4 Group, were standardized. Then, on their basis, the total index of international trade competitiveness of the agri-food industry products of the countries in question in 2001-2019 was calculated, (Fig. 6).

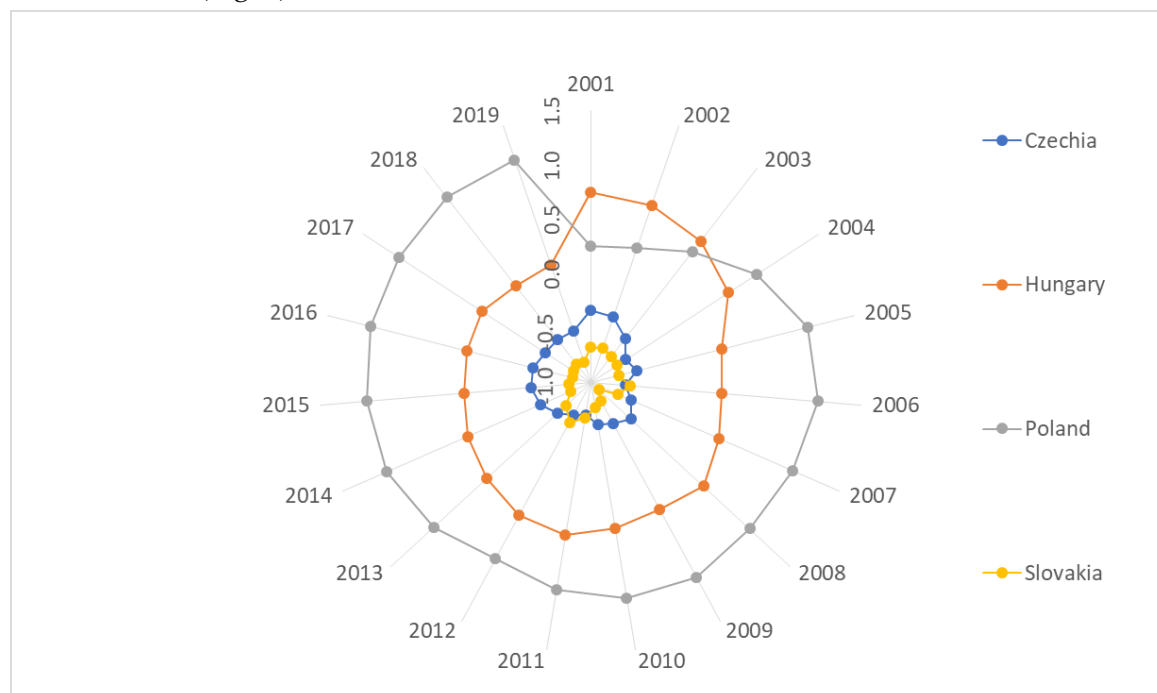


Figure 6. Ranking of the V4 Group countries' competitiveness in international trade in agri-food industry products based on a cumulative index. (International Trade Centre, 2020).

The obtained data showed that by 2003, Hungary achieved the best position in international trade among the V4 countries, while since 2004 (i.e., since the countries joined the European Union), Poland took the first position, and in subsequent years strengthened its advantage over other V4 countries. Slovakia was the last country in the ranking of the competitiveness of international trade in agri-food products in almost the entire analysed period (except for the years 2006, 2011 and 2012, when it was ranked 3rd, ahead of the Czech Republic).

4. Conclusions

The volume of foreign trade turnover of individual countries of the V4 group varied significantly, which is obviously largely related to their size and production potential of individual goods. However, general trends of changes are important in the analysis of data on the volume and value of foreign trade.

The entry of these countries into the uniform EU market and the significant opportunities for trade expansion were siezed in different degrees of success regarding agri-food products.

The highest growth dynamics of agri-food exports was recorded in Poland. The Czech Republic and Slovakia had a nearly two-fold lower increase in exports. The lowest dynamics characterized Hungarian exports among the analysed countries.

Simultaneously, a consequence of the opening of markets within the Community was also an increase in imports. In the case of Poland, however, imports increased to a much lesser extent than exports. In the case of the Czech Republic and Slovakia, the scale of growth in imports and exports in 2019 compared to 2001 was similar. The increase in the value of imports of agri-food products to Hungary was more significant than in the case of exports. Despite this, only Hungary recorded a positive foreign trade balance in the analysed group of goods in the entire research period. The Czech Republic and Slovakia showed a negative foreign trade balance throughout the period. The dynamic growth in exports in Poland's case resulted in the permanently positive turnover balance recorded since 2003.

The reported values of RCA indicators also prove the favourable competitive position in international trade in agri-food products. In the entire analysed period, the values of these indicators for Poland were higher than 1. In most years of the analysed period, in the case of Hungary, they were close to one. In 7 out of 19 examined years, they took more favourable values, but usually much lower than Poland's case. The RCA index values for the Czech Republic and Slovakia indicate a permanent lack of comparative advantages in trade in agri-food products.

Competitiveness indicators calculation summary allowed the assessment of the V4 countries' competitive positions and to follow the changes taking place over time. After the European Union's accession, Hungary's competitive position deteriorated, while Poland's position improved significantly. Compared to these countries, the Czech Republic and Slovakia's position was much worse and did not change significantly in the analysed years.

References

- Balassa, B. & Noland, M. (1989). Revealed Comparative Advantage in Japan and the United States. *Journal of International Economic Integration*. 4(2), 8–22. <https://doi.org/10.11130/jei.1989.4.2.8>
- Carraresi, L. & Banterle, A. (2008). *Measuring competitiveness in the EU market: a comparison between food industry and agriculture*. (European Association of Agricultural Economists 2008 International Congress). European Association of Agricultural Economists. <http://ageconsearch.umn.edu/record/43692/files/187.pdf>
- Doryń, W. (2019). Diversification of countries in terms of the share of domestic added value in exports. *The Polish Statistician*, 64(7), 32–47, <https://doi.org/10.5604/01.3001.0013.7603>
- Grubel, H. G., & Lloyd P. J. (1975). *Intra-Industry Trade: The Theory and Measurement of Intra-Industry Trade in Differentiated Products*. Macmillan.
- Hämäläinen, T. J. (2003). *National competitiveness and economic growth: the changing determinants of economic performance in the world economy*. Elgar.
- International Trade Centre. (2020). *Trade Map* [Data set]. Retrieved December 1, 2020, from <https://www.trademap.org/Index.aspx>
- Kowalska, A., & Gukowa, K. (2020). Development of Organic Farming in The V4 Group Countries After Accession to The European Union-Comparative Analysis. In S. Khalid (Ed.), *Proceedings of the 35th IBIMA Conference* (pp. 187-196). IBIMA Publishing Academic Publisher.
- Kowalska, A. (2017). Polsko-niemiecka wymiana handlowa produktami rolno spożywczymi. *Zeszyty Naukowe SGGW w Warszawie - Problemy Rolnictwa Światowego*, 17(2), 106–115. <https://doi.org/10.22630/PRS.2017.17.2.30>
- Kowalska, A., Tarnowska, A. & Kovárník, J. (2017). Polish - Czech Trade in Agri-Food Products Before and after Accession to the European Union. In P. Jedlička, P. Marešová, I. Soukal (Eds.), *Hradec Economic Days 2017*

- (pp. 449–459). University of Hradec Králové.
https://uni.uhk.cz/hed/site/assets/files/1046/proceedings_2017_1.pdf
- Kraciński, P. (2018). Konkurencyjność polskiego eksportu jabłek na rynki Wspólnoty Niepodległych Państw. *Zeszyty Naukowe SGGW w Warszawie - Problemy Rolnictwa Światowego*, 18(4), 13–22.
<https://doi.org/10.22630/PRS.2018.18.4.93>
- Latruffe, L. (2010). *Competitiveness, Productivity and Efficiency in the Agricultural and Agri-Food Sectors* (OECD Food, Agriculture and Fisheries Papers No. 30). <https://doi.org/10.1787/5km91nkdtd6d6-en>
- Lubiński M., Michalski T., & Misala, J. (1995). *The international competitiveness of the economy. The concept and method of measurement*. Instytut Rozwoju i Studiów Strategicznych.
- Misala, J. (2011). *Międzynarodowa konkurencyjność gospodarki narodowej*. Polskie Wydawn. Ekonomiczne.
- Molendowski, E. (2014). The V4 Group Countries – Changes in Intra-industry Competitiveness of their Economies During the World Financial and Economic Crisis. *Procedia - Social and Behavioral Sciences*, 110, 1006–1013. <https://doi.org/10.1016/j.sbspro.2013.12.947>
- Mróz, J. (2016). Determinants and measures of the international competitiveness of the economy, In P. Urbanek, & E. Walińska (Eds.) *Economics and management science in the conditions of European integration* (pp. 15–29). Wydawnictwo Uniwersytetu Łódzkiego.
- Nosecka, B., & Pawlak, K. (2014). *Wybrane problemy konkurencyjności sektora rolno-spożywczego w Polsce i Unii Europejskiej*. Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej– Państwowy Instytut Badawczy.
- Olczyk, M. (2008). *Konkurencyjność: teoria i praktyka; na przykładzie polskiego eksportu artykułów przemysłowych na unijny rynek w latach 1995 - 2006*. CeDeWu.
- Olszańska, A. (2016). Handel zagraniczny Polski produktami mięsnymi w latach 1996-2014 – ocena tendencji na podstawie wybranych wskaźników. *Zeszyty Naukowe SGGW w Warszawie - Problemy Rolnictwa Światowego*, 232–241. <https://doi.org/10.22004/AG.ECON.244348>
- Pawlak, K., Kołodziejczak, M., & Kołodziejczak, W. (2010). Konkurencyjność sektora rolno-spożywczego nowych krajów członkowskich UE w handlu wewnątrzwspólnotowym. *Zagadnienia Ekonomiki Rolnej*, 1, 126-142.
- Poland Statistical Office. (2018). *Produkcja i handel zagraniczny produktami rolnymi w 2017 r.* (Analizy statystyczne). Poland Statistical Office. <https://stat.gov.pl/en/topics/agriculture-forestry/agricultural-and-horticultural-crops/production-and-foreign-trade-of-agricultural-products-in-2017,1,6.html>
- Rubaj, P. (2019). Teoretyczny i praktyczny wymiar międzynarodowej konkurencyjności gospodarki. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie*, 6(984), 7-24
- Schwab, K. (2019). *The Global Competitiveness Report 2019* (Insight Report). World Economic Forum.
http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
- Szczepaniak, I., & Wigier, M. (2020). Polski biznes rolno-spożywczy wczoraj i dzisiaj – czynniki sukcesu. In R. Przygodzka & E. Gruszewska (Eds.), *Instytucjonalne i strukturalne aspekty rozwoju rolnictwa i obszarów wiejskich. Księga poświęcona pamięci dr hab. Adama Sadowskiego Profesora Uniwersytetu w Białymstoku* (pp. 233–256). Wydawnictwo Uniwersytetu w Białymstoku. <https://doi.org/10.15290/isarrow.2020.11>
- Szczepaniak, I., & Wigier, M. (2020). Polish agri-food business yesterday and today - success factors. In R. Przygodzka, E. Gruszewska (Eds.), *Institutional and structural aspects of agriculture and rural development. A book in memory of dr hab. Adam Sadowski, Professor of the University of Białystok* (pp. 233-256). Wydawnictwo Uniwersytetu w Białymstoku.
- Szczepaniak, I. (2017). Comparative advantages in Polish trade in agri-food products. In I. Szczepaniak (Ed.), *Competitiveness of Polish food producers and its determinants* (pp. 45–80). Monographs of the Multiannual Program No. 67. Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej - PIB.
- Trail, B., & Pitts, E. (1998). *Competitiveness in the Food Industry*. Springer Science & Business Media.
- Voinescu, R., & Moisoiu, C. (2015). Competitiveness, Theoretical and Policy Approaches. Towards a More Competitive EU. *Procedia Economics and Finance*, 22, 512–521. [https://doi.org/10.1016/S2212-5671\(15\)00248-8](https://doi.org/10.1016/S2212-5671(15)00248-8)

Impact of Housing Allowance and Housing Supplements in the Czech Republic

Martin KRÁL* and Martin MATĚJÍČEK

University of Hradec Králové, Hradec Králové, Czech Republic; martin.kral.2@uhk.cz;
martin.matejicek@uhk.cz

* Corresponding author: martin.kral.2@uhk.cz

Abstract: In most established countries, housing allowance and housing supplements as housing benefits play a key role. These instruments are designed to provide affordable housing at an affordable price for low-income citizens. The aim of this paper is to identify regions, with the use of cluster analysis, that are similar in terms of selected socio-economic indicators related to social housing support policies in the Czech Republic. Furthermore, the socio-demographic factors that differ significantly from region to region are identified. It turned out that the worst housing situation is in the Moravian-Silesian Region, which itself constitutes one cluster. Based on the results of the analysis of variance, it can be stated that the characteristics and thus statistically significant factors for the determination of individual clusters are only live births and deaths in addition to the number of recipients of housing benefits and aid paid. On the other hand, the situation in the area of state housing support is not surprisingly dependent on unemployment, the number of completed dwellings, nor on migration or immigration.

Keywords: housing allowance; housing supplement; public finance; Czech Republic

JEL Classification: H22; H53; R21

1. Introduction

In most established countries, housing allowance and housing supplements play a key role. These housing policy instruments are designed to provide affordable housing at an affordable price for low-income citizens. (Flambard, 2019; Kemp, 2007) Of course, the specific conditions for receiving this type of support vary from country to country.

Hykšová (2017) states that the provision of housing allowance and housing supplement contributes to reducing the number of people at risk of poverty or material deprivation. However, the payment of these entitlement benefits cannot address the cause of the problem. The benefits provided merely maintain the situation and, by increasing people's incomes, prevent them from falling into poverty and losing their housing or social exclusion. Moreover, the legislation in force is set up so that a person without income is entitled to a higher allowance and housing allowance than a person with his / her own income, because the person's income is considered when calculating these benefits and reduces the final amount of the benefit. At the same time, the allowance and the housing supplement are paid indefinitely. These facts reduce the motivation to gain economic self-sufficiency in addressing housing issues.

There are several journal articles and conference papers housing allowances in literature and expert databases. For example, a few authors have examined whether the amount of housing benefits has any effect on the price of rentals. The authors agree on the results. Kangasharju (2010) states in his study that an increase in the housing allowance of 1 Euro will cause a 60-70 cent increase in rental prices in the private sector. However, prices remain the same in the public sector. Viren (2013) analyzed the data of a set of 50,000 Finnish households who were receiving housing allowances in 2000-2008. The results reveal that an increase in the housing allowance may indeed have an impact on rental prices. The estimated increase in rent is from one third to half of the increase in the housing allowance. Similar results were also obtained by the authors Hyslop and Rea (2019) and Laferrère and Le Blanc (2004).

Other studies analyze the situation in specific countries and draw conclusions. Chen (2008) dealt with the situation in Sweden. In particular, he examined the effect of the introduction of the 1997 housing allowance reform. The situation in Norway was described by Nordvik and Sørvoll (2014) in an article entitled "Interpreting Housing Allowance: The Norwegian Case" and also in another paper by single Nordvik (2015). Norwegian situation with housing benefit also describes Ytrehus (2015). However, it specifically deals with housing allowances for elderly and their views. Grösche (2009) criticizes the situation in Germany. It points out that there is a tendency to choose cheap but energy-intensive flats to reduce government spending in case of housing allowance. This can lead to much higher energy expenditure, which is environmentally and financially inappropriate. Fallis et al. (1995) analyzed in Canada whether housing allowance program or a social housing (nonprofit housing program) is more cost effective. In most cases are programs equally costly. However, housing allowance seems to be more effective if private-sector real estate is favourably treated under income tax law. The situation with housing allowance in the Czech Republic was described by Lux and Sunega (2007) in the book called "Housing Allowances in Comparative Perspective".

Unfortunately, we did not find any scientific papers about the housing supplements as a tool for financial support of housing. This form of housing support is therefore probably used only in the Czech Republic. Also, none of the papers has yet used cluster analysis and variance analysis to determine which socio-economic indicators have a significant impact on housing allowance and housing supplement. We find this as a research gap.

The aim of this paper is to identify regions, with the use of cluster analysis, that are similar in terms of selected socio-economic indicators related to social housing support policies in the Czech Republic. Specifically, these are housing allowances and housing supplements. Furthermore, the aim is to identify socio-demographic factors that differ significantly from region to region, and thus makes it possible to identify the reasons leading to lower or higher expenditure on housing support. The analysis of variance will be used for this.

2. Situation in the Czech Republic

In the Czech Republic is the housing allowance one of the state social support benefits regulated by Act No. 117/1995, On State Social Support. The housing supplement is one of the benefits of assistance in material need, which is regulated by the Act No. 111/2006, On Assistance in Material Need. MoLSA (Ministry of Labour and Social Affairs of the Czech

Republic) is a superior authority of the Labor Office of the Czech Republic, which administers and pays the allowance and the supplement for housing. The MoLSA manages and controls its activities and decides on appeals against its decisions. Housing allowance and housing supplements are financed from the state budget, concretely from the MoLSA budget class. The MoLSA monitors on a monthly basis the number and volume of paid housing allowances. However, it does not regularly monitor and evaluate the number and structure of recipients of these benefits, although it has access to this information. (Hykšová, 2017)

The owner or tenant of a flat, who is registered in a flat for permanent residence, is entitled to the housing allowance if his housing costs exceed the product of decisive family income and a coefficient of 0.30, respectively 0.35 in Prague. (MPSV, n.d.b)

According to Act No. 117/1995, On State Social Support, housing allowance or part of it can be used without the consent of the recipient for direct payment of housing costs, so that it points to the payer's contribution to the landlord or service provider or providers of energy. In the event that the owner of the unit, as a service provider, has not paid the community of unit owners an advance for services related to the use of the apartment and a contribution to the repair fund, the lessee of the community of unit owners is considered as the service provider.

Hykšová (2017) states that the amount of the housing allowance is determined on the basis of actual or normative housing costs. The normative costs are set by the Act on State Social Support according to the number of persons in the household and the number of inhabitants of the municipality. However, actual costs may be lower than normative. The Act on State Social Support only states the amount of the so-called comparable costs for the ownership or cooperative form of housing and the costs of solid fuels. The amount of rent and costs of services provided in connection with the use of the apartment are not ceilinged. In the absence of a housing cost price map, there is a risk of artificially increasing the individual components of housing costs up to the total normative costs. In practice, applicants can purposefully increase advance payments, for example for services or electricity, thus entitling them to a housing allowance, which they can receive for three quarters, i.e. until the advance payment billing.

A person in material need is entitled to the housing supplement. It may primarily be the owner of the apartment or another person using the apartment. However, their income after reimbursement of justified housing costs, less the housing allowance, plus the living allowance paid, must be less than the amount of living. The housing supplement can receive also owner of the recreation building, a person living in the apartment, in an accommodation facility or in a non-residential area or person staying in a residential social service. (MPSV, n.d.a)

According to Act No. 111/2006, On Assistance in Material Need, the housing is set on the basis of justified housing costs up to the maximum amount that is usual in the given place. The Act on Assistance in Material Need only refers to comparable costs set out in the State Social Support Act when establishing similar housing costs for owner-occupied or cooperative forms of housing and provides a way of establishing demonstrable necessary energy consumption. Otherwise, there is no customary adjustment in place. In the absence of

a housing cost price map, there is a risk of artificially increasing the individual components of housing costs. In order to unify the procedure for determining the amount of the housing supplement, the Labor Office resolved the insufficiency of legislation by issuing an internal procedure for determining the place of usual rent for the system of benefits in material need with effect from 1st April 2015. With effect from 1st June 2017, they issued an instruction, the annex of which contains the procedure for calculating the usual amount of housing-related costs (water, sewage and central heating). The usual level of energy costs at the site is determined in cooperation with the Energy Regulatory Office. (Hykšová, 2017)

3. Methodology

This paper identifies regions that are similar in terms of selected socio-economic indicators related to social housing support policies. The added value is, in particular, the identification of factors that differ significantly from region to region, and thus makes it possible to identify the reasons leading to lower or higher expenditure on housing support.

In the first part, it first analyzes the long-term development of funds spent as housing benefits - housing allowance and housing supplement. The period 2009-2018 was chosen, i.e. it is 10 years, covering different phases of the economic cycle. The analysis uses primary data published annually in the Statistical Yearbooks by the Ministry of Labor and Social Affairs: total state expenditure on housing allowance and housing supplement, and the average monthly number of recipients of housing allowance and average monthly number of recipients of housing supplement.

In the second part, a cluster analysis is carried out. "Cluster analysis encompasses different methods and algorithms for grouping objects of similar kinds into respective categories." (Frades & Matthiesen, 2010) The aim is to identify regions that are similar in terms of the overall policy associated with state support for housing. In addition to the data related to the above-mentioned benefits, socio-demographic indicators published annually through the Czech Statistical Office (ČSÚ, 2020) are used for the cluster analysis. These are natural population growth, unemployment rate, migration balance, share of population 65+, completed dwellings, completed dwellings in family houses, live births, deaths, immigrants, and emigrants. Cluster analysis uses the average linkage (within groups) and Euclidean distance method, the total number of three clusters was chosen - the regions with the least problems to the regions with the greatest housing problems. Part of the cluster analysis is also the analysis of variance (ANOVA), thanks to which it is possible to identify variables that are statistically significant for the formation of clusters and therefore differ significantly between groups. *"ANOVA asks whether at least one of the group means of the data set differs significantly from any one or more of the other group means of the same dataset."* (Gaddis, 1998) This analysis has the potential to identify secondary problems associated with social housing policies that may not be obvious at first sight.

4. Results

In terms of long-term development, the volume of benefits paid and the number of beneficiaries in the Czech Republic has significantly increased over the last ten years. While

in 2009 the volume of paid housing allowances was “only” CZK 2.3 billion, ten years later it was CZK 7.7 billion. Even though the largest amount was paid out in 2015 (a total of CZK 9.3 billion), it is still an increase of more than three times higher. A similar trend is observed for housing supplements, whose volume was almost four times higher in 2009 compared to 2009:

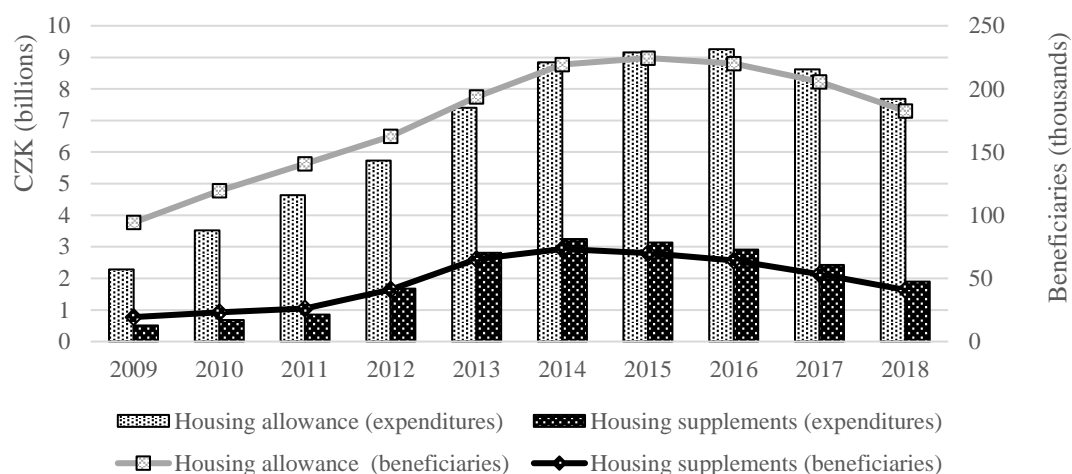


Figure 1. Expenditure on allowances and supplements to housing and average monthly number of beneficiaries in 2009–2018 (own processing based on (MPSV, 2020)).

Over the past three years, there has been a slight decrease in both the aid paid and the number of beneficiaries. To some extent, these developments correspond to very strong economic growth, which is accompanied by extremely low unemployment rate of around 2%. However, if a critical view were taken and only the number of recipients of housing benefits and unemployment rates were compared, it would be concluded that, despite the historically lowest unemployment rate, the number of recipients of housing benefits is high. It is therefore clear that other influences cause high government expenditure within these benefits. The most significant influence is the significantly rising cost of housing in recent years. These costs correspond to the property prices development, which have been experiencing an unprecedented boom in the past few years.

However, for this paper, we will not describe all the macroeconomic effects that affect property prices. Our analysis is based on the assumption that the direct factors that influence the situation in the housing market from society as a whole are the supply factor - especially the number of dwellings or houses (The smaller the supply of apartments or houses in a given location, the higher their relative price), and demand factor - especially the number and composition of the population (the higher the population and their increase, the higher the demand for flats and houses, and thus their relative price increases). Unemployment rate was chosen as an accompanying factor, as we assume natural migration of the population to locations with more job opportunities.

Cluster analysis was performed after selecting variables representing the above factors. It aimed to identify demographically similar regions and at the same time, this similarity will reflect the long-term development in the area of housing benefits. Average values over ten years were used as input data for this analysis, the target number was 3 clusters - it was

desirable to identify areas that perform best, areas that could be evaluated as “risky” and areas where is a long-term problem with the housing situation.

The following diagram illustrates the formation of individual clusters:

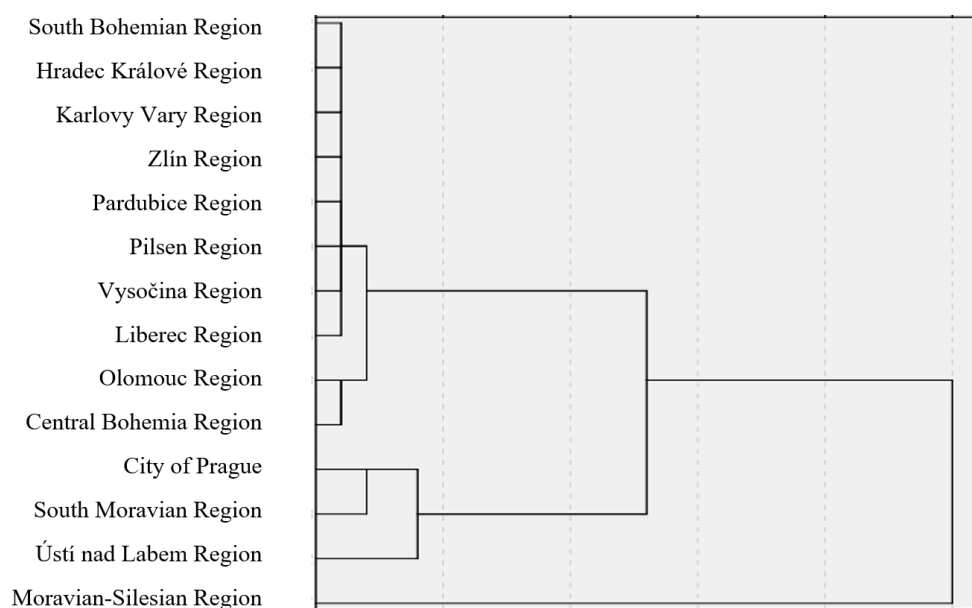


Figure 2. Cluster analysis – dendrogram using average linkage (within groups).

This confirmed the generally known information about a very bad situation in the Moravian-Silesian Region but is interested in the fact that this region itself constitutes a separate cluster. The Ústí nad Labem Region, which also reports negative information in connection with housing issues, was included together with the City of Prague and the South Moravian Region in the second cluster, which brings together areas where the situation can be assessed as risky. The last cluster consists of the remaining regions, which can thus be described as areas that are almost risk-free in terms of social housing issues. However, this does not mean that the situation in these regions is perfect, as compared to the Moravian-Silesian Region, half of the population receives housing benefits in these regions. More detailed characteristics of all clusters are given in Table 1.

In terms of population, it can be stated that there is a decline in the Moravian-Silesian Region, while other groups are characterized by (although sometimes only minimal) population growth. Paradoxically, however, while in the Moravian-Silesian Region there has been a long-term decline in population and an increasing number of completed dwellings and houses, the share of housing benefit recipients is the highest in the Czech Republic (more than 3%). The situation in the third, least risky cluster may at first glance be bad in terms of the number of completed residential properties, on the other hand, given the economic situation in these areas, the share of beneficiaries of housing benefits is below 1.5%. This fact can only be explained by a significantly different rate of unemployment and thus by an average wage. The low average wage may then be the cause of the lack of funds to cover the cost of housing and the increasing number of applications for state aid.

Table 1. Final Cluster Centers.

	Cluster		
	Moravian-Silesian Region	South Moravian Region, Ústí nad Labem Region City of Prague,	Karlovy Vary Region, Hradec Kralove Region, Liberec Region, Olomouc Region, Pardubice Region, Pilsen Region, Central Bohemia Region, South Bohemian Region, Vysočina Region Zlín Region
Natural population growth	-1,142.2	989.3	155.6
Unemployment rate (%)	9.14	7.58	7.43
Migration balance	-2,710.10	3,095.00	1,287.30
Share of population 65+ (%)	16.02	17.05	17.28
Completed dwellings	2,453.90	3,388.20	1,708.60
Completed dwellings in family houses	1,752.40	1,116.30	1,188.90
Live births	12,200.00	12,026.50	6,384.30
Deaths	13,342.20	11,037.30	6,228.70
Immigrants	24,557.40	29,598.90	16,348.00
Emigrants	27,267.50	26,503.80	15,060.70
Housing allowance (thousands CZK)	1,383,900.60	860,713.10	274,768.50
Share of beneficiaries of housing allowance (%)	3.17%	1.98%	1.37%
Housing supplements (thousands CZK)	507,509.40	203,990.30	89,590.00
Share of beneficiaries of housing supplements (%)	1.02%	0.51%	0.36%

To determine which factors resp. variables are essential for clusters determination and therefore statistically significantly differ between clusters, an analysis of variance (ANOVA) was performed. Its results are shown in Table 2.

Based on the results of the analysis of variance, it can be stated that the characteristics and thus statistically significant factors (at the level of significance $\alpha = 0.05$) for the determination of individual clusters are only live births and deaths in addition to the number of recipients of housing benefits and aid paid. On the other hand, the situation in the area of state housing support is not surprisingly dependent on unemployment, the number of completed dwellings, nor on migration or immigration. This result means that no statistically significant dependence has been identified between these clusters - therefore it cannot be explicitly stated that the low unemployment rate has a positive impact on the housing situation (due to higher employment and higher incomes of the population, the number of recipients of housing benefits is decreasing.). Similarly, no statistically significant level of dependence has been identified for the number of completed dwellings and multi-dwelling buildings - again it cannot be argued that a higher supply of housing increases the availability of housing and reduces the number and volume of benefits paid.

Table 2. ANOVA.

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Natural population growth	1,832,939.36	2	741,340.42	11	2.472	0.130
Unemployment rate (%)	1.33	2	2.51	11	0.531	0.602
Migration balance	12,818,869.68	2	14,781,168.07	11	0.867	0.447
Share of population 65+ (%)	0.73	2	0.98	11	0.747	0.496
Completed dwellings	3,314,508.44	2	2,715,306.01	11	1.221	0.332
Completed dwellings in family houses	162,404.26	2	1,193,976.70	11	0.136	0.874
Live births	46,190,864.33	2	9,821,526.16	11	4.703	0.033
Deaths	43,414,766.20	2	5,895,627.42	11	7.364	0.009
Immigrants	214,919,502.58	2	116,676,121.34	11	1.842	0.204
Emigrants	193,577,437.05	2	51,896,212.89	11	3.730	0.058
Housing allowance (thousands CZK)	836,530,321,708.36	2	7,674,095,903.04	11	109.007	0.000
Share of beneficiaries of housing allowance (%)	1.70	2	0.28	11	6.015	0.017
Housing supplements (thousands CZK)	862,700,174,33.45	2	3,235,827,905.91	11	26.661	0.000
Share of beneficiaries of housing supplements (%)	0.21	2	0.05	11	4.261	0.043

5. Discussion and Conclusion

While in 2009 the volume of paid housing allowances was “only” CZK 2.3 billion, ten years later it was CZK 7.7 billion. A similar trend is observed for housing supplements, which in 2018 were almost four times higher than in 2009. Furthermore, a cluster analysis was carried out to identify regions in the Czech Republic that are similar in terms of overall policy related to state housing support. It turned out that the worst situation in terms of state spending on housing benefits was in the Moravian-Silesian region in the long term. For ten years, the largest share of the population receiving both housing allowance and housing supplement has lived in this region. The fact that comparable housing construction has been comparable to that in other regions of the Czech Republic does not alter this situation - it is therefore evident that housing policy alone does not have a major impact on the situation in terms of state spending on housing benefits.

It is interesting to note that other regions have been evaluated as risky, which at first glance is problem-free in terms of the socio-economic situation. It is especially the capital city of Prague and the region of South Moravian Region. Although the average wage in Prague is about thousands of crowns higher than the national average, the share of housing benefit recipients is comparable to that in the Ústí nad Labem Region. The reason is undoubtedly rising property prices, which are rising much faster than wages. Therefore, many people are entitled to state aid despite their relatively higher incomes.

We agree with the audit conclusion from the NKÚ (2018) that the provision of housing allowances and supplements contributes to reducing the number of people at risk of poverty or material deprivation, but the payment of these benefits does not address the cause of the problem. The benefits provided merely maintain the situation and, by increasing people's

incomes, prevent them from falling into poverty and losing their housing or social exclusion. In the Czech Republic, under the legislation, persons without income are entitled to a higher allowance and housing supplement than persons with their own income. This fact undoubtedly reduces the motivation to gain economic self-sufficiency.

Indeed, by supporting housing (housing benefits), the state artificially increases the incomes of the population, which are intended to cover the cost of housing, thus essentially stimulating demand. By stimulating demand, rent prices are rising (this fact was already confirmed by the following authors: Kangasharju (2010), Viren (2013), Hyslop and Rea (2019), Laferrère and Le Blanc (2004) and state expenditures on social benefits are even higher. There is no doubt that this is not the only reason, but we are convinced that, together with increasing social benefits, market distortions and inefficiencies that could not stand up in the face of free competition - such as, for example, miserable conditions in northern Bohemia or around Ostrava, from which their owners demand disproportionately high rents. Unfortunately, people in an unfavorable social situation have no choice but to accept their offers. Real estate owners or those who can now obtain a mortgage loan to acquire investment property (Hedvicakova & Svobodova, 2016; Hedvicakova & Pozdilkova, 2015) are becoming major winners who take socially weak people hostage. The main loser is then the state because it devotes billions of crowns every year to maintain the existing system, which in the long term does not solve the essence of the problem or even make it worse.

Acknowledgments: The work was supported by the internal project “SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept”, 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic.

References

- Act No. 111/2006, *On Assistance in Material Need*. Czech Republic. The Parliament of The Czech Republic.
<https://www.zakonyprolidi.cz/print/cs/2006-111/zneni-20190101.htm?sil=1>
- Act No. 117/1995, *On State Social Support*. Czech Republic. The Parliament of The Czech Republic.
<https://www.zakonyprolidi.cz/print/cs/1995-117/zneni-20210101.htm?sil=1>
- Chen, J. (2008). The Effects of Housing Allowance Benefit Levels on Recipient Duration: Evidence from the Swedish 1997 Reform. *Urban Studies*, 45. <https://doi.org/10.1177/0042098007085967>
- ČSÚ. (2020). *ČSÚ a územně analytické podklady*. Retrieved March 14, 2020, from
https://www.czso.cz/csu/czso/csu_a_uzemne_analyticke_podklady
- Fallis, G., Hosios, A. J., & Jump, G. V. (1995). Housing Allowances, Nonprofit Housing, and Cost-Effective Program Choice. *Journal of Housing Economics*, 4(2), 136–152. <https://doi.org/10.1006/jhec.1995.1007>
- Flambard, V. (2019). Housing allowances: still struggling to make ends meet. *Housing Studies*, 34(4), 688–714.
<https://doi.org/10.1080/02673037.2018.1468420>
- Frades, I., & Matthiesen, R. (2010). Overview on Techniques in Cluster Analysis. In R. Matthiesen Ed., *Bioinformatics Methods in Clinical Research* (pp. 81–107). Humana Press. https://doi.org/10.1007/978-1-60327-194-3_5
- Gaddis, M. L. (1998). Statistical Methodology: IV. Analysis of Variance, Analysis of Co variance, and Multivariate Analysis of Variance. *Academic Emergency Medicine*, 5(3), 258–265.
<https://doi.org/10.1111/j.1553-2712.1998.tb02624.x>
- Grösche, P. (2009). *Housing, Energy Cost, and the Poor – Counteracting Effects in Germany’s Housing Allowance Program* (Working Paper No. 110). Ruhr Economic Papers. <https://www.econstor.eu/handle/10419/29941>
- Hedvičáková, M., & Pozdílková, A. (2015). Multi-Criteria Analysis for the Most Efficient Selection of Bank Account for Young People. In *Proceedings of the 7th International Scientific Conference Finance and Performance of Firms in Science, Education and Practice 2015* (pp. 234–241). Tomas Bata University in Zlín.

- Hedvičáková, M., & Svobodová, L. (2016). Development and the Current Situation of the Mortgages for the Czech Households. In *Proceedings of the 13th International Scientific Conference of the European Financial Systems 2016* (pp. 234–241). Masaryk University.
- Hykšová, H. (2017). *Kontrolní závěr z kontrolní akce 17/02 Podpora sociálního bydlení jako součást politiky sociálního začleňování*. NKÚ. <https://nku.cz/assets/kon-zavery/K17002.pdf>
- Hyslop, D. R., & Rea, D. (2019). Do housing allowances increase rents? Evidence from a discrete policy change. *Journal of Housing Economics*, 46, 101657. <https://doi.org/10.1016/j.jhe.2019.101657>
- Kangasharju, A. (2010). Housing Allowance and the Rent of Low-income Households. *The Scandinavian Journal of Economics*, 112(3), 595–617. <https://doi.org/10.1111/j.1467-9442.2010.01615.x>
- Kemp, P. (2007). *Housing allowances in comparative perspective*. Policy Press.
- Laferrière, A., & Le Blanc, D. (2004). How do housing allowances affect rents? An empirical analysis of the French case. *Journal of Housing Economics*, 13(1), 36–67. <https://doi.org/10.1016/j.jhe.2004.02.001>
- Lux, M., & Sunega, P. (2007). Housing allowances in the Czech Republic in comparative perspective. In *Housing allowances in comparative perspective*. Policy Press. <https://doi.org/10.1332/policypress/9781861347541.003.0011>
- MPSV. (2020). *Statistická ročenka z oblasti práce a sociálních věcí*. Retrieved March 14, 2020, from <https://www.mpsv.cz/statisticka-rocenka-z-oblasti-prace-a-socialnich-veci>
- MPSV. (n.d.a). *Doplatek na bydlení*. Retrieved March 14, 2020, from <https://www.mpsv.cz/-/doplatek-na-bydleni>
- MPSV. (n.d.b). *Příspěvek na bydlení*. Retrieved March 14, 2020, from <https://www.mpsv.cz/-/prispevek-na-bydleni>
- Nordvik, V. (2015). Housing allowances, mobility and crowded living: the Norwegian case. *Journal of Housing and the Built Environment*, 30(4), 667–681. <https://doi.org/10.1007/s10901-015-9439-4>
- Nordvik, V., & Sørvoll, J. (2014). Interpreting Housing Allowance: The Norwegian Case. *Housing, Theory and Society*, 31(3), 353–367. <https://doi.org/10.1080/14036096.2014.907199>
- Viren, M. (2013). Is the housing allowance shifted to rental prices? *Empirical Economics*, 44(3), 1497–1518. <https://doi.org/10.1007/s00181-012-0589-x>
- Ytrehus, S. (2015). The Role of the Housing Allowance for the Elderly in Norway: Views of Recipients. *Journal of Housing For the Elderly*, 29(1–2), 164–179. <https://doi.org/10.1080/02763893.2015.989775>

Imitation as a Competitive Strategy

Kazimierz KRZAKIEWICZ and Piotr BARTKOWIAK*

Poznań University of Economics and Business, Poznań, Poland, kazimierz.krzakiewicz@ue.poznan.pl;
piotr.bartkowiak@ue.poznan.pl

* Corresponding author: piotr.bartkowiak@ue.poznan.pl

Abstract: Contemporary management faces the necessity of transformation, the result of which should be the survival and proper functioning of the organization. The source of transformation can be imitation, which is just as important in business as, for example, innovation, and a strategic approach to imitation is necessary for effective and efficient innovative activity. The study attempts to present the nature and role of imitation in building competitive advantages in firms. It is posited that in addition to being a recognised phenomenon in economic sciences imitation also underpins a number of competitive strategies followed by modern-day companies. Successfully resolving the problem of compliance with the imitation object ensures success for imitators. However, if this problem is not resolved and the follower does not obtain the expected benefits, significant disruptions in building strategic advantage arise, which in turn affect the costs and risk of the activity. Therefore, at the management level of the imitator, a control division should be created that allows to determine the mismatch between the organization's activities and the expectations of various stakeholder groups.

Keywords: imitation; innovation; competitive advantages; competitive strategy

JEL Classification: M11; O31; O39

1. Introduction

Contrary to some existing views on the nature of imitative processes which peg the latter as nothing more than copying that does not deserve deeper study, imitation activity in firms plays key roles in a market economy.

At the beginning of the 19th century, it took about a hundred years to copy a modern solution. In the years 1877-1930 the time of dissemination of imitated products was shortened to 23 years, in the following years 1930-1939 it was reduced to 9 years, and in 1940-1961 even to 5 years. In the 1980s, imitators only needed 12-18 months to develop an imitation. (Mansfeld, 1985, pp. 217-223; Krzakiewicz & Cyfert, 2016b, p. 181)

The first to criticise the treatment of imitation was Israel Kirzner, a representative of the Austrian school of economics and a student of Ludwig von Mises. In his *Competition and Entrepreneurship* (1973) Kirzner addressed Schumpeter's classical view of entrepreneurship.

Kirzner noted that, as defined by Schumpeter, "entrepreneurship" is pursued by leaders – innovators and market pioneers (first movers). It is clearly contrasted with the activity of numerous "copycats" following in the footsteps of entrepreneurs. The Kirznerian view is that,

just like innovators, imitators, too, represent entrepreneurship. They take steps to exploit opportunities created as a result of the innovators' activity (Kirzner, 2010, p. 135).

It is exactly those numerous imitators – never relenting in their entrepreneurial alertness in pursuit of anything they might profitably use in their business (regardless of who developed or created it and when) – that set the market mechanism into motion. For all practical purposes, it is thanks to imitators that any innovation can materialise as far as is practicable. An increase in productivity can be noticed in business activity, because imitators can provide customers not only with a refined product, but also a much cheaper one. (Drucker, 2008) Therefore, it can be formulated that the most profitable innovations often have a large share of imitations. (Bayus et al., 2003, p. 198)

Firms imitate all the time. Nearly everything that is embraced as innovation (and often promoted as such through advertising campaigns) in reality builds extensively on the elements of imitation. Some Western experts in auditing innovative projects consider that only two percent of them are really innovative ventures. The rest are in fact imitations. They could involve major features of a product or just its small details; they could directly draw upon someone's experience, or they could result from product enhancement. The positive and negative consequences of changes in the organization in terms of imitation may be external and internal, relating to: 1) understanding and trust of employees; 2) flexibility of the organization and the ability to quickly adapt to the proposed changes, and consequently to achieve a competitive advantage; 3) recognition of the organization among all stakeholder groups; 4) the dynamics of changes, as a feature of the evaluation of the effectiveness of initiatives in the field of imitation introduced. (Jalagat, 2016, p. 1235)

In that regard, Kirzner posits that innovations and imitations are mutually complementary:

1. Innovation = artificial, perfect phenomenon.
2. Innovation + imitation = mass dissemination of innovations/new solutions.

In reality, copying alone is just a specific case of imitation – one that does not fully encompass its essence or reflect all of its diverse forms. One could say that the stereotypical understanding of imitation as plain emulation hinders the development of a general theory of imitative processes.

In the new conditions of the organization's operation, imitations refer to an increasing number of products, services or business models, becoming more and more rational due to the costs incurred and potential profits. These realities transform the imitation into an important strategic factor taken into account in every organization, because "the days of great minds are over, now the effectiveness of the strategy requires a skillful imitation". (Krzakiewicz & Cyfert, 2016a, p. 12)

2. Imitation as a Source of Competitive Advantages

The primary goal of imitation is to elicit information present in what is to be imitated and then use that information to achieve market success. A choice, a service, a technological

process, a model, or a business strategy – all of these can be the object of imitation. (Krzakiewicz & Cyfert, 2018b, p. 7)

Imitation presupposes underlying innovation. By definition, a market pioneer cannot be an imitator; after all, it has nothing to copy from. If a firm engages into copying, something must have already existed outside its organisation that the firm did not produce. In other words, imitation is not just copying but also involves dissemination and use of innovation where it has not been disseminated before.

Levitt has classified innovation by degree of their newness (Levitt, 2006, p. 2). The classification includes four kinds of innovation:

1. something that has never been done before;
2. something that has never been done in a given industry, although it is known by other industries;
3. something that is known by the industry, but has never been done in a given country;
4. something that has never been developed by the firm, although it is used by other firms from the same industry in a given country.

Except the last one, all of these cases involve an element of newness that is created for the first time (innovation). Also, except for the first one, all of them envisage a certain (different) amount of imitation. It is not by accident, therefore, that, looking at the relationship between the two, literature often examines “innovation” and “imitation” not as mutually exclusive terms but as ones that are placed along a sort of continuum, with full innovation at its one end, and full imitation at the other (Ethiraj, 2018). The latter means that all information the imitator has borrowed from the innovator as the sole source of knowledge underlying the copying process. (Krzakiewicz & Cyfert, 2017, pp. 215-216)

Products in between those two extremes on a continuum are particularly interesting. In their case, the imitator has developed, obtained from the outside and/or integrated certain other knowledge resources in addition to whatever knowledge it has copied from the innovator. Generally, such products are characterised by how they differ from what would be pure imitation and innovation. Essentially, they remain a reflection of the innovator’s product and are described as “creative imitation”. Theodore Levitt calls it creative emulation (Levitt, 2006).

Creative imitation involves improving a product that is already on the market or adapting a product that exists in another industry. A company involved in this kind of imitation is called an imovator (IMitator + innOVATOR). For an imovator, imitation is not an alternative and innovative strategy; rather, it crucially complements such strategy, ensuring the imovator’s competitiveness.

As it moves along the continuum towards its “pure innovation” extreme, innovativeness is increasing in its degree, as are its ordinary costs and the degree of risk involved. Where breakthrough innovation requires substantial expenditure and is not hedged against failure, imitation will always be less costly and its inherent risk can be determined relatively easily.

Generally, as innovativeness increases, so should a product’s potential market success (specifically, this might be reflected in its increasing sales and/or profits). If successful,

breakthrough innovation should bring huge benefits to the company that brought it on the market. That being said, one should remember that the more innovative a product is, the larger the risk involved, and not just potential success. For this reason, the expected effect will be gradually heading downwards on a growth curve: the potential for return on investment in solutions which are too revolutionary is limited by the higher risk. If events unfold according to this scenario (and while there are exceptions, it is a typical one) the maximum net result (that is, the difference between the expected effect and the expenditure) will not be achieved through high innovativeness alone. (Krzakiewicz & Cyfert, 2019, pp. 55-56)

From this perspective, it is easy to explain why it is often the case that an imitator turns out to be more effective than an innovator. The simple pattern also explains the main source of competitive imitation strategies: by spending substantially less than the innovator, an imitator will often earn at least the same revenue as the market pioneer.

It should also be emphasised that what generally leads to a positive outcome is creative rather than pure imitation. This is not surprising. A complete copy of an existing product has no significant advantages over it; indeed, it comes with a number of weak points, such as the product or its manufacturing technology being underdeveloped; being in the dark about the confidential know-how, lacking market reputation, operating a poor sales network, etc. This means that, generally, the pure imitator has to compete in what are clearly unfavourable conditions, often relying only on the impact of its lower product price.

With creative imitation, things are different. Firstly, the imitator often faces no competition at all. By adapting a known product and making its own version for the new industry, application or new national market, the imovator acts as a pioneer. Secondly, even if there is any direct market competition between the original and its modified copy, the original does not always have the competitive advantage. This is because the purpose of the adaptation process was to enhance some specific characteristics of the original

3. Competitive Processes in New Product Evolution

In most cases, when they are introduced on the market, products from pioneers are merely the first versions of what their customers expect. While there is potential in their newness, such products usually come with a number of deficiencies, hampering their development rather than giving the pioneer competitive advantage. The pioneer fails to gain the expected benefits and is forced to settle for the symbolic recognition of its mark it has left on the history of manufacturing or industry development. At the same time, a number of opportunities arise for those who follow the strategy of imitation.

Radical innovations are what especially drives product demand. For that reason, the inventors' goals need not be overly precise. Indeed, most new products out there turn out to be experimental and their consumers or users can only develop their preferences when using them. This has the following practical consequences:

1. If a new product fails to meet what is a clearly stated need, it will generally take a long time before customers embrace it, which means that one should expect product acceptance to be slow.
2. If clearly stated needs are hard to discern, it will be impossible to establish with clarity which new product variant will be appropriate. In practice, one should expect the market to become quickly flooded with different product types, all created based on what entrepreneurs predict to be what their customers really expect. (Krzakiewicz & Cyfert, 2018a, pp. 7)

In general terms, when they appear, the different innovations create some chaos. A wide range of competing product variants pops up, all having different performance characteristics and targeted towards different customer groups (although no special efforts are made in the targeting process). While the market becomes flooded with creative imitators, it is unclear for a long time which new features that were added to the original idea will hit “the bull’s eye”.

It is often the case that pioneers leave the market before sustained demand is created for their product. After the initial version of what was a successful product in the past failed to take off commercially, the pioneer may exit the market or indeed even go bust. In any such case, the future player that picks up the discarded idea will be considered an innovator, while what it did in fact was to copy that idea.

There might even be a few generations of unsuccessful pioneers. This was exactly the fate of a mobile phone, for which no competitive model could be successfully created for decades, even though how this new device functioned had been long known (this was the classic “devil is in the detail” situation).

Mobile phones are not an exception. There are numerous well-known products with a long wait time between their market launch and acceptance (e.g. 35 mm cameras – 40 years, microwave ovens – 20 years; videogames – 13 years; videocassette recorders – 13 years; credit cards – 8 years; ballpoint pens – 8 years). Also, it is not always the first innovator that enjoys commercial success. For example, it is hard to determine how many generations of pioneers have changed during the 40 years before the 35mm camera gained its market recognition.

Imitation at this stage in a product lifecycle has a specific character: imitators join the business venture when even the pioneer is unable to generate profit. In practical terms, the imitator is a copycat only in a narrow technical sense: it has copied what was the essence of an invention, in one way or the other acquiring or circumventing intellectual property rights or taking advantage that no such protection was in place. However, later in the process of commercialising innovation, the imitator in fact becomes a pioneer. It tries to solve a task nobody has undertaken before, namely, it tries to transform what has been a rather unpopular product so far into one that is in demand on the market.

Another stage in this evolution entails a consolidation wave. Here, market competition produces the winner out of a number of diverse product versions. This is the precisely the situation described by Friedrich Hayek who defined competition as a discovery procedure. The number of firms and product variants is getting smaller, very quickly at first, and then

more slowly and gradually, over a longer period. Ultimately, a specific/concrete product variant from one firm, or a small number of firms, becomes the “primary” one and starts to define its market.

The specific product model which defines the market and a narrow class of products that are put on it is described as the dominant model and its creation is a decisive event in the development of a mature market. Market players whose product underpins this dominant model gain sustainable competitive advantages, and although they are often copycats who only offer some specific product enhancements, they make a decisive contribution to market success and strengthen their reputation.

To give an example, the event that kicked off the consolidation process in the automotive industry was the launch of the Ford Model T. Importantly, H. Ford did not invent the car or the assembly line mode of production. Yet, for the public, he is the father of the automotive industry, having successfully combined the two inventions and creating the market-dominant Ford Model T.

This is actually the stage where inter-model competition transitions into one involving various variants of the same model. Companies derive their specific versions from the base product, adding to it the features which their customers have found most to their liking. This leads to the market becoming less diverse compared with the time before the dominant model was launched. The imitators’ further results at this stage become more canonical, which is an explicit consequence of the original-derived copying process.

While the products will differ from one another, those are not fundamental differences, facilitating comparisons. In their choice of one product over the others, consumers are guided primarily by the price-to-quality consideration. The most salient factor is that, once the dominant model is out there, new customers find it easier, and are more willing, to enter the market. An eccentric experimenter, who is willing to try out at his own risk something new that nobody else knows, is replaced by a reasonable client/consumer who knows precisely what product they are ready to buy, for what purpose, and at what maximum price. This is exactly the development that transforms what was initially a fragmented niche-based market into an established mass market in its own right.

Now comes the stage of evolution when groundbreaking innovations become incremental or develop gradually. Many innovations improve upon or develop the already existing products or services, allowing them to be used as before but with better effect. These gradual innovations are essentially creative imitations.

Phased innovations are determined by demand. They are usually designed to develop or expand the existing markets. Innovations of this kind usually take the form of product development or manufacturing process renewal and despite the benefits that could bring, they do not create new markets. The volume of demand may help determine which innovations will be successful on the market and which ones will end in failure.

One essential feature of creative imitations that occur in the gradual innovation process is their complex nature. Gradual innovation sees a number of product characteristics being improved simultaneously. At the same time, the product should remain within the appropriate price bracket and, as such, be manufactured at a low enough cost level. In effect,

gradual innovation is not just about the product itself, but also about its manufacturing technology. Generally, therefore, only large companies that lead the market can handle the task of complex and gradual product improvements. This points to a correlation between the size of the company and the effectiveness of its imitation strategy.

The time of market launch is therefore crucially important in executing the strategy of imitation. There is a perception that an imitator should act as quickly as possible so that it necessarily comes in second after the pioneer. As a matter of fact, the situation is significantly more complex than that and depends to a large extent on a stage in the product's life cycle and the nature of imitation itself. It is often the case that a pioneer will launch its innovation long before the established market starts showing a high growth rate. In such a case, should the imitator enter the market right after the first mover did, it will also – like the pioneer – be bogged down in what is a yet-undeveloped customer base, unable to benefit from its imitation.

Contrasting with it is a potential 'tardy imitator' situation. Here, it will be only the pioneer and the first imitators that will benefit from producing the innovation. The main group of followers enters the market when everybody already knows that the product to be copied has good prospects. As a result, there will be too many wanting to produce 'certain' innovations, effectively leading to overproduction and price wars. For that reason, the imitator should not enter the market right after the first-mover, and not when the market is maturing, but at a time when it shows the highest growth potential. It is also necessary that the imitator too has competitive advantages to strengthen its position on a growing market.

4. Competitive Processes in New Product Evolution

In order to treat imitation as something correct and part of the strategy, flexibility, openness and acceptance of changes are necessary (Henderson & Clark, 1999, pp. 9-30), however, there is an important obstacle in this regard – prejudice.

The literature describes a number of imitation strategies. While this somewhat of a simplification, they could be divided into four groups.

4.1. Price Advantage. Imitators Who Follow this Strategy Rely on Two Courses of Action

- They offer copies of an innovative product at the most affordable price possible;
- They offer a stripped-down product version at a much lower price than that offered by the pioneer (Schnaars, 2004, p. 211).

What is common to these two price strategies is that imitators seek those customers who want to use an innovative product but are not willing to pay the price at which the pioneer sells it. That said, they are not identical.

In the first variant, the strategy simply draws on what was already described as the main source of the imitator's low prices – its low costs. The lower R&D costs can lead to lower prices. It is estimated that the imitators' costs are 35-40% lower than those of innovators (Shenkar, 2010, p. 9). This difference in costs is what makes it possible to offer reduced prices or (at a given price level) provide a better quality product, distribution or maintenance

service, a longer warranty, or more financing for technological improvements. In addition to R&D spending, imitators can also save on promotion: unlike the pioneers, they do not have to pay for new product placement. Once the customers make their purchase drawn in by the innovator's advertising campaigns and see the advantages of the innovation, they can easily change their choice later on and start buying a cheaper copy of what they believe is the product with the same features as the original.

In its second variant, the low-pricing strategy is also based on the imitator's lower costs compared to those of the pioneer. However, there is an extra factor at play here: the imitator makes a deliberate decision to drop some functionalities of the innovation in order to bring it to a lower price class.

4.2. Product Advantage

In most cases, markets formed through radical innovation allow for a 'copy and improve' strategy to be employed. It is seldom the case that the pioneer gets everything right from the start. They are unable to predict exactly the direction in which the technology and the product market itself will develop. Even in those cases where the right solutions are found to the problems and the mass market is established, the imitator can still rely on this kind of strategy to offer a product that stands a chance to finding a certain market niche for itself. Indeed, apart from the general demand, there is diversity in demand for certain categories of products, with various customer groups requiring them to feature some specific features. More often than not, the pioneer is unable to cater to this and leaves global space for its imitators to develop.

In following the 'copy and improve' strategy, it is important that a future imovator has appropriate R&D resources. Accordingly, if imitation occurs at the time the pioneer's new product comes to market, this means that the imitator, too, had its own solutions in a specific area of production, but was unable to enter the market first. In such a case, the imitator tries to transform its weaknesses (being late in the leadership race) into strengths (taking advantage of the pioneer's mistakes). The imitator will borrow the essential features of the pioneering product and improve on it with ideas from its own products to arrive at a final version.

Another common situation is where imitation does not start when the new product is launched, but after its patent protection has expired, sometimes many years later. In this case, the "copy and improve" strategy is often targeted not just against the pioneer (or not so much against the pioneer) but also against pure imitators offering faithful product copies as part of their price advantage strategy.

The market that features both a well-placed pioneering product and its cheaper copies makes it difficult for another imitation to take root. It is inferior from the pioneer's product in terms of quality and reputation, while the cheaper copies outdo it in terms of price. The solution here might be the "copy and improve" strategy utilising the imitator's own R&D resources. The most important thing for the imitator is to demonstrate that, in some respects, its copy is better than the original.

4.3. Market Position Advantage

An imitation strategy can also rely on the imitator's market position advantage. The key feature of this strategy is that it does not seek for a product copy to stand out in terms of some characteristics (such as price or quality), but its purpose is to gain competitive advantage for the imitator's company. In practical terms, aware of its strength, the imitator just waits until innovation comes to and is embraced by the market and then just pushes the pioneer out of it. In fact, the market strength is one of the prerequisites for copycat companies to overtake the pioneers.

This does not mean that imitation will always ensure a competitive victory to large firms. It is not the imitator's size that is the more important factor, but the relationship between the imitator's size and that of the pioneering firm. The typical effects of large and small firms vying with each other might be as follows:

- A large imitator might be successful against a large pioneer, but its success will be very cost-intensive.
- A small imitator will stand a chance competing against a large pioneer primarily in niche markets.
- In most cases, a large imitator will gain dominance over a small pioneer and will determine the character of the new product's dominant model.
- Small imitators will operate on the market side by side with small pioneers until the new product's dominant model emerges.

Accordingly, a large pioneer will be rather invulnerable to attacks from its various imitators. To the extent innovation can be quickly brought to the stage where its dominant model emerges, the large pioneer has a chance of maintaining its competitive advantages over long term. If the pioneer's competitors include small copycat firms, they will have some chance of growth in niche markets (i.e. ones that the pioneer has no interest in).

The success of a large copycat firm's attack to undermine a large pioneering firm is not a foregone conclusion, either, as it involves an attempt to dethrone a market-dominant model using a product that is not much different from it. Changing product characteristics is not reasonable, given that the market has already embraced those of the new product. This means that the pioneer has on its side all the first-mover advantages, such as a well-honed product, an organised sales network, high reputation with customers, etc. In such a case, breaking through the defences will only be possible if there is a particularly strong consolidation of resources, but this rarely succeeds in practice.

The only exception to the "large pioneers are unassailable" rule, and one that is often seen in business, is where a pioneer whose patent protection has expired does not factor in the new reality it operates in and is not willing to reduce prices. Usually, this only ever happened when a large innovating company does not intend to fight for the market for its product (for example, because it holds another innovation in reserve).

4.4. Reducing Competitive Risk

The foregoing strategy options are offensive in nature. In turn, the competitive risk reduction strategy is primarily defensive, and its purpose is to defend incumbent companies against a market innovator (Lieberman & Asaba, 2016, pp. 366-385).

When used in this role, imitation is particularly effective (and therefore often employed) where innovation is incremental. When firms all take same actions, there is little chance that any one of them will get significantly ahead of others or that it will achieve inferior outcomes vis-à-vis the rest. Imitation thus helps to preserve the status quo among competitors, even when the rivalry in their sector is strong. In addition, at this point, one should also take into account the situation where the effects of imitation tend to decrease after the first market entry. (Guillen, 2017, pp. 514-515)

5. Discussion

Primarily, large firms have production capacity to mass produce the market-accepted innovations; additionally, they are characterised by robust marketing resources that allow them to promote their new products effectively and build their reputation. They also operate the right distribution channels they can use to sell their imitations. Finally, they have financial resources to ensure their business growth.

Small-scale pioneers are often victims of their own success. Demand for attractive innovations grows, quickly reaching the level at which small firms are unable to satisfy it. There occurs what one could term the effective innovator dilemma, which is whether to develop at a pace matching the market growth or at the innovator's natural pace, as determined by its internal resources. Therefore, Teece et al. (1997, p. 516) pointed out that the organization should achieve the appropriate dynamic capacity, i.e. "the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments" to achieve competitive advantage in range of hard-to-follow resources. (Pyle & Liker, 2014, p. 78)

The operating assumption in the first variant is that incipient demand will be satisfied. In this case, the fast-growing market requires the pioneer to produce at an equally fast pace, which might create problems internally. There is an important problem of business financing: loans are often expensive and might be unavailable for a small firm. What is more, debt might turn out to be a mine that can explode at the first sign of falling sales, for example at the onset of a crisis. Reaching out for an outside investor in such a situation might mean loss of autonomy. In practice, acquiring a pioneer is often an alternative route to imitation strategy. From a large company's perspective, creating its own copy of the innovation or taking over the pioneering firm to gain control over the original product are alternative courses of action.

In addition to its financial problems, a pioneer that tries to keep pace with a fast-growing demand will also face the problem of quality. Very often, the cost a pioneer pays for ramping up its production output rapidly is lower quality.

It is typical of quality to drop when transitioning to mass markets. The pioneer's production processes often lack stability, personnel loyalty takes a hit (a lot of new people

introducing the changes), maintenance service goes down in quality, and management mistakes crop up caused by insufficient experience navigating the mass market. In effect, when large imitators move in with the necessary resources and experience, they can often quite easily snatch the market share from the embattled pioneer.

The other solution to the effective innovator dilemma is for a firm to grow as its internal capabilities allow it, securing only that share of a growing demand that the pioneer is able to satisfy without overexploiting its own resources. Here, the problem of a too rapid growth, as mentioned above, will not arise, and the pioneer will essentially give up on its aspiration to lead as the producer of its own innovation. Gradually, the pioneer will become a niche manufacturer, with often expensive results of its activity. Seizing the opportunity to serve the market that is not occupied by the pioneer, a large imitator will start to dominate over it. Accordingly, an essential feature of the competition process is that large companies use imitation to start dominating the 'small' players as soon as the market comes a mass market.

Also, because incremental innovations are not radical, the level of information uncertainty involved is low, meaning that one can predict with precision how the market will react to whatever action is taken. There is no dilemma therefore as to which actions by competitors should be copied, and which ones should not. Essentially, copying incremental innovations is a procedure that limits the risk of an innovative competitor forging too far ahead of its competitors. The level of risk is affected in a much more complex manner by imitation in the environment of significant information uncertainty; an example could be radical innovation where company X pursues some hazardous venture (betting on electrical cars being mass produced). Market players do not know whether the bet will be successful. However, for other firms in the industry to maintain their relative competitive advantages, mimicking this behaviour will be reasonable, even under conditions of risk and uncertainty.

This will allow, in the long term, going beyond the manager's routine behavior, according to the literature on the subject, to determine the moderating influence of the context on the relationship between the company's activities and the competition. (Majora et al., 2016, p. 84)

Indeed, if imitators repeat what company X has done, and by that time the market has sufficiently matured for a share of electrical cars to grow significantly, imitation will prove to have been a rational choice for all the players. If the pioneer was wrong, however, and the long-heralded era of domination by electrical cars has failed to materialise, the pioneer and the imitators will be on the losing end. Importantly, though, everybody will have lost, meaning that nobody has lost relative to others, with everyone losing just as much. However, if competitors do not follow the example of company X, the situation will start looking like a gamble. If the market falls short on its promise, company X will be the only one to suffer losses, but the other players will have won hardly anything (just one competitor losing will not change the overall industry picture). If the market does live up to its promise, though, all competitors that have chosen not to follow company X will incur huge losses in relative terms. This is because they have given up on what turned out to be a promising market for electrical cars and handed it to just one of them. Therefore, imitating innovation even when it is uncertain does not carry a risk to any specific firm of its competitive position becoming

weaker. On the other hand, giving up on imitation might pose a great danger if the pioneer succeeds.

For this reason, the analysis of a specific industry should focus on the organization's business orientation and knowledge management strategy. Using the acquired knowledge based on Nonaka's knowledge creation theory, a model can be proposed that combines knowledge and an organization management strategy with the use of imitation and innovation processes. (Nguyen & Pham, 2017, p. 86)

6. Conclusion

The literature on the subject (Bolton, 1993) indicates that an organization achieves a competitive advantage by using knowledge in the field of innovation and imitation. Therefore, the inherent features of any innovative strategy (innovation vs. imitation) are: 1) learning processes, 2) sources of knowledge, 3) required expenditure on research and development, 4) information and its flow. In a situation of correlation between the organization's strategy and learning abilities in the organization, an improvement in effectiveness and efficiency can be observed, and consequently an increase in the competitive advantage of the organization. (Muafi & Uyun, 2019, p. 148)

More and more companies adopt business ideas from the outside in order to reduce costs and support the growth process, due to the adopted competition strategy. As a result, the organization of an imitation-oriented strategic management system attracts more and more attention of managers. Imitation is a typical form of activity that has emerged in various business conditions. The forms imitate each other in terms of new products or processes, in terms of implementing management systems and organizational solutions, methods of entering the market and directions of capital investments. In practice, there are many examples of companies using various imitation strategies as they strengthen their market position. As business ideas materialize, as the company grows, they go through certain stages that correspond to the nature of the imitative continuum. Initially, it may be a pure imitation of a new technology with a price competitive advantage in a given market. A creative element is gradually added as the company has the ability to meet the specific needs of the local market through innovation that complements the original product and meets specific customer specific needs. The success of the imitation strategy in the case of a small company may most often be related to the niche satisfaction of the recipient's needs. It is not without reason that companies of this type are described as conquerors of "blue oceans" (free market niches). As a result of the increase in the originality of its own ideas, the company begins to export its own products. The essence of the management strategy here lies in the fact that imitation of someone else's experience and own innovative activity are not alternative but mutually reinforcing processes.

References

- Bayus, B. L., Erickson, G., & Jacobson, R. (2003). The Financial Rewards of New Product Introductions in the Personal Computer Industry. *Management Science*, 49(2), 197–210.
<https://doi.org/10.1287/mnsc.49.2.197.12741>

- Bolton, M. K. (1993). Imitation versus innovation: Lessons to be learned from the Japanese. *Organizational Dynamics*, 21(3), 30–45. [https://doi.org/10.1016/0090-2616\(93\)90069-D](https://doi.org/10.1016/0090-2616(93)90069-D)
- Drucker, P. F. (2008). *The Essential Drucker: The Best of Sixty Years of Peter Drucker's Essential Writings on Management*. Harper Collins.
- Ethiraj, S. K., & Zhu, D. H. (2008). Performance effects of imitative entry. *Strategic Management Journal*, 29(8), 797–817. <https://doi.org/10.1002/smj.696>
- Guillen, M. F. (2002). Structural Inertia, Imitation, and Foreign Expansion: South Korean Firms and Business Groups in China, 1987–1995. *Academy of Management Journal*, 45(3), 509–525. <https://doi.org/10.5465/3069378>
- Henderson, R. M., & Clark, K. B. (1990). Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly*, 35(1), 9. <https://doi.org/10.2307/2393549>
- Jalagat, R. (2016). The Impact of Change and Change Management in Achieving Corporate Goals and Objectives: Organizational Perspective. *International Journal of Science and Research (IJSR)*, 5(11), 1233–1239.
- Kirzner, I. M. (2009). The alert and creative entrepreneur: a clarification. *Small Business Economics*, 32(2), 145–152. <https://doi.org/10.1007/s11187-008-9153-7>
- Kirzner, I. M. (2010). *Konkurencyjność i przedsiębiorczość*. Fijorr Publishing.
- Krzakiewicz, K., & Cyfert, S. (2016a). Innovation in shaping dynamic capabilities of organizations. *Management*, 20(2), 8–22. <https://doi.org/10.1515/manment-2015-0047>
- Krzakiewicz, K., & Cyfert, S. (2016b). Imitacja w epoce innowacji – dylemat i paradoks współczesnego zarządzania. *Prace Naukowe Uniwersytetu Ekonomicznego We Wrocławiu*, 420. <https://doi.org/10.15611/pn.2016.420.16>
- Krzakiewicz, K., & Cyfert, S. (2017). Strategie imitacji w procesie budowy przewagi konkurencyjnej. In A. Sopińska, & P. Wachowiak (Eds.), *Wyzwania współczesnego zarządzania strategicznego* (pp. 211–228). SGH Publishing House Warszawa.
- Krzakiewicz, K., & Cyfert, S. (2018a). Potential for imitation as a dynamic capability of organisation. *Management*, 22(1), 1–10. <https://doi.org/10.2478/manment-2018-0001>
- Krzakiewicz, K., & Cyfert, S. (2018b). Strategiczne aspekty dynamicznych zdolności replikacji i imitacji wiedzy. *Przegląd Organizacji*, 3, 5–12. <https://doi.org/10.33141/po.2018.03.01>
- Krzakiewicz, K., & Cyfert, S. (2019). Imitation strategies within the framework of dynamic capabilities. In K. Krzakiewicz, & S. Cyfert (Eds.), *Dynamic capabilities and their strategic dimension. Aspects of imitation and innovation* (pp. 52–63). Poznań University of Economics and Business.
- Levitt, T. (Ed). (2006). *Ted Levitt on Marketing*. A Harvard Business School Pub.
- Lieberman, M. B., & Asaba, S. (2006). Why Do Firms Imitate Each Other? *Academy of Management Review*, 31(2), 366–385. <https://doi.org/10.5465/amr.2006.20208686>
- Major, D. L., Maggitti, P. G., Smith, K. G., Grimm, C. M., & Derfus, P. J. (2016). Reflexive and Selective Competitive Behaviors—Inertia, Imitation, and Interfirm Rivalry. *Organization Management Journal*, 13(2), 72–88. <https://doi.org/10.1080/15416518.2016.1179564>
- Muafi, & Uyun, Q. (2019). Imitation vs Innovation: Is there an alignment between supply chain organizational learning and Islamic HRM practices? *HOLISTICA – Journal of Business and Public Administration*, 10(3), 143–156. <https://doi.org/10.2478/hjbpa-2019-0034>
- Nguyen, V. T., & Pham T. A. (2017). Knowledge Management Strategies, Imitation, and Innovation: An Empirical Study of Vietnamese Firms. In J. Hong, R. S. Snell, & C. Rowley (Eds.), *Organizational Learning in Asia. Issues and Challenges* (pp. 85–107). Elsevier. <https://doi.org/10.1016/B978-0-08-100983-3.00004-6>
- Pyle, M. J., & Liker, J. K. (2014). Imitation in Large Complex Organizations: A Case of Design for Six Sigma in the Automobile Industry. *Journal of Enterprise Transformation*, 4(2), 76–99. <https://doi.org/10.1080/19488289.2013.823897>
- Schnaars, S. P. (1994). *Managing imitation strategies: how later entrants seize markets from pioneers*. Free Prezz.
- Shenkar, O. (2010). Copycats: how smart companies use imitation to gain a strategic edge. *Strategic Direction*, 26(10), 3–5. <https://doi.org/10.1108/02580541011080474>
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, 18(7), 509–533.

Coefficients of Real Estate Tax: Case Study of the Czech Republic

Gabriela KUKALOVÁ, Daniela PFEIFEROVÁ, Ivana KUCHAROVÁ*,
Olga REGNEROVÁ and Dana ŠTURMOVÁ

Czech University of Life Sciences Prague, Prague, Czech Republic; kukalova@pef.czu.cz; pfeiferova@pef.czu.cz;
kucharovai@pef.czu.cz; oregnerova@pef.czu.cz; danasturmova@seznam.cz

* Corresponding author: kucharovai@pef.czu.cz

Abstract: The paper focuses on the use of the possible potential of real estate tax revenues by municipalities in the Czech Republic. Municipalities can set or adjust the rate of coefficients for real estate tax. The objective of the paper is to evaluate how municipalities in the Czech Republic use the possibility of introducing or adjusting real estate tax coefficients, and then determine the potential for possible revenues from this tax. The evaluation of revenues from real estate tax is performed for the period 2016-2018. The data were provided by the Financial Administration of the Czech Republic. The coefficient 1.5 was used in the analyzed period by 8-24% of municipalities depending on the type of real estate, the local coefficient was used by more than 9% of municipalities. The potential revenue from real estate tax was determined in three model cases on the basis of data for 2018. If all municipalities in the Czech Republic set both coefficients, revenue from real estate tax would increase by CZK 54.3 billion to CZK 62.1 billion per year. The share of real estate tax revenue in municipal tax revenues would increase from 4.76% to 27.45%.

Keywords: real estate tax; municipality; coefficient; yield; revenue; Czech Republic

JEL Classification: H7

1. Introduction

Tax revenues play a key role in financing the expenditure side of municipal budgets. The overall economic downturn and other negative impacts related to COVID 19 will affect the level of this revenue. Therefore, their specific composition will be important for municipalities. As stated in her paper Kukalová et al. (2019), from the point of view of management and development of municipalities and regions, it is important to know the basic principles of financing, financial management and also the redistribution of tax revenues.

Tax revenues and subsidy programs play a crucial role on the revenue side of municipal budgets. Revenues from land taxation generate revenue for city budgets in more or less all EU countries. Land taxation can also be linked to the tax autonomy of municipalities in connection with the redistribution of public resources Janoušková and Sobotovičová (2019). The influence of the tax burden on investments is reported by Moravec and Kukalová (2014).

Among other things, their study addresses the impact of the direct tax burden, which includes real estate tax, on investment allocation.

According to Drabek (2015), the implementation of a conscious tax policy for real estate taxes is a basic condition for the autonomy and financial self-sufficiency of the municipality. In his contribution, he solves the problem of the municipal strategy in relation to the determination of real estate tax rates. Correct determination of the real estate tax base according to research Žróbek et al. (2016), also affects the size of the revenue from this tax. Cammeraat and Crivelli (2020) also point out the importance of a proper consideration of all the factors that affect real estate tax revenue in Italy. Makovská et al. (2020) discusses the possible dependence of the size of the real estate tax rate and the local political cycle in selected municipalities in Poland. Polish municipalities have more freedom in formulating real estate rates than Czech municipalities Olejniczak et al. (2020). Blazic et al. (2016) emphasizes the different perception of the effect of the introduction of real estate tax from the perspective of qualified professionals and the general public. The importance of the real estate tax as a stable source for local governments is addressed in the Huang study (2018), following the problems that the collection of this tax brings to China. The real estate tax is a part of the tax system of the Czech Republic and this tax is one of the property taxes. They are of limited importance in the current tax system of the Czech Republic, although property taxes are among the oldest types of taxes and have been the first direct taxes in history to be applied (Vančurová & Láchová, 2016). The real estate tax in the Czech Republic consists of two partial taxes: land taxes and taxes on buildings and units. For buildings and units and for most plots of land, the tax is levied per unit. The tax base is the acreage of land or built-up or floor space.

The entire revenue from this tax goes to the municipal budget. Therefore, it is important that municipalities can, within their partial tax jurisdiction, influence the total amount of funds that will become part of the municipal budget by adjusting the basic rates of both land tax and taxes on buildings and units Pfeiferová et al. (2020). According to the Czechia (1992) § 6 par. 4 let. b) and § 11 par. 3 let. a), the municipality has the possibility to increase or decrease the coefficient by which the basic tax rate is multiplied (coefficient assigned to municipalities according to the number of inhabitants). Furthermore, according to the Czechia (1992) for specific taxable buildings defined in § 11 par. b) to d) and units according to § 11 par. 1 let. c) and d), the municipality may introduce a coefficient of 1.5, which multiplies the basic tax rate (coefficient 1.5). Furthermore, self-governing units may set a coefficient pursuant to Section 12 of Act No. 338/1992 Coll. (local coefficient). This is a coefficient of 2, 3, 4, or 5, which allows to increase the tax liability for real estate in this cadastral area (Czechia, 1992). The existence of large industrial or recreational areas can also significantly increase the income of individual territorial self-governing units.

As stated in the paper Sedmíhradská and Bakoš (2016), only 8% of municipalities in the Czech Republic use the local coefficient and its determination depends on the political composition of their executive bodies and on the overall structure of budget revenues and expenditures. According to Janoušková and Sobotovičová (2017), the motivation to increase

real estate tax revenues differs mainly in relation to the specific application of individual coefficients. The differences also result from the structure of buildings and land in the municipality and the way they are used. Some municipalities are introducing coefficients for increasing the taxation of buildings for family recreation, while others want to burden buildings for business with higher taxes Janoušková and Sobotovičová (2017). The relationship between real estate tax revenue and the introduction of a local coefficient for municipalities in the Czech Republic is also addressed in his contribution by Bečica (2014), according to which its use in statutory cities in the Czech Republic is insufficient. As determined by Pfeiferová et al. (2020), regional cities use coefficients for adjusting real estate tax revenue to a greater extent than other municipalities.

As stated in the mentioned studies, increasing real estate tax coefficients can serve as an alternative to strengthening the financial self-sufficiency of municipalities. The aim of the research is to evaluate how municipalities in the Czech Republic use the possibility of introducing or adjusting real estate tax coefficients. The main objective is to determine the potential of real estate tax revenues if municipalities use real estate tax coefficients.

Table 1. Prescribed tax by type of real estate A-Z and share in total prescribed tax in 2016 - 2018, source: Financial Administration (2019), own work

Type of real estate	2016		2017		2018	
	Tax (ths. CZK)	%	Tax (ths. CZK)	%	Tax (ths. CZK)	%
A farmland	1,836,431	17.78%	1,894,743	17.76%	1,914,823	17.76%
B permanent grassland	99,788	0.97%	102,966	0.97%	104,048	0.97%
C commercial forest	189,269	1.83%	159,265	1.49%	197,349	1.49%
D pond (fish farming)	1,292	0.01%	1,419	0.01%	1,347	0.01%
E built-up area and courtyard	113,198	1.10%	114,684	1.07%	118,030	1.07%
F building land	69,003	0.67%	69,508	0.65%	71,948	0.65%
G other area	525,095	5.08%	557,655	5.23%	547,510	5.23%
X paved area (business in agricult., etc.)	43,560	0.42%	46,086	0.43%	45,420	0.43%
Y paved area (other types of business)	820,956	7.95%	867,892	8.13%	856,000	8.13%
H residential building	1,383,604	13.39%	1,424,150	13.35%	1,442,666	13.35%
I building - outbuildings to H	201,047	1.95%	205,134	1.92%	209,629	1.92%
J cottage	233,754	2.26%	237,644	2.23%	243,732	2.23%
K outbuildings to J	18,174	0.18%	17,901	0.17%	18,950	0.17%
L garage	237,159	2.30%	241,768	2.27%	247,283	2.27%
M, N, O building used for business	3,254,523	31.50%	3,395,405	31.82%	3,393,449	31.82%
P other taxable construction	121,014	1.17%	113,934	1.07%	126,180	1.07%
R apartment (for living)	1,038,327	10.05%	1,066,202	9.99%	1,082,650	9.99%
S, T, U apartment (for business)	83,040	0.80%	88,477	0.83%	86,585	0.83%
V unit used as a garage	51,006	0.49%	53,577	0.50%	53,183	0.50%
Z others unit	10,757	0.10%	11,591	0.11%	11,216	0.11%
Overall	10,331,000	100.00%	10,670,000	100.00%	10,772,000	100.00%

2. Methodology

The amount of real estate tax and its development was evaluated for the period 2016-2018. Data on the amount of prescribed tax and shares in individual types of real estate in the total tax were provided to the Financial Administration of the Czech Republic from the ADIS system (see Table 1 above). The data were provided on the basis of a request pursuant to Act No. 106/1999 Coll., On Free Access to Information.

The evaluation of the use of coefficients was performed on the basis of data provided by the Financial Administration of the Czech Republic (from the ADIS system). The analyzes were focused on a coefficient of 1.5 and a local coefficient. The municipality may set the coefficient 1.5 (C 1.5) by a generally binding decree for selected types of buildings and units (according to § 11 paragraph 3 letter b) of Act No. 338/1992 Coll., On Real Estate Tax). If the municipality determines it, the tax rate is multiplied by this coefficient. The local coefficient (LC) may be set by municipalities by a generally binding decree for selected types of land and for all buildings and units in the amount of 2 or 3 or 4 or 5 for the entire territory of the municipality (according to § 12 of Act No. 338/1992 on real estate). If the municipality sets this coefficient, the tax calculated by it is multiplied.

As part of the analysis focused on C 1.5, buildings and units for which this coefficient can be determined were excluded from the data set. Subsequently, the number of municipalities that had C 1.5 determined in individual years of the analyzed period was determined. The numbers of municipalities had to be determined for each type of buildings and units, because some municipalities use this coefficient only for selected types of buildings and units. Part of the analysis was to determine the share of municipalities that use C 1.5 (for each type of buildings and units) in the total number of municipalities in the Czech Republic.

As part of the analysis focused on the use of the local coefficient, the total number of municipalities that determined the local coefficient was found out. A more detailed analysis was focused on determining the number of municipalities according to the local coefficient set above. Subsequently, the share of municipalities with a set LC in the total number of municipalities in the Czech Republic was determined. The share was also determined in terms of the amount of local coefficient used in individual municipalities. The potential revenue from real estate tax was determined in three model cases (Model 1, Model 2, Model 3). Model 1 presents cases of maximum use of C 1.5 by all municipalities in the Czech Republic. The model case is calculated on the assumption that neither the local coefficient nor the coefficient 1.5 is determined, the other coefficients are determined as in 2018. The calculation is performed using the formula:

$$\text{Potential tax revenue} = \text{Basic tax amount} \times C\ 1.5 \quad (1)$$

where *the basic amount of tax* is the amount of prescribed tax adjusted for the coefficient 1.5 and local coefficients set by some municipalities, C 1.5 is the coefficient for buildings and units of type J, K, L, M, N, O, S, T, U and V.

Model 2 presents cases of use of individual amounts of LC by all municipalities in the Czech Republic. The model case is calculated on the assumption that neither the local

coefficient nor the coefficient 1.5 is determined, the other coefficients are determined as in 2018. The calculation is performed using the formula:

$$\text{Potential tax revenue} = \text{Basic tax amount} \times LC \quad (2)$$

where *the basic amount of tax* is the amount of tax prescribed net of a coefficient of 1.5 and local coefficients set by some municipalities, *LC* is a local coefficient of 2, 3, 4 or 5 for all types of immovable property subject to tax with the exception of land types A and B.

Model 3 presents cases of maximum use of C 1.5 and LC by all municipalities in the Czech Republic. The potential tax revenue is determined based on a combination of calculations under (1) and (2).

The amount of the prescribed real estate tax in 2018 was subsequently compared with the determined revenue potential. The comparison was made as a share of tax and total revenues of municipalities in the Czech Republic. This comparison is made on the basis of data on total revenues and tax revenues of municipalities in the Czech Republic. In 2018, the total revenues of municipalities were 330,860,576 ths. CZK (Czech Statistical Office, 2020). Tax revenues in that year were 226,220,087 ths. CZK, of which real estate tax revenues amounted to 10,855,672 ths. CZK. This real estate tax revenue also includes amounts paid in tax from previous years, therefore it differs from the prescribed tax for 2018 of 10,772,000 ths. CZK.

3. Results

Municipalities can influence the amount of income from real estate tax by setting coefficients for real estate tax. The analyzes show that municipalities in the Czech Republic use this power only partially. The use of individual coefficients also differs. Real estate tax revenue is low and below potential.

3.1. Use of Real Estate Tax Coefficients in Czech Municipalities

The analysis of data provided by the Financial Administration of the Czech Republic (2019) shows that C 1.5 is used by municipalities mainly for type J and K buildings (Table 2). For these types of buildings (recreational building and outbuildings), C 1.5 was set by approximately 24% of municipalities. This coefficient was also often determined by municipalities for buildings used for business (M, N, O).

The analysis provided by the Financial Administration of the Czech Republic shows that the share of municipalities that use the local coefficient is less than 10 percent (Table 3). If a municipality sets this coefficient, it is most often in the amount of 2. Only 17 municipalities used the local coefficient of 5 in the monitored period (Table 3).

3.2. Determination of potential income from real estate tax

On the basis of the share of tax revenues in individual real estate, the potential tax revenue from buildings and units in the case of the use of C 1.5 by all municipalities in the Czech Republic was determined. The real estate tax revenue for all relevant types of buildings and units was adjusted for the purposes of the calculation from the coefficients set by some

COEFFICIENTS OF REAL ESTATE TAX

Table 2. Number of municipalities that used C 1.5 in the period 2016 - 2018 for individual types of buildings and units and share in the total number of municipalities, source: Financial Administration (2019); own work

Type of buildings and units	2016		2017		2018	
	Number of municipalities	Percentage	Number of municipalities	Percentage	Number of municipalities	Percentage
J	1,485	23.73%	1,520	24.29%	1,520	24.29%
K	1,486	23.75%	1,520	24.29%	1,519	24.27%
L	709	11.33%	730	11.67%	731	11.68%
M	802	12.82%	823	13.15%	826	13.20%
N	881	14.08%	906	14.48%	908	14.51%
O	877	14.01%	898	14.35%	901	14.40%
S	575	9.19%	596	9.52%	602	9.62%
T	606	9.68%	628	10.04%	635	10.15%
U	612	9.78%	634	10.13%	642	10.26%
V	522	8.34%	545	8.71%	549	8.77%

Table 3. Number of municipalities that used the local coefficient in the period 2016 - 2018 and the share in the total number of municipalities, source: Financial Administration of the Czech Republic (2019); own work

Local coefficient	2016		2017		2018	
	Number of municipalities	Percentage	Number of municipalities	Percentage	Number of municipalities	Percentage
2	482	7.70%	501	8.01%	507	8.10%
3	63	1.01%	67	1.07%	70	1.12%
4	11	0.18%	16	0.26%	14	0.22%
5	17	0.27%	17	0.27%	17	0.27%
Overall	573	9.16%	601	9.60%	608	9.72%

Table 4. Model 1: The potential for tax revenue from buildings and units for 2018, if municipalities make full use of the coefficient of 1.5 (ths. CZK); own calculation

Type of building or unit	Prescribed tax	Revenue without LC	Revenue without C 1.5	Revenue with full use C 1.5
J	243,732	240,665	201,695	302,543
K	18,950	18,712	15,680	23,520
L	247,283	244,171	225,156	3,377,34,8
M, N, O	3,393,449	3,350,742	2,410,164	3,615,246
P	126,180	124,592	126,180	126,180
R	1,082,650	1,069,025	1,069,025	1,069,025
S, T, U	86,585	85,495	68,354	102,531
V	53,183	52,514	452,670	679,005
Overall	5,252,012	5,185,916	4,568,925	6,255,784

municipalities for selected types of buildings and units. It was found that the potential tax revenue for these types of real estate would increase by approximately CZK 1 billion (Table 4).

In the calculations, the potential for real estate tax revenue was calculated in model cases if all municipalities in the Czech Republic used only the local coefficient. The calculations performed for individual values of local coefficients show that municipalities could achieve a significant increase in real estate tax revenue this way. In the case of determining LC 2, the revenue would amount to more than CZK 19 billion, if all municipalities used LC 5, the total revenue would amount to more than CZK 45 billion (Table 5).

Table 5. Model 2: The potential for tax revenue for 2018, if municipalities use the local coefficient (ths. CZK), own calculation

Type of real estate	Tax prescription	Yield without LC	Use of LC 2	Use of LC 3	Use of LC 4	Use of LC 5
A	1,914,823	1,914,823	1,914,823	1,914,823	1,914,823	1,914,823
B	104,048	104,048	104,048	104,048	104,048	104,048
C	197,349	197,332	394,664	591,996	789,328	986,659
D	1,347	1,330	2,661	3,991	5,322	6,652
E	118,030	116,545	233,090	349,635	466,180	582,725
F	71,948	71,043	142,085	213,128	284,171	355,214
G	547,510	540,619	1,081,238	1,621,858	2,162,477	2,703,096
X	45,420	44,848	89,697	134,545	179,393	224,242
Y	856,000	845,228	1,690,455	2,535,683	3,380,910	4,226,138
H	1,442,666	1,424,510	2,849,020	4,273,529	5,698,039	7,122,549
I	209,629	206,991	413,982	620,973	827,964	1,034,954
J	243,732	240,665	481,330	721,995	962,660	1,203,326
K	18,950	18,712	37,423	56,135	74,847	93,559
L	247,283	244,171	488,341	732,512	976,683	1,220,854
M, N, O	3,393,449	3,350,742	6,701,484	10,052,227	13,402,969	16,753,711
P	126,180	124,592	249,185	373,777	498,369	622,961
R	1,082,650	1,069,025	2,138,050	3,207,076	4,276,101	5,345,126
S, T, U	86,585	85,495	170,991	256,486	341,982	427,477
V	53,183	52,514	105,028	157,542	210,057	262,571
Z	11,216	11,075	22,149	33,224	44,299	55,374
Overall	10,772,000	10,664,308	19,309,746	27,955,183	36,600,621	45,246,058

Potential real estate tax revenues were also determined for model cases where all municipalities in the Czech Republic would set C 1.5 and at the same time LC. The potential was determined for all values of the local coefficient. The maximum real estate tax revenue in the case of the use of C 1.5 in combination with LC 5 would amount to more than CZK 62 billion (Table 6).

COEFFICIENTS OF REAL ESTATE TAX

Table 6. Model 3: Potential tax revenue for 2018, if municipalities use a coefficient of 1.5 and a local coefficient (ths. CZK), own calculation

Type of real estate	Tax prescription	Without LC a C 1.5	Combination of uses LC 2 and C 1.5	Combination of uses LC 3 and C 1.5	Combination of uses LC 4 and C 1.5	Combination of uses LC 5 and C 1.5
A	1,914,823	1,914,823	1,914,823	1,914,823	1,914,823	1,914,823
B	104,048	104,048	104,048	104,048	104,048	104,048
C	197,349	197,332	394,664	591,996	789,328	986,660
D	1,347	1,330	2,660	3,990	5,320	6,650
E	118,030	116,545	233,090	349,635	466,180	582,725
F	71,948	71,043	142,086	213,129	284,172	355,215
G	547,510	540,619	1,081,238	1,621,857	2,162,476	2,703,095
X	45,420	44,848	89,696	134,544	179,392	224,240
Y	856,000	845,228	1,690,456	2,535,684	3,380,912	4,226,140
H	1,442,666	1,424,510	2,849,020	4,273,530	5,698,040	7,122,550
I	209,629	206,991	620,973	620,973	1,241,946	1,552,432
J	243,732	201,695	605,085	907,628	1,210,170	1,512,713
K	18,950	15,680	47,040	70,560	94,080	117,600
L	247,283	225,157	675,469	1,013,204	1,350,939	1,688,673
M-O	3,393,449	2,410,164	7,230,492	10,845,738	14,460,984	27,114,345
P	126,180	126,180	252,360	757,080	504,720	630,900
R	1,082,650	1,069,025	2,138,050	3,207,075	4,276,100	5,345,125
S-U	86,585	68,354	205,062	307,593	410,124	768,982
V	453,183	452,670	1,358,010	2,037,015	2,716,020	5,092,537
Z	11,216	11,075	22,150	33,225	44,300	55,375
Overall	10,772,000	10,047,317	21,656,473	31,543,327	41,294,074	62,104,830

The share of real estate tax in the tax and total revenues of municipalities would increase depending on the application of specific coefficients. If all municipalities in the Czech Republic set C 1.5 for all buildings and units and at the same time set LC 5, the share of tax revenues would be 22.32% instead of the original 4.76% (Table 7).

Table 7. Share of prescribed tax and potential revenues when introducing coefficients on tax and total revenues of municipalities for 2018, own calculation

	Prescribed tax	Combination of uses LC 2 and C 1.5	Combination of uses LC 3 and C 1.5	Combination of uses LC 4 and C 1.5	Combination of uses LC 5 and C 1.5
Share of tax revenue of municipalities in the Czech Republic	4.76%	9.11%	12.73%	16.04%	22.32%
Share in total revenue of municipalities in the Czech Republic	3.26%	6.32%	8.95%	11.40%	16.22%

4. Discussion

Real estate tax is included among property taxes. Vančurová and Láchová (2016) state that they are of limited importance in the current Czech tax system. The Czech Republic has one of the lowest shares of property tax revenue in total tax revenues from EU countries, and the Czech Republic is criticized for this by the OECD (Janoušková & Sobotovičová, 2016).

These statements can also be supported by the analyzes performed. Real estate tax revenue in 2018 represented a share of 1.2% in the total collection of collected taxes in the Czech Republic. The share of real estate tax revenue in the total collection of collected taxes in the Czech Republic over the last 15 years ranged between 0.68-1.63%. According to Almy (2014), real estate tax generally accounts for a small share of total tax revenues as well as GDP, both in the first world and in developing countries. The share of the revenue from all property taxes in the total GDP in the Czech Republic in 2018 was 0.5%. The average of OECD countries for this indicator is 1.9%. The share of real estate tax in GDP was only 0.2%.

Real estate tax revenues in the Czech Republic are the income of municipalities. The situation is similar in other countries. According to Norregaard (2013), real estate tax revenues belong to local governments and make a significant contribution to their financing. Income from this tax was the fourth highest of all tax revenues for municipalities in the Czech Republic in 2018, but it accounted for only 3.4% of total municipal tax revenues. The analyzes of real estate tax revenues in the context of the use of its potential show that municipalities use the possibility of increasing or setting coefficients to a very limited extent. Thus, municipalities limit their revenues from this tax. If all municipalities used at least LC 2 in 2018, the tax revenue would be 1.8 times the actual revenue. If the analyzed coefficients were used in full, the potential yield would be 5.8 times the original yield. Municipalities have the power to significantly increase their real estate tax revenues, but this power is used only to a limited extent. In the period 2016 to 2018, the number of municipalities that used C1.5 increased only in cases where this coefficient was determined, namely for buildings and units used for business (M, N, O, S, T, U) and for units used as a garage (V). In the above period, the number of municipalities that set LC 2 or LC 3 increased. In the case of using LC 4, the number of municipalities that used this coefficient decreased between 2017 and 2018.

5. Conclusions

In the Czech Republic, the real estate tax is an exclusive tax in terms of municipal budgets and its revenues flow into the municipal budget. It is the only tax for which the municipality can influence the income by adjusting or setting coefficients that increase the rate, or by a local coefficient by which the calculated tax is multiplied.

The analyzes show that the increase in the rate using C 1.5 was used by municipalities mainly for type J and K constructions. In 2018, it was more than 24% of municipalities. For other types of buildings and units, this coefficient was used less frequently. Only 8–14% of municipalities out of their total number used it for various types of buildings and units. In 2018, only 608 municipalities used the increase in real estate tax revenue through the local coefficient, ie. 9.72% of the total number of municipalities in the Czech Republic.

Calculations of yield potentials using individual coefficients were performed for the model year 2018. Input data on revenues from individual types of real estate were adjusted for the effect of coefficients, which were determined for this year in individual municipalities. The use of C 1.5 would mean an increase in real estate tax revenue in a given year by more than CZK 1 billion. Another model calculation was performed in case of determining only the local coefficient. In this case, the potential for revenue was set at CZK 45.25 billion, which would mean an increase in revenue by CZK 34.7 billion. The yield potential was also determined for a combination of the use of coefficients. The maximum potential yield in the model year 2018 would be CZK 62.1 billion with the combination of C1.5 and LC 5. The share of real estate tax revenue in tax revenues would increase from 4.76% to 22.32%.

Acknowledgments: This paper is a partial result of the research project No. 2019B0010 - Czech Social System Fraud Rate Estimation and System Optimization Proposals, supported by the Internal Grant Agency (IGA) of Faculty of Economics and Management, CULS Prague.

References

- Act. no 338/1992. *On real estate tax*. Czech Republic. The Parliament of The Czech Republic.
<https://www.zakonyprolidi.cz/cs/1992-338>
- Almy, R. (2014). *Valuation and Assessment of Immovable Property* (OECD Working Papers on Fiscal Federalism No. 19). OECD. <https://doi.org/10.1787/22265848>
- Bečica, J. (2014). Czech Municipalities and Real Estate Tax. In *19th International Conference: Theoretical and Practical Aspects of Public Finance 2014* (pp. 19–27). Praha, Czech Republic.
- Blazic, H., Simovic, H., & Stambuk, A. (2016). Introduction of a Local Real Estate Tax in Croatia: A Survey of Expert and Public Opinion. *Lex Localis-Journal of Local Self-Government*, 14(1), 53–74.
<https://doi.org/10.4335/14.1.53-74>
- Cammeraat, E., & Crivelli, E. (2020). Justifiably unpopular? The Italian property tax and inequality. *Applied Economics Letters*. <https://doi.org/10.1080/13504851.2020.1827129>
- Czech Statistical Office. (2020). *Příjmy územních rozpočtů (Revenue of local budgets)* [Data set]. Retrieved July 18, 2020 from https://vdb.czso.cz/vdbvo2/faces/cs/index.jsf?page=vystup-bjekt&pvo=FIN02&z=T&f=TABULKA&katalog=30830&str=v26&u=v4_VUZEMI_97_19
- Drabek, K. (2015). Identification of the Urban Municipalities of the Malopolska Region in Terms of Changes in the Real Estate Tax Rates in Business Activities of Enterprises in the Period 2010-2015. In A. Nalepka, & A. Ujwary-Gil, (Eds.), *Proceedings of the 4th Conference on Business and Non-Profit Organizations Facing Increased Competition and Growing Customers' Demands* (pp. 223–232). <https://hdl.handle.net/11199/8965>
- Financial Administration of the Czech Republic. (2019). *Daň z nemovitých věcí (Real estate tax)* [Data set]. Financial Administration of the Czech Republic, ADIS. Retrieved July 27, 2020 from <https://www.financnisprava.cz/cs/dane/analyzy-a-statistiky/danova-statistika>
- Huang, Y. (2018). Design of the Elements of Real Estate Tax on Possession from Real Estate Tax in the UK. In R. Green, I. Solovjeva, Y. Zhang, R. Hou, & E. McAnally (Eds.), *Proceedings of the 3rd International Conference on Judicial, Administrative and Humanitarian Problems of State Structures and Economic Subjects (JAHP)* (pp. 150–154). <https://doi.org/10.2991/jahp-18.2018.31>
- Janouskova, J., & Sobotovičova, Š. (2016). Immovable property tax in the Czech Republic as an instrument of fiscal decentralization. *Technological and Economic Development of Economy*, 22(6), 767–782.
<https://doi.org/10.3846/20294913.2016.1236355>
- Janouskova, J., & Sobotovičova, Š. (2017). Local Coefficient as a Tool to Increase Revenues from Taxes on Immovable Property. In V. Klimova, & V. Zitek (Eds.), *Proceedings of 20th International Colloquium on Regional Sciences* (pp. 848–854). Masaryk University. <https://doi.org/10.5817/CZ.MUNI.P210-8587-2017-111>
- Janouskova, J., & Sobotovičova, Š. (2019). Fiscal autonomy of municipalities in the context of land taxation in the Czech Republic. *Land Use Policy*, 82, 30–36. <https://doi.org/10.1016/j.landusepol.2018.11.048>

- Malkowska, A., Gluszak, M., Marona, B., & Telega, A. (2020). The Impact of the Electoral Cycle on Area-Based Property Tax in Poland. *Eastern European Economics*, 58(6), 517–535.
<https://doi.org/10.1080/00128775.2020.1798160>
- Kukalová, G., Ječmínek, J., Moravec, L., & Bína Filipová, D. (2019). Municipal Finance Education Results at FEM CULS Prague Appraisal. In J. Fejfar, M. Fejfarova, M. Flegl, J. Husak, & I. Krejci (Eds.), *Proceedings of the 16th International Conference on Efficiency and Responsibility in Education (ERIE)* (pp. 146–153). Czech University of Life Sciences. <https://erie.v2.czu.cz/en/r-14822-proceedings-2019>
- Moravec, L., & Kukalová, G. (2014). Investments Allocation Tax Factors in Pre-crisis Time. In O. Deey, V. Kajurova, & J. Krajicek (Eds.), *Proceedings of the 11th International Scientific Conference on European Financial systems 2014* (pp. 396–402). Masaryk University.
<https://is.muni.cz/do/econ/sborniky/2014/proceedings-EFS-2014.pdf>
- Norregaard, J. (2013). *Taxing Immovable Property Revenue Potential and Implementation Challenges* (IMF Working Papers No. 13). IMF. <https://doi.org/10.5089/9781484369050.001>
- Olejniczak, J., Bednarska-Olejniczak, D., Maci, J., & Svobodova, L. (2020). Real Property Tax in Polish Communes of the Polish-Czech Border Region. In P. Jedlicka, P. Maresova, K. Firlej, & I. Soukal (Eds.), *Proceedings of the International Scientific Conference on Hradec Economic Days 2020 (HED)* (pp. 565–573). University of Hradec Králové. <https://doi.org/10.36689/uhk/hed/2020-01-032>
- Pfeiferová, D., Ulrych, M., Kuchařová, I., & Kozlová, H. (2020). In P. Jedlicka, P. Maresova, K. Firlej, & I. Soukal (Eds.), *Proceedings of the International Scientific Conference on Hradec Economic Days 2020 (HED)* (pp. 598–605). University Hradec Kralove. <https://doi.org/10.36689/uhk/hed/2020-01-068>
- Sedmíhradská, L., & Bakoš, E. (2016). Municipal Tax Autonomy and Tax Mimicking in Czech Municipalities. *Lex Localis-Journal of Local Self-Government*, 14(1), 75–92. [https://doi.org/10.4335/14.1.75-92\(2016\)](https://doi.org/10.4335/14.1.75-92(2016))
- Vančurová, A., & Láchová, L. (2016). *Daňový systém ČR (Tax system of the Czech Republic)* (13th ed). VOX.
- Zróbek S., Manzhynski S., Zysk E., & Rassokha, Y. (2016). Some aspects of local real estate taxes as an instrument of land use management. *Real Estate Management and Valuation*, 24(3), 93–105.
<https://doi.org/10.1515/remav-2016-0024>

Impact of COVID-19 on the Aviation Business in the Russian Federation

Alfiya KUZNETSOVA

¹ Bashkir State Agrarian University, Ufa, Russia; alfia_2009@mail.ru

Abstract: The number of air travelers in the Russian Federation in 2020 decreased by 41.3% against the level of 2019. Due to the Coronavirus pandemic, the share of international air travel with non-CIS countries dropped sharply to 29%, the share of international flights with the countries of the near abroad decreased to 2.2%. Despite the decrease in the number of domestic flights by 17%, the share of the number of domestic passenger flights increased from 43.9% to 68.5%. In Russia, in 2020 the leaders in passenger air transportation are three airlines: 1) Aeroflot (with a market capacity of 21%), 2) Siberia (18%), 3) low-cost airline Pobeda (13.2%). According to our calculations, the economic losses of Russian airlines due to the pandemic amounted to 13.708 billion dollars (or 8.8% of airline losses on a global scale). Our analysis showed that there are two large aviation harbors in Russia – Moscow and St. Petersburg. They account for an average of 45-55% of the total number of flights in the country. Nine Russian airports account for 75% of air travel. In the near future, the development of all types of domestic tourism will continue the growth dynamics, which will contribute to the revitalization of the aviation business.

Keywords: air travel, passengers, Covid pandemic, losses, lost profits

JEL Classification: R40, R41

1. Introduction

One of the important spheres of the economy and human activity, thanks to which borders are erased in the world, and people acquire many personal communications, impressions, exchange knowledge and experience, expand their worldview, adopt the best traditions, relax, acquire competitive advantages, is the aviation industry that accompanies the external outbound and domestic tourism. Currently, there is a small number of works of scientists in the world in which the economic size of the loss of profits caused by the coronavirus pandemic in the aviation business would be calculated.

An analysis of the assessment of changes in passenger traffic in the world due to the Covid pandemic is given in the work of Iacus et al (2021). Trends in global changes in air traffic to identify different types and trends of transnational human mobility are presented in Gabrielli et al (2020).

The decline in economic activity in the world has negatively affected the tourism sector. The destructive power of the impact of the Covid pandemic on tourism development is detailed in the works of Kaushal and Srivastava (2021). In the course of their research, the authors state that vital knowledge for the industry includes: «the need for multi-skills and

professional development of employees, an increased sense of hygiene, sanitation and related SOPs, optimism about the revival of the industry, the role of the media and the need for more preparedness for crises». Other authors argue that «the larger the tourism sector in a country, the more actively fiscal and monetary policy measures have been taken to mitigate the impact of the pandemic» (Khalid et al., 2021). Relationship management in the tourism supply chain to overcome epidemics is presented in Gonzalez-Torres et al. (2020). The impact of the pandemic on hospitality education explored in Ye and Law (2021). The impact of the pandemic on human health and performance has been investigated by Seghieri et al. (2021) as well as Wu et al. (2020).

Scientists from different scientific fields investigated the consequences of the impact of the coronavirus situation, both on the state of development of society, economy, tourism, as well as on the effectiveness of government measures taken (Mofijur et al., 2020; Hossain, 2021). A preliminary assessment of the consequences of the coronavirus situation on the economy is given in the work of the Chinese scientist Jin et al. (2020).

At the same time, the lack of information on the consequences of the coronavirus situation on the state of domestic and foreign air travel was the basis for this study.

2. Methodology

The work uses analytical and economic-statistical methods to study the analysis of the current situation in the field of aviation business. The information base of the study was compiled by the official data of the Federal Air Transport Agency of the Russian Federation. The main purpose of this article is to assess the loss of profits experienced by the aviation business due to the Covid-19 Pandemic. A temporary empirical analysis of the data due to inflationary processes can distort the real understanding of the situation in the industry; comparable indicators are taken over the past three years. At the first step, we identified significant seasonal fluctuations in the aviation business. At the second step of the study, we studied the structure of air transportation: international and domestic. At the third step of the research, we identified the leading airlines in the number of air traffic. At the fourth step, the degree of occupancy in passenger seats was assessed. In the fifth step of the study, we calculated the loss of profit due to imperfect flights due to self-isolation during the Covid-19 pandemic. At the sixth step of the research, we tried to assess the leading airports in terms of the number of air traffic in the country. At the seventh step, we assessed the capacity of the air transportation market at the airports of Moscow and St. Petersburg. At the eighth step of the study, the leading airports in terms of the number of air traffic were assessed. At the ninth step of the research, we assessed the loss of profits at one of the airports in Russia and compared them on a global scale.

3. Results

In 2018, as a whole, 206.6 million air passengers were registered in the Russian Federation, in 2019 - 220.9 million people, in 2020 - only 129.6 million people. The number of air travelers in the Russian Federation as a whole in the period from 2018 to 2020 decreased

by 41.3%. This was facilitated by the coronavirus pandemia. Also, it is important to say that there are seasonal fluctuations in this type of business. Seasonal nature by months of the year is associated with increased travel during the holidays, and, as a rule, in the warm season (Figure 1).

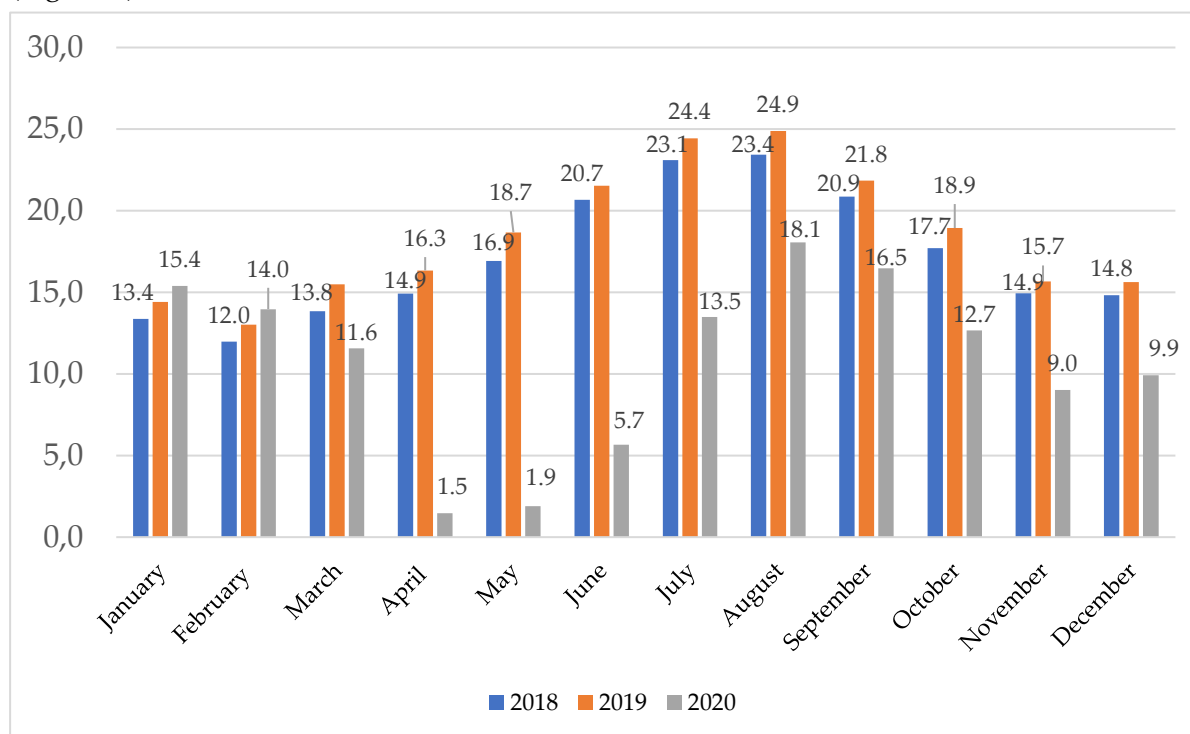


Figure 1. Schedule of seasonal fluctuations of air travel of passengers in the Russian Federation for the period from 2018 to 2020 (million people). Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favl.gov.ru/> [Date of access: 15.01.2021]

In 2019, compared to 2018, the number of air flights in Russia increased by 6.9%. This growth trend could continue in 2020, if not for the coronavirus infection that swept the whole world. In 2020, against the level of 2018, the reduction in the number of air flights was 37.3%, in 2020 against the level of 2019, there was a record reduction in air flights in the country - by 41.3%.

Analysis of the structure of air travel allows us to conclude that the share of international traffic in 2019 compared to 2018 increased by 3.4 percentage points. If it were not for the pandemic, we could observe a continuing trend of growth in the number of international air travel (Figure 2).

However, due to the coronavirus pandemic, the share of international air travel with non-CIS countries dropped sharply from 50.3% in 2018 to 29.3% in 2020. The share of international flights with the countries of the Commonwealth of Independent States (former Soviet republics) decreased from 5.7% to 2.2%, i.e. by 3.4 percentage points. During the pandemic, the number of domestic air travel decreased by 17% compared to 2018, amounting to 105.2 million flights in 2020. At the same time, the share of the number of domestic passenger flights increased from 43.9% to 68.5%, since by 24.9 percentage points.

There are companies that are leaders in the air transportation market. Among Russian airlines, fourteen leaders should be noted in terms of the number of air traffic, which own more than 90% of all air flights in the country (Figure 3).

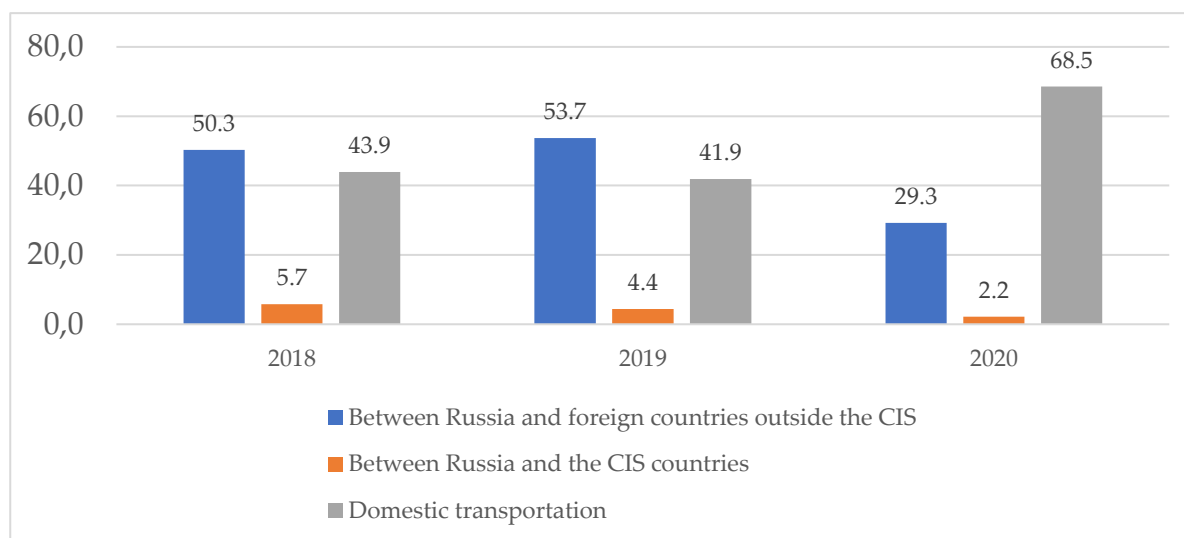


Figure 2. Structure of international and domestic flights in the Russian Federation (percentage). Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favl.gov.ru/> [Date of access: 15.01.2021]

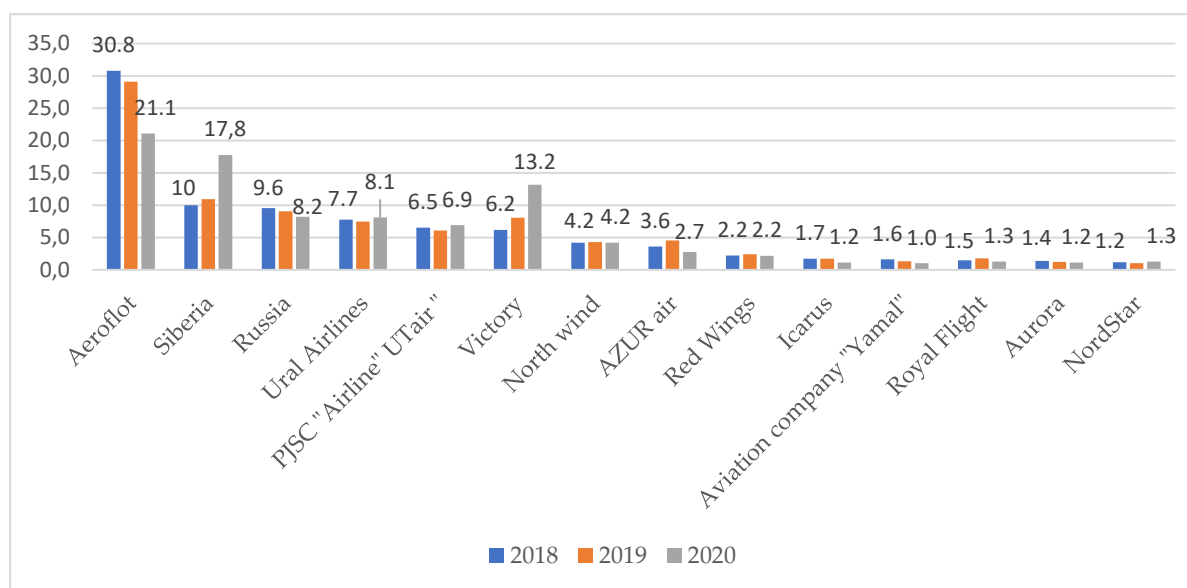


Figure 3. Share of the leading Russian airlines by the number of air traffic (percent). Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favl.gov.ru/> [Date of access: 15.01.2021]

The share occupied by «Aeroflot», the leader in air transportation, decreased from 30.8% in 2018 to 21.1% in 2020. The share of «Siberia» airlines increased from 10% in 2018 to 17.8% in 2020. The share of «Russia» airlines decreased from 9.6% in 2018 to 8.2% in 2020. The share of «UTair» on the market increased slightly - from 6.5 to 6.9%.

As for the rapid breakthrough, it was demonstrated by the «Pobeda» airlines. The capacity of the air travel market it covers increased from 6.2% to 13.2%. During the pandemic,

the low-cost airline «Pobeda» took third place in the country after «Aeroflot» and «Siberia» airlines, primarily due to unprecedented low prices for air tickets and 100% of flight load. This low-cost airline, which is a subsidiary of «Aeroflot», has proven to be in high demand, especially in the summer on the routes of flights to the Black Sea coast.

Low-cost airlines have a number of advantages: low cost, high safety: over the past ten years, there has been no fatal accident in the world, no baggage losses, punctual flights. The disadvantages are: non-refundable tickets, departures at uncomfortable times, random distribution of seats in the cabin, no indication of the seat in the boarding pass, lack of free meals on board, paid check-in at the airport counter, departures from minor airports, paid baggage transportation, cramped in the cabin (little space) and some others. Despite the possible disadvantages, the demand for low-cost airlines is quite high.

All airlines operating in the Russian market in 2020 saw not only a decrease in both the number of passengers carried and the share of the air transportation market coverage, but also a decrease in the share of passenger seats (Figure 4).

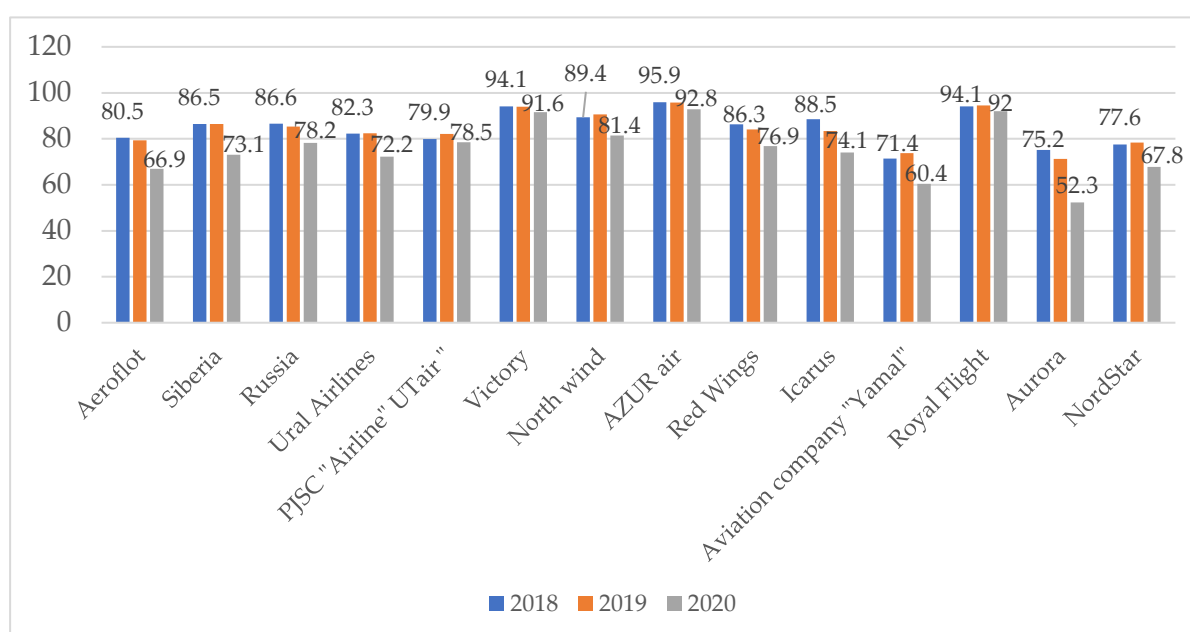


Figure 4. Passenger seat occupancy rate in Russian airlines (percent). Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favt.gov.ru/> [Date of access: 15.01.2021]

The average monthly number of flights in 2018 was 17.2 million, in 2019 - 18.4 million, and in 2020 - only 10.4 million. Traditionally, the peak of the seasonal growth in the number of air travel falls in the period from June to October, i.e. for the vacation period.

People all over the world are so used to freedom of movement that the growth of the aviation business could rapidly gain momentum further. In January 2020, there was an increase in the number of flights by 6.8%, in February - the growth was 7.3%, but already in March, the number of flights by 2019 was 25.4%, in April - by 91%, in May - by 90%, in June - by 73.7%, in August - by 44.8%, in September - by 24.8%, in October - by 33.1%, in November - by 42.5%, in December - by 36.6%.

The fantastic reduction in the number of flights due to the coronavirus situation of Covid-19 has led to a significant loss in the industry. The crisis began to spread to related areas of activity: aircraft construction, airport operations, ground handling operators, trade, tourism. The rise in costs and the decline in revenues led to huge losses. According to our calculations, while maintaining the growth rate of the number of air flights at the level of the previous year, the hypothetical number of air flights, which should have taken place in 2020, was 236.3 million, and the actual - 129.6 million (which is 45.2% less, than expected) (Table 1).

Table 1. Calculation of the missed number of flights in the Russian Federation (million)

Months	2018 y.	2019 y.	2020 y.	2020 to 2018, in %	2019 to 2018, in %	2020 to 2019, in %	Must it would be in 2020	Lost benefit in 2020	Lost profits in rubles, million rubles.	Lost profits, million euros	Lost profits, million dollars
January	13.4	14.4	15.4	115.2	107.8	106.8	15.5	-0.1	900.0	10.0	12
February	12.0	13.0	14.0	116.7	108.8	107.3	14.2	-0.2	1800.0	20.0	24
March	13.8	15.5	11.6	83.6	112.0	74.6	17.4	-5.8	52200.0	580.0	696
April	14.9	16.3	1.5	9.8	109.5	9.0	17.9	-16.4	147600.0	1640.0	1968
May	16.9	18.7	1.9	11.2	110.3	10.1	20.6	-18.7	168300.0	1870.0	2244
June	20.7	21.5	5.7	27.4	104.2	26.3	22.4	-16.8	*9,5= 159600.0	1774.1	2129
July	23.1	24.4	13.5	58.4	105.8	55.2	25.9	-12.4	*11= 136400.0	1516.5	1819
August	23.4	24.9	18.1	77.0	106.2	72.6	26.4	-8.4	*13= 109200.0	1213.8	1457
September	20.9	21.8	16.5	79.0	104.7	75.4	22.9	-6.4	57600.0	640.0	768
October	17.7	18.9	12.7	71.5	106.9	66.9	20.2	-7.6	68400.0	760.0	912
November	14.9	15.7	9.0	60.3	104.9	57.5	16.4	-7.4	66600.0	740.0	888
December	14.8	15.6	9.9	66.8	105.4	63.4	16.5	-6.6	59400.0	660.0	792
Σ	206.6	220.9	129.6	62.7	106.9	58.7	236.3	-106.7	1028000.0	11424.4	13708
Change	-	-	-	- 37.3	+ 6.9	- 41.3	-	-		-	-

Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://famt.gov.ru/> [Date of access: 15.01.2021]

According to the official data of the Russian State News Agency, the average cost of air tickets departing in June was just over 9.5 thousand rubles, in July - just over 11 thousand rubles, and in August - about 13 thousand rubles (Tacc, 2020).

If in ordinary months (except for the summer months the average cost of one air flight on low-cost airlines is taken equal to 9,000 rubles, which is equivalent to 100 euros or 120

dollars), then the cost of air travel in June will be about 105.6 euros (126.7 dollars), in July - 122.3 euros (146.7 dollars), in August - 144.5 euros (or 173.4 dollars).

According to our calculations, the minimum number of passengers who could not make flights on the territory of the Russian Federation in 2020 is over 106.7 million, and the lost profits amounted to 1,028 billion rubles. (equivalent to € 11.424 million or \$ 13.708 million).

According to the official data of the International Air Transport Association (IATA), which in June 2020 predicted losses for the airline in the world in the amount of \$ 100 billion, in November it became known that airlines are actually losing \$ 157 billion due to the worsening pandemic situation (Laurence, 2020).

As we noted above, according to our calculations, the losses of Russian airlines due to the pandemic amounted to 1,028.0 billion rubles, which is equivalent to 13.708 billion dollars. This means that the share of losses of Russian airlines on a global scale (from 157 billion dollars) is approximately 8.8%.

It is important to note that there are two large aviation harbors in Russia - Moscow and St. Petersburg. They accounted for about 60 million air flights out of 129.6 million in the country in 2020, i.e. 46.3% (Figure 5).

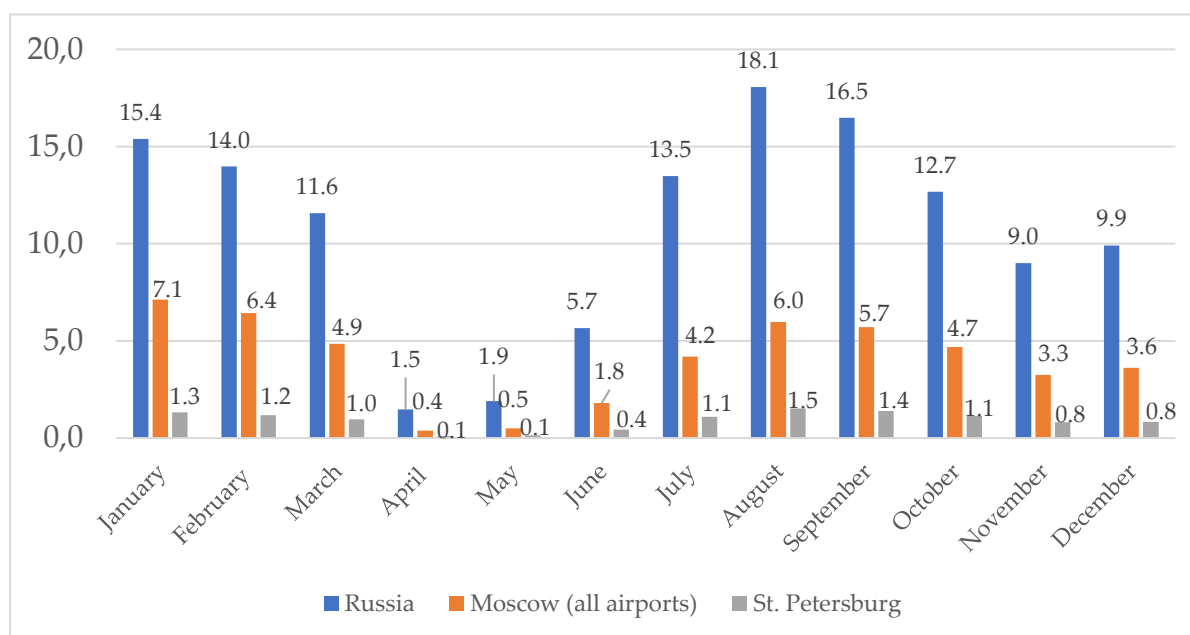


Figure 5. Number of air traffic in the Russian Federation, Moscow and St. Petersburg in 2020 (million people). Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favt.gro.ru/> [Date of access: 15.01.2021]

In January 2020, the number of flights to the "two capitals" of Russia was 8.4 million, in February - 7.6 million. In 2020, in March, the number of flights to Moscow and St. Petersburg was 5.9 million, in April - 0.5 million, in May - 0.6 million, in June - 2.2 million, in July - 5.3, in August - 7.5, in September - 7.1, in October - 5.8, in November - 4.1, in December - 4.2 (Figure 6).

Thus, two Russian cities - Moscow and St. Petersburg - account for an average of 45-55% of the total number of flights in the country. Before the start of the pandemic crisis, in January, Moscow and St. Petersburg accounted for 54.8% of the total number of flights in the country,

and in February - 54.4%. Despite the fact that in March the actual number of air flights decreased throughout the country, the share of the number of air flights to Moscow and St. Petersburg was 50.3%, in April - 34.1%, in May - 33.5%, in June - 39.5%, in July - 39.2%, in August - 41.5%, in September - 43.1%, in October - 46%, in November - 45.2%, in December - 44, 9% (Figure 7).

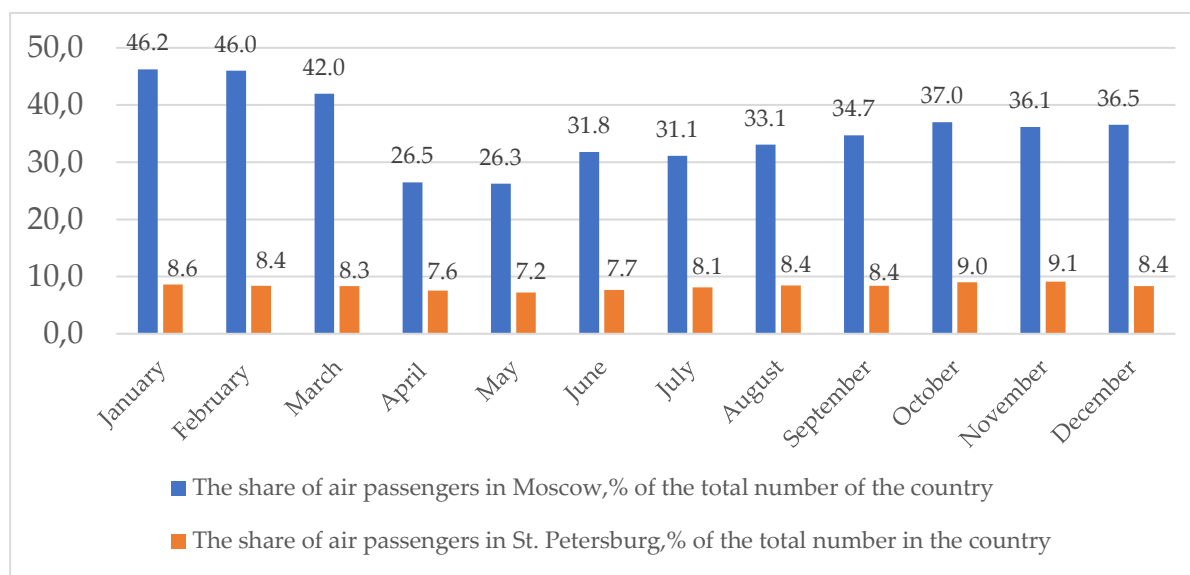


Figure 6. The share of passengers at the airports of Moscow and St. Petersburg (percent). Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favl.gov.ru/> [Date of access: 15.01.2021]

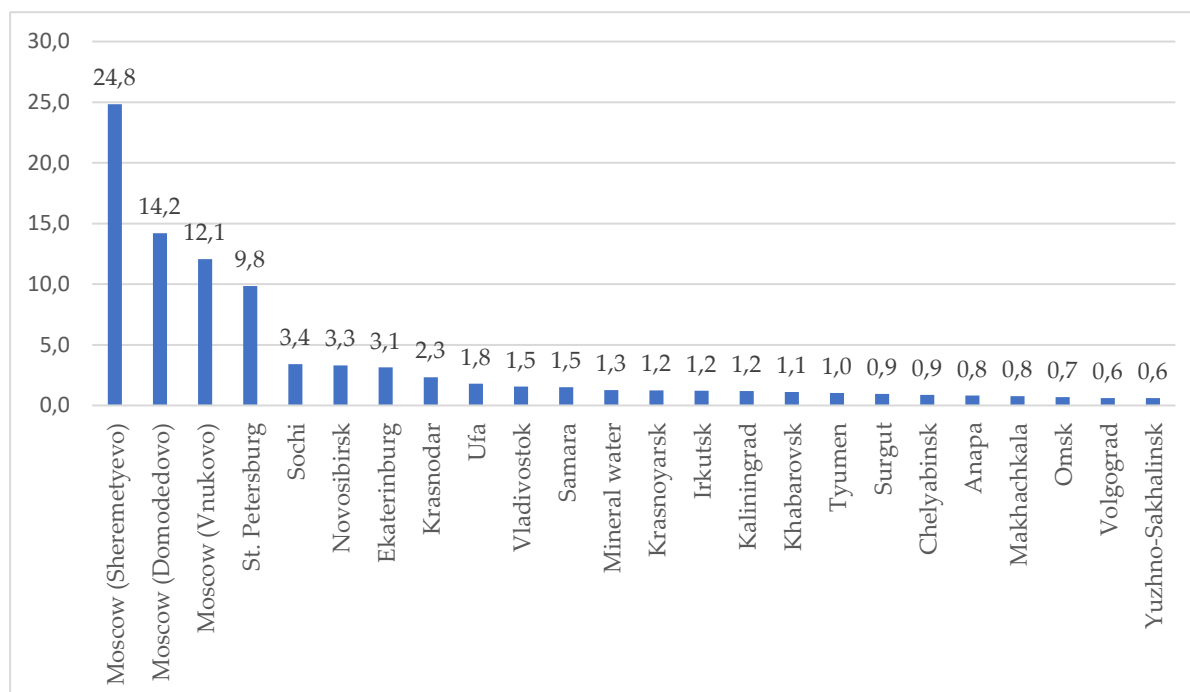


Figure 7. The share of air travel to the main airports of the Russian Federation (percentage). Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favl.gov.ru/> [Date of access: 15.01.2021]

More than 90% of air travel in the country falls on 24 Russian airports. The largest share of air flights falls on Moscow (Sheremetyevo airport) - 24.8%, Moscow (Domodedovo airport) - 14.2%, Moscow (Vnukovo airport) - 12.1%, then St. Petersburg - 9.8%, Sochi - 3.4%, Novosibirsk - 3.3%, Yekaterinburg - 3.1%, Krasnodar - 2.3%, Ufa - 1.8%, airports in Vladivostok, Samara - 1.5% of air travel, Mineralnye water – 1.3%, to the cities of Krasnoyarsk, Irkutsk, Kaliningrad - 1.2% each, to Khabarovsk and Tyumen - 1% each, Surgut - 0.9%, Chelyabinsk - 0.9%, Anapa and Makhachkala – 0.8%, Omsk - 0.7, Volgograd - 0.6%, Yuzhno-Sakhalinsk - 0.6%.

Nine Russian airports account for 75% of air travel - these are: Moscow (Sheremetyevo), Moscow (Domodedovo), Moscow (Vnukovo), St. Petersburg, Sochi, Novosibirsk, Yekaterinburg, Krasnodar and Ufa.

Table 2. Seasonal number of air passenger movements at Ufa airport (thousand passengers)

Indicators	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Σ
2018	220	198	216	229	290	323	342	344	314	272	235	240	3,223
2019	237	205	246	253	322	340	367	368	339	322	276	282	3,557
2020	275	253	227	32	55	135	225	278	266	232	177	214	2,369
2020/2018, in %	124.9	128.1	105.0	138	19.0	41.6	65.9	80.9	84.8	85.2	75.3	89.3	73.5
2020/2019, in %	116.0	123.4	92.3	12.6	17.1	39.7	61.3	75.5	78.5	72.0	64.1	75.9	66.6
Rate of change 2020 to 2019 (+/-)	+38	+48	-19	-221	-267	-205	-142	-90	-73	-90	-99	-68	-1,188
Average ticket price, USD	-	-	120	120	120	126.7	122.3	173.4	120	120	120	120	-
Lost profits, thousand USD	-	-	-2,280	-26,520	-32,040	-25,973.5	-17,366.6	-15,606	-8,760	-10,800	-11,880	-8,160	159,386.1
Average ticket price, ruble	-	-	9,500	9,500	9,500	95,000	11,000	13,000	9,500	9,500	9,500	9,500	-
Average ticket price, million ruble	-	-	-180.5	-2,099.5	-2,536.5	-19,475	-1,562	-1,170	-693.5	-855	-940.5	-646	-30,158.5

¹ Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favt.gov.ru/> [Date of access: 15.01.2021]

Let us consider in more detail the consequences of the pandemic for the airport of one of the Russian cities - the city of Ufa (which is located in the Republic of Bashkortostan and is one of 85 Russian regions). Since 2007, one hundred percent of the shares of the Open Joint Stock Company "International Airport" Ufa "are 100% owned by the Government of the Republic of Bashkortostan. The airport is one of the ten best international airports in the country, is a major transport and logistics hub connecting Europe and Asia. Thanks to the reconstruction of the airport in 2015 (in the amount of 1.6 billion rubles), it became possible

to increase the capacity from 200 to 800 passengers per hour. In 2018, the volume of passenger traffic for the first time exceeded the number of 3 million people per year. In 2018, another reconstruction of the airport was carried out, which increased the capacity to 1.2 thousand people per hour.

The pandemic has made its insidious adjustments to the activities of the aviation business at the airport in Ufa. Consider the trends in seasonal fluctuations in air travel to the airport of Ufa for the period from 2018 to 2020 (Table 2).

According to our calculations, the losses of the aviation business of the Republic of Bashkortostan due to the Coronavirus pandemic amounted to about \$159.4 million (11.3 million rubles), which is 1.2% of the total losses of Russian airlines.

In 2018, the airport of the city of Ufa received and sent 3,223 thousand passengers, in 2019 – 3,557 thousand, which is 10.4% more than in 2018. In 2020, the number of air flights decreased by 33.4% compared to 2019 and by 26.5% less than in 2018 (Figure 8).

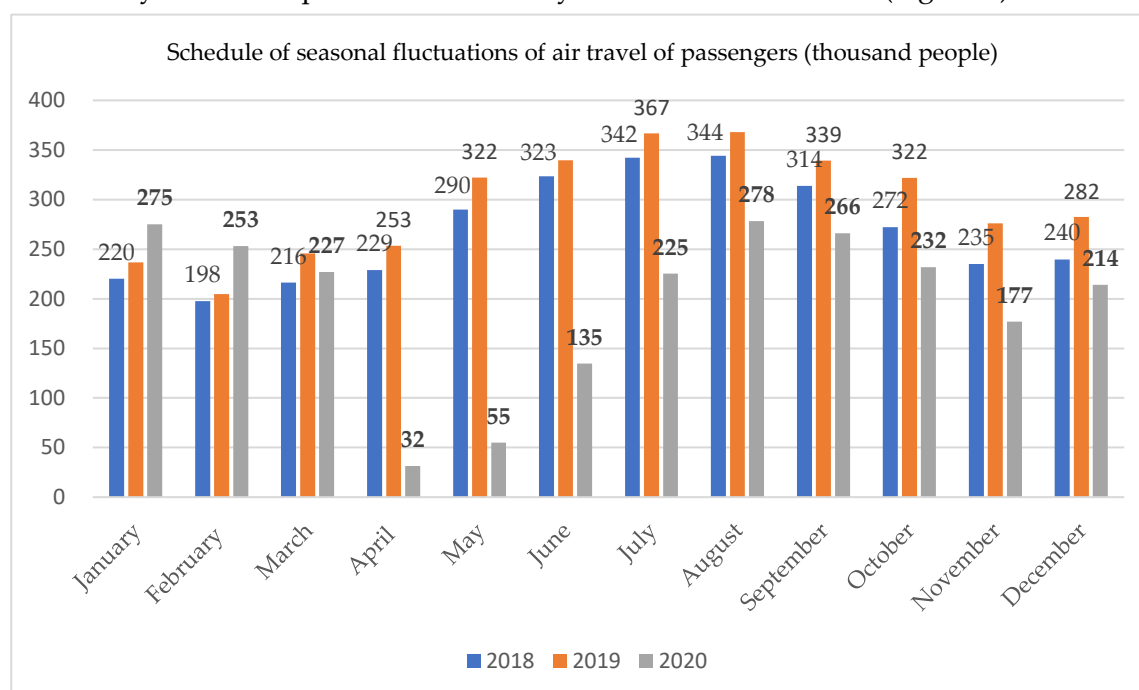


Figure 8. Schedule of seasonal fluctuations of air travel of passengers (thousand people). Calculated by: The official website of the Official site of the Federal Air Transport Agency of the Russian Federation. Source: <https://favt.gov.ru/> [Date of access: 15.01.2021]

Just like on a national scale, in the regional aviation industry in January the increase in the number of air flights was 25%, in February - by 127.8%, in March - by 105.1%. Since April, there has been a decrease in the number of air flights by 86%, in May - by 90.6%, in June - by 58.2%, in July - by 34.2%, in August - by 19.2%, in September - by 15.3%, in October - by 14.7%, in November - by 24.7%, in December - by 10.8%.

The demand for domestic transportation was also limited by the self-isolation regime, the closure of hotels, resorts, restaurants, and places of mass recreation.

4. Conclusions

The conducted research allows us to draw the following conclusions:

1. Air travel has been recognized as one of the most affected industries in Russia by the spread of COVID-19, as well as around the world. Due to the epidemic of the coronavirus situation, the number of people moving in the air transportation market in Russia, as well as throughout the world, has sharply decreased (by 90%). Restrictions on flights led to a decrease in demand for related industries: aircraft construction, maintenance, lessors, ground handling.

2. The airports of Moscow and St. Petersburg occupy 45-55% of the market share of all air transportation in Russia. These airports are the aviation hubs in the country. Due to the low profitability of interregional air transportation, many flights to nearby regions are made only through Moscow or St. Petersburg. Despite the pandemic, representatives of business travel are the main consumers of air travel.

3. Airlines carrying out international transportation received the greatest blow. These include the companies «Nord Wind», «AZUR air», «Icarus», «Red Wings», «Royal Flight», «Nord Star».

4. Airlines with a reduced risk to business should include those that receive government support measures: «Aeroflot», «S7», «Pobeda», «Aurora», «Yakutia», «Yamal».

5. The percentage of occupancy of air seats in 2019 on international flights was 85%, on domestic routes - 82.6%, on regional - 65%. High service costs at regional airports, accompanied by long distance flights, as well as high flight underutilization lead to high operating losses, especially on domestic routes. Therefore, the main source of income for the industry has usually always been international shipping.

6. The reduction in the number of air travel has resulted in a reduction in the number of staff, which has led to an increase in one-time costs.

7. The reduction in the number of international air transportations and a slight increase in domestic air transportations do not compensate for the recovery of the situation in the industry, but significantly smooths out the financial losses.

8. According to our calculations, in 2020, the economic losses of Russian airlines due to the pandemic amounted to 1,028.0 billion rubles, which is equivalent to 13.708 billion dollars (or 8.8% of airline losses on a global scale).

9. In response to the crisis, most of the aircraft fleet was stopped, flights were canceled. Representatives of the aviation business began to revise investment programs, cut marketing budgets, headcount, and working hours. The search for ways to solve the problems of paying taxes and tariffs with airports, as well as tax incentives and deferrals for mandatory payments, including credit payments, has intensified.

10. Government measures to mitigate the effects of the pandemic focused on providing interest-free payroll loans, deferral of taxes and insurance premiums, monthly payments to pay fixed costs of air carriers, and a moratorium on filing for bankruptcy. Taken together, all these support measures contributed to the preservation of the main professional staff, however, according to experts, it will take at least another 2-3 years to restore the economy of the aviation business.

References

Federal Air Transport Agency of the Russian Federation. (2021). *The official website of the Official site of the Federal Air Transport Agency of the Russian Federation*. <https://favt.gov.ru/>

- Gabrielli, L., Deutschmann, E., Natale, F., Recchi, E., & Vespe, M. (2020). Dissecting global air traffic data to discern different types and trends of transnational human mobility. *Epj Data Science*, 8(1). <https://doi.org/10.1140/epjds/s13688-019-0204-x>
- Gonzalez-Torres, T., Rodriguez-Sanchez, J. L., & Pelechano-Barahona, E. (2020) Managing relationships in the Tourism Supply Chain to overcome epidemic outbreaks: The case of COVID-19 and the hospitality industry in Spain. *International journal of hospitality management*, 92, 102733. <https://doi.org/10.1016/j.ijhm.2020.102733>.
- Hossain, M. (2021) The effect of the Covid-19 on sharing economy activities. *Journal of Cleaner Production*, 280(1), 124782. <https://doi.org/10.1016/j.jclepro.2020.124782>
- Iacus, S. M., Natale, F., Santamaria, C., Spyrtatos, S., & Vespe, M. (2021) Estimating and projecting air passenger traffic during the COVID-19 coronavirus outbreak and its socio-economic impact. *Safety Science*, 129, 104791. <https://doi.org/10.1016/j.ssci.2020.104791>
- Jin, H., Wang, H., Li, X., Zheng, W., Ye, S., Zhang, S., Zhou, J., & Pennington, M. (2020) Economic burden of COVID-19, China, January-March, 2020: a cost-of-illness study. *Bulletin of the World Health Organization*, 99(2), 112-124. <https://doi.org/10.2471/BLT.20.267112>
- Kaushal, V., & Srivastava, S. (2021) Hospitality and tourism industry amid COVID-19 pandemic: Perspectives on challenges and learnings from India. *International Journal of Hospitality Management*, 92, 102707. <https://doi.org/10.1016/j.ijhm.2020.102707>
- Khalid, U., Okafor, L. E., & Burzynska, K. (2021) Does the size of the tourism sector influence the economic policy response to the COVID-19 pandemic? *Current Issues In Tourism*. <https://doi.org/10.1080/13683500.2021.1874311>
- Laurence, F. (2020, November 24). *Airlines are losing \$ 157 billion due to the worsening pandemic*. <https://www.reuters.com/article/us-airlines-iata/airlines-set-to-lose-157-billion-amid-worsening-slump-iata-idUSKBN2841KA?il=0>
- Mofijur, M., Fattah, I. M., Rizwanul, A., Md, A., Islam, A. B. M. S., Ong, H. C., Rahman, S. M. A., Najafi, G., Ahmed, S. F., Uddin, M. A., & Mahlia, T. M. I. (2020) Impact of COVID-19 on the social, economic, environmental and energy domains: Lessons learnt from a global pandemic. *Sustainable Production and Consumption*, 26, 343-359. <https://doi.org/10.1016/j.spc.2020.10.016>
- Seghieri, C., La Regina, M., Tanzini, M., & Tartaglia, R. (2021) Looking for the right balance between human and economic costs during COVID-19 outbreak. *International journal for quality in health care: journal of the International Society for Quality in Health Care*. <https://doi.org/10.1093/intqhc/mzaa155>
- Tacc. (2020, July 9). *Research: The cost of air tickets in Russia in the summer of 2020 decreased by 30%*. <https://tass.ru/ekonomika/8919431>
- Wu, X. X., Yin, J., Li, C. L. Xiang, H. X., Lv, M., & Guo, Z. Y. (2020) Natural and human environment interactively drive spread pattern of COVID-19: A city-level modeling study in China. *Science of the Total Environment*, 756, 143343. <https://doi.org/10.1016/j.scitotenv.2020.143343>
- Ye, H. Y., & Law, R. (2021) Impact of COVID-19 on hospitality and tourism education: a case study of Hong Kong. *Journal of Teaching in Travel & Tourism*. <https://doi.org/10.1080/15313220.2021.1875967>

Economics and Management of Agricultural Production in the Republic of Bashkortostan in the Context of the COVID Pandemic

Alfiya KUZNETSOVA

Bashkir State Agrarian University, Ufa, Russia; alfia_2009@mail.ru

Abstract: Taking into account all existing opinions on food security and generally agreeing with them, in our work we are faced with the task of defining directions for the development of agricultural production in one of the 85 regions of the Russian Federation– in the Republic of Bashkortostan. The main purpose of this paper is to identify the key directions for the development of the agricultural sector, taking into account the situation of Covid for the period up to 2030. Agriculture of the Republic of Bashkortostan is one of the leading in the Russian Federation with 3.4%. For the main types of food: milk, meat, potatoes, vegetable oil and sugar, the region is completely independent. Despite the situation with Covid, in 2020 the region increased its agricultural production by 5%. the average monthly wage of agricultural producers is about 30% less than the wages of workers in processing industries. In turn, the level of remuneration of workers in the agricultural sector is on average 56-58% of the average for the region, in food processing industries – about 79%. It is quite obvious that an insufficiently high level of attractiveness of work in the agro-industrial complex leads to an outflow of qualified personnel to other industries. But to 2025-2030 the Republic of Bashkortostan needs an increase in the production of vegetables - not less than 30%, fish - 77%, fruits, berries - in 3-4 times.

Keywords: food; security; agro-industrial; production; level of consumption

JEL Classification: O3; Q13

1. Introduction

The issues of ensuring food security through the creation of conditions for sustainable development of rural areas have been paid attention in the works of various scientists and researchers: Bouwman De CaZK et al. (2021), Godfray et al. (2010), De Carvalho et al. (2021), Drangert (2021), Farcas et al. (2021), Neelakantan, DeFries, and Fanzo (2020), O'Hara and Toussaint (2021) and many others.

In our opinion, in modern conditions the world is faced with three key contradictions that hold back the progressive development of agro-industrial production. The first contradiction boils down to the fact that the growth of agricultural production directly depends on the problem of climate warming, significant temperature changes and often recurring unpredictable natural phenomena (Kassie & Alemu, 2021), as well as on the processes of intensification of agricultural production (Mishra et al., 2021). Secondly, some scientists (mainly from southern countries), considering food security, pay attention to water

scarcity as a key factor constraining the growth of crop yields. (Drangert, 2021). The third controversy that impedes effective food security management is the occurrence of frequent floods, «which cause a loss of household income and contribute to an increase in the level of poverty» (Oskorouchi & Sousa-Poza, 2021).

Another new contradiction that had a serious impact on the economic recession and the deterioration of the management processes of agro-industrial production was the Covid-19 pandemic. It attracted the attention of scientists around the world of completely different scientific fields and all types of economic activity. For example, Brazilian academics note that «measures to directly purchase food from family farmers, deliver school food kits directly to students, and exemptions from paying electricity bills for vulnerable persons and other emergency measures were not coordinated enough to contain the food crisis in Brazil» (Carvalho et al., 2021; Kansime, 2021). O'Hara and Toussaint (2021) writes about the constant disparity in the population's access to food.

The full interconnection of factors «water-food-energy, as a tool for increasing productivity and sectoral policy», write in their work (Beekma et al., 2021), emphasizing «the need to search for tools to increase productivity and sectoral policy, in order to avoid unforeseen consequences». European scientists examine the interconnectedness «of food management issues during a pandemic crisis, and the need to maintain a sound food security system, by adopting the right strategies to match the needs and requirements of consumers with the requirements of food safety, manufacturers, distribution chain, economic environment, and waste management» in an integrated manner, through bioeconomics.

Taking into account all existing opinions on food security and generally agreeing with them, in our work we are faced with the task of studying the processes of managing agro-industrial production in one of 85 regions of the Russian Federation – in the Republic of Bashkortostan, agriculture has occupied a leading position over the past 50 years.

2. Methodology

The work used statistical, tabular and graphical methods for researching the analysis of the current situation in the agroindustry. The information base of the study was made up of official data from the statistical services of the Russian Federation and the Republic of Bashkortostan. The main purpose of this article is to identify the key directions for the development of the agricultural sector, taking into account the situation of Covid for the period up to 2030. At the first stage of the study, we assessed the level of food self-sufficiency in the region against the background of national indicators. At the second stage, we assessed the degree of utilization of production capacities for processing agricultural products. At the third stage of the research, we compared the level of profitability of the functioning of agricultural and processing enterprises. At the fourth stage of the study, we calculated the required volume of production of the main types of agricultural products in the region for the period up to 2030.

3. Results

Agriculture of Bashkortostan is a branch of the economy of the Republic of Bashkortostan. Agriculture of the Republic of Bashkortostan is one of the leading in the Russian Federation. With 3.4% (7.069 million hectares, arable land – 3,636.7 thousand hectares) of agricultural land in Russia, the republic produces 3.2% of all its agricultural products. A comparative analysis of the level of self-sufficiency of the population of the Republic of Bashkortostan shows that for all the main types of agricultural products: meat, milk, potatoes, eggs, vegetable oil, as well as bread and grain products, it is higher than in the whole country (Table 1).

Table 1. Comparative analysis of the level of consumption of basic food products in the Russian Federation and the Republic of Bashkortostan (per capita per year; kilograms)

Indicators	2010	2015	2016	2017	2018	2019	2019/2010 (%)
Potatoes							
Russian Federation	95	91	90	90	89	89	93.7
Republic of Bashkortostan	78	86	85	87	91	91	116.7
Vegetables							
Russian Federation	98	102	102	104	107	108	110.2
Republic of Bashkortostan	70	78	76	76	76	76	108.6
Fruits and berries							
Russian Federation	57	60	60	59	61	62	108.8
Republic of Bashkortostan	40	44	45	42	41	42	105.0
Meat and meat products							
Russian Federation	69	73	74	75	75	76	110.1
Republic of Bashkortostan	78	74	76	78	78	78	100.0
Milk							
Russian Federation	245	233	231	230	229	234	95.5
Republic of Bashkortostan	324	297	293	300	300	301	92.9
Eggs, pieces							
Russian Federation	270	273	277	282	284	285	105.6
Republic of Bashkortostan	301	272	293	304	301	302	100.3
Sugar							
Russian Federation	39	39	39	39	39	39	100.0
Republic of Bashkortostan	35	38	37	37	37	37	105.7
Vegetable oil							
Russian Federation	13.4	13.6	13.7	13.9	14.0	14.0	104.5
Republic of Bashkortostan	13.2	15.1	15.0	15.2	15.3	15.3	115.9
Bread products							
Russian Federation	120	118	117	117	116	116	96.7
Republic of Bashkortostan	126	120	119	120	121	121	96.0

Calculated by: The official website of the Federal State Statistics Service of the Russian Federation. Source: <https://rosstat.gov.ru/> [Date of access: 10.01.2021]; The official website of the Federal State Statistics Service for the Republic of Bashkortostan. Source: <https://bashstat.gks.ru/> [Date of access: 10.01.2021]

The territory of the Republic of Bashkortostan is divided into several agricultural zones, differing in natural and climatic conditions, landscape, soil and vegetation cover. There are six natural and climatic zones in the region: the mountain-forest zone occupies 15.1% of the territory of the Republic of Bashkortostan; Trans-Ural steppe zone – 13% of the territory; the

pre-Ural steppe zone – 26.2%, the northern forest-steppe zone – 20.7% of the territory, the northeastern forest-steppe zone – 8.2% of the territory, the southern forest-steppe zone – 16.8%.

Each of the designated zones has its own characteristics of farming and growing plants. For example, buckwheat, sunflowers, legumes are grown in the forest-steppe and steppe zones: red clover (meadow), alfalfa, sainfoin, white sweet clover and yellow sweet clover, Oriental goat's rue (galega), as well as crops of annual crops - mustard and rape.

From the data It follows, that the natural and climatic potential and territorial distribution of the region does not allow to fully increase the production of vegetables, fruits and fish.

The level of food self-sufficiency of the Republic of Bashkortostan has always been and is now quite high, but there is reason to believe that the production potential of the region is not being used effectively enough. Analysis of the level of use of the average annual capacity of enterprises for the production of food products proves this fact (Figure 1).

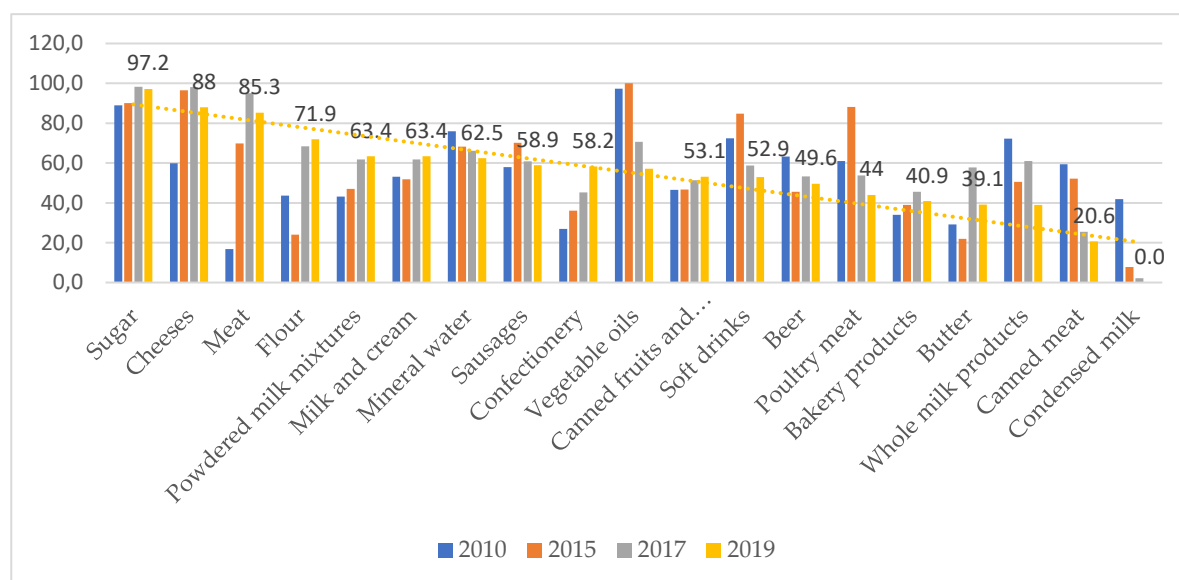


Figure 1. Load capacity of food enterprises in the Republic of Bashkortostan (percent). Calculated by: The official website of the Federal State Statistics Service of the Russian Federation. Source: <https://rosstat.gov.ru/>; The official website of the Federal State Statistics Service for the Republic of Bashkortostan. Source: <https://bashstat.gks.ru/> [Date of access: 10.01.2021]

The level of utilization of the production capacities of food processing enterprises at the level (above the norm) – above 95% is observed for such types of products as: sugar (98%) and cheese (98%). The republic has a powerful potential for the development of its own production for such types of food as: cereals, condensed milk products (by 88%), milk and cream in solid forms (by 81%), canned fruits and vegetables (by 39%), beer (by 37%), meat and by-products (36%), butter (32%), soft drinks (31%), sausages (39%), whole milk products (29%), dry milk mixtures (28%), mineral water (24%), flour (22%), unrefined vegetable oil (19%) and other types of finished food products. It is clear that the region has significant potential to increase the level of utilization of production facilities, at least up to 90%. One of the main reasons for the narrowed reproduction processes in agriculture and the agro-industrial complex is the unprofitableness of some operating industries (Figure 2).

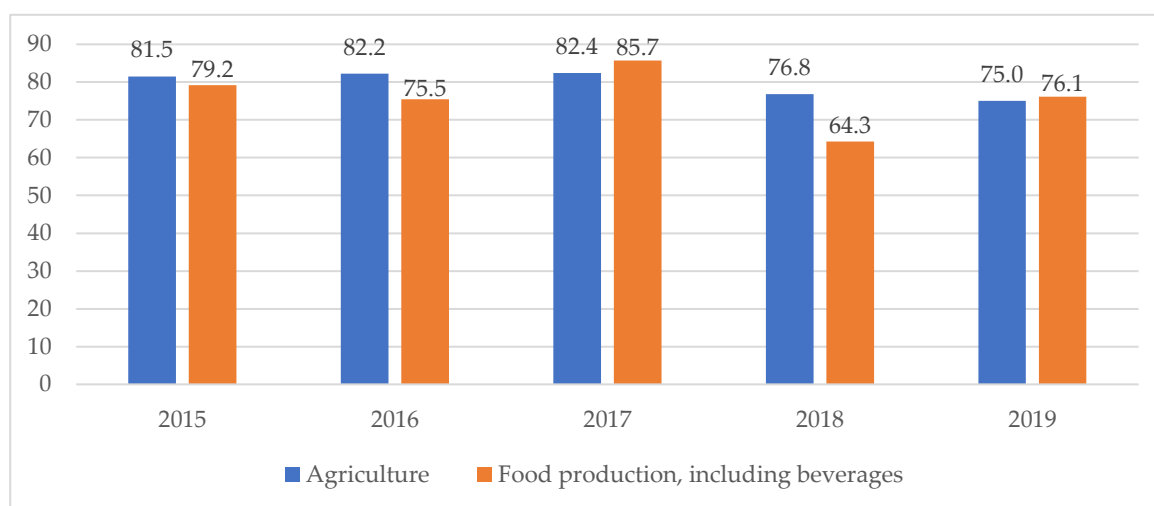


Figure 2. Percentage of profitable organizations as a percentage of the total number of organizations in the Republic of Bashkortostan (in percentage). Calculated by: The official website of the Federal State Statistics Service of the Russian Federation. Source: <https://rosstat.gov.ru/> [Date of access: 10.01.2021]; The official website of the Federal State Statistics Service for the Republic of Bashkortostan. Source: <https://bashstat.gks.ru/> [Date of access: 10.01.2021]

The actual level of profitable agricultural enterprises decreased from 81.5 to 75%, food processing enterprises – from 79 to 76%. Thus, about 25% of agricultural and about 26% of processing enterprises in Bashkiria are unprofitable. The unprofitableness of many agricultural enterprises is associated, first of all, with the low level of purchase prices set by processing enterprises. This leads to a differentiation in the level of remuneration of workers in agricultural and processing enterprises, as well as enterprises of the flour and cereal industry (Figure 3).

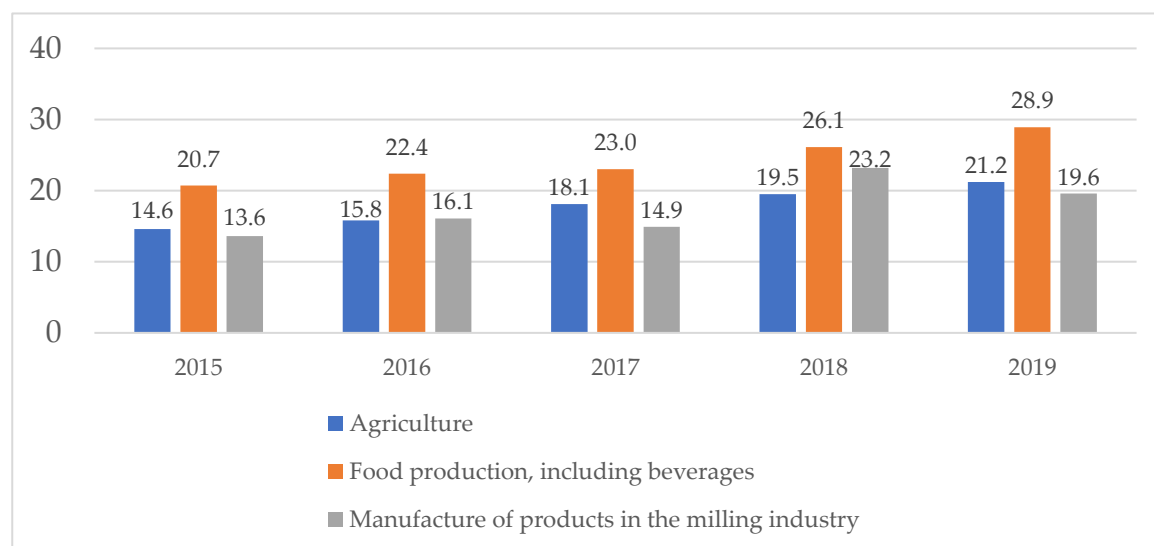


Figure 2. Percentage of profitable organizations as a percentage of the total number of organizations in the Republic of Bashkortostan (in percentage). Calculated by: The official website of the Federal State Statistics Service of the Russian Federation. Source: <https://rosstat.gov.ru/> [Date of access: 10.01.2021]; The official website of the Federal State Statistics Service for the Republic of Bashkortostan. Source: <https://bashstat.gks.ru/> [Date of access: 10.01.2021]

The unprofitableness of some food processing enterprises, in turn, is associated with a large number of imported, cheaper food products on the market, winning in terms of price-quality. In addition, it is important to note that the average monthly wage of agricultural producers is about 30% less than the wages of workers in processing industries. In turn, the level of remuneration of workers in the agricultural sector is on average 56-58% of the average for the region, in food processing industries – about 79%. It is quite obvious that an insufficiently high level of attractiveness of work in the agro-industrial complex leads to an outflow of qualified personnel to other industries, where work turns out to be not so hard and tedious, and money is paid in much larger amounts to maintain a decent level and quality of people's life. For import substitution of food, it is necessary to take comprehensive and radical measures, rational use of available land, climatic and labor resources (Kuznetsova et al., 2019a, 2019b).

According to the official forecasts of the official website of the Federal State Statistics Service of the Russian Federation and Federal State Statistics Service for the Republic of Bashkortostan, the population of the Republic of Bashkortostan by 2025 will be about 3,990 thousand people, by 2030 – 3,860 thousand people. Calculations of the required volumes of food in Bashkiria by 2025 and by 2030 are presented in Table 2.

Table 2. Calculations of the required volumes of food in the Republic of Bashkortostan by 2025 and by 2030 (thousand tons)

Indicators	Potatoes	Vegetables	Meat	Sugar	Vegetable oil	Fruits and berries	Milk	Fish
Actual level of production in all forms of management (2018), thousand tons	851.9	313.0	400.1	no data	no data	no data	1623.9	no data
Required production volumes, taking into account rational consumption rates, thousand tons								
2025 year	379.1	518.7	299.3	103.7	47.9	399.0	1316.7	87.8
2030 year	366.7	501.8	289.5	100.4	46.3	386.0	1273.8	84.9
Required production volumes, taking into account the Food Doctrine, thousand tons								
Doctrine Indicators, %	95.0	90.0	85.0	80.0	90.0	60.0	90.0	80.0
2025 year	360.1	466.8	254.4	83.0	43.1	239.4	1185.0	70.2
2030 year	348.4	451.6	246.1	80.3	41.7	231.6	1146.4	67.9

Calculated by: The official website of the Federal State Statistics Service of the Russian Federation. Source: <https://rosstat.gov.ru/> [Date of access: 10.01.2021]; The official website of the Federal State Statistics Service for the Republic of Bashkortostan. Source: <https://bashstat.gks.ru/> [Date of access: 10.01.2021]

Thus, according to the Doctrine of the country's food security, as well as taking into account rational consumption standards, by 2025-2030 the Republic of Bashkortostan needs an increase in the production of vegetables - not less than 30%, fish - 77%, fruits, berries - in 3-4 times. For the main types of food: milk, meat, potatoes, vegetable oil and sugar, the region is completely independent.

By 2030, the population of the region may decrease by 3.3%, this may entail a decrease in the required volumes of agricultural production, however, while maintaining an export-oriented strategy, it is desirable to maintain an expanded reproductive approach both in agricultural production and in processing industries and the agro-industrial complex.

4. Discussion

Traditionally, the Republic of Bashkortostan was a leader in the production of agricultural products, this has always been favored by natural and geographical conditions and the availability of labor resources. Since the region may well provide agricultural products to neighboring regions, it is necessary to increase the volume of production in large-scale forms of management and increase its processing, to intensify marketing and logistics work to promote goods. The republic has significant potential for the development of agriculture. The work of the agro-industrial complex in 2020 was built within the framework of key program documents. These are the State Program "Development of Agriculture", Decree of the Head of the Republic of Bashkortostan No. 310 "On strategic directions of socio-economic development of the Republic of Bashkortostan until 2024" and national projects related to the development of small business and exports. In addition, in all three packages of anti-crisis measures, agriculture in the region was given special attention, thanks to which in 2020 production growth was about 5%.

It is important to note that in modern conditions there is an urgent need for the development and systematic implementation of the targeted Food Program of Bashkiria for the period up to 2030.

5. Conclusions

For the guaranteed and reliable functioning of the agro-industrial complex of the Republic of Bashkortostan in 2025-2030, it is necessary to increase the land and technical-production potential of the region (on average for one year):

- to ensure land growth: for grain crops - by 20-22 percent; for industrial crops - by 10-15 percent; under potatoes - up to 20 percent; under vegetables and fruits - by 25-35 percent; under meadows and pastures for livestock - three times; under grasses and linden trees - 2.8-3 times; for crops of chemically pure herbs (for collecting medicinal plants and environmentally friendly beekeeping) - 4-5 times; reclaimed (by all reclamation methods) lands - at least three times;
- to achieve an increase in greenhouse areas: for cucumbers and tomatoes - three times; for other vegetables and fruits - 2.5-2.6 times; under flowers - five to six times;
- to increase the number of livestock (for all types of economic entities), including: cattle (cattle) - 1.7-1.8 times (Kuznetsova et al, 2020); pigs - twice; horses, sheep and goats - 3.5-4 times (including breeding horses - no less than 8-10 times) (Kuznetsova et al, 2019a; Askarov et al, 2020);
- to increase the number of poultry (for all economic entities) including: chickens - up to 1.5 times; ducks and turkeys - not less than 3.5 times; geese - 2-2.2 times;
- to ensure an increase in the number of bee hives by 2.5-3 times;
- to ensure the increase in the applied fertilizers (by weight): mineral fertilizers - at least three times; organic fertilizers (including processed animal and poultry waste) - 10-12 times;

- to ensure an increase in the area of rivers and all types of open water bodies with an artificial stocking regime - 4-5 times;
- to ensure an increase in the production of fresh and concentrated feed - at least three times.

These goals can be achieved by increasing labor productivity, strengthening fixed assets and increasing the motivation of workers to work and some other activities.

References

- Askarov, A., Kuznetsova, A., & Gusmanov, R. (2020). Cost-effective horse breeding in the Republic of Bashkortostan, Russia. *Veterinary World*, 10, 2039-2045. <https://doi.org/10.14202/vetworld.2020.2039-2045>
- Beekma, J., Bird, J., Mersha, A.N., Reinhard, S., Prathapar, S.A., Rasul, G., Richey, J., Van Campen, J., Ragab, R., & Perry, C. (2021). Enabling policy environment for water, food and energy security. *Irrigation and Drainage*. <https://doi.org/10.1002/ird.2560>
- Bouwman, T.I., Andersson, J.A., & Giller, K.E. (2021). Adapting yet not adopting? Conservation agriculture in Central Malawi. *Agriculture ecosystems & environment*, 307, 107224. <https://doi.org/10.1016/j.agee.2020.107224>
- De Carvalho, C.A., Viola, P.C.D.F., & Sperandio, N. (2021). How is Brazil facing the crisis of Food and Nutrition Security during the COVID-19 pandemic? *Public Health Nutrition*, 24(3), 561-564. <https://doi.org/10.1017/S1368980020003973>
- Drangert, J.O. (2021). Urban water and food security in this century and beyond: Resource-smart cities and residents. *Ambio*, 78, 963. <https://doi.org/10.1007/s13280-020-01480-z>
- Farcas, A.C., Galanakis, C.M., Socaciu, C. et al. (2021). Food Security during the Pandemic and the Importance of the Bioeconomy in the New Era. *Sustainability*, 13(1), 150. <https://doi.org/10.3390/su13010150>
- Godfray, H., Charles, J., Beddington, J. R., Crute, I. R. et al. (2010). Food security: the challenge to feed 9 billion people. *Science*, 327, 812-818.
- Kansiime, M.K., Tambo, J. A., Mugambi, I. et al. (2021). COVID-19 implications on household income and food security in Kenya and Uganda: Findings from a rapid assessment. *World Development*, R., 137(105199). <https://doi.org/10.1016/j.worlddev.2020.105199>
- Kassie, K.E., & Alemu, B.A. (2021). Does irrigation improve household's food security? The case of Koga irrigation development project in northern Ethiopia. *Food Security*. <https://doi.org/10.1007/s12571-020-01129-5>
- Kuznetsova, A. (2020). Prospects for the Development of the Dairy Industry in the Republic of Belarus and in the Russian Federation. In *Hradec Economic Days* (vol. 10, pp. 417-425). <https://doi.org/10.36689/uhk/hed/2020-01-048>
- Kuznetsova, A., Avzalov, M., Gogbunov, D., & Stovba, E. (2019a). Trends and Status of Agribusiness in Animal Husbandry of the Russian Federation. *Hradec Economic Days*, 9(1), 519-527.
- Kuznetsova, A., Kolevid, G., Kostyaev, A. et al (2019b). Reproduction of the Qualified Personnel of Working Professions in Agriculture. In *Hradec Economic Days* (vol. 9, pp. 11-22).
- Mishra, A., Ketelaar, J.W., Uphoff, N., & Whitten, M. (2021). Food security and climate-smart agriculture in the lower Mekong basin of Southeast Asia: evaluating impacts of system of rice intensification with special reference to rainfed agriculture. *International Journal of Agricultural Sustainability*. <https://doi.org/10.1080/14735903.2020.1866852>
- Neelakantan, A., DeFries, R., & Fanzo, J. (2020). Food security and livelihoods of post-resettlement households around Kanha National Park. *Plos One*, 12, e0243825. <https://doi.org/10.1371/journal.pone.0243825>
- O'Hara, S., & Toussaint, E.C. (2021). Food access in crisis: Food security and COVID-19. *Ecological Economics*, Tom 180(106859). <https://doi.org/10.1016/j.ecolecon.2020.106859>
- Oskorouchi, H.R.; Sousa-Poza, A. (2021). Floods, food security, and coping strategies: Evidence from Afghanistan. *Agricultural Economics*, 52(1), 123-140. <https://doi.org/10.1111/agec.126101>
- The official website of the Federal State Statistics Service of the Russian Federation. (2021). <https://rosstat.gov.ru/>
- The official website of the Federal State Statistics Service for the Republic of Bashkortostan. (2021). <https://bashstat.gks.ru/>

Development of Disruptive Growth Engine: Double Cases Study Based on Alibaba and Tencent

Wei LI¹, Yuchen LEI² and Yutian LIU³

¹ Northwest University, Xi'an, China; xbdxw@126.com; 534625535@qq.com; 2915930624@qq.com

* Corresponding author: xbdxw@126.com

Abstract: Facing the new situation, new problems and new challenges, China firmly implements the innovation-driven development strategy and places scientific and technological innovation at the core of the overall national development. Christensen's disruptive innovation theory provides a theoretical direction for Chinese enterprises to practice the innovation-driven development strategy and break through growth barriers through innovation, Christensen & Raynor pointed out the future research direction that how to develop a disruptive growth engine to enable enterprises to repeatedly start disruptive business and achieve disruptive growth. Through the double case study of Alibaba and Tencent, this paper answers three questions of how to get the ideas of disruptive innovation, how to shape the ideas of disruptive innovation into disruptive business, and how to make disruptive business achieve disruptive growth, finds out the driving force for enterprises to start disruptive business continuously, and constructs the theory model of disruptive growth engine remembering and responding to Christensen.

Keywords: disruptive innovation; disruptive business; disruptive growth engine

JEL Classification: M10; O12; O33

1. Introduction

Facing the new situation, new problems and new challenges, China firmly implements the innovation-driven development strategy and places scientific and technological innovation at the core of the overall national development. As the main body of market economy and the main carrier of economic development, enterprises are duty bound to become the main force of innovation-driven development strategy and play a decisive role in market allocation of innovation resources. However, as an emerging economy, how can domestic enterprises, especially those in strategic emerging industries, break through the growth barriers through independent innovation, catch up with and surpass leading enterprises, and play the main role in practicing the innovation-driven development strategy?

Christensen established the theory of disruptive innovation through series of articles and two classic books named the innovator's Dilemma (1997) and the innovator's solution (2003), provided a new idea for emerging enterprises to catch up with and surpass leading enterprises, and also provided a theoretical direction for Chinese enterprises to break through the growth barriers through innovation. Based on the theory of disruptive innovation, Christensen and Raynor (2003) first put forward the concepts of disruptive

growth and disruptive growth engine in his book named the innovator's solution, that is the process of constantly creating disruptive business, so that enterprises can repeatedly start disruptive business and complete disruptive growth. Although they have not yet found that any enterprise has developed such an engine, they think it is possible, and put forward four key steps to develop destructive growth engine. Under the influence of Christensen & Raynor, Anthony et al. (2008) tried to develop the process of disruptive growth of enterprises, designed the innovation structure and innovation system of enterprises. Dyer et al. (2011) studied the genes of innovators, that is, the five discovery skills for generating innovative ideas. Silverstein et al. (2012) developed 58 skills and two processes for enterprises to grow through innovation. Xu and Li et al. (2014) studied the growth mechanism of enterprises based on disruptive innovation, and found that technology disruption, product disruption, market disruption and service disruption jointly form a disruptive growth engine on the basis of opening the window of technology and market opportunity, launch disruptive attacks on existing industry leaders, constantly occupy their market share, and finally establish new industry competition rules. Brad et al. (2016) studied the lean design method of disruptive innovation. Generally speaking, the research of destructive growth engine is still in the exploratory stage. Under the background of China's innovation-driven development strategy and industrial transformation and upgrading, many enterprises, especially strategic emerging enterprises, will get unprecedented development opportunities and broad space, it has great theoretical value and practical significance to study the disruptive growth engine based on the Chinese context.

Based on the theory of disruptive innovation, this paper selects Chinese case enterprises to study how to get the ideas of disruptive innovation, how to shape the ideas of disruptive innovation into disruptive business, and how to make disruptive business achieve disruptive growth, find out the driving force for enterprises to start disruptive business continuously, and construct the theory model of disruptive growth engine remembering and responding to Christensen, a master of innovation management.

2. Methodology

2.1 Case Selection

This paper studies how to construct the theory model of disruptive growth engine, which is an exploratory research problem and suitable for case study (Yin, 2014). However, the research problem explored in this paper is neither a universal problem nor an extreme phenomenon, but an interesting business phenomenon. Therefore, based on the principle of theoretical sampling, the method of double case study is adopted. To study a pair of mutually reinforcing cases can reflect and supplement the same phenomenon, and enhance the application of the theory (Eisenhardt, 1989; Mao & Chen, 2017).

There are three reasons for selecting the research case in the Internet industry. First, the Internet industry has fast innovation and development speed, and there are many business cases of disruptive innovation, especially the cases of repeatedly starting disruptive

innovation business that are in line with the theoretical sampling are not available in other industries. Second, the competitive structure of the Internet industry is relatively stable, which is convenient for selecting typical cases and collecting data. Third, the development of Internet industry is relatively mature, which is convenient for the correct evaluation of leading enterprises' disruptive innovation business operation and disruptive growth.

The cases studied in this paper should meet the following conditions. First, they are Chinese local enterprises, which is convenient to study the disruptive growth engine based on Chinese context. Second, they are in line with the principle of theoretical sampling, the selected enterprises have obtained the concept of disruptive innovation for several times, and successfully operate the disruptive innovation business repeatedly to achieve disruptive growth. Third, they are in line with the principle of typicality, which can fully show the process of constantly creating disruptive business. Fourth, data is relatively easy to obtain. Based on the above four conditions, this paper selects Alibaba and Tencent as research cases.

2.2 Case Introduction

Alibaba was founded in 1999. With the mission to Make It Easy to Do Business Anywhere, it has made intensive efforts in the Internet field and served the development of Chinese small and medium-sized enterprises for a long time. Through a series of disruptive innovation businesses, it has realized the sustained disruptive growth and become a leading enterprise in China's e-commerce industry. So, it is the most typical Chinese case of constructing the theory model of disruptive growth engine. Considering the different levels of development and disruptive degree of Alibaba's business, this paper focuses on 1688, Taobao, and Tmall business in the field of e-commerce, Alipay and Yu'e Bao business in the Internet financial field, Cainiao Network in the modern logistics field, and new retail business as the research object.

Tencent was founded in 1998, it has adhered to the business philosophy of User Value is Our Guiding Principle since its establishment. Through a series of imitative innovation of instant messaging software, it has provided consumers with high-quality Internet comprehensive services, and gradually grown into an Internet-based technology and culture enterprise, which has profoundly affected and changed the way of communication and living habits of humanity. Based on the enterprises' disruptive business, this paper focuses on the QQ and WeChat business as the research object.

2.3 Data Collection

This paper collects data from various sources and establishes a case database. First, investigated and surveyed Alibaba and Tencent. Second, collected 484 papers about Alibaba and 324 papers about Tencent by CNKI database. Third, bought 12 books about Alibaba and Tencent. Fourth, collected 34 full texts of Jack Ma's public speeches and 27 full texts of Huateng Ma's public speeches. Fifth, collected enterprise information on the official websites of Alibaba and Tencent.

2.4 Data Analysis

This paper adopts single case analysis and comparative analysis between cases. First of all, the paper makes a longitudinal analysis on each case enterprise, straightens out the historical evolution of the enterprise, studies the ideas source, business operation and enterprise growth of each disruptive innovation business of the enterprise, and further studies the driving force of repeatedly starting disruptive innovation business of the enterprise, so as to construct a clear theoretical framework of disruptive growth engine. Secondly, makes a comparative analysis between the two cases for looking for differences and similarities, then constructs a theoretical model.

3. Results

Under the guidance of disruptive innovation theory, based on the case study of Alibaba and Tencent, this paper draws the following five conclusions.

3.1 It Is Feasible to Develop the Disruptive Growth Engine of Enterprises

On the basis of theoretical research and case study, this paper constructs a theoretical model of disruptive growth engine, as shown in Figure 1. Therefore, based on the case study of Chinese enterprises, it is found that developing disruptive growth engine is feasible, which responds to the expectation of Christensen and Raynor.

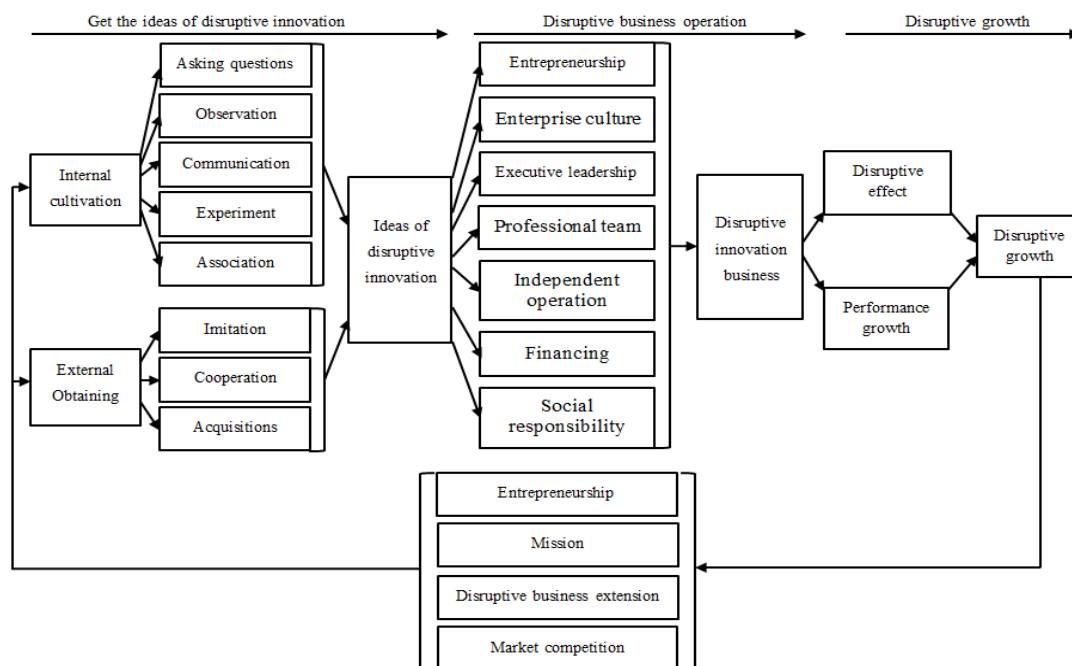


Figure 1. Theoretical model of the disruptive growth engine

3.2 Disruptive Innovation Ideas Can Come From Both Internal and External Sources

From the inside, through entrepreneurs and team members repeatedly using the five discovery skills of asking questions, observation, communication, experiment and association, enterprises can cultivate disruptive innovation ideas. From the outside,

enterprises can also obtain disruptive innovation ideas through imitation, cooperation and acquisitions. In particular, the idea of disruptive innovation is not necessarily original innovation. The practice of Alibaba and Tencent shows that enterprises can Chinese innovate based on imitation, for example, Alibaba's B2C, C2C and Alipay respectively imitate Amazon, eBay and PayPal, Tencent's QQ and WeChat respectively imitate ICQ and KIK, and turn the continuous innovation in mature markets into disruptive innovation in China's emerging markets. In other words, disruptive innovation has the characteristics of market relativity, and the continuous innovation of one market may be the disruptive innovation of another market.

3.3 The Enterprises Shape Disruptive Innovation Ideas into Disruptive Businesses by Using a Variety of Means

For enterprises pursuing innovation and growth, the core problem is not the lack of good ideas, the real problem lies in the commercialization process, that is, transforming disruptive innovation ideas into specific business models. Therefore, how to transform disruptive innovation ideas into successful disruptive innovation business under certain conditions is the key to the good operation of disruptive growth engine. From the perspective of Alibaba and Tencent's disruptive innovation business operation, entrepreneurship, enterprise culture, executive leadership, professional team, independent operation, financing and social responsibility are all important conditions for transforming disruptive innovation ideas into disruptive innovation business, a brief description will be given in 4.2. Enterprises can combine their own reality and comprehensively use these means to shape disruptive innovation ideas into disruptive innovation business.

3.4 The Extension of Disruptive Business can Start New Disruptive Business and Promote the Disruptive Growth of Enterprises

Business innovation based on disruptive innovation is the extension of the original business, this extension may bring continuous innovation or new disruptive innovation to the enterprise. However, for competitors and consumers, the innovation of enterprises based on the original disruptive innovation business is often another disruptive innovation, because enterprises in their own core track, every small step forward, can get rid of competitors a big step. In other words, disruptive innovation has the subject relativity, and the continuous innovation of disruptive innovation enterprises may be a disruptive innovation for competitors and consumers. Therefore, the extension of the original disruptive innovation business is an important way for enterprises to obtain the disruptive innovation ideas again and successfully operate the disruptive innovation business.

3.5 Disruptive Innovation Can Trigger Cross-border Disruption

With the commercialization of the new generation of information technology, disruptive innovation of enterprises can not only produce disruptive effects in their industries, but also trigger cross-border disruptive effects in other fields and industries. For example, WeChat, developed by Tencent, is obviously disruptive to the traditional media

industry and telecom industry. Therefore, in the future, it is not enough for enterprises to focus only on their own industry, competitors and competition structure, they must always be alert to the impact of cross-border disruptive innovation. Just as China Telecom, China Mobile and China Unicom have been competing with each other for so many years, they suddenly find that Tencent is their real competitor.

4. Discussion

4.1 *Get the Ideas of Disruptive Innovation*

- Internal Cultivation

From the perspective of internal cultivation, the five discovery skills of asking questions, observation, communication, experiment and association proposed by Dyer et al. (2011) are very conducive to get the ideas of disruptive innovation, and the discovery skills of enterprise leaders are more important.

Asking Questions. Good questions are the key catalyst to inspire creative thinking. In 1995, Jack Ma first used the Internet through his friend Bill in Seattle, and asked the questions to stimulate his entrepreneurial enthusiasm. Why is there no information about China? Why not create something about China? (Alibaba Group, 2015a; Alibaba Group, 2017). These problems made Jack Ma decide to take the Internet as a breakthrough for entrepreneurship and open Alibaba's Internet business empire. In 1997, Huateng Ma first used the instant messaging software ICQ, which was jointly developed by three Israelites, he was attracted by its infinite charm, but the English version of ICQ is difficult to popularize in China. Huateng Ma asked himself, why not make a Chinese version of ICQ (Guan, 2015). This question aroused Huateng Ma's impulse to start a business and eventually developed the Chinese version of instant messaging software OICQ, which is the predecessor of QQ.

Observation. Disruptive innovators are also diligent observers. They carefully observe the world around them, including markets, customers, products, services, policies and competitors. They not only observe the successful experiences that are worth learning from, but also keenly observe the existing problems and opportunities that can be further improved. Through positive observation, they gain unique insights and ideas.

When Jack Ma first used the Internet in Seattle, he observed that there was no Chinese information on the Internet, which planted the seeds of his entrepreneurship in the Internet field. While working in China's Ministry of Foreign Trade and Economic Cooperation, Jack Ma keenly observed that the Internet wave around the world was coming, so he left Beijing and went back to Hangzhou to start his new business. In 1999, Jack Ma observed that at the Asian e-commerce conference, the discussion was mainly about the European and American e-commerce model serving large enterprises, and he also witnessed the difficulties of Chinese small and medium-sized enterprises, so he decided to create an e-commerce model serving small and medium-sized enterprises. In 2002, eBay entered China, which attracted Jack Ma's great attention. He observed all the websites in the world at that time and found that eBay would become Alibaba's biggest challenge. So he launched

Taobao. By observing the competition between eBay and Amazon and the problems existing in Taobao, Jack Ma realized that B2C is the mainstream of e-commerce, so Alibaba launched Tmall. Jack Ma further observed that lack of credit has become the most serious bottleneck, he launched Alipay which was the third-party online payment platform. The application of Alipay has been widely popularized, and more and more money have been deposited in Alipay's account, which has aroused widespread concern and doubt, so Alibaba launched Yu'eobao. With the rapid development of e-commerce, Jack Ma observed that logistics has become a new bottleneck, so Alibaba launched the Cainiao Network.

After using ICQ, Huateng Ma observed that ICQ was likely to bring about a communication revolution in China, but its English interface and operation didn't conform to the market in China at that time, so he obtained a clear direction of entrepreneurship. In 2010, an application named KIK gained 1 million users within 15 days, Xiaolong Zhang, who was in charge of Tencent's e-mail business, obviously noticed the rapid rise of KIK, but his observation was more profound. What he saw was that the blooming of KIK and KIK-like software was likely to pose a fatal threat to QQ. Therefore, with the support of Huateng Ma, he quickly got the idea of disruptive innovation and launched the WeChat.

Communication. Disruptive innovators are often typical idea communicators, they have a wide range of interpersonal relationships, actively participate in all kinds of idea communication activities, communicate with people with different backgrounds and views, spend time and energy to find and test ideas, so as to get very different views. In Jack Ma's view, after meeting all kinds of people in the world, listening to all kinds of views, and communicating with excellent people, the vision and depth of observing will be very different. When he was a college student, Jack Ma served as the president of the student union and the president of the Hangzhou Federation of Students. And when he was a teacher, he founded the first English corner on the West Lake and established Haibo translation agency. These experiences have trained his skills of communication and organization. Because he knew Bill when he was running Haibo translation agency, he had the opportunity to use firstly the Internet. After leaving school to start a business, extensive communication is an important means for Jack Ma to obtain business ideas. Externally, he actively participates in various conferences, makes friends with heads of state and business leaders of various countries, listens to the voice of customers, and has in-depth communication with the team and employees, which sparks innovation. In the early days of Tencent's, it faced the risk of breaking the capital chain. The founder team of Tencent participated in Chinese international high-tech achievements fair and met Shu Wang, the general manager of IDG, they convinced Shu Wang to invest in Tencent and broke the capital bottleneck.

Experiment. Disruptive innovators are always trying new experiences and new ideas. Unlike scientists, business innovators don't work in the laboratory because the world is their laboratory. Although asking questions, observation and communication can provide data in past and present, for disruptive innovation, there is no data to reference, the best way to collect data is experiment. Just as Jack Ma said, "if you want to do something, action is essential, if you do it, you have a chance to succeed, but if you give it up, it's like thinking

a thousand ways at night and going the same way in the morning” (Alibaba Group, 2015a). Therefore, every innovative business can’t do without experiments. For the establishment of Alibaba and the development of every business, there are no successful experience to learn from, so Alibaba can only grope through experiments again and again. In the initial stage, no one was optimistic about OIQ, if Huateng Ma gave it up because of others’ doubts, if he didn’t carry out the business experiment, there would be no QQ and Tencent’s business empire. Xiaolong Zhang, the inventor of WeChat, said, “at the beginning, WeChat was not as a strategic project, it was just an experiment, no one knew what the future would be like” (Jiang et al., 2014).

Association. The key skill to form new ideas is association. Disruptive innovators actively explore a wide range of new information and ideas through asking questions, observation, communication and experiment, these methods are important catalysts for association. Disruptive innovators connect their own experiences and integrate them into new ideas. In fact, most of the new things that innovators invent are not real new things, innovators just recombine the ideas in a new way. By actively using the methods, innovators can improve association ability. Innovators collect the more ideas, the more they can get new ideas.

- External Obtaining

Imitation. From B2B to C2C, and then to B2C, they are not entirely Alibaba’s own innovation, these models are originated in developed market of U.S.A. Alibaba’s e-commerce models are essentially imitations, but these imitations are not simple copying, but closely combining these e-commerce models with China’s national conditions. So they are Chinese innovation based on imitation and disruptive innovation in China’s emerging markets.

Although Tencent has become a global giant, it still can’t tear off the label of imitation. The prototype of QQ, WeChat, as well as every value-added service can be found. However, Tencent is growing stronger and stronger by imitation, while the objects been imitated gradually fade out our vision. The key reason is that Tencent’s success is not simple imitation too, but the innovation based on imitating, adding new elements of Chinese culture and consumer demand. Huateng Ma believes that imitation is the safest innovation (Zhang, 2013).

To sum up, innovation based on imitation can also lead to disruptive innovation, continuous innovation in a mature market may become disruptive innovation in another emerging market.

Cooperation. The idea of Yu’eobao is not from the internal team of Alibaba, but the cooperation of Alibaba and Tianhong Asset Management Co. Ltd. Cainiao Network is from cooperation of Alibaba and logistics enterprises and warehousing enterprises, and has become an essential infrastructure for Chinese business. Although Hema Fresh, one of the new retail models, was launched by Alibaba, its idea does not come from Alibaba. It was first proposed by Yi Hou, the former head of JD.COM. When Yong Zhang who was Alibaba’s CEO and Yi Hou got to know each other, they had a strong ideological resonance,

so in 2015, Yi Hou left JD.COM and officially joined Alibaba to help Alibaba launch Hema Fresh.

Acquisition. The idea of WeChat comes from Xiaolong Zhang, although the idea is not acquired through acquisition, the innovation team is acquired through acquisition. For Alibaba and Tencent's disruptive innovation, they didn't obtain the ideas directly through acquisition, but this mode is completely possible in theory. As the domestic and even international enterprises that can repeatedly start disruptive business are very rare, we still insist that acquisition is one of the channels for enterprises to obtain disruptive innovation ideas from the outside in the theoretical model.

To sum up, the disruptive innovation ideas of enterprises can be obtained through both internal and external, it is often the result of multiple means working together. Moreover, internal cultivation is the main method, supplemented by external obtaining.

4.2 Disruptive Business Operation

How to transform disruptive innovation ideas into successful disruptive business is the key to the disruptive growth engine. From the perspective of Alibaba and Tencent's disruptive business operation, entrepreneurship, enterprise culture, executive leadership, professional team, independent operation, financing and social responsibility are all important conditions for transforming disruptive innovation ideas into disruptive business.

- Entrepreneurship

China needs entrepreneurs, especially entrepreneurship. However, for entrepreneurs who promote disruptive innovation, in addition to the general characteristics of honesty, adventure, cooperation and dedication, they also especially need the entrepreneurship of forward thinking, innovation courage, taking responsibility, never giving up and passion, these characteristics are the most powerful driving force.

- Enterprise Culture

Enterprise culture is enterprises' soul and inexhaustible power. For Alibaba and Tencent, enterprise culture is the driving force for entrepreneurs and employees to work hard, and it is also the rudder of enterprises. No matter how the business environment changes, the two enterprises have never deviated from the values orientation, which is the most important factor for the two enterprises to get disruptive innovation ideas and start disruptive business again and again. Alibaba is an enterprise driven by mission and values (Alibaba Group, 2017), all activities are closely around the mission to Make It Easy to Do Business Anywhere. Jack Ma said, "If you ask where Alibaba's ideas come from, they are come from mission and values" (Alibaba Group, 2015b). All innovative activities of Tencent always start from consumer's demand and value, which is the principle of thinking and operation.

- Executive Leadership

Executives not only play an important role in getting disruptive innovation ideas, but also play an indispensable role in the operation of disruptive business. Executives often

need to personally operate disruptive business, choose the right time to start disruptive business, coordinate the conflicts between existing business and new disruptive business, allocate resources and deal with emergencies. In short, executives need to use their power and influence to support disruptive business.

- Professional Team

The successful operation of disruptive business also needs a united and efficient team. Jack Ma believes that the most precious wealth of an enterprise is the team and its cohesion. He was pretty confident that it doesn't matter to lose Alibaba or Taobao, as long as the team is still there, he can recreate a miracle (Alibaba Group, 2015b). Huateng Ma also believes that team is the enterprise's biggest asset, the success of an enterprise is never just a matter of money or resources, the key is team (Ma, 2017).

- Independent Operation

Independent operation helps to improve the concentration, flexibility and freedom of disruptive business. Alibaba and Tencent attach great importance to the independent operation of business, and ensure the independence of business. If the organizational structure becomes the constraint of business and restricts the innovation and development, the enterprises will make timely and reasonable adjustments.

- Financing

For disruptive business, sufficient money is related to the successful operation of the business and the survival of the enterprise, especially in the early stage of enterprise. However, not all money is suitable for disruptive business, disruptive business needs the patient money, not the money eager for quick success and instant benefit. Therefore, the choice of what kind of money, when to finance and how to use the money all play a crucial role in the successful operation of disruptive business.

- Social Responsibility

A great company must solve social problems(Alibaba Group,2017). One of the important characteristics of disruptive innovation is the social responsibility. Only strive to solve social problems, the disruptive business can be operated smoothly. For Alibaba and Tencent, one of the important reasons for repeatedly starting and successfully operating disruptive business is that enterprises have implanted social responsibility into the business model. Tencent has taken the social responsibility of improving the quality of human life with technological innovation, completely changed human's living habits, and made outstanding contributions to social development.

4.3 Disruptive Growth

- Alibaba's Disruptive Growth

Through successful operation of disruptive business such as 1688, Taobao, Tmall, Alipay, Yu'eobao, Cainiao Network and new retail business, Alibaba has built a new market credit system in China, created a new way of payment, fostered e-commerce industry,

promoted the vigorous development of Internet finance, modern logistics and other emerging industries, accelerated the transformation and upgrading of traditional industries, forced the reform of the financial system, constructed a national logistics infrastructure, changed the mode of enterprises operation, market competition and human life, promoted China's consumption upgrading and high-quality economic development, and created a new path for China to solve the poverty.

Disruptive business has made Alibaba develop rapidly. The sales in annual Singles' Day of Tmall increased from 52 million Yuan in 2009 to 372.3 billion Yuan in 2020, with an average annual compound growth rate of 124.10 percent (Alibaba Group, 2010-2021). At present, Alibaba ranks first among China top 100 Internet enterprises in 2020, second among Hurun's top 500 private enterprises in 2020, 18th among Fortune's China top 500 in 2020, 132nd among Fortune's world top 500 in 2020, and second among Fortune's 100 companies that will change the world in 2020.

- Tencent's Disruptive Growth

Through QQ and WeChat, Tencent has created China's leading instant messaging platform, made instant messaging, especially WeChat, become an essential infrastructure like water, electricity and highway, deeply affected and changed the communication habits and lifestyle of residents, as well as the business model and environment, so the quality of human life has been effectively improved. Nowadays, instant messaging and a series of value-added services are destroying the business model of telecommunications, media and other traditional industries, even affected China's monetary policy.

Tencent's performance has improved significantly. The revenues and profit have increased respectively from 1.144 billion Yuan and 0.447 billion Yuan in 2004 to 377.289 billion Yuan and 94.351 billion Yuan in 2019, the average annual compound growth rate has reached 43.68 percent and 39.73 percent respectively (Tencent, 2004-2019). The monthly active consumers of QQ has increased from 135 million in 2004 to 727 million in 2019, and the monthly active consumers of WeChat has increased from 355 million in 2013 to 1.165 billion in 2019.

4.4 Driving Force of Disruptive Growth Engine

The "engine" needs enough "fuel" to continuously provide power. Through the study on Alibaba and Tencent, it has found that the synergy of entrepreneurship, enterprises mission, extension of disruptive business and market competition makes enterprises have a steady stream of motivation to strive to obtain disruptive innovation ideas from inside or outside and start disruptive business.

- Entrepreneurship

Entrepreneurship is the key driving force of disruptive growth engine. Forward-thinking enables entrepreneurs to see and think things in the next decade or even beyond. As Jack Ma said, "we will start to do what we need in ten years later"(Alibaba Group,2014). Innovation courage makes entrepreneurs not satisfied with the present

situation, have the courage to break through the boundaries of thinking and the shackles of the environment, and do something that others dare not or can't. The enterprisers taking responsibility integrate social responsibility and their love for the country into the innovation, when the enterprise encounters setbacks, they can stand up and become the navigator of enterprise and the spiritual leader of all employees. Never giving up means that entrepreneurs have firm belief and, no matter what difficulties they encounter, they will never give up. The passion is not only reflected in the entrepreneurial passion and energy, but also can affect everyone around them with passion and positive energy.

- Enterprise Mission

Enterprise mission embodies the value proposition and social responsibility of the enterprise, and is also the lofty goal of enterprise. Alibaba's mission is to Make It Easy to Do Business Anywhere, and Tencent's mission is to Improve the Quality of Human Life Through Internet Services, the important reason for the success of the two enterprises through disruptive innovation is that they not only determine the enterprise mission in line with the social development, but all business must closely around the mission, and any business contrary to the mission has been resolutely abandoned.

- Extension of Disruptive Business

The innovation of Alibaba and Tencent shows that the disruptive growth engine is based on the mission and starting from the first disruptive business. Alibaba's disruptive innovation is gradually extended with e-commerce as the main line, while Tencent's disruptive innovation is gradually extended with instant messaging as the main line. Every innovation of Alibaba and Tencent may be disruptive innovation or continuous innovation for the enterprise itself, but it is disruptive innovation for consumers and competitors. Therefore, the extension based on the original disruptive business is an important way for enterprises to obtain the ideas of disruptive innovation and successfully operate the new disruptive business again.

- Market Competition

Market competition makes enterprises have a strong consciousness of crisis, and forms a forced mechanism for disruptive innovation of enterprises, so that enterprises can get the ideas and start disruptive business by imitation. Alibaba launched Taobao business in response to eBay, Jack Ma said, "We launched C2C to prevent that when eBay enters China, we have no defense capability" (Alibaba Group, 2015b). One of the purposes of Alibaba's launch of Alipay is PayPal, Jack Ma recalled, "Before we launched Alipay, we have realized that if we do not do it now, what shall we do when PayPal enters China in the future?" (Alibaba Group, 2015b). With the rapid rise of KIK, Xiaolong Zhang and Huateng Ma deeply felt the serious threat to QQ. Therefore, Huateng Ma immediately organized three teams to develop WeChat at the same time. It can be seen that, as Jack Ma said, "Most of innovation is not because enterprises want to innovate, but because they have to do" (Alibaba Group, 2017).

5. Conclusions

Christensen & Raynor (2003) put forward the concept of disruptive growth engine for the first time. However, because there are very few enterprises successfully starting disruptive business continuously, the literature in this field is very rare. Through the double case study of Alibaba and Tencent, this paper answers three questions of how to get the ideas of disruptive innovation, how to shape the ideas of disruptive innovation into disruptive business, and how to make disruptive business achieve disruptive growth, finds out the driving force for enterprises to start disruptive business continuously, and constructs the theory model of disruptive growth engine remembering and responding to Christensen, a master of innovation management.

References

- Alibaba Group. (2015a). *Jack Ma's internal speech: Believe in tomorrow*. Red Flag Press.
- Alibaba Group. (2015b). *The age of the Internet has just begun: Jack Ma's internal speech 2.0*. Red Flag Press.
- Alibaba Group. (2017). *Jack Ma: The future has come*. Red Flag Press.
- Alibaba Group. (2009-2020). *Financial Annual Report*. <https://www.alibabagroup.com/cn/ir/reports>.
- Anthony S. D., Johnson M. W., Sinfield, J. V., & Altman E. J. (2008). *The innovator's guide to growth: Putting disruptive innovation to work*. Harvard Business Press.
- Tencent (2019). *Financial Annual Report*. <https://www.tencent.com/zh-cn/investors/financial-reports.html>.
- Brad, S., Murar M., & Brad, E. (2016). Methodology for lean design of disruptive innovations. *Procedia CIRP*, 50(1), 153–159. <https://doi.org/10.1016/j.procir.2016.04.204>
- Cheng, Z. (2013). Tencent: Internet empire created by "taking doctrine". *Military Correspondent*, 2, 47–48. <https://10.13765/j.cnki.cn11-4467/g2.2013.02.031>
- Christensen, C. M. (1997). *The innovator's dilemma: When new technologies cause great firms to fail*. Harvard Business School Press.
- Christensen, C. M., & Raynor, M. E. (2003). *The innovator's solution: Creating and sustaining successful growth*. Harvard Business School Press.
- Dyer, J., Gregersen H., & Christensen C. M. (2011). *The innovator's DNA: Mastering the five skills of disruptive innovators*. Harvard Business School Press.
- Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, 14, 532–550. <https://doi.org/10.5465/amr.1989.4308385>
- Jiye, M., Cheng, C. (2017). Theoretical construction of case study: Eisenhardt's new insight. *Management World*, 2, 135–141. <https://doi.org/10.19744/j.cnki.11-1235/f.2017.02.012>
- Jiuxiang, X., Hua, L., & Chunyuan, W. (2014). Research on enterprise growth model based on disruptive innovation. *Science of Science and Management of S. & T*, 35(2), 134–142.
- Hongjun, J., Shulong, H., & Xiumin, F. (2014). Xiaolong Zhang: WeChat brings new challenges to the world. *Business Research*, 20, 28–39.
- Huateng, M. (2017). I started Tencent these years. *Chinese & Foreign Entrepreneurs*, 22, 4–6.
- Lan, G. (2005). Huateng Ma: The father of Tencent QQ. *Management & Technology of SME*, 2005, 9, 12–13.
- Silverstein, D., Samuel, P., & Decarlo, N. (2012). *The innovator's toolkit: 50+ techniques for predictable and sustainable organic growth* (2nd ed). Management Group International.
- Yin, K. (2014). *Case study research: Design and methods* 5th ed. Sage Publications, Inc.

Income Distribution and Industrial Structure in China's Urban and Rural Areas

Guobin LIU*, Beibei SHI¹ and Rong KANG

Northwest University, Xi'an, China; 2936612690@qq.com; pgyky412@163.com; kangrong@nwu.edu.cn

* Corresponding author: 2936612690@qq.com

Abstract: Since China's reform and opening up, China's economy has achieved a growth miracle. The people's income is constantly increasing, but according to World Bank statistics, Gini coefficient has exceeded the inequality warning line. The income distribution gap is getting bigger and bigger, which has become a serious problem China facing under the requirements of high-quality development. This article makes a brief theoretical analysis of the current situation of China's urban and rural income distribution and economic structure, and collected 31 provinces and cities, 9 consecutive years of panel data. The fixed effect model is used to empirically analyze the relationship between the urban and rural income distribution and industrial structure in various regions of China. The research results show that the upgrading of industrial structure has exacerbated the income distribution gap. Moreover, comparing the estimated parameters of the regression model between urban and rural areas, it is found that the impact of urban industrial structure upgrading on income disparity is more sensitive than that in rural areas.

Keywords: urban and rural; income distribution; industrial structure; Gini coefficient

JEL Classification: E64; L16; O18

1. Introduction

China's high-quality development goals in the report of the Fifth Plenary Session of the Nineteenth Central Committee paid special attention to the income distribution of residents. A key point in China's road to common prosperity is the rationality of income distribution. Normative analysis of economic issues often encounters the dilemma of fairness and efficiency. Income distribution is obviously related to the issue of equity. Excessive income distribution gaps will lead to social instability.

The process of China's industrialization continues to deepen, and the proportion of industrial added value in the industrial structure has gradually increased from the primary industry to the secondary and tertiary industries. With the continuous upgrading of the industrial structure, what is the income distribution situation in China?

The research perspectives on income distribution include: government transfer payments, human capital, tax regulation, production factor flow, industrial structure, etc. Among them, scholars who study tax regulation have found that China's tax system design is not very reasonable and needs to be improved. Income growth has an inverted U-shaped effect on income distribution. In particular, China's reform and opening up, rapid economic

growth, and the mechanism of income distribution's influence on investment: income distribution pattern→income level→effective demand→capital accumulation and investment structure (Wang & Cai, 2006). Conversely, the investment structure will also lead to the gap in income distribution. This article analyzes it as one of the reasons for the gap between urban and rural income distribution from the investment information channels in rural and urban areas. The flow of rural labor in China, on the one hand, increases the income of rural households, on the other hand, it has a positive effect on regulating income distribution and alleviating the gap between urban and rural areas (Li, 1999). The impact of industrial structure on income distribution, from the perspective of the different stages of China's economic development, with the 2008 financial crisis as the boundary, the previous advancement of the industrial structure will widen the income gap, and then there will be a trend of narrowing the income gap (Wu & Liu, 2018).

This paper divides the structure of income distribution based on the above documents: income groups are divided into urban and rural areas, and income sources are divided into wages and investment income. Analyze the impact of the current industrial structure upgrade in China on the income distribution of residents in a deeper level, and establish analytical theories and classical mathematical model analysis to explain the expansion of the urban-rural income distribution gap. Corresponding suggestions are given to alleviate the impact of changes in the industrial structure on the income distribution of residents.

The following arrangement is as follows: the second part is the literature review, which sorts out the research on income distribution; the third part is the methodology, including theoretic mechanism, model establishment and data processing, establish benchmarks model based on hypotheses; the fourth part is the results, verify the proposed hypothesis; the fifth part is the discussion, robustness test of the regression results and empirical conclusions; the sixth part, Conclusions and recommendations, the process of upgrading China's industrial structure should weigh economic development and residents' income distribution, the distribution of industries between urban and rural areas should be rational, and investment information and channels should be smoother for urban and rural residents.

2.Literature Review

The impact on China's income distribution is mainly studied from the aspects of economic growth, fiscal revenue and expenditure, and education. The following documents are sorted out from these three aspects.

Economic growth and income distribution:

When the government follows the comparative advantage development strategy, income distribution will continue to decline in the process of economic development. When the government implements the strategy of prioritizing the development of heavy industry, economic development may stagnate, income distribution presents an inverted U-shaped characteristic of rising first and then falling, and steady-state income inequality is higher than the comparative advantage development strategy (Lin & Chen, 2013). In the process of economic development of various countries in the world, the changing trend of labor share

in the primary distribution shows a U-shaped law, and China is no exception (Li & Liu, 2009). Financial repression has caused "unequal opportunities" in the financial market, and the wealth of the poor grows slowly, even falling into a poverty trap (Chen & Lin, 2012). There is a co-integration relationship between China's economic growth and inequality in income distribution (Zhou, 2002). China's economic growth strategy and its impact on industrial structure will directly and indirectly affect income distribution through factor markets such as finance, products, and labor. In the pursuit of economic growth, we must avoid the poor from falling into a trap.

Financial revenue and expenditure and income distribution:

The income gap between urban and rural areas should be narrowed by increasing the proportion of labor remuneration in the primary distribution and reversing the urban bias of expenditures on science, education, culture, health, and welfare (Lei & Cai, 2012). From the perspective of conducive to adjusting the distribution pattern of factor income, it is necessary for China to further adjust the current taxation policy and improve the taxation system (Guo & Lu, 2011). Under China's current economic system and tax structure, the increase in the share of turnover taxes, income taxes, resource taxes, and property taxes will expand the gap in the distribution of market income between capital owners and labor owners. An increase in the share of behavioral taxes will narrow the income distribution gap between capital and labor (Li & Geng, 2005). The problem of the overburden of farmers stems from China's urban-biased national income distribution policy and the urban-rural dual tax system structure (Liu, 2001). Fiscal revenue and expenditure have substitution effect and income effect on income distribution. At present, China is undergoing a gradual tax system reform. It is necessary to rationally adjust the income of high-income groups and low-income groups and expand middle-income groups.

Education and income distribution:

The reduction of educational inequality in the long term has not improved income inequality, but income inequality in the current period, education inequality can be exacerbated (Yang & Huang, 2008). There is an inverted U-shaped relationship between educational expansion and changes in income inequality. This inverted U-shaped change is the result of the expansion effect and the suppression effect of educational expansion (Lai, 1997). Education expansion may be more conducive to the income growth of the low-income population (Luo, 2007). Inequality in education will exacerbate income inequality (Bai, 2004). The investment in education mainly affects the investment in human capital. For the process of industrial upgrading in China, more and more high-quality talents are needed, so the income gap between education and residents may be reduced.

This article, based on the above literature, studies from the perspective of industrial structure, how China leads to the income distribution effect of urban and rural residents in the process of industrial structure? At the same time, the sensitivity of the income distribution gap between rural and urban residents to the upgrading of industrial structure is analyzed.

3. Methodology

3.1. Theoretic Mechanism

The industrial structure is usually divided into three major industries, the primary industry, the secondary industry and the tertiary industry. The industrial structure upgrade we define here is that the total value added of the secondary and tertiary industries and the local GDP account for an increasing proportion.

The theoretical part of this article simply assumes that the products produced by the secondary and tertiary industries are capital-intensive. According to the current income situation in China, the investment structure is that people above middle income pay more attention to investment than people below middle income. As the process of industrialization continues to deepen and investment channels are becoming more diversified, the investment structure is becoming more obvious for people above and below middle income. China's industrial structure is upgraded. The income of people above the middle income is the return of capital plus wage income, while the income of people below the middle income plus a small amount of capital return (sometimes even without capital investment, there is no return of capital). Therefore, the industrialization upgrade will eventually lead to an increasing income gap. At the same time, considering that most industrialized enterprises gather in the suburbs of cities and towns and the service industry economy is more active in cities and towns. Rural investment channels and information are not as diverse and unobstructed as in urban areas, leading to certain resistance to the investment of middle-income and above people who are willing to invest in rural areas compared to middle-income people who are willing to invest in urban areas. Furthermore, in the process of upgrading China's industrial structure, the urban income gap is more sensitive to the upgrading of the industrial structure than the rural income gap. In other words, the sum of the added value of the secondary and tertiary industries accounts for a percentage of the local area's GDP. The ratio changes by 1%, and the effect of expanding the urban income gap in this region is stronger than the effect of expanding the rural income gap in this region.

In order to understand the above theories more deeply, a simple mathematical economic model analysis is established:

Assume that the production function of the firm is the C-D production function, with two elements input, labor L , wages w ; capital K , interest rates r . Residents provide labor and invest in enterprises. In a perfectly competitive market, corporate profits are zero. The output value of the product is all transformed into the return of the input elements.

$$F(K, L) = AK^\alpha L^\beta \quad \alpha + \beta = 1$$

The conditions that the enterprise pursues the principle of theoretical maximization:
 $MPK = r$, $MPL = w$

According to Euler's theorem (product is exhausted): $\frac{\partial F}{\partial K} \cdot K + \frac{\partial F}{\partial L} \cdot L = F$

which is, $r \cdot K + w \cdot L = F$

The products produced by the secondary and tertiary industries are capital-intensive. The more capital invested by the middle-income, the larger the product distribution. The income distribution gap will widen.

Based on theoretical analysis, the following hypotheses are proposed:

1. *The income gap between residents will continue to widen as the industrial structure upgrades*
2. *With the continuous upgrading of industrial structure, the effect of expanding urban income gap is stronger than the effect of expanding rural income gap in the region*

3.2. Model Establishment

This paper refers to the literature (Liu & Liu, 2019) and selects the control variables, thus establishing the following benchmark model:

$$gni_{it} = \beta_0 + \beta_1 \times instru_{it} + \beta_2 \times instru_{it} * inrate + \beta_3 \times X_{it} + \theta_i + \gamma_t + u_{it}$$

Among them, the explained variable is *gni*, and the Gini coefficient of the region is the urban (*ugni*) and rural Gini coefficient (*cgni*). The core explanatory variables are: *instru*, an indicator of industrial structure, used to describe the upgrading of industrial structure, using the sum of the added value of the secondary industry and the tertiary industry divided by the regional gross product. The interaction term *instru*inrate*, where *inrate* is the industrialization rate, is obtained by dividing the secondary industry by the region's GDP. The introduction of interaction terms is to verify whether China's industrialization rate continues to advance, whether it will play a role in the impact of industrial structure on income distribution. *X* represents a series of control variables. The control variables sought in this article are: proxy variables of economic development level, GDP per capita: *lngdppc* and the square term *lngdppcsq*; the introduction of the square term is due to Kuznets's inverted U theory; the capital formation rate (*invest*), which uses the total fixed capital formation divided by the regional GDP; the degree of trade openness (*Intrade*), is the region's imports divided by the regional GDP; foreign countries direct investment (*fdi*), expressed as the ratio of the total foreign direct investment to the regional GDP; urbanization rate (*urb*), the ratio of the urban population to the area's permanent population; education level (*edu*), the ratio of the number of people receiving high school and above to the total number of people in the sample.

3.3. Data Processing

The data source of this article: collect the original data of the China Statistical Yearbook, and use the calculation method of the Gini coefficient in Tian Weimin's article "Calculation of China's Gini Coefficient and Analysis of Its Change Trend" to obtain the Gini coefficient of cities and rural areas in various regions. All other raw data comes from the National Bureau of Statistics.

Explanation for the treatment of variable observations: Foreign direct investment (*fdi*) uses the total amount of foreign direct investment to compare the gross product of the region, and directly uses the original value to calculate the ratio, and there is no unified unit. The reason for this is that the unified unit method is to multiply by the average exchange rate and

the magnitude multiplier. The total conversion effect is a specific multiple value. In the measurement regression, only the coefficient multiple changes. It will not affect the positive or negative of the regression coefficient and significance. Similarly, there is no unified unit for the degree of trade openness (Intrade), and considering that the value of the direct ratio is still relatively large, the logarithm is taken on the basis of the ratio to obtain the variable observation value in the econometric regression.

4. Results

4.1. Unit Root Test

First of all, because it is panel data. Each sequence of variables to be regressed is tested for stationarity. It is found that except for the urbanization rate (urb) and education level (edu) which are series with a time trend, the other variable series are all stationary series.

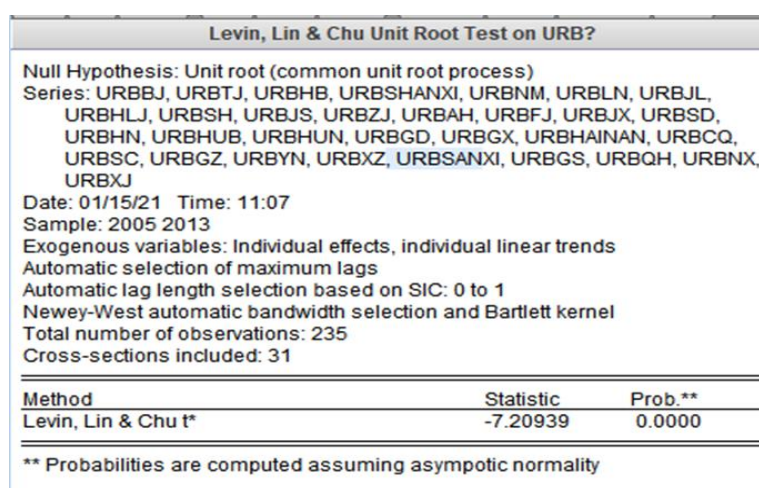


Figure 1. Unit root test.

The above figure is an LLC unit root test with a time trend item on the urbanization rate (urb) sequence. The test result is that there is no unit root. Therefore, the urbanization rate (urb) sequence is a sequence with a time trend.

In the same way, found that edu is also a series with time trend. Therefore, urb and edu, two explanatory variables cannot be directly added to the model regression.

4.2. Choose the Most Reasonable Model

In addition to urb and edu, all other variables are added for step regressions. In this paper, two sets of regressions are performed, and the explained variables are: urban Gini coefficient (ugni) and rural Gini coefficient (cgni).

- **The explained variable is ugni:**

First do a simple cross-sectional regression of stacked data, without selecting cross-section and time effects, use the EGLS method to perform regression estimation.

Dependent Variable: UGNI?
Method: Pooled EGLS (Cross-section weights)
Date: 02/23/21 Time: 11:43
Sample: 2005 2013
Included observations: 9
Cross-sections included: 31
Total pool (balanced) observations: 279
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INSTRU?	0.405126	0.036149	11.20704	0.0000
LNGDPPC?	0.014206	0.004828	2.942628	0.0035
LNGDPPCSQ?	-0.000386	0.000240	-1.610093	0.1085
INVEST?	0.004682	0.012051	0.388503	0.6979
FDI?	-0.001153	0.000278	-4.149641	0.0000
LNTRADE?	-0.002774	0.002265	-1.224503	0.2218

Weighted Statistics			
R-squared	0.553505	Mean dependent var	0.595046
Adjusted R-squared	0.545328	S.D. dependent var	0.299343
S.E. of regression	0.031761	Sum squared resid	0.275394
Durbin-Watson stat	0.438655		

Unweighted Statistics			
R-squared	0.358963	Mean dependent var	0.440957
Sum squared resid	0.296668	Durbin-Watson stat	0.247106

Figure 2. Invariant coefficient model regression.

It is found that the residual sum of squares of the statistical model estimated after weighting is 0.2754, which is smaller than the estimated value of 0.2967 for the model without weighted estimation. At the same time, the estimated model fits better after weighting. Looking at the DW statistical value of the weighted model test is only 0.4387, indicating that there is a correlation between the residual series.

Therefore, it is unreasonable to directly use a simple regression model. Let's check whether the panel data regression should use a fixed effects model or a random effects model? The Hausmann random effects test was performed on the model.

Correlated Random Effects - Hausman Test
Pool: GNI
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	26.536443	7	0.0004

Figure 3. Hausman random effects test.

The test result is that random effects are rejected. Therefore, it is suitable to use a fixed effects model for regression estimation.

Dependent Variable: UGNI?
Method: Pooled EGLS (Cross-section weights)
Date: 12/28/20 Time: 14:58
Sample: 2005 2013
Included observations: 9
Cross-sections included: 31
Total pool (balanced) observations: 279
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.712123	0.290182	2.454060	0.0148
INSTRU?	0.662551	0.100695	6.579783	0.0000
INSTRU?*INRATE?	-0.011265	0.040822	-0.275967	0.7828
LNGDPPC?	-0.142925	0.057868	-2.469848	0.0142
LNGDPPCSQ?	0.006493	0.002816	2.306187	0.0219
INVEST?	0.051348	0.013202	3.889377	0.0001
FDI?	0.000323	0.000177	1.823527	0.0695
LNTRADE?	-0.014956	0.003188	-4.691418	0.0000

Fixed Effects (Cross)

Figure 4. Fixed effects model regression (weighted).

Although the model fit is good, the coefficients of some variables (interaction term: instrument*inrate) failed the t test. Thus, the model needs to continue to be revised.

Dependent Variable: UGNI?				
Method: Pooled EGLS (Cross-section weights)				
Date: 02/12/21 Time: 00:39				
Sample: 2005 2013				
Included observations: 9				
Cross-sections included: 31				
Total pool (balanced) observations: 279				
Linear estimation after one-step weighting matrix				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.734569	0.236933	3.100320	0.0022
INSTRU?	0.646526	0.083925	7.703609	0.0000
LNGDPPC?	-0.145672	0.050331	-2.894293	0.0041
LNGDPPCSQ?	0.006652	0.002416	2.752660	0.0064
INVEST?	0.050173	0.013217	3.795972	0.0002
FDI?	0.000323	0.000167	1.937350	0.0539
LNTRADE?	-0.015071	0.003165	-4.761720	0.0000
Fixed Effects (Cross)				
Weighted Statistics				
R-squared	0.918750	Mean dependent var	0.545725	
Adjusted R-squared	0.906663	S.D. dependent var	0.241585	
S.E. of regression	0.014930	Sum squared resid	0.053944	
F-statistic	76.01299	Durbin-Watson stat	1.277919	
Prob(F-statistic)	0.000000			

Figure 5. Final model regression determined after screening variables.

Screening variables and using the fixed effects model, using the EGLS estimation method, found that the adjusted coefficient of determination was 0.9. The DW statistic is 1.28, which is relatively close to 2. It can be considered that the correlation of the residual sequence is weak. The resulting estimation results are credible. Based on the results of the above figure, we analyze the impact of the selected variables on the urban income gap:

The greater the proportion of the combined secondary and tertiary industries in the local area's GDP, the larger the urban income gap in the region. Economic growth will reduce the income gap. At the same time, it is verified that the relationship between economic growth and income gap is not Kuznets inverted U-shaped, but U-shaped. At the same time, combining the two proxy variables of economic growth, my country's economic growth It is still on the left side of the U shape, so economic growth will reduce the income gap. An increase in the investment formation rate will widen the income gap between urban residents. The possible reason is that high-income earners will invest more, which will result in more capital income than low-income earners and widen the income gap. The greater the amount of foreign direct investment, the greater the income gap between urban residents, but the significance is not very large, only a significant level of 10%. The greater the degree of opening to the outside, the smaller the income gap among urban residents.

- **The explained variable is cgni:**

Similar to the above process, here is just to show the most reasonable regression results for analysis.

Dependent Variable: CGNI?
Method: Pooled EGLS (Cross-section weights)
Date: 02/23/21 Time: 07:48
Sample: 2005 2013
Included observations: 9
Cross-sections included: 31
Total pool (balanced) observations: 279
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.860908	0.356056	2.417899	0.0164
INSTRU?	0.556826	0.123118	4.522687	0.0000
LNGDPPC?	-0.182509	0.075978	-2.402143	0.0171
LNGDPPCSQ?	0.009851	0.003677	2.678932	0.0079
INVEST?	0.091100	0.019920	4.573301	0.0000
FDI?	0.000476	0.000251	1.895586	0.0592
LNTRADE?	-0.020422	0.004037	-5.058840	0.0000
Fixed Effects (Cross)				

Weighted Statistics			
R-squared	0.838701	Mean dependent var	0.491003
Adjusted R-squared	0.814706	S.D. dependent var	0.152065
S.E. of regression	0.020984	Sum squared resid	0.106557
F-statistic	34.95327	Durbin-Watson stat	1.773816
Prob(F-statistic)	0.000000		

Figure 6. Regression results of the final selected model for rural areas.

Analysis of the impact of each selected variable on the rural income gap: because the regression results are consistent with the urban regression results. The conclusion drawn here is consistent with that of the town.

Let's analyze the difference between urban and rural areas (Table 1):

Table 1. Comparison of estimated coefficients between urban and rural areas (fixed effect model).

Variables	Coefficient for citys and towns	Coefficient for rural areas
instru	0.646525872	0.556825659
lngdppc	-0.14567215	-0.18250945
lngdppcsq	0.006651755	0.009850525
invest	0.050173008	0.091100037
fdi	0.000323145	0.000476049
lntrade	-0.0150705	-0.02042154

Comparing the estimated coefficients of the explanatory variables between urban and rural areas, it can be found that the impact of industrial structure upgrading on the expansion of urban income gap is greater than that in rural areas. The effects of other explanatory variables are stronger than those in urban areas.

5. Discussion

Switch to stata software to perform regression on the explained variables as ugni and cgni respectively, estimate the regression coefficients, and use different estimation methods to compare and analyze the robustness of the regression results. The results are analyzed as follows:

Table 2. The explained variable is the urban Gini coefficient, and the robustness test.

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	BE	FE	FE_robust	RE_fgls	RE_mle
instru	0.346*** (0.0850)	0.0861 (0.177)	0.575*** (0.104)	0.575*** (0.150)	0.536*** (0.0803)	0.553*** (0.0802)
lngdppc	0.203 (0.141)	0.578 (0.468)	-0.0991 (0.0606)	-0.0991 (0.0974)	-0.0804 (0.0949)	-0.0894 (0.0566)
lngdppcsq	-0.00931 (0.00681)	-0.0255 (0.0236)	0.00450 (0.00294)	0.00450 (0.00477)	0.00374 (0.00464)	0.00413 (0.00276)
invest	-0.0142 (0.0436)	0.00553 (0.0553)	0.0533*** (0.0155)	0.0533* (0.0282)	0.0376 (0.0244)	0.0423*** (0.0150)
fdi	-0.000911 (0.000779)	-0.00361** (0.00131)	0.000307 (0.000193)	0.000307*** (0.0000708)	0.000296*** (0.0000786)	0.000310* (0.000187)
Intrade	-0.00294 (0.00689)	0.00214 (0.0118)	-0.0156*** (0.00388)	-0.0156*** (0.00484)	-0.0105*** (0.00336)	-0.0117*** (0.00327)
_cons	-0.927 (0.708)	-2.866 (2.418)	0.550** (0.279)	0.550 (0.485)	0.447 (0.479)	0.488* (0.272)
_cons(sigma_u)						0.0327*** (0.00444)
_cons(sigma_e)						0.0149*** (0.000671)
N	279	279	279	279	279	279
R2	0.383	0.610	0.283	0.283		

The regression results in Table 2 and Table 3: The column (1) is the robust ordinary least squares estimation; the column (2) is the regression estimation between groups; the columns (3) and (4) are the fixed effects regression, among which Column (4) is the result of robust fixed-effects regression; column (5) and (6) are random-effects regression and are the results of feasible generalized least squares and maximum likelihood estimation respectively.

It can be found that the coefficients of the core explanatory variables of the industrial structure are only insignificant in the between groups regression result, and the others are all significantly positive, and the result is robust.

We also introduce the educational indicators (edu) and urbanization rate (urb) with a time trend to conduct regression robustness tests and finds that the core explanatory variable of industrial structure is still robust. By changing the year and selecting other years for estimation, the results are robust.

At the same time, comparing the regression coefficients of each column in urban (Table 2) and rural (Table 3), it is found that the conclusion of sensitivity is still consistent with the conclusion of the previous analysis.

Table 3. The explained variable is the rural Gini coefficient, and the robustness test.

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	BE	FE	FE_robust	RE_fgls	RE_mle
instru	0.216** (0.0873)	0.0935 (0.162)	0.542*** (0.146)	0.542** (0.198)	0.357*** (0.0708)	0.388*** (0.0932)
lngdppc	0.223 (0.144)	0.669 (0.427)	-0.156* (0.0850)	-0.156 (0.105)	-0.0626 (0.106)	-0.0852 (0.0778)
lngdppcsq	-0.00914 (0.00694)	-0.0304 (0.0215)	0.00863** (0.00412)	0.00863 (0.00512)	0.00445 (0.00513)	0.00549 (0.00381)
invest	-0.00534 (0.0395)	0.00702 (0.0505)	0.0822*** (0.0218)	0.0822** (0.0307)	0.0510** (0.0259)	0.0586*** (0.0204)
fdi	-0.000944 (0.000840)	-0.00311** (0.00119)	0.000471* (0.000271)	0.000471*** (0.0000764)	0.000290* (0.000159)	0.000353 (0.000259)
Intrade	-0.00821 (0.00617)	0.00213 (0.0108)	-0.0179*** (0.00544)	-0.0179** (0.00671)	-0.0136*** (0.00397)	-0.0144*** (0.00394)
_cons	-1.006 (0.726)	-3.296 (2.206)	0.714* (0.391)	0.714 (0.522)	0.355 (0.527)	0.451 (0.380)
_cons(sigma_u)						0.0283*** (0.00409)
_cons(sigma_e)						0.0209*** (0.000947)
N	279	279	279	279	279	279
R2	0.430	0.594	0.461	0.461		

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The regression results in Table 2 and Table 3: The column (1) is the robust ordinary least squares estimation; the column (2) is the regression estimation between groups; the columns (3) and (4) are the fixed effects regression, among which Column (4) is the result of robust fixed-effects regression; column (5) and (6) are random-effects regression and are the results of feasible generalized least squares and maximum likelihood estimation respectively.

It can be found that the coefficients of the core explanatory variables of the industrial structure are only insignificant in the between groups regression result, and the others are all significantly positive, and the result is robust.

We also introduce the educational indicators (edu) and urbanization rate (urb) with a time trend to conduct regression robustness tests and finds that the core explanatory variable of industrial structure is still robust. By changing the year and selecting other years for estimation, the results are robust.

At the same time, comparing the regression coefficients of each column in urban (Table 2) and rural (Table 3), it is found that the conclusion of sensitivity is still consistent with the conclusion of the previous analysis.

6. Conclusions and Recommendations

This paper finds that with the continuous upgrading of China's industrial structure, the income gap between rural and urban residents is widening. At the same time, comparing the income gap between urban and rural residents, it is found that the income distribution effect between rural and urban is basically similar. The only difference is that the Gini coefficient fluctuates relatively more in rural areas over time. Empirical analysis of the effect of expanding the income gap between urban residents is greater and more sensitive than the effect of expanding the income gap in rural areas.

Economic growth will reduce the income gap, and at the same time verify that the relationship between economic growth and income gap is not Kuznets inverted U-shaped, but U-shaped, and my country's economic growth is still on the left side of the U-shaped. Therefore, economic growth will reduce the income gap. An increase in the investment formation rate will widen the income gap between urban residents. The possible reason is that high-income earners will invest more, which will result in more capital income than low-income earners and widen the income gap. The greater the amount of foreign direct investment, the greater the income gap between urban residents, but the significance is not very large, only a significant level of 10%. The greater the degree of opening to the outside, the smaller the income gap among urban residents.

In the process of upgrading the industrial structure, we must weigh the relationship between economic growth and residents' income distribution. Reasonable income distribution of residents is conducive to social harmony and stability, and will further improve the quality of industrial structure upgrading.

The geographic distribution of China's industries needs to be improved. It is necessary to make the investment information and channels between urban and rural areas more convenient and transparent, which will be more conducive to the capital flow of the rural and urban populations above the average level, and the population below the average level can also be transparent. Increase the amount of investment in diversified channels to increase capital income to help adjust the previously monotonous income structure, and also make income sources more diverse and stable.

Actively promote the opening up of regions and smooth the flow of products and factors of production between regions. This is more conducive to the rational allocation of resources, and people's income distribution is more diversified.

Acknowledgments: This research was funded by Shanxi Provincial Department of Education 2020 General Special Scientific Research Project (No. 20JK0367), China-Central Eastern European Countries Higher Joint Education Project (No. 202028) Shanxi Provincial Social Scientific Circles 2020 Major Theoretical and Practical Research Project (No. 2020Z287), Shanxi Financial Assets 2021 Major Research Project (No. 20JZ-41).

References

- Bai X. (2004). Education and Income Inequality: An Empirical Study in China. *Management World*, 06, 53-58.
<https://doi.org/10.19744/j.cnki.11-1235/f.2004.06.006>
- Chen, B., & Lin, Y. (2012). Financial Repression, Industrial Structure and Income Distribution. *World Economy*, 35(1), 3-23. <http://www.cnki.com.cn/Article/CJFDTotal-SJJJ201201004.htm>

- Guo, Q., & Lu, B. (2011). On the influence of taxation on the distribution of essential income. *Economic Research*, 46(6), 16-30. <http://www.cnki.com.cn/Article/CJFDTOTAL-JJYJ201106003.htm>
- Lai, D. (1997). Educational Expansion and Income Inequality. *Economic Research*, 10, 46-53. <http://www.cnki.com.cn/Article/CJFDTOTAL-JJYJ710.006.htm>
- Lei, G., & Cai, X. (2012). Primary distribution distortion, fiscal expenditure city bias and urban-rural income gap: Empirical evidence from China's provincial panel data. *Quantitative Economics and Technical Economic Research*, 29(3), 76-89. <https://doi.org/10.13653/j.cnki.jqte.2012.03.011>
- Lin, Y., & Chen, B. (2013). Development strategy - industrial structure and income distribution. *Economics (Quarterly)*, 12(4), 1109-1140. <https://doi.org/10.13821/j.cnki.ceq.2013.04.016>
- Li, D., Liu, L., & Wang, H. (2009). U-shaped law of labor share evolution in GDP. *Economic Research*, 44(1), 70-82. <http://www.cnki.com.cn/Article/CJFDTOTAL-SHEK200904011.htm>
- Li, S., & Geng, Y. (2005). China's tax structure, economic growth and income distribution. *Economic Research*, 05, 118-126. <http://www.cnki.com.cn/Article/CJFDTOTAL-JJYJ200505011.htm>
- Liu, S. (2001). Unifying the urban and rural tax system and adjusting the distribution policy: a new theory of reducing the burden on farmers. *Economic Research*, 02, 43-49+60. <http://www.cnki.com.cn/Article/CJFDTOTAL-JJYJ200102005.htm>
- Luo, C. (2007). The rate of return to education for urban residents and its distribution characteristics. *Economic Research*, 06, 119-130. <http://www.cnki.com.cn/Article/CJFDTOTAL-JJYJ200706010.htm>
- Wu, W., Liu, Y., & Xu, L. (2018). Industrial structure change and income inequality: micro-evidence from China. *Management World*, 34(2), 22-33. <https://doi.org/10.19744/j.cnki.11-1235/f.2018.02.003>
- Yang, J., Huang, X., & Li, X. (2008). Educational Inequality and Income Distribution Gap: An Empirical Analysis of China. *Management World*, 01, 38-47+187. <https://doi.org/10.19744/j.cnki.11-1235/f.2008.01.006>
- Zhou, W. (2002). Empirical analysis of the relationship between income distribution and economic growth of Chinese urban residents. *Economic Science*, 01, 40-47. <https://doi.org/10.19523/j.jjlx.2002.01.005>
- Zou, W., & Zhang, F. (2006). Income differences and human capital accumulation in rural areas. *Chinese Social Sciences*, 02, 67-79+206. <http://www.cnki.com.cn/Article/CJFDTOTAL-ZSHK200602006.htm>

Relationship between Climate Change and Agricultural Development Transition

Yanni LIU* and Jingrun SU

Northwest University, Xi'an, China; lyn@nwu.edu.cn; 201920082@stumail.nwu.edu.cn

* Corresponding author: lyn@nwu.edu.cn

Abstract: Extensive agricultural development mode increases the climate problem caused by carbon emissions, thus restricting the development of agricultural economy. Under this background, this paper studies the relationship between climate change and the transformation of agricultural development mode from the perspective of carbon emissions and agricultural total factor productivity (TFP). Based on the Regional Panel Data of 1995-2016, this paper uses the co-integration model and error correction model to explore the impact of long-term and short-term carbon emissions on agricultural TFP, and further analyzes the impact mechanism. The research shows that carbon emissions from diesel fuel, irrigation and pesticide for agriculture mainly restrain agricultural TFP by restraining agricultural technology efficiency (TEC) in the long and short term; agricultural film carbon emissions only have the same effect in the short term; in the short term, carbon emission of agricultural machinery restrains agricultural TFP by restraining TP. In the long and short term, fertilizer carbon emissions will promote the growth of agricultural TFP by improving TEC. There is a short-term reverse correction mechanism between them, and the short-term deviation will recover more quickly. This paper puts forward suggestions on low-carbon circular agriculture, adjustment of agricultural production structure and promotion of agricultural modernization.

Keywords: carbon emission; agricultural total factor productivity; co-integration model; error correction model

JEL Classification: Q54

1. Introduction

The issue of climate change is accompanied by the way of human development. It is a necessary product of mankind's transformation of nature and social activities. In turn, climate change will also affect and restrict the way of human development. Especially agriculture is very sensitive to climate change, so it is vulnerable to the potential impact of changes in climate conditions. The production methods in the process of agricultural development are one of the important reasons for climate change. Extensive farming methods, excessive use of agricultural industrial products such as chemical fertilizers and pesticides, and the abuse of agricultural energy caused by "modern agriculture" all emit large amounts of greenhouse gases. The increase of greenhouse gas emissions, such as methane, nitrogen oxides and carbon dioxide, gradually accumulates from quantity to quality, affecting the global climate change. Climate changes such as rising temperatures, changes in precipitation, changes in glaciers, and extreme weather will restrict the high-quality growth of the agricultural economy by affecting the

layout of the agricultural planting industry, and the output and quality of agricultural products. To improve the impact of climate change, the fundamental way to achieve high-quality development of agricultural economy lies in the transformation of agricultural development methods. The transformation of the agricultural development model means the transformation from extensive to intensive, from quantitative to qualitative, and transforms agricultural economic growth from an increase in factor input to an increase in agricultural total factor productivity. Therefore, to study the relationship between climate change and the transformation of agricultural development mode, we must first study the relationship between agricultural carbon emissions and agricultural total factor productivity.

Agricultural TFP has been widely concerned by scholars at home and abroad. They use different measurement methods to analyze the TFP and its influencing factors of different regions and varieties of crops (Mead, 2003; Wen, 1993; Chen, Ma, Che et al., 2020). The calculation methods of agricultural total factor productivity can be divided into Solow residual method, non-parametric data envelope analysis and typical SFA stochastic frontier production model. On the basis of C-D production function, Solow (1957) proposed that capital, labor and technical efficiency are the driving forces of economic growth, and constructed CES production function. On this basis, some scholars use the Solow residual method and its extended model to calculate the total factor productivity (Huiling & Lei, 2018; Schultz & Abramovitz, 1956). However, it has strong constraints, Hicks neutrality and constant returns to scale. It ignores the existence of technical efficiency, only regards the total factor growth rate as the result of technological progress. Due to the strong uncertainty of natural factors such as climate change, some scholars use stochastic production frontier function to measure agricultural TFP (Liu & Zhang, 2017; Brümmer et al., 2006; Kumbhakar & Lovell, 2000). This method considers the influence of random factors, which is more in line with the background of climate change. The advantage of nonparametric data envelopment analysis is that it does not need to determine the specific production function and is not affected by the dimension of input-output variables. It is suitable for the calculation of a large amount of data. The DEA method originates from the analysis of Farrell (1957). Through the development of Charnes (1978), a more mature analysis paradigm has been formed. Tone (2002) systematically explains such methods. This method is applied to the calculation of TFP (Liu et al., 2016; Coelli & Rao, 2003; Fare et al., 1994).

Climate change is an important factor affecting agricultural TFP. Zhong and Jiang (2019) believe that factors such as annual total precipitation, mean temperature in growing season, and evaporation intensity have significant negative effects on regional agricultural total factor productivity. Jin and Kan (2013) found that natural disasters in the agricultural production environment can restrain agricultural TFP by affecting technological progress. Based on the perspective of carbon emissions, the literature studying the impact of climate change on agricultural development mode mainly includes agricultural carbon emissions as an unexpected output into the productivity calculation, so as to obtain agricultural green productivity, and then compare with the traditional agricultural total factor productivity. Scholars have found that environmental pollutants such as agricultural carbon emissions can inhibit agricultural total factor productivity, and the path of impact includes technological progress and technical efficiency (Wang et al., 2019; Zhan et al., 2019; Pan Dan, 2014). Climate

change and agricultural development is a two-way interactive mechanism. The relationship between economic development and carbon emissions presents an inverted U curve. With the increase of production investment, carbon emissions increased. When the economy develops to a certain scale, high-quality economic development model will inhibit agricultural carbon emissions (Li et al., 2011; Zhang et al., 2014). Xu and Song (2010) obtained the same effect in central and eastern China by using the Co-integration Model. The Co-integration Model reflects the long-term stable relationship between variables. Zhao and Li (2011) used the Co-integration Model to find that economic growth will bring about an increase in carbon emissions, and an increase in carbon emissions will also bring about economic growth.

There are still the following deficiencies, agricultural carbon emissions include agricultural planting and animal husbandry and other carbon emissions. Greenhouse gases are emitted from chemical fertilizer, pesticide, agricultural film, machinery, irrigation and other carbon sources in agricultural planting industry. However, the existing literature does not discuss the impact of specific carbon emissions on agricultural total factor productivity and the path. On the other hand, high quality agricultural development will inhibit agricultural carbon emissions. Climate change and agricultural development mode is a two-way interaction mechanism. So this paper uses the Co-integration Model to study the long-term relationship between climate change and the transformation of agricultural development mode, and uses the error correction model to explore the short-term impact. In view of this, this paper intends to build a Co-integration Model of carbon emissions from various carbon sources of agricultural planting industry and agricultural total factor productivity and analyze the impact of carbon emissions from various carbon sources on agricultural total factor productivity for a long time and the impact path. If there is a long-term equilibrium relationship, build a Vector Error Correction Model to study whether there is any deviation in the short-term and the correction speed to restore to the long-term equilibrium.

Huang and Mi (2011) divided the sources of carbon emissions from agricultural production into five parts: agricultural industrial products input, agricultural energy, planting emissions, aquaculture emissions and organic waste. By quantifying the agricultural carbon footprint, they found that the most important carbon emissions are from the industrial products (chemical fertilizer, pesticide, agricultural film, etc.) input in the agricultural production process and the use of agricultural energy. Therefore, in order to study the impact of agricultural carbon emissions on agricultural total factor productivity, it is necessary to analyze the input of agricultural industrial products and the carbon emissions of agricultural energy. Due to the impact of traditional "agricultural modernization", farmers only care about output but not quality, which will deepen the mechanization and chemistry of agricultural production. In the process of mechanization, it is inevitable to increase agricultural energy consumption such as electricity, oil and coal, and increase carbon emissions. On the other hand, the production, use and treatment of chemical fertilizer, pesticide and agricultural film will directly or indirectly generate carbon emissions. Ammonia will escape into the atmosphere during the application of chemical fertilizer, followed by the nitrification and denitrification process of nitrogen in the soil, which will produce greenhouse gases. In addition, due to the extensive use of chemical fertilizer, the natural properties of the soil have been changed and the process of

carbon emission has been accelerated. The use of pesticide such as weedicide, pesticide, and fungicide will also change the respiratory rate of crops and other factors to increase greenhouse gas emissions. In order to protect the seedlings, the agricultural land needs to be covered with film before the crops are planted, the residual agricultural film will change the nature and structure of the soil, thus accelerating carbon emissions. The increase of agricultural carbon emissions has brought about climate changes such as temperature rise, precipitation change and natural disasters caused by greenhouse effect. Agricultural production is more sensitive to the impact of climate change, so the increase in carbon emissions caused by climate change will certainly have a certain impact on the agricultural economy. The increase of carbon emissions from various carbon sources has positive and negative effects on the agricultural economy. On the one hand, the increase of carbon emission from agricultural sources means the deepening of agricultural mechanization and chemistry, which will undoubtedly promote economic growth. On the other hand, the increase in carbon emissions has also intensified the climate change caused by environmental pollution, thus affecting agricultural production. From the perspective of positive effects of agricultural carbon emissions. The use of agricultural machinery can improve the production efficiency of farmers, and the use of chemical fertilizer, pesticide and agricultural film can protect the growth and development of crops. With the continuous improvement of technology, the research and development of new equipment and the upgrading of agricultural industrial inputs can improve the total factor productivity of agriculture by promoting technological progress. The negative effect of agricultural carbon emissions is reflected in the fact that climate change will affect agricultural total factor productivity by affecting agricultural planting systems, regions, types of crops and agricultural production habits. Therefore, the increase of agricultural carbon emissions has positive and negative effects. It is of great significance to quantify the positive and negative effects of specific carbon source emissions and analyze the impact path to understand the impact of climate change on agricultural development.

2. Methodology

This paper calculates agricultural carbon emissions by using the input of key elements in national agricultural planting production, and then uses the co-integration model to analyze the long-term and short-term relationship between agricultural total factor productivity and carbon emissions from various agricultural carbon sources.

2.1 Calculation Method of Agricultural Carbon Emission

Agricultural carbon emissions are greenhouse gases formed in the process of agricultural production activities, including carbon emissions caused by the use of pesticide in agricultural production; the production of fertilizer and fertilizer; the production of agricultural film and membrane; the inflow of organic carbon in the soil into the air during the ploughing and diesel fuel consumed during the mechanized production. Computing formula:

$$E = \sum E_i = \sum T_i * \delta_i \quad (1)$$

where represents the total amount of carbon emissions, $\sum E_i$ represents the sum of carbon emissions from different source, T_i represents the amount of various carbon sources, δ_i represents the corresponding emission coefficient of various carbon sources. According to the relevant literature (IREEA, 2016; ORNL, 2016; Li et al., 2011; IPCC, 2006; West & Marland, 2002), the coefficients of different agricultural carbon sources are shown in Table 1:

Table 1. Carbon emission sources and factor

sources	factor	sources	factor
chemical fertilizer	0.8956 kg c/kg	diesel oil	0.5927 kg c/kg
pesticide	4.9341 kg c/kg	irrigation	266.48 kg c/hm ²
agricultural film	5.18 kg c/kg		

The calculation of carbon emission from agricultural machinery is based on the calculation formula: $Ee = Ae * D + We * F$, where Ae representative planting area, We represents the total power of agricultural machinery $D = 16.47 \text{ kg c/hm}^2$, $F = 0.18 \text{ kg c/kW}$. In this paper, carbon dioxide emission is used as a variable to measure carbon emissions. According to the mass balance method, the formula for converting carbon into carbon dioxide is: $co_2 = c \times \frac{44}{12}$.

2.2 Co-integration Model and Vector Error Correction Model

Cointegration test, also known as EG cointegration test. In 1987, Engle and Granger proposed to determine whether there is a long-term equilibrium relationship between unstable sequences. Definition of Cointegration Relation: Set the random sequence x_i to contain only components of order D single integers, record as $x_i \sim I(d)$. Assume there is a non-zero vector β can satisfy random vector $Y_i = \beta x_i \sim I(d, b)$, we can say that x_i is b, d order cointegration, record as $x_i \sim CI(d, b)$, β is cointegration vector. In particular, Y_i and x_i are random variables, $Y_i, x_i \sim I(1)$, $Y_i = k_0 + k_1 x_i \sim I(0)$, then called Y_i, x_i are cointegrated, k_0, k_1 is the co-integration coefficient.

It seems that there is a long-term equilibrium among some variables obtained through the co integration test, but it is not the case. It is also normal for some variables with stable co-integration relationship to fail to reach the equilibrium in the short term. Therefore, we need to use error correction model to make up for this defect. The specific method of error correction model is to combine the short-term relationship with the long-term and medium-term data and correct the part that cannot reach the equilibrium state. It can be defined as: assuming that x and y are single integral sequences of the same order, if there is a co-integration relationship between x and y , we can use the Vector Error Correction Model to reflect this short-term relationship:

$$y_t = a + \delta_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t \quad (2)$$

$$\Delta y_t = a - (1 - \delta_1) y_{t-1} + \beta_0 \Delta x_t + (\beta_0 + \beta_1) x_{t-1} + u_t \quad (3)$$

$$\Delta y_t = \beta_0 \Delta x_t - (1 - \delta_1)(y_{t-1} - k_0 - k_1 x_{t-1}) + u_t \quad (4)$$

$k_0 = \frac{\alpha}{1-\delta_1}$, $k_1 = \frac{\beta_0+\beta_1}{1-\delta_1}$, Formula (4) is called first order error correction model. β_0 is the influence parameter; $(1 - \delta_1)$ is feedback effect; k_0, k_1 is the long-term reflection coefficient. It is not difficult to see that the specific approach of the model will separate the short-term impact from the long-term impact in the explained variables, and then clearly and intuitively reflect how the short-term fluctuations affect the co integration relationship between different variables. Therefore, the co-integration theory and error correction model not only help us in the selection of variables, but also help us to determine the relationship between variables.

2.3 Data Source and Variable Selection

Based on previous literature studies and considering the requirements of sample availability and timeliness, the panel data variables of China from 1995 to 2016 are selected as follows.

Dependent variables. Total Factor Productivity of Agriculture (TFP), Technical efficiency index (TEC), Technology progress index (TP). Wang Junyang and Xiuyun (2019) use the classic non parameter DEA-Malmquist index to calculate the national and sub regional agricultural TFP, technical efficiency index (TEC) and technical progress index (TP) through the added value of the first industry, the number of employees in the first industry, the planting area of crops, the converted net amount of chemical fertilizer and the total power of agricultural machinery. This paper refers to their calculated results.

Core explanatory variables. Carbon dioxide emissions from inputs of various elements in agricultural production activities, including Carbon emission of chemical fertilizer (fertilizerp), Carbon emissions of pesticides (pesticidep), Carbon emission of agricultural plastic film (filmp), Mechanical carbon emissions (machinep), Carbon emission of diesel oil (Oilp) and Carbon emissions of agricultural irrigation (irrp). The calculation of carbon emission is based on such indexes as total power of agricultural machinery/10,000 kW, plastic film usage for agriculture/ton, diesel oil usage for agriculture/10,000 tons, pesticide usage/10,000 tons, effective irrigation area/1,000 hectares, and purified fertilizer application for agriculture /10,000 tons. Calculate the carbon emissions by 2.1.

Control Variables. According to the previous literature research, the following variables that have an impact on agricultural TFP are selected as the control variables. The fixed asset investment amount of rural households/billion yuan (fi) and the number of employees in agriculture, forestry, animal husbandry and fishery/10,000 (labor), these 2 indicators reflect the level of capital and labor input in agricultural production in various regions. Industry, this indicator is measured by the ratio of industrial added value of each region to the regional GDP. The larger the ratio, the higher the degree of industrialization. The level of open(open) is measured by the number of foreign-invested enterprises in each region. Agricultural electricity (electricity), which is measured by rural electricity consumption per 100 million kwh, also affects the total factor productivity of agriculture.

The above data are from China research data service platform (CNRDS) Regional Economic Research (CRED), China Statistical Yearbook and China Rural Statistical Yearbook. In order to eliminate the effect of the variance, we carry out natural logarithm transformation

on the absolute variables such as open, electricity, fi, labor, pesticidep, Oilp, irrp, filmp, fertilizerp and machinep, and standardize the independent variables to eliminate the dimensional effect.

3. Results

This paper attempts to study the relationship between agricultural carbon emissions and total factor productivity by building a long-term Co-integration Model. This requires first performing the unit root (ADF) test of each variable and then the cointegration test to determine the long-term relationship model between each variable on the premise that each component has the same order sequence. Since TFP is also affected by short-term fluctuations in carbon emissions, Vector Error Correction Model need to be constructed to determine whether corrective mechanisms exist.

3.1. Panel Unit Root Test for Each Variable

Only when the variables introduced into the model reach the same level of single integration, the co-integration test can be carried out. We used LLC test (2002), IPS test (2003) and Breitung test (2000, 2005) to conduct panel unit root test for each variable. The original assumption of the tests is that the variable has unit root process and belongs to non-stationary series. The reserve assumption of IPS test is that a certain proportion of individuals are stationary series, while the reserve assumption of LLC test (2002) and Breitung test is that all individuals are stationary series. For the 3 results, whether the variable is stable is judged by voting. The test result with the largest number of votes is the final result. The specific inspection results are shown in Table 2.

Table 2. Panel stability test result

Variable	Original sequence			First difference series		
	LLC	IPS	Breitung	LLC	IPS	Breitung
lnopen	1.9682	0.6407	-0.7571	-4.3181***	-3.6620***	-1.9901**
lnelectricity	0.8958	1.6204	-1.2208	-6.9916***	-6.3356***	-1.8349**
lnfi	0.9136	0.3691	1.5001	-9.3840***	-6.9165***	-1.0029
lnlabor	0.7362	2.2085	-0.2578	-5.9556***	-7.4676***	-1.6789**
industry	0.2128	0.9157	1.2514	-6.6757***	-7.5598***	-0.4483
lnpesticidep	0.7142	2.9601	1.2520	-8.8024***	-8.9973***	-1.7801**
lnoilp	1.3158	1.1584	-0.4711	-6.1860***	-5.3366***	-2.0663**
lnirrp	-2.7952***	-0.3711	2.1530	-5.4343***	-4.7845***	-2.7195***
lnfilmp	0.5435	-0.2644	-0.1712	-5.5707***	-7.0388***	-2.0935**
lnfertilizerp	4.5421	0.4799	0.2300	-4.9664***	-6.5711***	-1.5922*
lnmachinep	1.7261	2.3316	1.7233	-4.4988***	-4.7558***	-1.8035**
tfp	-4.4850***	-0.7685	1.2260	-13.4825***	-12.5275***	-4.7837***
tp	-1.3097	-5.3469***	-0.2947	-12.6374***	-11.7734***	-3.6708***
tec	-0.5929	-1.5927*	0.4241	-5.4496***	-9.9811***	-3.7761***

² The superscript ***, **, * are significant at the level of 1%, 5%, and 10%, respectively.

To sum up, the original sequence of each variable is not stationary, while their first-order difference sequence is stationary. Each variable is integrated of order one, i.e. the I (1) process. Since each sequence belongs to the same order single integer sequence, we can perform long-term co-integration analysis between variables.

3.2 Cointegration Test for Total Samples

This paper uses Kao test (1999) and Pedroni test (1999, 2004) to test whether there is a long-term cointegration relationship between variables. Both of these methods are panel co-integration tests based on residuals and assume that the sections are independent. The original assumption of both methods is that there is no co-integration relationship for all individuals, while the alternative assumption is that there is co-integration relationship for all individuals. This paper tests the long-term cointegration relationship between different variables by six types of cointegration relationships. Dependent variables tfp, tp, tec and core explanatory variables lnpesticidep, lnoilp, lnirrp, lnfilmp, lnfertilizerp and lnmachinep form model 1, model 2 and model 3 respectively. Dependent variables tfp, tp, tec and core explanatory variables and control variables lnopen, lnelectricity, lnfi, lnlabor, industry constitute model 4, model 5 and model 6 respectively. The inspection results are shown in Table 3 below.

Table 3. Panel cointegration test results

Statistic	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Kao test	-5.8875***	-3.8026***	-9.2822***	-5.6898***	-3.6459***	-9.3964***
DF value	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
Pedroni test						
Panel v	-2.4821*** (0.0065)	-2.5968*** (0.0047)	-2.5312*** (0.0057)	—	—	—
Panel rho	1.0074 (0.1569)	0.1497 (0.4405)	0.5281 (0.2987)	—	—	—
Panel pp	-7.5448*** (0.0000)	-8.3155*** (0.0000)	-7.0675*** (0.0000)	—	—	—
Panel ADF	-1.360e+15*** (0.0000)	-8.9155*** (0.0000)	-5.4093*** (0.0000)	—	—	—
Group rho	1.8463** (0.0324)	0.9025 (0.1834)	1.2624 (0.1034)	—	—	—
Group pp	-8.4454*** (0.0000)	-10.0927*** (0.0000)	-9.2630*** (0.0000)	—	—	—
Group ADF	-4.599e+15*** (0.0000)	-11.0363*** (0.0000)	-6.1461*** (0.0000)	—	—	—

³ The superscript ***, **, * are significant at the level of 1%, 5%, and 10%, respectively. The p-value is in brackets.

In the case of small samples, group ADF and panel ADF are the best in pedroni test. Due to the limitation of data, there are too many variables in the model after adding control variables, so pedroni test cannot be carried out. Therefore, the values of seven statistics in pedroni test of model 4, model 5 and Model 6 are not listed in the table. According to the results of Kao test, we reject the hypothesis that there is no co integration relationship at the significance level of 1%. Therefore, we can also think that the variables in model 4, model 5 and Model 6 with control variables have cointegration relationship. In summary, the six models have been tested by Kao test and pedroni test, and the original hypothesis that there is no co integration relationship is rejected. We think that there is co integration relationship among variables in each model.

3.3 The Residual-Based Panel Fully Modified OLS (FMOLS)

After determining that there is a co-integration relationship between variables, we used FMOLS for co-integration regression. Compared with OLS estimation method, FMOLS estimation can better solve the problems of endogeneity of variables and biased estimation results. Dependent variables tfp, tp, tec and core explanatory variables and control variables lnopen, lnelectricity, lnfi, lnlabor, industry constitute model 4, model 5 and model 6 respectively. The estimated results are shown in Table 4.

Table 4. FMOLS regression results

Explanatory variables	Model 4	Model 5	Model 6
lnfilmp	0.006419 (0.475686)	0.035371 (1.421778)	-0.027437 (-0.984457)
lnoilp	-0.042155*** (-3.690655)	0.099332*** (4.311886)	-0.136897*** (-5.384061)
lnmachinep	-0.002718 (-0.134199)	-0.023887 (-0.723819)	0.031494 (0.839363)
lnirrp	-0.232587*** (-9.602969)	0.022899 (0.579870)	-0.242263*** (-5.339365)
lnfertilizerp	0.110299*** (2.961456)	-0.146511** (-2.602231)	0.274641*** (4.280323)
lnpesticidep	-0.104460*** (-5.717707)	0.162924*** (5.433335)	-0.263281*** (-7.711458)
Control Variables	YES	YES	YES
R2	0.529568	0.323185	0.286022

⁴ The superscript ***, **, * are significant at the level of 1%, 5%, and 10%, respectively. The t-statistic is in brackets.

We can find that the carbon emission of agricultural film has no significant effect on the improvement of TFP. As the first largest carbon source of agricultural carbon emissions, chemical fertilizer has made great contribution to the growth of agriculture in China. However, excessive use of chemical fertilizer will also cause pollution. The coefficient of lnfertilizerp is 0.110299, which is significant at a significant level of 1%, indicating that the carbon emission of fertilizer increases by 1%, and the agricultural TFP increases by 0.110299 units. In addition, the carbon emissions from the other 4 carbon sources will inhibit the growth of agricultural TFP. The effect of carbon emission from agricultural machinery (lnmachinep) is not significant. The coefficient of lnoilp, lnirrp, lnpesticidep are -0.042155, -0.232587, -0.104460, respectively, which is significant at a significant level of 1%. Its carbon emission increased by 1%, the agricultural TFP decreased by 0.042155 units, 0.232587 units, 0.104460 units, respectively. Agricultural irrigation, as the second largest carbon source of agricultural carbon emissions, its growth trend is still rising, and has seriously affected the improvement of agricultural total factor productivity. How to solve the problem of irrigation emission reduction is the focus of current research.

In order to further analyze the path of each carbon source affecting agricultural total factor productivity, this paper respectively constructs model 5 and Model 6 with agricultural technology progress (tp), agricultural technology efficiency (tec) and core explanatory variables and control variables. The results are as follows:

Model 5 reflects the impact of carbon emissions from various carbon sources of agricultural production on agricultural technological progress (TP). The coefficient values of $\ln\text{pesticidep}$ and $\ln\text{oilp}$ are 0.162924 and 0.099332, respectively, which are significant at a significant level of 1%, indicating that their carbon emissions increased by 1%, and the agricultural TP increased by 0.162924 and 0.099332 units, respectively. The coefficient of carbon emission from fertilizer ($\ln\text{fertilizerp}$) is -0.146511, which is significant at a significant level of 5%. It increases by 1%, and the agricultural TP will decrease by 0.146511 units. $\ln\text{filmp}$ and $\ln\text{irrp}$ did not significantly promote the agricultural TP. The inhibition of agricultural machinery carbon emission ($\ln\text{machinep}$) was not significant.

Model 6 reflects the impact of carbon emissions from various carbon sources of agricultural production on agricultural technical efficiency (TEC). The coefficient values of $\ln\text{pesticidep}$, $\ln\text{oilp}$, $\ln\text{irrp}$ and $\ln\text{fertilizerp}$ are -0.263281, -0.136897, -0.242263 and 0.274641, respectively, which are significant at the significant level of 1%. Inhibitory effect of $\ln\text{filmp}$ on TEC is not significant. $\ln\text{machinep}$ do not significantly promote technical efficiency. This indicated that the $\ln\text{pesticidep}$, $\ln\text{oilp}$, $\ln\text{irrp}$ could significantly inhibit the agricultural TEC, which increased by 1% and reduced the agricultural technical efficiency by 0.263281, 0.136897 and 0.242263 units respectively. $\ln\text{fertilizerp}$ will have a significant positive effect on agricultural technology efficiency, which will increase by 1% and agricultural TEC increase by 0.274641 units.

In summary, in the long run, there are positive and negative effects of carbon emissions from various carbon sources on agricultural TFP, and they can be divided into technological progress and technological efficiency. Agricultural film carbon emissions and agricultural machinery carbon emissions have no significant impact on agricultural TFP, TP, TEC for a long time. Agricultural diesel carbon emissions, agricultural irrigation carbon emissions, and pesticide carbon emissions mainly restrain agricultural TFP by restraining agricultural TEC, while their promotion to agricultural TP slows down the degree of restraint. However, carbon emissions from agricultural irrigation did not significantly promote TP, which also led to the greatest inhibition on agricultural TFP. Chemical fertilizer carbon emission mainly promotes agricultural TFP by promoting agricultural TEC, while its inhibition on TP reduces the degree of promotion.

3.4 Vector Error Correction Model

The long-term equilibrium relationship between agricultural TFP and carbon sources of agricultural production is reflected by the previous Co-integration Model. How to correct short-term fluctuations around the long-term equilibrium relationship needs to be achieved by establishing the Vector Error Correction Model. In this paper, the regression residuals (ecm) of model 4, model 5 and Model 6 are calculated according to the three co-integration regression equations. The first-order difference sequence of agricultural TFP, TP, TEC and the first-order difference sequence of each agricultural carbon source carbon emission and control variable as well as the regression residual (ecm) constitute error correction models 7, 8 and 9. The model regression results are shown in Table 5 below.

Table 5. Error Correction Model regression results

Explanatory variables	Model 7	Model 8	Model 9
	Δ (tfp)	Δ (tp)	Δ (tec)
Δ (Yt-1)	0.084375 (1.531608)	0.274609*** (15.68571)	0.254149*** (13.30265)
Δ (Infilmp)	-0.007760 (-0.443973)	0.169190*** (11.27335)	-0.193812*** (-12.86921)
Δ (Inoilp)	-0.088953*** (-8.282938)	0.037398*** (3.988770)	-0.109907*** (-11.04025)
Δ (Inmachinep)	-0.049073** (-2.568566)	-0.071263*** (-5.323341)	0.040485*** (2.908704)
Δ (Inirrp)	-0.243873*** (-8.349004)	0.075005 *** (4.042169)	-0.306101*** (-14.84638)
Δ (Infertilizerp)	0.178028*** (5.328472)	-0.371455*** (-17.06731)	0.568451*** (27.34397)
Δ (Inpesticidep)	-0.103922*** (-6.634281)	0.132566*** (12.69320)	-0.232114*** (-20.39417)
ecm (-1)	-1.391406*** (-14.49810)	-1.593920*** (-54.32370)	-1.577293*** (-49.65659)
Control Variables	YES	YES	YES
R2	0.684020	0.732803	0.706428

⁵ The superscript ***, **, * are significant at the level of 1%, 5%, and 10%, respectively. The t-statistic is in brackets. Y is dependent variables.

The error correction term coefficients of model 7, model 8 and model 9 are -1.391406, -1.593920 and -1.577293, which are significant at the 1% significant level. It indicates that in the long-term equilibrium process of agricultural TFP, TP, TEC and carbon emissions from various carbon sources, if there is deviation fluctuation in a short time, it will deviate back to the equilibrium level with strong regulation efficiency, which is in line with the reverse correction mechanism.

From the short-term effect analysis, except in Model 7, the carbon emission coefficient of agricultural film is not significant, the carbon emission coefficient of machinery is significant at a significant level of 5%, the other core explanatory variables are significant at a significant level of 1%. The results show that in the short term, agricultural film carbon emissions, agricultural diesel emissions, agricultural irrigation carbon emissions, and pesticide carbon emissions will inhibit agricultural TFP by suppressing agricultural TEC, while its promotion on TP will slow down this effect. However, compared with the inhibition, the carbon emission of agricultural film has a greater promotion on TP, so its inhibition on agricultural TFP is not significant. Agricultural machinery carbon emissions can inhibit agricultural TFP by inhibiting TP, while the improvement of TEC slows down the degree of inhibition. Carbon emissions from fertilizers promote the improvement of agricultural TFP by promoting TEC, while its inhibition on TP weakens the promotion.

4. Discussion and Conclusions

This paper explores the relationship between climate change and the transformation of agricultural development mode from the perspective of carbon emissions and agricultural

total factor productivity. Based on the Regional Panel Data of China from 1995 to 2016, the long-term cointegration model and error correction model of agricultural carbon emission and agricultural total factor productivity are constructed. Three conclusions can be drawn: (1) There is a long-term equilibrium relationship between the carbon emissions of pesticide, chemical fertilizer, agricultural irrigation, diesel and agricultural TFP. Agricultural carbon emissions, agricultural diesel emissions and agricultural irrigation carbon emissions will inhibit the growth of agricultural total factor productivity, and the degree of suppression from large to small is irrigation carbon emissions, pesticide carbon emissions and agricultural diesel carbon emissions in turn. Carbon emission from chemical fertilizer will promote the growth of agricultural TFP. (2) Further analysis of the impact mechanism shows that agricultural diesel carbon emissions, agricultural irrigation carbon emissions, pesticide carbon emissions mainly inhibit agricultural TFP by inhibiting TEC, but its promotion on agricultural TP has slowed down the degree of inhibition. Increased carbon emissions from chemical fertilizers will promote the growth of agricultural TFP by increasing TEC, but its negative effect on TP will reduce the degree of promotion. It is consistent with the conclusion of Wang et al. (2019), they believe that the increase of carbon emission intensity will lead to the decrease of the growth rate of green TFP through the expansion of the ineffective rate of production technology. In this article, the impact of the carbon source on the TFP was discussed in detail. (3) Through the error correction model, it can be found that there is a short-term reverse correction mechanism between carbon emission from each carbon source and agricultural TFP, TP, TEC which will recover faster after short-term deviation. In the short term, agricultural membrane carbon emissions, agricultural diesel emissions, agricultural irrigation carbon emissions, and pesticide carbon emissions will inhibit agricultural TFP by suppressing agricultural TEC, while its promotion on agricultural TP has slowed down the degree of suppression. The carbon emission of agricultural machinery will inhibit the agricultural TFP by restraining TP, while it will slow down the degree of suppression to the improvement of TEC. The carbon emission of chemical fertilizer will promote the improvement of agricultural TFP by promoting the improvement of TEC, while its suppression on TP weakens the role of promotion.

Acknowledgments: ALL this, as well as the results of this study, would not have been possible without the moral and administrative support of my colleagues from School of Economics & Management Northwest University.

References

- Brümmer, B., Glauken, T., & Lu, W. (2006). Policy Reform and Productivity Change in Chinese Agriculture: A Distance Function Approach. *Journal of Development Economics*, 81(1), 61-79. <https://doi.org/10.1016/j.jdevco.2005.04.009>
- Coelli, T., & Rao, D. S. (2003). Total Factor Productivity Growth in Agriculture: A Malmquist Index Analysis of 93 Countries, 1980-2000. *Agricultural Economics*, 32, 115-134. <https://doi.org/10.1111/j.01695150.2004.00018.x>
- Charnes, A., Cooper, W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2, 429-444. [https://doi.org/10.1016/0377-2217\(78\)90138-8](https://doi.org/10.1016/0377-2217(78)90138-8)
- Chen, M., Ma, L., Che, X., & Dou, H. (2020). Identification of Transformation Stages and Evolution of Agricultural Development Types Based on Total Factor Productivity Analysis: A Case Study of Gansu Province, China. *Agriculture*, 10(8), 363. <https://doi.org/10.3390/agriculture10080363>

- Färe, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries. *The American Economic Review*, 84, 66-83.
- Farrell, M. J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society. Series A (General)*, 120(3), 253-290. <https://www.jstor.org/stable/2343100>
- Huang, Z., & Mi, S. (2011). Research on Agricultural Carbon Footprint -- Taking Zhejiang Province as an Example. *Issues in Agricultural Economy*, 32(11), 40-47,111. <https://doi.org/10.13246/j.cnki.iae.2011.11.007>
- Huilong, M., & Lei, L. (2018). Analysis on the transformation of agricultural economic development mode of BINGTUAN based on TFP. *Journal of Agricultural Sciences*, 39(3), 33-37. <https://doi.org/10.13907/j.cnki.nykxyj.20180925.004>
- Institute of Resource, Ecosystem and Environment of Agriculture in Nanjing Agricultural University (IREEA). (2016). <http://ireea.njau.edu.cn>.
- Intergovernmental Panel on Climate Change (IPCC). (2006). *IPCC Guidelines for National Greenhouse Gas Inventories*. www.ipcc-ggip.iges.
- Jin, H., & Kan L. (2013). Measurement and Influential Factors Analysis of China's Agricultural Total Factor Productivity. *Agriculture, Farmers and Countryside Journal of Northwest Sci Tech University of Agriculture and Forestry*, 13(2), 29-35. <https://doi.org/10.13968/j.cnki.1009-9107.2013.02.021>
- Kumbhakar, S. C., & Lovell, C. (2000). *Stochastic Frontier Analysis: Frontmatter*. Cambridge University Press <https://doi.org/10.1017/CBO9781139174411>
- Li, B., Zhang J., & Li H. (2011). Spatio-temporal characteristics of agricultural carbon emissions and decomposition of influencing factors in China. *China Population Resources and Environment*, 21(8), 80-86. [http://refhub.elsevier.com/S0959-6526\(17\)31007-7/sref12](http://refhub.elsevier.com/S0959-6526(17)31007-7/sref12)
- Liu, L., & Zhang, W. (2017). China's agricultural TFP growth and spatial spillover effect: An Empirical Analysis Based on the data of 31 provinces and cities from 2000 to 2014. *Western Forum*, 27(6), 49-57.
- Liu, S., Zhang, S., He, X., & Li, J. (2016). Efficiency change in North-East China agricultural sector: A DEA approach. *Agricultural Economics*, 61, 522-532. <https://doi.org/10.17221/233/2014-AGRICECON>
- Mead, R W. (2003). A revisionist view of Chinese agricultural productivity? *Contemporary Economic Policy*, 21(1), 117-131. <https://doi.org/10.1093/cep/21.1.117>
- Oak Ridge National Laboratory. (2016). <https://www.ornl.gov>.
- Pan Dan. (2014). Calculation of China's Agricultural Green Productivity and Analysis of Influencing Factors Based on Resource and Environment Constraints. *Statistics & Information Forum*, 29(8), 27-33. <https://chn.oversea.cnki.net/kcms/detail/detail.aspx?FileName=TJLT201408005&DbName=CJFQ2014>
- Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, 39(3), 312-320. <https://www.jstor.org/stable/1926047>
- Schultz, T. W., & Abramovitz, M. (1956). Resources and Output Trends in the United States since 1870. *Journal of the American Statistical Association*, 52, 281. <https://www.jstor.org/stable/2280866>
- Tone, K. (2002). A slacks-based measure of super-efficiency in data envelopment analysis. *European Journal of Operational Research*, 143, 32-41. [https://doi.org/10.1016/S0377-2217\(01\)00324-1](https://doi.org/10.1016/S0377-2217(01)00324-1)
- Wang, L., Yao H., & Han X. (2019). Carbon emission, green total factor productivity and agricultural economic growth. *Inquiry into Economic Issues*, (2), 142-149. <https://chn.oversea.cnki.net/kcms/detail/detail.aspx?FileName=JJWS201902019&DbName=CJFQ2019>
- Wen, J. G. (1993). Total Factor Productivity Change in China's Farming Sector: 1952-1989. *Economic Development and Cultural Change*, 42(1), 1-42. <https://doi.org/10.1086/452063>
- West, T. O., & Marland, G. (2002). A synthesis of carbon sequestration, carbon emissions, and net carbon flux in agriculture: comparing tillage practices in the United States. *Agriculture, Ecosystems & Environment*, 91(1-3), 217-232. [http://refhub.elsevier.com/S0959-6526\(17\)31007-7/sref36](http://refhub.elsevier.com/S0959-6526(17)31007-7/sref36)
- Xu, G., & Song D. (2010). An empirical study on the Kuznets curve of China's carbon emission environment based on Provincial Panel Data. *China Industrial Economics*, (5), 37-47. <https://doi.org/10.19581/j.cnki.ciejournal.2010.05.005>
- Zhan, J., Xu, Y., Ge, J. (2019). Changes in China's agricultural green productivity considering the cost of carbon emissions. *Resources Science*, 41(5), 884-896. <https://chn.oversea.cnki.net/kcms/detail/detail.aspx?FileName=ZRZY201905006&DbName=CJFQ2019>
- Zhang, B., Xu, K., & Chen T. (2014). Research on influence of technological progress on carbon dioxide emission intensity. *Resources Science*, 36(3), 567-576. <https://chn.oversea.cnki.net/kcms/detail/detail.aspx?FileName=ZRZY201403016&DbName=CJFQ2014>

- Zhong, Z., & Jiang, L. (2019). Impact of Climate Change on Agricultural Total Factor Productivity Based on Spatial Panel Data Model: Evidence from China. *Sustainability*, 11(6), 1516.
<https://doi.org/10.3390/su11061516>
- Zhao, A., & Li, D. (2011). Cointegration and Cause-Effect Analysis of Carbon Emissions and Economic Growth in China. *Resources and Environment in the Yangtze Basin*, 20(11), 1297-1303.
<https://chn.oversea.cnki.net/kcms/detail/detail.aspx?FileName=CJLY201111002&DbName=CJFQ2011>

Industry 4.0 – Relationship Between Capital Equipment and Labor Productivity

Peter MARINIČ* and Pavel PECINA

Masaryk university, Brno, Czech Republic; marinic@ped.muni.cz; ppecina@ped.muni.cz

* Corresponding author: marinic@ped.muni.cz

Abstract: Using new technology in production process is naturally connected with the economic development due to attempt to increase labor productivity and/or decrease in unit production costs. In last decades, term Industry 4.0 is used for such cases, as industrial revolution connected with new technology, especially information and communication technology, used in production process. Industry 4.0 is also connected with a fear of disappearing different kind of occupations replaced by new technology and with the fear of lack of employees in other occupations requiring suitable but not yet existing qualification. In the article we present the development of economic indicators and ratios based on production output, compensation on employees, capital equipment, volume of workers, and hours worked to illustrate development of labor productivity in 1995-2018 in Czech Republic, Slovakia, Poland, Hungary, Austria, and Germany. We present results about significant changes in economic structure in analyzed countries, but as results of economic development or economic transformation process. Thus, we try to articulate that the development is rather economic evolution than industrial revolution and that there is no reason to be afraid of Industry 4.0 process.

Keywords: economic development; economic indicators; labor productivity; capital equipment; Industry 4.0

JEL Classification: O11; E24

1. Introduction

In the last years, the debate about the Industry 4.0 has increased and a lot of people are interested in this topic. It is no longer the topic of only the technicians and economists, but also the politicians of local and national level are debating it, and the teacher as well (Mason & Vanark, 1994; Pecina & Sládek, 2017). All the above-mentioned groups are trying to implement this topic to their agenda and to prepare for the inevitable changes which the Industry 4.0 is about to bring to our lives. The debate is not only about the direct changes in the industrial flow, process of making things and the economic influence on the entrepreneurs, but also about the influence on the labor market, national policy and the education system as well. The politicians are debating the steps needed to prepare for the changes in the labor market structure in the sense of the appropriate skills of the workers, and with the connection with the teachers they try to find out what new skill, competencies in the fashion style of speech, are needed to develop in the pupils and students as future workers (Brahama, Tripathi, & Sahay, 2020) There are a lot of emotion in those debates due to fear of losing the competitive

position of the national economy, losing the high educated and skilled workers, and other factors. Especially the fear of radical changes in the economic structure of the industrial sectors connected with the Industry 4.0 initiatives.

But if we look for the examples in the human history (Settsu & Takashima, 2020; Hasino & Otsuka, 2020), there are a lot of cases where there was similar fear of exchanging the human force as workers by the force of inventions and especially machines. Nowadays we are not even able to imagine our life without the mobile phones and other mobile devices making the communication easy and very available. We are not able to imagine constructing a lot of building and structures without help of different kind of tools and machinery. And it is true that it creates a lot of pressure to our ability to use those devices and technology. But we as the humankind are very adaptable and creative. The emotional point of view connected with the fear of losing the individual competitive position of each of us as the worker not depending on the type of work, we are doing is understandable at the individual level. But there should be some-kind of global perspective which could make us calm and provide us with the suitable understanding that all the changes of implementation of Industry 4.0 to life would have positive effect on our lives.

2. Methodology

The main idea of the article is to point out the development of chosen economical indexes to show the development of industrialization process in the chosen European countries, namely Czech Republic (CZ), Germany (DE), Hungary (HU), Austria (AT), Poland (PL), and Slovakia (SK). The indexes were chosen in such way that they can illustrate the labor productivity (Szirmal, 2019; Vonyo & Klien, 2019) and other connected economic indexes (Gashenko et al., 2020; Xu, Xu & Li, 2018).

Labor productivity, signed as workers productivity, is computed as ratios of output (O) to number of employees within total employment as volume of persons (PTE). Due to inventions, automatization and technological development connected with the overall economic development it is assumed that labor productivity will increase in time. However, due to Industry 4.0 as the revolutionary process, the abrupt increase should be identified. This abrupt increase should also occur due to replacement of manual work by machinery, in other words by increasing personal capital equipment as ratio of consumption of fixed capital (CoFC) to number of employees within total employment as volume of persons (PTE).

The workers wage as ratio of compensation of employees (CoE) to number of employees within total employment as volume of persons (PTE) and the hour worked per employee as ratio of hours worked by employees within total employment (HTE) to number of employees within total employment as volume of persons (PTE) is also analyzed. As manifestation of the initiative, there should be reduction in the volume of work per employee, and as result of increased labor productivity wages could increase. Both are positive consequences of Industry 4.0 process and something that employees should not be afraid of.

The analysis also includes two ratios, first as personal costs (compensation of employees) to output and second as fixed cost (consumption of fixed costs) to output used for analysis of the economic impacts connected with the changes in range of labor and capital equipment.

The negative relationship is assumed because of more intensive increase in capital equipment per employee than labor costs.

For the analysis, the data from Eurostat database were used. The data were analyzed in the time-period from 1995 till 2018, which is the longest range available. In the fact that there were, and in some countries still are, different currencies, the Euro was chosen as the summarizing currency for the whole time-period.

The selected data were (with abbreviation in brackets):

- (O) output,
- (CoE) compensation of employees,
- (CoFC) consumption of fixed capital,
- (GFCF) gross fixed capital formation (total fixed assets),
- (HTE) hours worked by employees within total employment,
- (PTE) number of employees within total employment as volume of persons.

Those data were analyzed for the six chosen economies using breakdown to sector type according to NACE classification as follows (with abbreviation in brackets):

- (All) total – all NACE activities,
- (A) agriculture, forestry, and fishing,
- (B-E) industry except construction,
- (F) construction,
- (G-I) wholesale and retail trade, transport, accommodation, and food service,
- (J) information and communication,
- (K) financial and insurance activities,
- (L) real estate activities,
- (M-N) professional, scientific, and technical activities; administrative and support service activities,
- (O-Q) public administration, defense, education, human health, and social work activities,
- (R-U) Arts, entertainment and recreation, other service activities; activities of household and extra-territorial organizations and bodies.

From the abovementioned ratios the most important for the influence of the Industry 4.0 are the following (computation of ratios from economic variables in brackets):

- workers productivity (O/PTE),
- workers wage (CoE/PTE),
- personal capital equipment (CoFC/PTE),
- ratio of personal costs (CoE/O),
- ratio of fixed costs (CoFC/O),
- hours worked per employee (HTE/PTE).

In the analysis there were selected economic variables (output, compensation of employees, consumption of fixed capital, gross fixed capital formation, hours worked by employees within total employment, number of employees within total employment as

volume of persons) used for computing the different types of ratios (workers productivity, workers wage, personal capital equipment, ratio of fixed costs, ratio of personal costs, hours worked per employee). These variables were analyzed through the year-to-year per cent change in the selected time-period from 1995 till 2018 for each country separately – results are presented in the tables. In the graph there are mutual comparison of the selected ratios in the first year, 1995, and the last year, 2018, of the analyzed period and changes during the period presented to illustrate the development of chosen ratios in all countries. To identified relationship between chosen ratios in more sensitive way the sector breakdown according to NACE was used, so more variables were obtained and there was higher possibility to identify specific sectors, with interesting results for further analysis.

If Industry 4.0 is truly revolutionary process, abrupt change in data should occur, but if it is a natural development, evolutionary process, then the change should be smooth.

3. Results

In Figure 1, there is presentation of the indicators of chosen EU countries which were used for computation of the following ratios below. It consists the volume of indicators in 2018, the last year of the analyzed period which could be considered the best approximation of the current state, the absolute volume of difference between the first and the last year (1995 to 2018 difference), and the ratio in per cent of the year-to-year change of each indicator.

Output*				Gros Fixed Capital Formation (Total Fixed Assets)*			
Country	2018	1995-2018	1995-2018 (r-r;%)	Country	2018	1995-2018	1995-2018 (r-r;%)
CZ	478,379	378,338	7.04	CZ	55,485	39,938	5.69
DE	6,189,483	2,851,322	2.72	DE	707,719	242,210	1.84
HU	258,487	190,454	5.98	HU	33,677	25,953	6.61
AT	715,461	412,596	3.81	AT	92,365	45,726	3.02
PL	1,000,777	797,700	7.18	PL	90,684	71,729	7.04
SK	210,723	176,773	8.26	SK	18,765	14,769	6.96

Compensation of Employees*				Consumption of Fixed Capital*			
Country	2018	1995-2018	1995-2018 (r-r;%)	Country	2018	1995-2018	1995-2018 (r-r;%)
CZ	93,546	75,386	7.39	CZ	41,864	32,307	6.63
DE	1,770,255	714,566	2.27	DE	608,731	285,894	2.80
HU	57,326	41,356	5.71	HU	21,257	14,488	5.10
AT	185,109	91,108	2.99	AT	69,261	40,038	3.82
PL	195,213	151,821	6.76	PL	56,809	41,067	5.74
SK	37,377	31,366	8.27	SK	15,141	10,594	5.37

Thousand Hours Worked				Thousand Persons			
Country	2018	1995-2018	1995-2018 (r-r;%)	Country	2018	1995-2018	1995-2018 (r-r;%)
CZ	9,666,520	314,832	0.14	CZ	5,417	312	0.26
DE	62,344,000	4,118,000	0.30	DE	44,854	6,812	0.72
HU	8,067,981	387,188	0.21	HU	4,666	724	0.74
AT	7,239,410	874,276	0.56	AT	4,489	902	0.98
PL	32,842,692	2,057,962	0.28	PL	16,404	1,617	0.45
SK	4,123,329	218,604	0.24	SK	2,420	313	0.60

* volumes in millions of Euros

Figure 1. Analyzed economic indicators of chosen EU countries (Eurostat database, 2020)

Productivity per employee*				Wage per employee*			
Country	2018	1995-2018	1995-2018 (r-r;%)	Country	2018	1995-2018	1995-2018 (r-r;%)
CZ	88,309	68,714	6.77	CZ	17,269	13,712	7.11
DE	137,992	50,242	1.99	DE	39,467	11,716	1.54
HU	55,391	38,136	5.20	HU	12,284	8,234	4.94
AT	159,380	74,949	2.80	AT	41,236	15,031	1.99
PL	61,009	47,276	6.70	PL	11,901	8,966	6.28
SK	87,079	70,968	7.61	SK	15,446	12,593	7.62

Productivity per hour*				Wage per hour*			
Country	2018	1995-2018	1995-2018 (r-r;%)	Country	2018	1995-2018	1995-2018 (r-r;%)
CZ	49.49	38.79	6.89	CZ	9.68	7.74	7.23
DE	99.28	41.95	2.42	DE	28.39	10.26	1.97
HU	32.04	23.18	5.75	HU	7.11	5.03	5.49
AT	98.83	51.25	3.23	AT	25.57	10.80	2.42
PL	30.48	23.88	6.88	PL	5.94	4.53	6.46
SK	51.11	42.41	8.01	SK	9.06	7.53	8.01

Hours worked per employee				Capital equipment per employee*			
Country	2018	1995-2018	1995-2018 (r-r;%)	Country	2018	1995-2018	1995-2018 (r-r;%)
CZ	1,784	-47	-0.11	CZ	10,243	7,197	5.42
DE	1,390	-141	-0.42	DE	15,778	3,542	1.11
HU	1,729	-219	-0.52	HU	7,217	5,258	5.83
AT	1,613	-162	-0.41	AT	20,576	7,574	2.02
PL	2,002	-80	-0.17	PL	5,528	4,246	6.56
SK	1,704	-149	-0.36	SK	7,754	5,858	6.32

* volume in units of Euro

Figure 2. Analyzed economic ratios of chosen EU countries (Eurostat database, 2020)

In Figure 2, there are data about the state and development of the economic ratios computed according to chosen indicators. In both tables (Tab. 1 and Tab. 2) there are evident differences between the countries of Visegrad group and the Germany and Austria in both, the absolute volumes and the per cent ration of year-to-year change. Data also indicate that convergence process occurs. In all analyzed countries all analyzed indicator and almost all ratios grow. Only the number of hours worked per employee indicates slight decrease. In other words, productivity, capital equipment and wages of employees, per hour and per person, increase which lead to less hours worked per each employee. Due to constant increasing of work efficiency employees spend less time in a work and produce more output at the same time.

This identified relationships represent the motivation for further investigation. Thus, there are analysis of the relationship between the labor productivity and the capital equipment per worker (Figure 3), analysis of the relationship between the wage per employees and labor productivity (Figure 4) and analysis of the personal costs and fixed costs (Figure 5), to illustrate in more detail the mutual relationship. There seems to be a direct link from capital equipment growth through increase labor productivity to wage growth, but not significant relationship between ratios of personal costs and fixed costs growth.

As can be seen in the figures, the ratios are used for the identification of the relationship in the first year of analyzed period, 1995, and the last year, 2018, as well as for the year-to-year change of ratios. For the better, more strength, and detailed view on the relationship, and to be able to indicate possible significant influence of each economic sector, the sector breakdown according to NACE where used. However, there are some differences between

the sectors, there are also differences between the countries, but not indicated clear clarifying information about the specific situation in some sector. Rather, it seems there is tendencies for the whole economy.

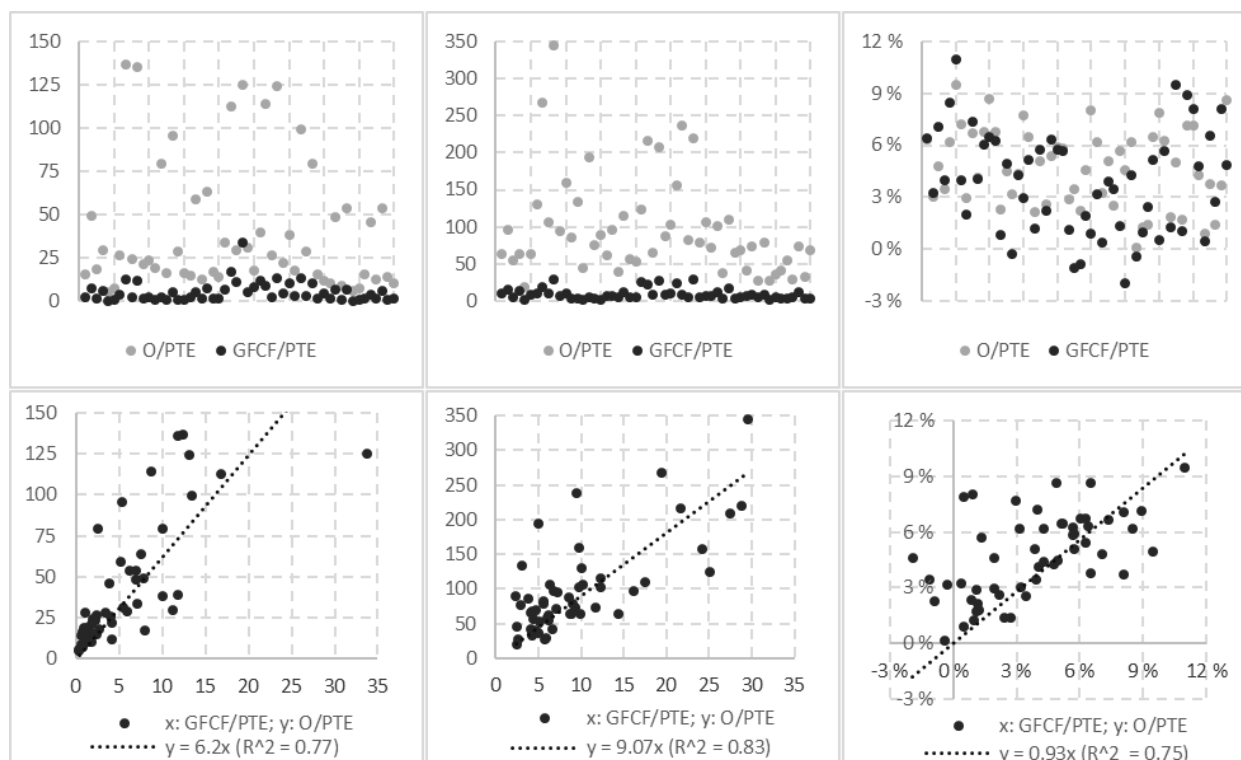


Figure 3. Relationship between productivity and capital equipment (Eurostat database, 2020)

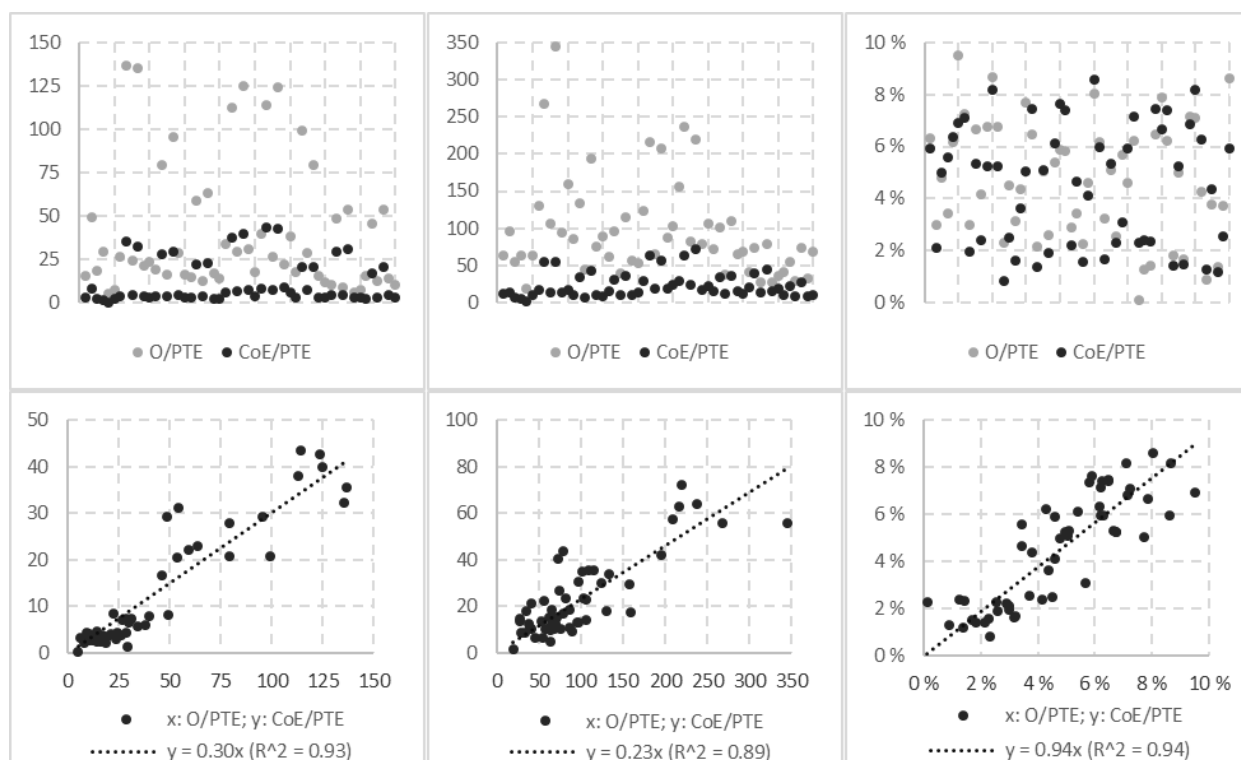


Figure 4. Relationship between wage and productivity (Eurostat database, 2020)

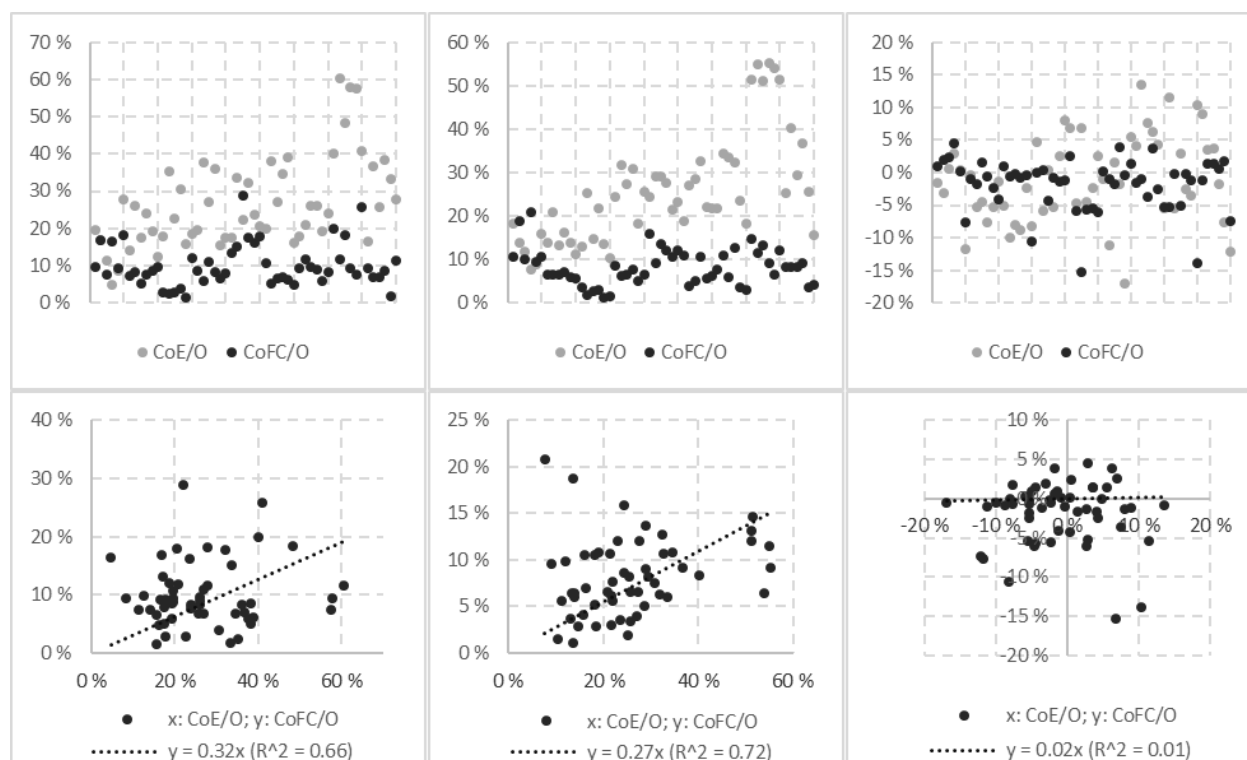


Figure 5. Relationship between personal cost and fixed costs (Eurostat database, 2020)

4. Discussion

Analyzed mutual relationships between analyzed ratios were not such strong as expected according to similar analyses of the development of chosen European countries, which one of the authors was participated to (Záthurecký & Marinič, 2019). In the previous analysis, it was assumed that the use of the sectoral breakdown will help achieve more significant results with the potential to identify significant changes in specific sector. However, the data suggest that the positive effects of Industry 4.0 are in labor productivity, wage increase, and reduction of hours worked, together with the tendency of Visegrad countries to converge to Germany and Austria, but the changes are ongoing without any significant leaps. This can be due to internal differences in each sector type when using only 10 sectors according to NACE classification. There is possibility to use wider NACE classification obtaining 64 sectors and provide the analysis in this range to find out specific sectors more influenced by Industry 4.0 initiatives. But there is still the question if there is any sector with radical changes in analyzed economic variables or ratios.

We do not deny the significant contribution of technological development, informatization and digitization, which brings or is referred to as Industry 4.0, in the field of labor productivity (Kurt, 2019; Trenovski et al., 2020). The consequent effect of the increasing volume of production output, with the current aging of the European population, creates enormous opportunity to maintain prosperity and high level of consumption in the future. Even the creation of the more ecologic economy (Rutkowska & Sulich, 2020).

Our analysis came to similar results as the analysis of the labor productivity at Slovakia in the context of the implementation of Industry 4.0, which also concluded that Slovakia is

showing increasing economic output, increasing GDP, as well as increasing labor productivity. The contribution of Industry 4.0 is identified in industrial production, where it has the greatest potential for increasing labor productivity, but also the creation of new jobs (Grencikova, Kordos, & Berkovic, 2020).

The specific sectors are often used as argument in debate among politicians and specifically teachers, especially teachers of vocational education and training. They expect the radical changes in specific industries and are afraid of the future of their own expertise and the usability of the pupils and students as future workers (Pecina & Sládek, 2017). There will be need for the new competencies, abilities, and skills of employees, especially connected with the digitalization and other technologically advanced areas, putting also pressure on educational needs (Grenčíková, Kordoš, & Navickas, 2021). Not only technology-related skills should be developed, but also creativity, emotional intelligence, critical thinking, and interpersonal skills should be developed as well (Beke, 2020).

The economic development of the chosen countries can be recognized and the convergence process of the new European Member States to the economic level of old Member States reveals as well. But these results were assumed due to common conviction of ongoing process of mutual connection between the chosen economics and their gradual harmonization. At the same time, the data point to the fact that there was no abrupt change in the analyzed time, but the development of individual indicators took place more as a continuous process of long-lasting change. And here we agree with the opinion that Industry 4.0 is rather technological and economic evolution, than revolution (Asadollahi-Yazdi et al., 2020).

5. Conclusions

The aim of the article was to identify changes in relatively long time-period – 24 years from 1995 to 2018. According to the analysis and results it seems that the analyzed countries are developing in their production possibilities – increase of output. Also, the increase of production possibilities is enabling the enterprises to use more financial sources for the investments, and we can identify the increase of the consumption of fixed capital, increase in labor productivity and increase in compensation on employees connected with wages. This process of increasing the various economic indexes is also connected with the decrease of time spent in the work. Whole development is rather fluent change than revolution jump.

References

- Asadollahi-Yazdi, E., Couzon, P., Nguyen, N. Q., Quazene, Y., & Yalaoui, F. (2020). Industry 4.0: Revolution or Evolution? *American Journal of Operation Research*, 10, 241-268. <https://doi.org/10.4236/ajor.2020.106014>
- Beke, E. (2020). The relationship and interaction between Industry 4.0 and education. *Műszaki Tudományok Közlemények*, 13, 36-39. <https://doi.org/10.33894/mtk-2020.13.03>
- Brahama, M., Tripathi, S. S., & Sahay, A. (2020). *Developing curriculum for industry 4.0: digital workplaces*. Higher Education Skills and Work-based Learning.
- Eurostat Database. (2020). *National accounts*. Statistical code: nama_10_a64; nama_10_a64_e.
- Gashenko, I. V., Khakhonova, N. N., Orobinskaya, I. V., & Zima, Y. S. (2020). Competition between human and artificial intellectual capital in production and distribution in industry 4.0. *Journal of intellectual capital*, 21(4), 531-547. <https://doi.org/10.1108/JIC-11-2019-0275>

- Grencikova, A., Kordos, M., & Berkovic, V. (2020). Impact of Industry 4.0 on Labor Productivity in the Slovak Republic. *Problems and Perspectives in Management*, 18(2), 396–408.
[https://doi.org/10.21511/ppm.18\(2\).2020.32](https://doi.org/10.21511/ppm.18(2).2020.32)
- Grenčíková, A., Kordoš, M., & Navickas, V. (2021). The Impact of Industry 4.0 on Education Contents. *Business: Theory and Practice*, 22(1), 29–38. <https://doi.org/10.3846/btp.2021.13166>
- Hashino, T., & Otsuka, K. (2020). The Rise and Fall of Industrialization: The Case of a Silk Weaving District in Modern Japan. *Australian Economic History Review*, 60(1), 46–72. <https://doi.org/10.1111/aehr.12182>
- Kurt, R. (2019). Industry 4.0 in Terms of Industrial Relations and Its Impacts on Labour Life. *Procedia Computer Science*, 158, 590–601. <https://doi.org/10.1016/j.procs.2019.09.093>
- Mason, G., & van Ark, B. (1994). Vocational Training and Productivity Performance: An Anglo-Dutch Comparison. *International Journal of Manpower*, 15(5), 55–69. <https://doi.org/10.1108/01437729410061456>
- Pecina, P., & Sládek, P. (2017). Fourth Industrial Revolution and Technical Education. In L. Gómez Chova, A. López Martínez, I. Candel Torres (Eds.), *International Technology, Education and Development Conference* (pp. 2089–2093). IATED Academy. <https://doi.org/10.21125/inted.2017.0621>
- Rutkowska, M., & Sulich, A. (2020). Green Jobs on the background of Industry 4.0. *Procedia Computer Science*, 176, 1231–1240. <https://doi.org/10.1016/j.procs.2020.09.132>
- Settsu, T., & Takashima, M. (2020). Labour Productivity Growth in the Long Run: Japan, 1600–1909. *Australian Economic History Review*, 60(1), 5–26. <https://doi.org/10.1111/aehr.12188>
- Szirmai, A. (2015). *Socio-economic development* (2nd ed.). Cambridge: Cambridge University Press.
<https://doi.org/10.1017/CBO9781107054158>
- Trenovski, B., Trpkova-Nestorovska, M., Merdzan, G., & Kozheski, K. (2020). Labour productivity in terms of the fourth industrial revolution. *Southeast European Review of Business and Economics*, 1(2), 38–51.
- Vonyó, T., & Klein, A. (2019). Why did socialist economies fail? The role of factor inputs reconsidered: why did socialist economies fail? *The Economic History Review*, 72(1), 317–345. <https://doi.org/10.1111/ehr.12734>
- Xu, L. D., Xu, E. L., & Li, L. (2018). Industry 4.0: state of the art and future trends. *International Journal of Production Research*, 56(8), 2941–2962. <https://doi.org/10.1080/00207543.2018.1444806>
- Záthurecký, V., & Marinič, P. (2019). Industry 4.0 – analysis of the economic development in the chosen European countries. In *6th SWS International Scientific Conference on Social Sciences ISCSSL 2019* (pp. 599–606). <https://doi.org/10.5593/SWS.ISCSSL.2019.2/S05.073>

University Spin-Off: Effective Solution on Technology Transfer in AEC Industry for Intelligent City Transformation

Raihan MASKURIY^{1,2}, Ali SELAMAT¹, Kherun Nita ALI³, Akbariah MAHDZIR¹,
Petra MAREŠOVÁ⁴ and Ondřej KREJCAR^{4*}

¹ Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia; raihan.maskuriy@gmail.com, aselamat@utm.my, akbariah.kl@utm.my

² Universiti Putra Malaysia, Kuala Lumpur, Malaysia; raihanmaskuriy@upm.edu.my

³ Universiti Teknologi Malaysia, Johor Bharu, Malaysia; b-kherun@utm.my

⁴ Hradec Kralove University, Hradec Kralove, Czech Republic; petra.maresova@uhk.cz; Ondrej.krejcar@uhk.cz

* Corresponding author: Ondrej.krejcar@uhk.cz

Abstract: The growing use of Building Information Modelling (BIM) has had a positive impact on the Architecture, Engineering, and Construction (AEC) projects' implementation since the past few decades. On top of it, the arrival of Industry 4.0 has made a significant breakthrough by promoting digitalisation in the industry through BIM. However, this industrial transformation requires a lot of attention on the technology innovation process – from technology development to technology adoption, where most innovations came from research in universities involving many disciplines. Collaboration between spin-off company with industry players acts as a natural Technology Transfer (TT) process able to exploit the research project before it goes into actualisation. This paper discusses a new way of collaboration between university and industrial players in order to achieve high level of innovation to give positive impact to the economy and social. This paper focusing on initial university-industry set up on the development of intelligent cities in Malaysia by 2040 using TT spin-off process and stage-gate innovation process.

Keywords: technology transfer; spin-off company; building information modelling; intelligent city; industry 4.0

JEL Classification: O30

1. Introduction

The Architecture, Engineering, and Construction (AEC) industry has experiencing an extraordinary rate of digital transformation due to the arrival of Building Information Modelling (BIM). For the past two decades, BIM provides faster development, reduced building costs, customer lifecycle management and eco-friendly business decisions throughout the construction life cycle (RIBA, 2013). The arrival of Industry 4.0 has introduced the AEC industry with digitalisation where BIM become the center of the development of powerful and innovative applications by extending the capability of BIM with the amalgamation of the disruptive technologies provided by industry 4.0 (Autodesk n.d.; Bilal et al., 2015). From smart design for virtual experience (Heidari et al., 2014), to smart

construction to improve industrial process, quality and service (Štefanič & Stankovski, 2019), to smart building to allow digital twin to facilitate the development of various smart applications (Chevallier et al., 2020), and to the development of smart city for sustainable and efficient living lifestyle, AEC industry has been taking advance innovation and social transformational steps to be an intelligence-enabled living lifestyle as an initiative to achieve sustainability and efficiency (Krejcar et al., 2019). However, to integrate such technologies and actualise it, many stakeholders and disciplines that cover multi-dimensions to complete the smart-things ecosystem need to be considered (Fernandez-Anez et al., 2018).

Research on disruptive technologies in AEC industry have been blooming though the stage of implementation is still infancy (Raihan Maskuriy et al., 2019) and literature continues to deliver high value outcome from the technologies to be utilised (Guerrero et al., 2019). University institutions have successfully driving TT to the industry players for commercialisation towards actualising the innovation of technology integration (Guerrero et al., 2019). Evidence says TT have a significant impact to the AEC market as it able to take large technological leap by investing on the technology from the institutes to gain new market and disrupt the current market and remain competitive (Uusitalo & Lavikka 2020). To reach to this intensive TT and commercialisation, active role of scholars and scholarly and research institutions within academic entrepreneurship is necessary (Łacka, 2012). This spurred patenting and licensing activities from universities to allow intellectual property commercialisation where a university spin-off company acting as intermediaries between the university and other institutional spheres to bring forward their research to the industry (Clauss et al., 2018).

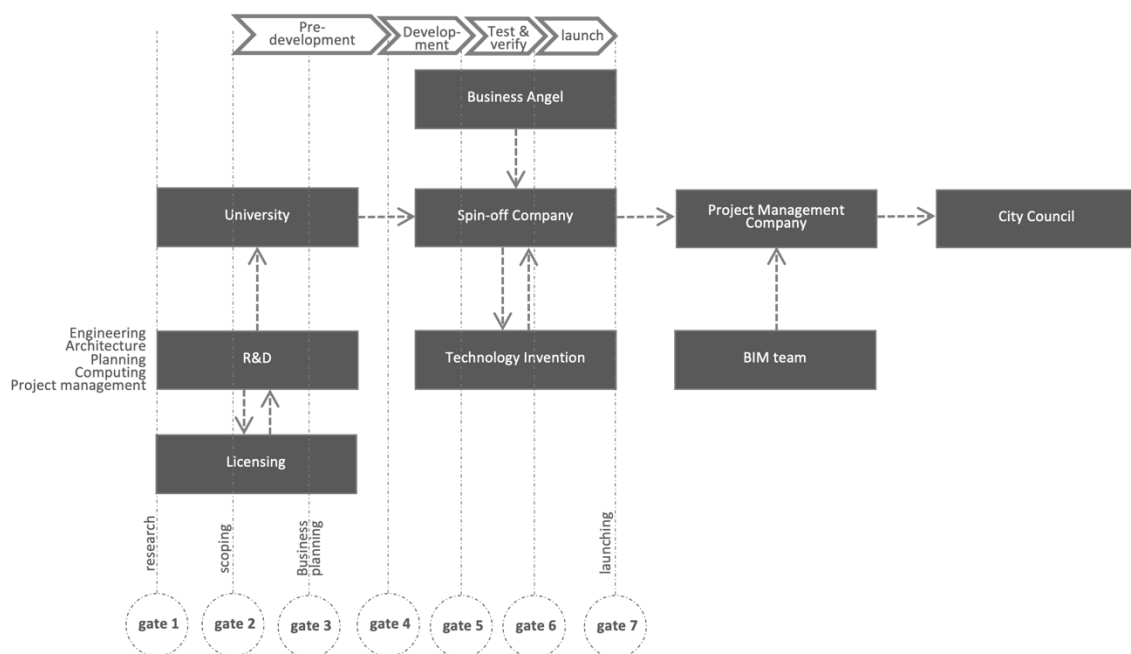


Figure 1. TT process of university spin-off in the development of intelligent city. (Adopted from Cooper, 1990 and Łacka, 2012)

University spin-offs company refers to new firms created to exploit commercially viable knowledge, technology, or research outputs that were developed within a university which has the capacity to TT as the parent university act as the stakeholder (Jung & Kim 2018). Research output that is marketable after receiving the licensing will be further developed by the spin-off company and will be going on test and verification stage to justify the workability of the technology. Adopted from TT spin-off process (Łacka, 2012) and stage-gate innovation process (Cooper, 1990), figure 1 shows the TT process of university spin-off where marketable research output will be further developed to contribute to the development of intelligent city.

In AEC industry during Industry 4.0 era, studies on the collaboration of BIM with technologies from Industry 4.0 to transform how the industry has been operating for decades, improving the quality and performance of the AEC industry. When study on BIM-based in industry 4.0 era is blooming in academic profession, collaboration between university-industry on education has been flourishing in the literature. However, little evidence in the literature shows on BIM-based collaboration between university-industry for more industrial and commercialisation use. This paper would like to present a possible collaboration solution of TT using spin-off company as the intermediary entity to actualise a prospective marketable technology using the integration of BIM and sensor that could significantly contribute to the development of intelligent cities in Malaysia by 2040.

2. Development of TT Spin-off

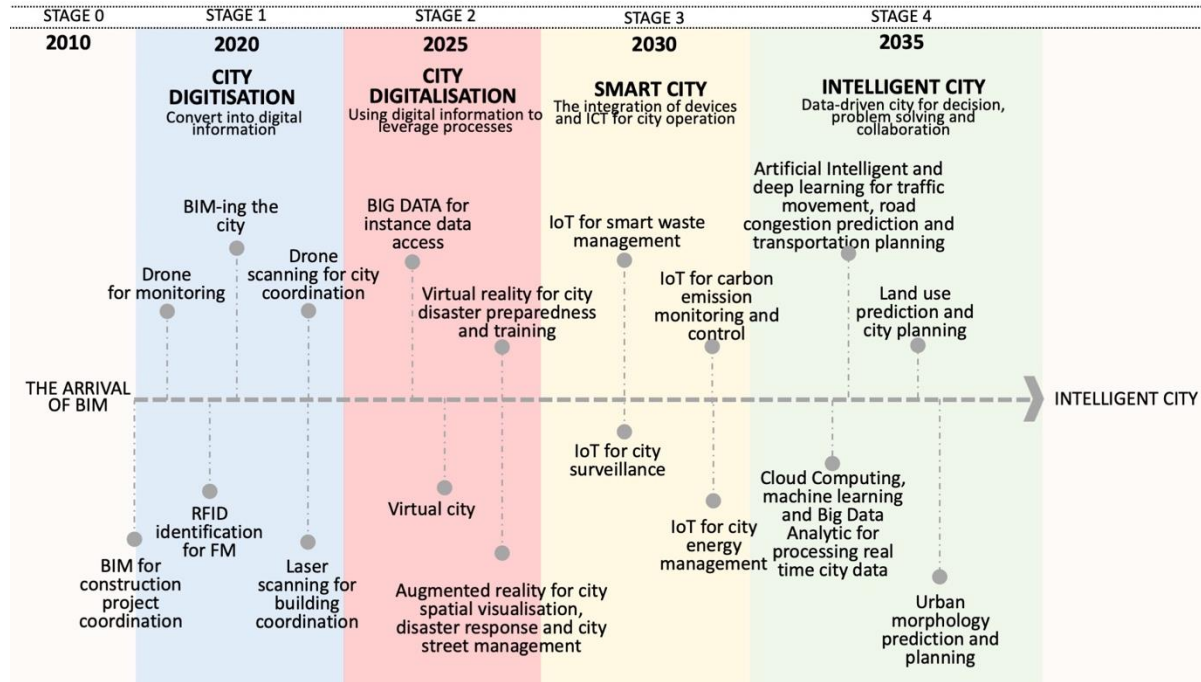


Figure 2. Initial intelligent city transformation roadmap

This paper is conceptualising the utilisation of TT spin-off process for the development of intelligent city in Malaysia. To actualising a BIM-based intelligent city is Malaysia, a collaboration between city council, industry players and universities is needed by proposing

an intelligent city transformation roadmap before identifying potential technologies from research output to come up with commercialisation innovations that could benefit the development of intelligent city. The initial proposed intelligent city transformation roadmap is as illustrated in Figure 2.

The project started with the idea of digitising the city by the city council using BIM modelling with LoD 400 for full capacity operation. It is estimated that to digitise a 30km² city in two years with approximate 13,500 buildings require approximately 300 BIM staffs that run in two shifts a day all year around. If the project started in 2021, a complete digital city will be ready in 2023. After the city digitisation is completed, by taking the advantages of the BIM city model and leveraging the city process and upgrading the city lifestyle, the spin-offs are required to actualise technologies from research output to digitalise the digital city that can feed the needs of city based on the city council needs. Among the proposed technologies are Big Data city for instant data access, virtual city, virtual reality for city disaster preparedness and training, augmented reality for city spatial visualisation, disaster responses and city street management. This project is projected to be actualised by 2025. The precedent case is Tokyo disaster simulation response that was proposed to demonstrate the disaster response to visitors for Tokyo Olympics 2020.

By 2030, the selected city is projected to be smarter by integrating the BIM-based city with smart devices and ICT for smart city operation. Among the technologies proposed are IoT for smart waste management, smart city surveillant, carbon emission monitoring and city energy management on top of other smart city technologies that do not required BIM-based city model. By 2035, the city is projected to be more intelligent by integrating the Artificial Intelligent, machine learning and deep learning for data driven insights for city intelligent decision planning. Among the technologies proposed are land use prediction and urban morphology for city planning, traffic movement, road congestion prediction and transportation planning.

3. The Role of Actors in TT Spin-off for Intelligent City Transformation

3.1. Role of Researcher

Researchers' task is to develop new technologies that are needed for future needs of the intelligent city transformation. The current targeted research is BIM-based smart energy monitoring and smart construction waste management. For BIM energy management, researchers created BIM model for smart indoor temperature monitoring using a BIM authoring application, and sensors devices are installed to collect environment data. Autodesk Revit is used to create the BIM model of an existing building in the experiment. A mini Weather Station in the room using Arduino microcontrollers and Raspberry Pi was built. The sensor readings are then automatically stored in the BIM model. In order to store sensor readings in the model, a software application is developed using Dynamo, which is a visual programming environment for Revit. The sensor reading will be appeared in the BIM model to monitor the environment in the room for smart building program (Figure 5). The system will be further undergoing experiments in few buildings for city energy monitoring.

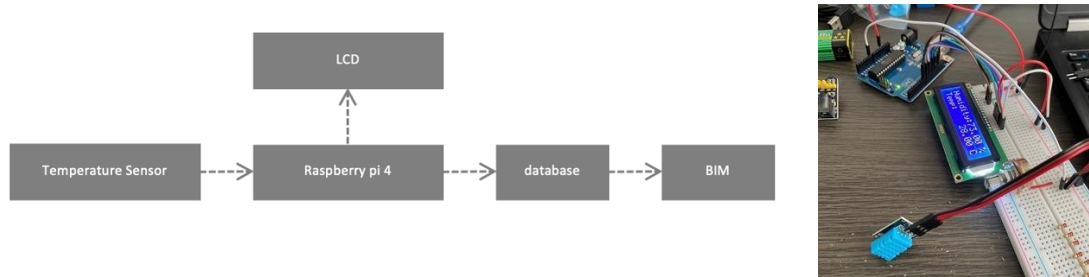


Figure 5: BIM-based smart energy monitoring

For smart construction waste management, during the waste production (construction stage), IoT application able to optimise the use of BIM. It increases the productivity by improving the waste management operations. It extends the BIM capabilities by monitoring the material handling on site, segregates the waste on site, monitors the operation of the project, and supervises the workers using the BIM model. This process could be done when the IoT Waste Analysis is coordinated with the BIM Waste Analysis. The innovation of IoT application also able to be extended to track down the routes, location of the truck, and the amount of waste carried by the trucks. This enhances the operation and data management for third party use such as local authorities, government agencies and waste collectors. From the IoT Waste Analysis, the recorded data able to be channelled out to the construction waste solution to project for new material value chain.

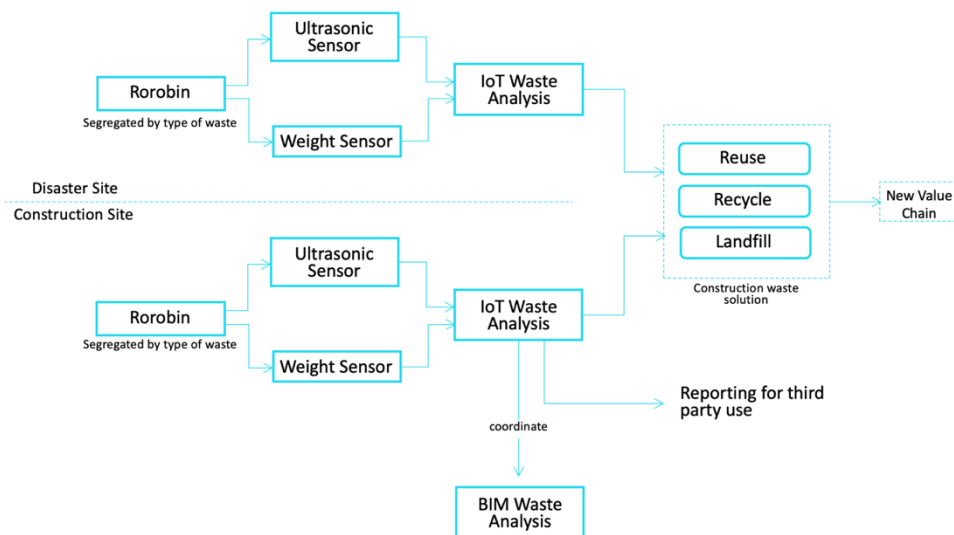


Figure 6: Waste Analysis Strategy at Waste Production Stage. (Maskuriy et al., 2020)

3.2. Role of University Spin-off

The university spin-off company task are 1) to do the screening of the proposed technology for BIM-based smart energy management and smart construction waste management that derived from the research according to the client's needs and academic study; 2) to do prototyping and refinement of the technology for commercial purposes, 3) to make the business plan real, 4) to propose extensive angel funding mechanisms, and 5) to

network by doing industry linkages session with industry players to actualising the technology.

3.3. Role of Project Management Company

The project management company task are 1) to do pitching business presentation to the city council regarding the proposed technologies for the intelligent city, 2) develop clear, straightforward plans to reach full potential of the project, 3) program the action planning schedule, 4) estimate a projection cost, and 5) monitor and managing the project including the risk.

3.4. Role of BIM Team

BIM team are divided into three departments – BIM management team, BIM coordination team and BIM modelling team. As of now, these departments are required to do 1) architectural, structural, mechanical and electrical BIM model, 2) review the quality and issues of the models, 3) report and document to project management company. These tasks are only covering the digitisation stage. The task will be revised after spin-off company come out with new BIM-based innovation technology and BIM team will requires extensive training to integrate BIM technology with technology from industry 4.0.

4. Discussion

Malaysia has spent huge amount to R&D, however the innovation produced are much fewer than other country that spent lesser as lacking of exposure to the advantages of IP rights and the commercial value of patenting local research output are dominating the research industry (Kaur 2019). Spin-off is an excellent solution to TT to the industry for innovation and commercialisation especially in AEC industry for intelligent city transformation. TT is known as an approach that favoured by developed country like Germany and Korea to successfully innovate and commercialise their product and changeover to Industry 4.0 (Gausemeier et al. 2016; Jung & Kim 2018). While spin-off acts as centre mechanism that add values to the research output by ensuring the viability of the product or service through the innovation of technologies after go through series of screening, scoping, development, testing and verifying.

In Malaysia, the development of smart city has been initiated in the Twelve Malaysia Plan as an initiative to transform the city in Malaysia into a vibrant and prosperous metropolitan area. To move forward toward more intelligent, government agencies, universities and industry players must joint force to actualise the ideas that have been initiated in the research from universities, research institutes and centre of excellent in Malaysia. The milestone program has been outlined according to the fit of the technology adoption strategy based on TT approach through the university spin-off company. This approach able leverage the knowledge that previously stays in as a research output and provide added value for the industry with a commercially valuable innovation in research output.

For Malaysia able to adopt TT spin-off approach, universities must break the shell and work together with the industries and government agencies. University spin-offs needs to do more screening for more potential technologies that can be actualised to pace up with the development of intelligent city. More IPs should be developed and commercialised locally for the investment to R&D would not be in vain. Malaysia should follow other developed country where their IPs have spurred their country's economic growth.

Acknowledgments: This study would like to thank you to ViewDepth Resources for generous information and contribution to the research project.

References

- Autodesk. "BIM 360 API." : 1–4. <https://forge.autodesk.com/en/docs/bim360/v1/overview/introduction/> (May 1, 2019).
- Bilal, M., et al. (2015). Analysis of Critical Features and Evaluation of BIM Software: Towards a Plug-in for Construction Waste Minimization Using Big Data. *International Journal of Sustainable Building Technology and Urban Development* 6(4), 211–228. <https://doi.org/10.1080/2093761X.2015.1116415>
- Chevallier, Z., Finance, B., & Boulakia, B. C. (2020). A Reference Architecture for Smart Building Digital Twin. In *CEUR Workshop Proceedings* (vol. 2615, pp. 1–12).
- Clauss, T., Moussa A., & Kesting, T. (2018). Entrepreneurial University: A Stakeholder-Based Conceptualisation of the Current State and an Agenda for Future Research. *International Journal of Technology Management* 77(1–3), 109–44. <https://doi.org/10.1504/IJTM.2018.091726>
- Cooper, R. G. (1990). Stage-Gate Systems: A New Tool for Managing New Products. *Business Horizons*.
- Fernandez-Anez, V., Fernández-Güell, J. M., & Giffinger, R. (2018). Smart City Implementation and Discourses: An Integrated Conceptual Model. The Case of Vienna. *Cities*, 78(August), 4–16. <https://doi.org/10.1016/j.cities.2017.12.004>
- Gausemeier, J., et al. (2016). On the Road To Industry 4.0: Technology Transfer in the SME Sector. *It's OWL Clustermanagement GmbH* (pp. 1–32). https://www.its-owl.com/fileadmin/PDF/Informationsmaterialien/2017-Technology_Transfer_web.pdf.
- Guerrero, M., Urbano, D., & Herrera, F. (2019). Innovation Practices in Emerging Economies: Do University Partnerships Matter? *Journal of Technology Transfer*, 44, 615–646. <https://doi.org/10.1007/s10961-017-9578-8>
- Heidari, M., et al. (2014). Smart-BIM Virtual Prototype Implementation. *Automation in Construction*, 39, 134–144. <https://doi.org/10.1016/j.autcon.2013.07.004>
- Jung, H., & Kim, B. K. (2018). Determinant Factors of University Spin-off: The Case of Korea. *Journal of Technology Transfer*, 43(6), 1631–1646. <https://doi.org/10.1007/s10961-017-9571-2>
- Kaur, M. (2019, May 16). *Malaysia's R&D Spending More than Finland's, but Is It Worth It, Asks Think Tank*. Retrieved from <https://www.freemalaysiatoday.com/category/nation/2019/05/16/malysias-rd-spending-more-than-finlands-but-is-it-worth-it-asks-think-tank/>
- Krejcar, O., Maresova, P., Selamat, A., Melero, F. J., Barakovic, S., Husic, J. B., Herrera-Viedma, E., Frischer, R., & Kuca, K. (2019). Smart Furniture as a Component of a Smart City — Definition Based on Key Technologies Specification. *IEEE Access*, 7, 94822–94839. <https://doi.org/10.1109/ACCESS.2019.2927778>
- Łacka, I. (2012). The Role of Academic Entrepreneurship and Spin-Off Companies in the Process of Technology Transfer and Commercialisation. *Journal of Entrepreneurship, Management and Innovation*, 8(1), 68–83.
- Maskuriy, R., et al. (2020). Manmade Disaster Prevention Using Waste Management Hierarchy and Disaster Management Cycle. In *IOP Conference Series Earth and Environmental Science*.
- Maskuriy, R., Selamat, A., Ali, K. N., Maresova, P., & Krejcar, O. (2019). Industry 4.0 for the Construction Industry — How Ready Is the Industry? *Applied Sciences*, 9(14), 2819. <https://doi.org/10.3390/app9142819>
- RIBA. (2013). *RIBA Plan of Work 2013: Overview*.
- Štefanič, M., & Stankovski, V. (2019). A Review of Technologies and Applications for Smart Construction. *Proceedings of the Institution of Civil Engineers - Civil Engineering*, 172(2), 83–87. <https://doi.org/10.1680/jcien.17.00050>
- Uusitalo, P., & Lavikka, R. (2020). Technology Transfer in the Construction Industry. *Journal of Technology Transfer* (0123456789). <https://doi.org/10.1007/s10961-020-09820-7>.

Different Types of Fee Calculations on the RCBS Market in the Czech Republic

Martin MATĚJČEK^{1*} and Anna S. KOWALSKA²

¹ University of Hradec Králové, Hradec Králové, Czech Republic; martin.matejcek@uhk.cz

² Wrocław University of Economics and Business, Wrocław, Poland; anna.kowalska@ue.wroc.pl

* Corresponding author: martin.matejcek@uhk.cz

Abstract: Nowadays, almost everyone uses banking services. However, there is room in the market for bad decision-making by clients in the RCBS market, which is caused by information asymmetries. The main goal of this paper is to simulate consumer behavior and compare the offer in the banking services market in the Czech Republic. A total of 9 different payment accounts were selected for the research, which are intended for non-business natural persons. Furthermore, two customer groups were defined, for which the fees for the mentioned payment accounts were subsequently calculated on the basis the intensities of the use of certain services. In general, it was found that the stochastic calculation is more different than the deterministic one, especially for accounts and services that contain a certain condition, and the intensity of use is close to the transitional limit of this condition. On the contrary, in the case of bank calculators, the differences compared to the calculation from the tariffs were too large, and there was also a considerable mixing of the order according to the price.

Keywords: RCBS; consumer behaviour; banking services; stochastic simulation; online comparison tool

JEL Classification: C15; G21

1. Introduction

Nowadays, almost everyone uses banking services. However, there is room in the market for bad decision-making by clients in the RCBS market, which is caused by information asymmetries. Banks have complex rates and it is not worthwhile for the client to study these rates in detail and compare the differences due to time constraints. However, consumers can use online applications to calculate the prices of specific banking products. This paper will examine how the results of calculators differ from reality and it also pays attention to the stochastic simulation of the client and the difference in the result compared to deterministic reasoning. The topic of probabilistic model in the RCBS market has already been addressed by, for example, the authors Hedvicakova et al. (2012).

Information asymmetries occur when one party in the market has better information than the other (Sojka, 2002). Currently, this problem is one of the causes of market failure. The American economist George Akerlof pointed out this problem as early as 1970, in his publication called *„The Market for 'Lemons': Quality Uncertainty and the Market Mechanism“* (Akerlof, 1970).

As already mentioned, information asymmetries also appear in the RCBS market. The problem is mainly on the demand side, where the consumer does not have simple and clear prices that are linked to basic banking services. Banks usually make their rates very non-transparent and complicated. Soukal and Draessler (2014) discuss the asymmetry of information in the RCBS market in more detail. The client's effort to obtain the required information can therefore be relatively mentally and time consuming.

The main goal of this paper is to simulate consumer behavior and compare the offer in the banking services market. For example, Hedvicakova (2017) made a similar comparison on the market in the Czech Republic, but her study was focused only on student's accounts. Our goal is further elaborated mainly on the approximation of selected payment accounts on the market, on the calculation of bank fees in different ways for certain client profiles and on the interpretation of differences in the results of given calculation methods.

Using multi-criteria optimization and fuzzy analysis this article aims to select the most suitable bank account for young people. Two scientific questions are asked: Is the same type of student account suitable for an active as well as an inactive client? Are there any free of charge student accounts? The first part focuses on the introduction to the topic, a summary of the advantages and disadvantages of student accounts and modelling of two target groups. The second part describes the methodology of decision-making by using a fuzzy set theory. Selection of the optimum student account will be made by the transformation matrix. Subsequently, the retransformation matrix is set. The most suitable student accounts are again selected for each profile and the results are compared with the analysis in the first part. To complete the solution, the last part of the article focuses on decision-making with the uncertainty of input information. Due to ignorance of their own monthly needs and the number of payments, fuzzy sets are used. In addition to the active and passive client, a third profile will be newly created and can be identified with some of the profiles to a certain extent.

2. Methodology

The total number of 9 banking institutions were selected to calculate the fees. One specific payment account was selected from each bank, which is intended for non-business natural persons, and the basic fees associated with the use of the account were determined according to the price lists. Specifically, the payment accounts "*Air Bank Malý tarif*", "*ČS Moje zdravé finance*", "*ČSOB Plus Konto*", "*Fio osobní účet*", "*KB Můjúčet*", "*mBanka mKonto*", "*MONETA Tom účet*", "*RFB eKonto Smart*" and "*UCB U konto*" were selected.

To calculate the fees, it is first necessary to define the intensity of use of individual banking services. Data from the research of Draessler et al. (2011) are used for this purpose. These are the intensities of the use of retail banking, the services of which are used by non-business natural persons. Data collection took place through the portal www.bankovnipoplatky.com. It was therefore assumed that the respondents were information literate and had access to the Internet. The aim of the research was to classify the

clients of Czech banks and to define the basic groups in relation to transactions on client accounts.

The first profile was marked as the average internet banking client, resp. Mainstream making up more than 62% of the total. His preference for this information channel is very strong. This client does not withdraw foreign banks from the ATM (automated teller machine) and it can therefore be argued that within these clients there was a fee diversification, resp. gradual increase in prices of withdrawals from ATMs of foreign banks, successful. The share of transfer services between sending funds to the accounts of own and foreign banks is approximately 1:2. (Draessler et al., 2011)

The second profile was marked as the average client with branch preference. Although it is a relatively small cluster (4%), it cannot be described as a low-element cluster composed only of remote observations without interpretive value. Its activity is practically identical to the average client, but the main difference is the choice of communication channel, where the occasional visit to a bank branch on average once every three months is preferred. Thus, there is a group of clients with active internet banking, who still sometimes prefer to visit a branch for normal operations. (Draessler et al., 2011)

Table 1. Used client profiles. (Draessler et al., 2011)

Service	I1	I2
Minimum credit turnover	CZK 21,120	CZK 17,409
Average balance	CZK 22,103	CZK 23,428
Withdrawal from ATM from own bank in the Czech Republic	2.9	3.1
Withdrawal from ATM from foreign bank in the Czech Republic	0	0.5
Withdrawal from ATM from f. b. - amount	0	CZK 815
Withdrawal from ATM abroad (EU)	0	2
Incoming payment from foreign bank	2.2	2.0
Incoming payment from own bank	0.9	1.0
Single PO to own bank at the branch	0	0.3
Single PO to own bank from the Internet	1.8	1.8
Single PO to foreign bank at the branch	0	0.3
Single PO to a foreign bank from the Internet	3.8	3.2
Standing PO to own bank at the branch	0	0.2
Standing PO to own bank from the Internet	0.9	0.7
Standing PO to foreign bank at the branch	0	0.2
Standing PO to foreign bank from the Internet	2.4	1.7
DD payment to own bank at the branch	0	0.2
DD payment to own bank from the Internet	0.3	0.2
DD payment a foreign bank at the branch	0	0.3
DD payment to a foreign bank from the Internet	0.9	0.5
Cash deposit at the branch	0.2	0.5
Cash withdrawal at the branch	0.1	0.3
Incoming SEPA payment up to 50 thousand EUR	0	1.0
Outgoing SEPA payment up to 50 thousand EUR	0	1.0

I1 = use intensity for the 1st selected client profile; I2 = use intensity for the 2nd selected client profile;
PO = payment order; DD = direct debit.

For the needs of simulation in this research, a selection from ATM abroad (EU, twice a month), incoming SEPA payment up to EUR 50 thousand (once a month) and outgoing SEPA

payment up to EUR 50 thousand (once a month) were added to the 2nd variant profile. The data are clearly summarized in the following table of client profiles.

Some bank account rates contain additional conditions for calculating the price or discount for certain services. For this reason, the following data are also set for the needs of the research, which apply to both client profiles:

- average card payment 5 times a month,
- average amount of card payments = CZK 4,000 per month,
- average amount of withdrawal from own ATM in the Czech Republic = CZK 1,500,
- average amount of withdrawal from ATM abroad = CZK 815,
- amount of outgoing payments and deposits min. CZK 10,000
- min. outgoing payment 3 times a month,
- client's age 26-58 years.

The fees were calculated on the basis of bank tariffs for defined customer groups. Calculations are performed deterministically and stochastically with the help of a Microsoft Excel spreadsheet. The deterministic calculation consists in simply multiplying the fee by the respective intensity of use of the given service and the given client profile. The Monte Carlo simulation method was used for the stochastic calculation, and an add-on in Excel called "*Data Analysis*" was chosen as a generator of pseudo-random numbers.

Skalská (2006) states that the Monte Carlo method belongs to the sector of experimental mathematics, which deals with experiments with random numbers. It can be used to solve statistical, mathematical or even non-mathematical simulation problems with the help of random selections. The method consists in repeating a certain random experiment (simulation) several times. However, the condition for success is the possibility of independent multiple retries. This approach in the field of banking was used, for example, by Král (2017a, 2017b), when calculating the costs of cash processing.

The Monte Carlo test in this study contains a total of 10 simulation series, each of which simulates the client's behavior of each service for 60 months. Pseudorandom numbers for simulation of service use intensities are generated with a Poisson's type of probability distribution, and the intensity of use of a given service of a certain client profile is chosen as a key parameter λ (lambda). New series have been generated for each service and each client profile. The final amount of the fee of each service is then calculated by averaging all ten simulation series (600 pseudo-random numbers - 600 monthly fee amounts).

For some services of selected accounts, the account balance, the amount of withdrawals from ATMs or the total monthly amount for card payments are also simulated. For these calculations, the Student's probability distribution is chosen, and the numbers are generated using a formula in Excel.

The last type of fee calculation for specified customer profiles are online calculators. The calculators Bankovnipoplatky.com and Finparáda were chosen for the calculation.

3. Results

For the first client profile, the average difference (in absolute value) in the method of calculation is CZK 6.52, see the following table 2. The biggest difference is with the mBank mKonto account, and with the Air Bank Malý tarif. In the first case, there was the biggest difference in the ATM withdrawal service from your own bank in the Czech Republic, where a fee of CZK 29 is charged for withdrawing cash up to CZK 1,500. Withdrawals above CZK 1,500 are free. In the Monte Carlo test, the intensity of the withdrawal and the selected amount were simulated, where the pseudo-random number generator generated amounts with the parameter $k = \text{CZK } 1,500$, which is the very limit of the condition that decides whether the withdrawal will be charged or not. There was a difference of CZK 6.71 for the Air Bank Malý tarif account thanks to the interest bonus simulation. If the client uses a card payment 5 times a month in a store or on the Internet, as a bonus, the account will earn interest at a rate of 1% per annum. In the deterministic calculation, this bonus was awarded every month, as the average intensity of payment card use was entered 5 times a month for both client profiles. The stochastic calculation simulated the intensity of payment card use (Poisson distribution, $\lambda = 5$), as well as the balance from which interest is calculated (student distribution, $k = 59$ degrees of freedom, * CZK 22,103).

Table 2. Comparison of deterministic and stochastic calculation for the 1st profile.

Profile 1	DET	STO	Difference
Air Bank M.t.	-18.42 CZK (1.)	-7.15 CZK (1.)	11.27 CZK
Fio osobní účet	0 CZK (2.)	0 CZK (2.)	0 CZK
RFB eKonto S.	0 CZK (3.)	2.04 CZK (3.)	2.04 CZK
ČSOB Plus Konto	8 CZK (4.)	7.73 CZK (4.)	0.27 CZK
UCB U konto	10 CZK (5.)	9.67 CZK (5.)	0.33 CZK
MONETA Tom ú.	24 CZK (6.)	24.93 CZK (6.)	0.93 CZK
KB MůjÚčet	68.1 CZK (7.)	69.25 CZK (8.)	1.15 CZK
ČS MZF	71.4 CZK (8.)	72.79 CZK (9.)	1.39 CZK
mBank mKonto	87 CZK (9.)	59.01 CZK (7.)	27.99 CZK
AVERAGE	27.79 CZK	24.62 CZK	6.71 CZK

DET = deterministic calculation; STO = stochastic calculation.

Air Bank Malý tarif proved to be the cheapest account here. The price is negative - the client is rewarded with this amount. In the overall ranking, there was only one difference in the simulation compared to the deterministic calculation - mBank mKonto changed its position from 9th place to 7th place.

In the case of the second profile (Table 3), there was an average difference (in absolute value) in the method of calculation of CZK 8.97. The biggest difference is with the account from mBank. The reason for the main factor of the difference has already been mentioned for the first profile. There was also an above-average difference in the account from Česká spořitelna (CZK 11.68). The difference here is mainly the selection of ATMs abroad and SEPA payments. An optional service was included for withdrawals abroad (for CZK 25 per month, the client has foreign withdrawals from the Erste Group ATM free of charge and CZK 40 is charged at other banks for withdrawals). For the deterministic calculation, 1 withdrawal per

month was calculated for Erste and 1 withdrawal per month for other banks. However, the stochastic calculation simulated these values by generating pseudorandom numbers. The second main source of difference was SEPA payments. An optional service for CZK 25 per month was applied here. This package then includes 2 free incoming payments and 2 outgoing payments for CZK 40. The difference in price therefore arose in the case of generating higher numbers than the package benefits.

Table 3. Comparison of deterministic and stochastic calculation for the 2nd profile.

Profile 2	DET	STO	Difference
Fio osobní účet	160.8 CZK (1.)	164.1 CZK (1.)	3.3 CZK
ČS MZF	289.4 CZK (2.)	277.72 CZK (2.)	11.68 CZK
MONETA Tom ú.	429.4 CZK (3.)	429.13 CZK (3.)	0.27 CZK
UCB U konto	544.2 CZK (4.)	545.2 CZK (4.)	1 CZK
RFB eKonto S.	590.8 CZK (5.)	592.7 CZK (5.)	1.9 CZK
KB MůjÚčet	663.4 CZK (6.)	661.76 CZK (6.)	1.64 CZK
ČSOB Plus Konto	674 CZK (7.)	683.87 CZK (7.)	9.87 CZK
Air Bank M.t.	N – 132.02 CZK	N – 121.27 CZK	10.75 CZK
mBank mKonto	N – 171.1 CZK	N – 130.74 CZK	40.36 CZK
AVERAGE	478.86 CZK	479.21 CZK	8.97 CZK

DET = deterministic calculation; STO = stochastic calculation.

Note: Accounts highlighted in red do not support the branch operations that are included in the second profile. They are not listed in the overall ranking, but they are included in the calculation of the averages.

Fio personal account turned out to be the cheapest account here. Accounts from Air Bank and mBank were excluded from the overall ranking due to the absence of operations at the branch, which are otherwise an integral part of the second client profile. There was no order change for the remaining accounts due to the method of calculation.

The third type of calculation was calculation using online calculators. The calculators Bankovnípoplatky.com and Finparáda were selected. Both calculators have a different structure and do not allow entering intensities to decimal places. Therefore, the data had to be slightly adjusted and rounded. The results for the first profile are in the following Table 4.

Table 4. Comparison of deterministic calculation with online calculators for the 1st profile.

Profile 1	DET	BP.COM	Difference	FINPARÁDA	Difference
Air Bank M.t.	-18.42 CZK (1.)	0 CZK (1.-3.)	18.42 CZK	-15.66 CZK (1.)	2.76 CZK
Fio osobní účet	0 CZK (2.)	0 CZK (1.-3.)	0 CZK	0 CZK (3.-7.)	0 CZK
RFB eKonto S.	0 CZK (3.)	29 CZK (4.)	29 CZK	0 CZK (3.-7.)	0 CZK
ČSOB Plus Konto	8 CZK (4.)	80 CZK (5.)	72 CZK	0 CZK (3.-7.)	8 CZK
UCB U konto	10 CZK (5.)	117 CZK (6.)	107 CZK	-0.15 CZK (2.)	10.15 CZK
MONETA Tom ú.	24 CZK (6.)	119 CZK (7.)	95 CZK	0 CZK (3.-7.)	24 CZK
KB MůjÚčet	68.1 CZK (7.)	168 CZK (9.)	99.9 CZK	66 CZK (9.)	2.1 CZK
ČS MZF	71.4 CZK (8.)	130 CZK (8.)	58.6 CZK	50 CZK (8.)	21.4 CZK
mBank mKonto	87 CZK (9.)	0 CZK (1.-3.)	87 CZK	0 CZK (3.-7.)	87 CZK
AVERAGE	20.39 CZK	71.44 CZK	62.99 CZK	11.13 CZK	20.36 CZK

DET = deterministic calculation; BP.COM = Bankovnípoplatky.com.

For red product prices, the calculator stated that the calculated fees for opening and maintaining a given account do not include items that the account does not offer. In the case of the first profile, Air Bank Malý tarif would be the absence of a withdrawal and deposit at a branch that the bank does not allow. In the deterministic calculation of Air Bank, for the needs of this study, this service was replaced by ATM withdrawal and deposit, as the ATM is available at each branch and supports withdrawals and cash deposits. However, the calculator marked other products in this way, probably because it does not include the amount for the basic non-embossed payment card in its internal tariff. Some monitored accounts offer the issuance and maintenance of an embossed payment card free of charge and do not offer non-embossed cards at all - for example, Fio banka. If the consumer enters a non-embossed card into the calculator, the calculator should rather react by including the embossed card if the non-embossed card is not offered. For all monitored accounts, at least one card is available free of charge (issue and maintenance), whether embossed or non-embossed.

In this case, this designation can be ignored and the order within the given calculation is given for all monitored accounts. However, on the calculator portal itself, the accounts marked in red were placed only at the end of order, which certainly has an impact on consumer decisions.

For the first client profile, the average difference (in absolute value) compared to the calculation from the current tariffs is CZK 71.44 for the Bankovnípoplatky.com calculator and CZK 20.36 for the Finparáda calculator. In the case of both calculators, there was also a considerable mixing of the order. According to Finparáda, the cheapest account is Air Bank Malý tarif. According to Bankovnípoplatky.com, there are three accounts on the first place with a final price of CZK 0 - Air Bank Malý tarif, Fio osobní účet and mBank mKonto.

For the second client profile (Table 5), the average difference (in absolute value) compared to the calculation from the current tariffs is CZK 136.01 for the Bankovnípoplatky.com calculator and CZK 144.64 for the Finparáda calculator. Here, also, the order of the two calculators was significantly mixed. The cheapest account for this profile is Fio osobní účet according to both calculators.

Table 5. Comparison of deterministic calculation with online calculators for the 2nd profile.

Profile 2	DET	BP.COM	Difference	FINPARÁDA	Difference
Fio osobní účet	160.8 CZK (1.)	258 CZK (1.)	97.2 CZK	268.15 CZK (1.)	107.35 CZK
ČS MZF	289.4 CZK (2.)	700 CZK (4.)	410.6 CZK	465.3 CZK (2.)	175.9 CZK
MONETA T. ú.	429.4 CZK (3.)	518 CZK (2.)	88.6 CZK	492.65 CZK (3.)	63.25 CZK
UCB U konto	544.2 CZK (4.)	667 CZK (3.)	122.8 CZK	549.83 CZK (4.)	5.63 CZK
RFB eKonto S.	590.8 CZK (5.)	707 CZK (5.)	116.2 CZK	678.15 CZK (6.)	87.35 CZK
KB MůjÚčet	663.4 CZK (6.)	778 CZK (7.)	114.6 CZK	668 CZK (5.)	4.6 CZK
ČSOB Plus K.	674 CZK (7.)	770 CZK (6.)	96 CZK	1420 CZK (7.)	746 CZK
Air Bank M.t.	132.02 CZK	125 CZK	7.02 CZK	108.41 CZK	23.61 CZK
mBank mKonto	171.1 CZK	0 CZK	171.1 CZK	83 CZK	88.1 CZK
AVERAGE	406.12 CZK	502.56 CZK	136.01 CZK	525.94 CZK	144.64 CZK

DET = deterministic calculation; BP.COM = Bankovnípoplatky.com.

In the deterministic calculation from the tariff, the red color indicates the absence of branch operations at Air Bank and mBank. Branch operations are an integral part of the second profile, so these accounts are not ranked, but are not excluded from the calculation of averages. The red coloring of other accounts from the Bankovnípoplatky.com calculator has already been addressed in the previous table. Finparáda did not even point out the absence of branch operations in the given accounts, which is a big mistake.

4. Discussion and Conclusion

The main part of the paper was the interpretation of the results and a comparison of differences in the method of calculating fees associated with accounts. Air Bank Malý tarif was the cheapest account for the first client profile. This was confirmed by a deterministic and stochastic calculation from tariffs, as well as by the fee calculators Bankpoplatky.com and Finparáda. For the second client profile, this was the case with Fio osobní účet account.

Overall, this research found that the stochastic calculation is more different than the deterministic one, especially for accounts and services that contain a certain condition, and the intensity of use is close to the transitional limit of this condition. Fluctuations in the calculation could also occur when using large intensities and when simulating a short simulation series. In general, however, the difference is usually negligible, the stochastic calculation changed the order of services by price for only one payment account for the first client profile. The average absolute value of the difference against the deterministic calculation is only CZK 7.84 in total.

On the contrary, in the case of bank calculators, the differences were too large compared to the calculation from the tariffs (the average of the absolute value of the difference is a total of CZK 91), and there was also a considerable mixing of the order according to price. In most cases, the consumer selects the product according to the final order. In addition, the Bankovnípoplatky.com calculator misjudges the payment card requirement and the Finparáda does not point out the absence of certain required services of the given accounts. So far, the main problem is the quality and settings of online calculators. Soukal (2019) also confirmed this idea.

All this points to significant shortcomings of the calculators, although they should, according to Directive 2014/92 / EU of the European Parliament and of the Council, provide accurate and up-to-date information.

This study focused on the calculation of fees. However, it is important to mention that clients do not always decide only on the basis of price. A number of other factors play a role here, such as image, seriousness, loyalty, public speaking, and so on. Many authors agree with this, for example Amoako et al. (2017), Soukal and Draessler (2015), Shafee et al. (2017) and Shahrinaz et al. (2017).

Acknowledgments: The work was supported by the internal project "SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept", 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic.

References

- Akerlof, G. A. (1970). The Market for "Lemons": Quality Uncertainty and the Market Mechanism*. *The Quarterly Journal of Economics*, 84(3), 488–500. <https://doi.org/10.2307/1879431>
- Amoako, G. K., Anabila, P., Asare Effah, E., & Kumi, D. K. (2017). Mediation role of brand preference on bank advertising and customer loyalty: A developing country perspective. *International Journal of Bank Marketing*, 35(6), 983–996. <https://doi.org/10.1108/IJBM-07-2016-0092>
- Draessler, J., Soukal, I., & Hedvicakova, M. (2011). Shluková analýza poptávkové strany trhu základních bankovních služeb. *E&M: Ekonomie a Management*, 14(4), 102–114.
- Hedvicakova, M. (2017). Key study of bank accounts for young people with using multi-criteria optimization and fuzzy analysis. *Applied Economics*, 49(36), 3599–3610. <https://doi.org/10.1080/00036846.2016.1265073>
- Hedvicakova, M., Soukal, I., & Draessler, J. (2012). Probabilistic model of optimal price search on the retail core banking services market. *International Journal of Mathematical Models and Methods in Applied Sciences*, 6(2), 386–393.
- Kral, M. (2017a). Modelling of Savings in Decentralized Cash Processing Costs in the Czech Republic. In P. Jedlicka, P. Maresova, & I. Soukal (Eds.), *15th International Scientific Conference on Hradec Economic Days 2017* (pp. 478–485). Hradec Králové: University of Hradec Králové.
- Kral, M., & Hajek, L. (2017b). Modelling and Optimization Cash Processing Costs in the Czech Republic. In P. Novak, Z. Jurigova, L. Kozubikova, & J. Zlamalova (Eds.), *8th International Scientific Conference on Finance and Performance of Firms in Science, Education and Practice* (pp. 420–433). Zlin: Tomas Bata University Zlin.
- Shafee, N. B., Suhaimi, S., Hashim, H., & Mohamed, Z. S. (2017). Customer Preferences in Selecting Commercial Bank in Malaysia. *Advanced Science Letters*, 23(11), 10925–10928. <https://doi.org/10.1166/asl.2017.10188>
- Shahrinaz, I., Kasuma, J., Naim, A. S. A., Rahim, E. A., Arabi, A., Ismawi, N., & Rosli, R. (2017). Determinant of customers' preference in selecting Islamic banks. *International Journal of Advanced and Applied Sciences*, 4(3), 117–121. <https://doi.org/10.21833/ijaas.2017.03.018>
- Skalská, H. (2006). *Stochastické modelování* (2nd ed.). Gaudeamus.
- Sojka, M. (2002). Asymetrické informace a jejich důsledky pro metodologii ekonomie. *Ekonomika, Právo a Politika*, 4(8), 39–50.
- Soukal, I. (2019). Information quality of web services: Payment account online comparison tools survey in the Czech republic and Slovakia. *Information Systems*, 341, 244–257. https://doi.org/10.1007/978-3-030-11395-7_21
- Soukal, I., & Draessler, J. (2014). *Základní bankovní služby a asymetrie informací z hlediska spotřebitele*. Grada.
- Soukal, I., & Draessler, J. (2015). Price Information Asymmetry Impact on Optimal Choice - RCBS Market Case Study. In A. Kocourek (Ed.), *Proceedings of the 12th International Conference: Liberec Economic Forum 2015* (pp. 144–153). Technical university of Liberec.

Multicriterial Analyses of Theoretical Models of Innovation Use in Business Practice with a Focus on Open Innovation and Transfer Technology

Pavla MATULOVÁ

University of Hradec Králové, Hradec Králové, Czech Republic; pavla.matulova@uhk.cz

Abstract: Innovations are an integral part of corporate strategies and corporate vision, and strategies for their fulfilment are the cornerstone for assessing the innovation capacity of the economy. Innovation is extremely dependent on the availability of knowledge management, and therefore the complexity created by knowledge management tools plays an important role in the successful implementation of innovations. Open innovation is an important concept for any organization or company, no matter how small or large it is. Open innovation involves a collaborative approach, whereby firms integrate external knowledge and expertise into their innovation processes. The aim of this work is to propose an evaluation model of innovation use in business practice with a focus on open innovation. The model will be based on management as a discipline specifying work with explicit and tacit knowledge, as they are the key to innovation. Methodological approaches to modelling include retrospective analysis, qualitative and quantitative surveys in the private sector, multi-criteria decision-making and interviews with business innovation managers. The target users of this model are primarily firms in the secondary public sector. The proposed model will both allow the evaluation of quality benefits and contribute to the expansion of the possible methods used in knowledge management.

Keywords: multi-criteria decision-making deals; multi-criteria analysis; scoring method open innovation; knowledge management; innovation drivers; evaluation model of innovation

JEL Classification: O30

1. Introduction

Innovation has been defined in various manners throughout literature. Chen et al. (2004) expands on the concept by calling it the entrance of a new set of important elements that inform the production process or influence the production system. Innovation capital is the competence of not only implementing but also organizing research and development aspects of the business, which eventually lead to new products and technology geared at catering to the needs of the customer. It has to do with the fresh product, technology, market, material and more that come into play. Cardinal et al. (2001) explain that the process of innovation covers the physical, technical, and knowledge-oriented activities that are key in creating the development routines for the goods or product in question. Herkema (2003) says that it is the process of developing knowledge that is geared at developing new information and skills,

aiming to creating viable commercial solutions. IT is a process which holds knowledge in extreme importance because it is further assimilated and shared with the goal of developing knowledge that is fresh and embodies services and goods. Herkema (2003) further explain that it is the process through which an idea or behaviour is brought into an organisation, which previously was alien to the organisation in question. This innovation could be an altogether new service or good or technology that the organisation is willing to adapt or adopt. The change that the firm experiences can be incremental and take place through several steps or be entirely abrupt and come off as a radical modification of processes. Innovation is a process through which change takes place to make room for interventions and discoveries that will augment existing processes and outcomes – this can be true for goods, processes, products, and more (Gloer & Terziovski, 2004). Radical and incremental modification have been set apart from one another by the authors. Incremental setups have line extensions that impact products that already exist. They do not need substantial modification of existing practices and can often lead to an augmentation of the processes that are already in place. On the other hand, a radical innovation will mean the firm would have to start from scratch because existing competences would be entirely destroyed. It required new skills and practices to be put into place, making older knowledge and skills redundant. This could prove to be a risk for the business because it can be tricky to commercialize a radical change. Nevertheless, a radical switch is thought to be substantially important when it comes to long term success because it brings on new age or more current approaches and helps the company come up to the speed of the market.

“Open innovation is usually contrasted with closed innovation, supposedly its predecessor, where companies generate their own innovation ideas, and then develop, build, market, distribute, service, finance, and support them on their own” (Chesbrough, 2003a, p. 20). On the other hand, the reality is that only a handful of firms go for a fully closed innovation method, and it is imperative that the process of innovation be more open because of the many developments both within and outside the arena of innovation itself.

The aim of this work is to propose an evaluation model of innovation use in business practice with a focus on open innovation. The model will be based on management as a discipline specifying work with explicit and tacit knowledge, as these are the key to innovation.

2. Theoretical Background

A simple search through Google Scholar on the subject returned over two million results. Chesbrough's 2003 book on the subject has more than 1,800 citations. Several different disciplines have demonstrated a substantial interest in the subject as well, including sociology, economics, cultural anthropology. When we talk about innovation as a revolution, we mostly see that it is more of an evolutionary process. This is the case with open innovations as well. Chesbrough's publications caused a revolution when they were first released, i.e. Chesbrough (2003a, 2003b, 2003c), helped it become fairly obvious that the crux of them matter dates back by a large margin. Neither using the input of outsiders to improve internal innovation processes, nor searching for outside commercialization opportunities for

what has been developed internally is new. Most of these activities have been implemented by many companies over many decades. In an extensive literature review, Dahlander and Gann (2010) found many references to concepts such as absorptive capacity, complementary assets and the exploration.

Bures (2006) has split the topic into different parts. Knowledge, according to him, can be tacit, implicit, or explicit. Explicit knowledge is essentially documented and is easy to transfer because of its concrete structure. On the other hand, implicit knowledge, as the name implies, has to do with subjective information which can be converted into something more explicit at any time. Knowledge that is unformulated exists in the minds of the person working on something but can prove difficult to turn into something more concrete or formal.

The typical manner through which tacit knowledge is defined is to put it in comparison with objective knowledge. This can then be communicated from the person who possesses it to another. The method of communication can be symbolic and the receiver then has the same information as the original communication (Winter, 1987). This puts forth that objective knowledge can be deconstructed into two aspects, the first being the objective knowledge's communicability and the second being its possession (Sobol & Lei, 1994). The authors further argue that "such knowledge is not specific or idiosyncratic to the firm or person possessing it" (p. 170). This knowledge can be shared. This definition is widely used throughout the literature to define objective knowledge. However, despite this agreement about what objective knowledge is, there is an abundance of terms used to refer to it: articulated knowledge, articulable knowledge, explicit knowledge (Nonaka, 1991), verbal knowledge and declarative knowledge (Kogut & Zander, 1992). It is important to be aware of these various synonyms because it helps us in deciphering and understanding authors' ideas and arguments. Defining objective knowledge is a way of highlighting what tacit knowledge is not. In what follows, we concentrate on what tacit knowledge is."

Before outlining the nature of tacit knowledge, it should be noted that a large majority of authors that write about tacit knowledge refer to Polanyi (1962, 1966, 1976) who introduced the concept. Polanyi describes tacit knowledge as follows: "I shall reconsider human knowledge by starting from the fact that we can know more than we can tell' (1966, p. 4) or we have a power to know more than we can tell (1976, p. 336). One of the characteristics of tacit knowledge is that it is difficult to write down, to formalize (Nonaka, 1991). People that possess tacit knowledge cannot explain the decision rules that underlie their performance: the aim of a skillful performance is achieved by the observance of a set of rules which are not known as such to the person following them (Polanyi, 1962, p. 49). Another characteristic of tacit knowledge is that it is personal knowledge. Sternberg (1994) and Nonaka (1991) argue that tacit knowledge has a cognitive dimension, in the sense that it is scripted. For them, tacit knowledge consists of mental models that individuals follow in certain situations. These are deeply embedded in the individuals and tend to be taken for granted." Ravetz (1971) suggests that: "tacit knowledge becomes so embedded in the individual that it seems entirely natural. This is a reason why it cannot be expressed and why it is attached to the knower." Another feature of tacit knowledge is that it is practical (Sternberg, 1994) and that it describes a process. If, like some authors (Amit & Shoemaker, 1993; Grant, 1991; Rao, 1994) we were to

make a distinction between resources, i.e. inputs into the production process, and capabilities, i.e. processes by which the resources are utilized, rather than use the generic term of resource (meaning both) it would be appropriate to use the term capability rather than resource when referring to tacit knowledge. In this respect, it is similar to know-how (Kogut & Zander, 1992; Nonaka, 1991). Nonaka (1991) saying that: " know-how may be used as a synonym for tacit knowledge because 'tacit knowledge consists partly of technical skills –the kind of informal, hard-to-pin down skills captured in the term know-how. "

3. Research Methodology

The aim of this work is to propose an evaluation model of innovation use in business practice with a focus on open innovation. The model will be based on management as a discipline specifying work with explicit and tacit knowledge, as these are the key to innovation. Sub-steps to address the above goal are:

Literature research in relation to models and methodologies of knowledge management and possible methods of innovation evaluation as a basis for determining the framework of the proposed model.

Multi-criteria analysis of variants for the selection of a specific methodological approach to knowledge management.

Table 1. Questions and corresponding research methods

Question	Methods
I. What key knowledge or knowledge management approaches can be used for open innovation in business?	Literature research Multi-criteria analysis Scoring method Pool of experts
II. What key flows, segments and vectors of innovation through an appropriate knowledge model influence open innovation?	Literature research Correlation to models and methodologies of knowledge management Multi-criteria analysis

A synthesis of the above-mentioned findings will provide an answer to the question: "Is it possible to design such a model and methodology of effective evaluation of open innovations which would reflect the character of the business environment within the European business territory?" In order to obtain the above-mentioned partial materials for the model creation, quantitative and qualitative research, an analysis of statistical data and expert interviews with key subjects of the innovation strategy of companies were chosen with respect to the used methods.

This work uses the following main methods: synthesis of knowledge, a qualitative research represented by a sophisticated questionnaire and multi-criteria analysis. Qualitative research works with diverse data sources and enables a wide range of methods to be used to find and process data. However, it is more time-consuming and the results are more difficult to interpret (Hendl, 1997). Research takes place in the field, where information and opinions

are obtained from respondents through direct contact with them. Structured questionnaire interviews are a sophisticated concept of these surveys. Subsequently, the obtained data are classified in a way that allows their statistical analysis.

3.1. Multi-criteria Analysis

The theory of multi-criteria decision-making deals with situations where the decision maker evaluates the consequences of the choice according to several criteria. These are quantitative criteria, which are usually expressed in natural scales (referred to also as numerical criteria). Another option are qualitative criteria, when an appropriate scale is introduced, e.g., introducing a classification scale and at the same time defining the direction of better evaluation, i.e., whether the maximum or minimum value is better (falling or rising values) (Skulinova, 2005). If a set of permissible variants (alternatives) is specified implicitly by a set of constraint conditions that the decision alternatives have to meet, it is a vector optimization. If the set of permissible variants is final (given in the form of a final list), it is a complex of evaluation of alternatives or the role of multi-criteria evaluation of variants.

3.2. Scoring Method

In this method, it is assumed that the user is able to quantitatively evaluate the importance of the criteria using a certain number of points. With this method, the evaluator assigns each point of each variation to a given criterion a certain number of points from the selected scale, the better the value of the criterion, the greater the score for the variation in question. The number of degrees on the scale depends on the evaluator's resolution, which may not be the same for all criteria. However, the maximum (or minimum) number of points assigned to the best (or worst) value of a criterion must be the same for all criteria. In doing so, it is not excluded that in the case of a partial evaluation according to any criterion, no variant will reach this extreme number of points (it may be a hypothetically determined number).

3.3. Pool of Experts

As the selection of criteria and determination of their impact is rather subjective issue, were the criteria consulted with an expert board. The pool of experts included entrepreneurs of important industry fields focusing on innovative entrepreneurship (7experts), experts and consultants from the South Moravian Innovation Centre (4 experts) and the academics (4 experts). The total number of the pool of experts involved into consultation on the multi-criteria analysis were 15 members. To the selection of the experts, several principles were applied. It was based on a purpose selection. Experts from the Innovation Centre had to meet several criteria, in particular at least 5 years of consulting experience with a focus on innovation and increase of innovation potential in companies. Furthermore, they had to be currently involved in the process of consulting activities at high-tech companies. Experts coming of commercial field had to meet the focus of the pool of companies on which the research was targeted and actively participate in the implementation of the company innovations. The sampling method was included in the involvement of company experts.

A method of selecting respondents also referred to as a chain or reference sample, is a type of the selection in which not all units or groups of units have the same chance of being selected for the sample. The selection process begins with individuals who are known to meet the criteria. Subsequently, they are asked to nominate other persons who meet the criteria in the interview and to allow researchers to contact them. These individuals are then interviewed and the process could be repeated. Thus, the sample grows by connecting to social contacts. Because it is difficult to involved experts of these group selected sampling method was very suitable. The academic's background was the field of knowledge management, business and economics. The principle of volunteering was applied to all expert groups. The work with experts was based on individual interview.

The basic information for determining the preferential arrangement of variants is the results of pairwise comparison of these variants with respect to the individual evaluation criteria. Due to its nature, this group of methods is suitable for evaluating variants in a set of qualitative criteria, resp. in situations with a mixed set of criteria where qualitative criteria prevail. The result is not a numerical overall assessment of the variations, but only a breakdown of the set of evaluated variants into several indifferent classes and preferential arrangements of these classes. Variants included in each indifferent class can be considered equivalent to the whole set of criteria.

This group includes methods:

- AGREPREF method
- ELECTRE method class (ELECTRE I., ELECTRE III.)
- PROMETHEE method class (PROMETHEE I., PROMETHEE II.)
- MAPPAC

The above-mentioned methods, based on input information, are used as a tool to support decision-making on the method for assessing the benefits of knowledge management. The specific calculation is performed using MS Excel for manual processing of the scoring method and MCA Scythe for the method of linear partial functions benefit (weighted sum), TOPSIS and ELECTRE I, AGREPREF, MAPPAC and PROMETHE.

4. Results

Choice of criteria and impact assessment of individual alternatives in relation to these criteria. The design of the criteria and its weights is a matter of the only expert who will probably also himself calculate and sort the variants by any of the methods of multi-criteria decision making. A group of experts is involved in determining the weighting of criteria and, where appropriate, selecting criteria. The result can then be obtained, for example, by a selected group of experts and selecting a relevant criterion for solving the given decision problem and determining their mutual percentage importance. There is also the amount of the selected group of experts to send questionnaires with draft criteria into which they give their opinion on the importance of each criterion. In this case, the criteria and the determination of their weights is set in frame of work by the author of the present work.

4.1. Identifying Alternatives

Based on literature research and the focus of the work on the possibility of interconnecting the open innovation model with the knowledge management four relevant models of knowledge management were found. The following alternatives were taken:

- SECI model Nonaka – Takeuchi.
- Knowledge spiral.
- “Choo” model.
- Boisot model.

4.2. Selection of Criteria

Following criteria were selected:

C1: Ability of the model to reflect the specifics of the innovation potential of the company
- the most important criterion

C2: Simplicity and Clarity of the Model

C3: Interconnection of model with literature

C4: Quantitative Result of Model Segments

C5: Model Case Study Availability

4.3. Decision Matrix

The following table shows the evaluation of methods by selected criteria. Evaluation of alternatives. A large number of methods have been developed over the years to support decision-making. With their help, the user should be able to select the most appropriate option for solving the problem or obtain a preferential arrangement of the options and on the basis of this to justify their decision. The methods differ from each other in the situations in which they are used, the number of criteria, the methods of calculation and the demands placed on the solver.

Table 2. Assessment Criteria Rating Scales Result – methods TOPSIS, ORESTE, PROMETHE

	TOPSIS method		ORESTE method		PROMETHE method	
	Distance from nadir (relative index)	ri values	ri values	Order	Net flow	Order
Choo	0.462634	50	50	2	0.002583	2
Boisot	0.442539	58	58	4	0.002975	1
Seci	0.622606	44.50	44.50	1	-0.00313	4
Knowledge intensity	0.368844	57.50	57.50 ri values	3	-0.00243 Net flow	3 Order

Source: author's own work

Table 3. Assessment Criteria Rating Scales Result – method TOPSIS

	Choo	Boisot	Seci	Knowledge intensity	Effectivity of alternatives
Choo	--	0	0	0	Non effective
Boisot	0	--	0	0	Non effective
Seci	0	0	--	1	Effective
Knowledge intensity	0	0	0	--	Non effective

Source: author's own work

The choice of method for evaluating the benefits of knowledge management will be based on cardinal methods. There are three basic approaches to evaluating variants in this way:

- Maximizing benefits.
- Minimizing the distance from a fictitious variation.
- Preference sessions.

5. Conclusion

For the overall evaluation of all used methods of multi-criteria evaluation of variants, a clear table is used in which the results of individual methods are captured. The order of advantage of given decision options, determined by one of the methods of multi-criteria evaluation of variants, depends mainly on the weights of individual criteria and on the method used. The decision matrix clearly show that the first order appears in the first order, which is represented by the SECI model.

The proposed process evaluation model of innovation use in business practice with a focus on open innovation based on the SECI model contributes to the development of a theoretical framework in the field of the knowledge management science discipline. Specifically, it is based on a modification of the SECI model and in the planned connection with the Ba model in the context of open innovation. The author's solution clearly demonstrates the possibilities of using the theoretical foundations of the knowledge management science discipline in the areas related to the mapping of innovation potential and determines the extension of the knowledge management area to the aspects of processes in the field of evaluation of the use of innovation. Evaluating the use of innovations and describing the interrelated individual processes as well as organisations is a very complex area of research. This work discusses in detail one of the possible approaches, which is based on the dynamics of knowledge processes in relation to the SECI model. The main benefits of the open innovation model are: simplifying work and saving time for the company, as it only explains its challenge once, and the facilitators take over the tedious job of pre-selection and routine communication with potential partners and get the company's offer through to the relevant partners across the region/country. The individual segments and vectors of innovation can be seen as two forms of tacit and explicit knowledge. Based on the evaluation of the vector of innovation, the potential of a company for open innovation can be measured. So far, the model of tacit and explicit knowledge and its flow have been described on the theoretical level by the SECI model. It is possible to follow up on this work by examining individual segments of innovations and their vectors. Based on the optimization of the

selection of theoretical models, it is possible to design the model which allows the evaluation of quality benefits and the expansion of the possible methods used in knowledge management. Working in a cohesive manner that leads to strategic innovation management can result in a number of new skilled jobs in several new high-tech firms. Supporting open innovation helps foster a system where there is collaboration and reduced costs when it comes to transaction, augmenting the entrepreneurs' and researchers' comprehension of what innovation is. This helps augment the demand for greater functionality when it comes to research institutes and their internal processes and regulations in terms of collaboration for companies and researchers.

Acknowledgments: This work was supported by the Technology Agency the Czech Republic TL02000066 "Effective knowledge transfer management "and internal specific research "Investments under the Industry 4.0 concept."

References

- Boisot, M. (1999). *Knowledge assets: securing competitive advantage in the information economy*. Oxford: Oxford University Press.
- Bureš, V. (2011). *System thinking for managers*. Prague: Professional Publishing.
- Bureš, V. (2006). Knowledge management and its implementation. In *Proceeding of 2nd International Conference on Web Information Systems and Technologies* (pp. 115-118).
- Cardinal, L. B., Allessandri, T. M., & Turner, S. F. (2001). Knowledge codifiability, resources, and science based innovation. *Journal of Knowledge Management*, 5(2), 195-204. <https://doi.org/10.1108/13673270110393266>
- Cavusgil, S. T., Calantone, R.J., & Zhao, Y. (2003). Tacit knowledge transfers and firm innovation capability. *Journal of Business & Industrial Marketing*, 18(1), 6-21. <https://doi.org/10.1108/08858620310458615>
- Chen, J., Zhaohui, Z., & Xie, H. Y. (2004). Measuring intellectual capital. *Journal of Intellectual Capital*, 5(1), 195-212. <https://doi.org/10.1108/14691930410513003>
- Chesbrough, H. (2003a). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA: Harvard Business School Publishing.
- Chesbrough, H. (2003b). The era of open innovation. *Sloan Management Review*, 44(3), 35-41.
- Chesbrough, H. W. (2007). Why companies should have open business models. *MIT Sloan Management Review*, 48(2), 22-28.
- Chesbrough, H. W., & Crowther, A. K. (2006). Beyond high-tech: early adopters of Open Innovation in other industries. *R&D Management*, 36(3), 229-236. <https://doi.org/10.1111/j.1467-9310.2006.00428.x>
- Chesbrough, H. (2012). Open innovation: Where we've been and where we're going. *Research-Technology Management*, 55(4), 20-27.
- Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research Policy*, 39(6), 699-709. <https://doi.org/10.1016/j.respol.2010.01.013>
- Herkema, S. (2003). A complex adaptive perspective on learning within innovation projects. *The Learning Organisation*, 10(6), 340-6. <https://doi.org/10.1108/09696470310497177>
- Kogut, B. & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organisation Science*, 3(3), 383-96. <https://doi.org/10.1287/orsc.3.3.383>
- Nonaka, I. (1991). The knowledge-creating company. *Harvard Business Review*, 162-171.
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company: how Japanese companies create the dynamics of innovation*. Oxford: Oxford University Press.
- Nonaka, I., & Konno, N. (1998). The Concept of "Ba": Building a Foundation for Knowledge Creation. *California Management Review*, 40(3), 40-54. <https://doi.org/10.2307/41165942>
- Novak, J. D., & Gowin, D. B. (1984). *Learning How to Learn*. Cambridge: University of Cambridge.
- Ravetz, J. R. (1971). *Scientific Knowledge and its Social Problems*. Oxford: Clarendon Press
- Sobol, L., & Let, D. (1994). Environment, manufacturing technology and embedded knowledge. *International Journal of Human Factors in Manufacturing*, 4(2), 167-189. <https://doi.org/10.1002/hfm.4530040205>

Measuring Chatbot Effectiveness

Hana MOHELKA and Marcela SOKOLOVA*

University of Hradec Králové, Hradec Králové, Czech Republic; hana.mohelska@uhk.cz;
marcela.sokolova@uhk.cz

* Corresponding author: marcela.sokolova@uhk.cz

Abstract: The paper deals with a technology called chat robot. Chatbot is one of the Fourth Industrial Revolution trends, and so far, there is no commonly used approach that has proven to measure its effectiveness. The aim of this paper is to delve deeper into this issue, describe the current state, and further analyse possible known alternatives for measuring the chatbot effectiveness and identify a suitable approach according to selected criteria. The translated paper's main aim is to select a suitable tool for measuring the effectiveness of chatbot. A literature search was carried out within the paper's elaboration, quantitative and qualitative research was gradually used to select a suitable tool for measuring the effectiveness of the chatbot, while specific data collection techniques are a document study, questionnaire survey in the form of pairwise comparison, where output is an expert opinion and semi-structured interview. Furthermore, a multi-criteria analysis is performed in the Expert Choice 2000 decision support tool. User friendliness, Information ability and equipment, Language level and equipment, Humanity, Business aspect were chosen as the most important criteria. The 2018 approach by the Croatian author D. Peras was chosen to carry out an analysis of approaches to measuring chatbot effectiveness.

Keywords: chatbot; efficiency; measurement; approach

JEL Classification: M14; M31; O31

1. Introduction

The advent and adoption of the "Industry 4.0" initiative, or simply the fourth industrial revolution, has gradually changed and continues to change the thinking philosophy of today's companies. Under this concept, one can imagine the transformation of production into a fully integrated automated and continuously optimised environment, which regards the digitisation of industrial production, but a comprehensive system of changes associated with phenomena such as the Internet of Things, Services and People, autonomous robots and artificial intelligence development, Big Data analysis, digital twin, virtualisation, cloud computing as well as augmented reality. The third industrial revolution gave companies the form of information, i.e., information knowledge, which consists in the ability to manage information efficiently, the fourth industrial revolution then follows and enables the use of newly introduced technologies to streamline the use of resources significantly.

This paper deals with a technology called chat robot, more commonly known as chatbot, which can be included among the above trends. Although its origin dates back to the 1960s, it generally began to find its use over the last few years, in various forms (Kotoučková, 2020),

(Bureš et al., 2012). Due to its abundant deployment, it is often discussed whether it really fulfils its purpose or it is only a utopian idea of the robot's ability to effectively replace human activity. In order for a company to be able to answer this question, it needs to have a well-established process for measuring this technology's effectiveness. However, a unified approach that would be commonly used has not yet been developed, and this is the issue the paper addresses.

2. Research Objective and Methodology

The translated paper's main aim is to select a suitable tool for measuring the chatbot effectiveness. The following research question was determined in line with this aim: *RQ: "How is it possible to measure the effectiveness of a chatbot?"*

The following sub-goals must be met to fulfil the main aim:

- 1) Definition of the term chatbot - Literature Review
- 2) Determining the evaluation criteria of tools for measuring chatbot effectiveness
- 3) Identification of tools that can measure chatbot effectiveness
- 4) Selection of a suitable tool for measuring the effectiveness of the chatbot

A search of professional literature was carried out as part of this paper's elaboration, first focusing on the issue of chat robots, then on measuring the effectiveness of IS/ICT and approaches to measuring the chatbot effectiveness. Both printed and electronic sources were used, mainly foreign studies obtained from scientific databases, such as Science Direct, Springer, Web of Science. Their searches used the keywords such as "chatbot", "effectiveness", "measurement", "assessment", "evaluation", "metrics", in various combinations. Quantitative and qualitative research was gradually used to select a suitable tool for measuring chatbot effectiveness, with specific data collection techniques being document study, a questionnaire survey in the form of a pairwise comparison method, where the output is an expert opinion and a semi-structured interview. Furthermore, a multi-criteria analysis is performed in the Expert Choice 2000 decision support tool, whereby a suitable approach was selected to help measure chatbot effectiveness. Among other things, it is desirable to determine the weights of the individual criteria. For their objective determination, six interested experts were used who were subjected to a survey in the form of a pairwise comparison of defined criteria. Based on the individual results, Saaty matrices were compiled which led to the final output in the form of an expert opinion of the weights of the given criteria.

3. Literature Review

3.1. Chatbot - History and Classification

The term chatbot is sometimes also referred to as "chatterbot" or just "chat robot", and you can find several different definitions, which say that it is a technology automating or simulating human conversation or directly calling it artificial intelligence, as explained in the following subchapters, which is not entirely true. In conjunction with the above, Shawar and Atwell (2007) define this technology in an acceptable and clear manner as a computer programme that mediates interaction between it and a living person using natural language.

This means that it should not be recognised that a person is communicating with a robot during the process, and therefore there should be a completely immediate transfer of information between the two parties. Brandtzaeg and Følstad (2017) further state that the interaction occurs through chat interfaces, which companies often place on their websites or use existing platforms such as Facebook Messenger, WhatsApp, Skype, Slack and others. Some include voice-powered virtual assistants such as Siri, SVoice, Google Assistant, Cortana and Alexa (Rieke, 2018).

Although chatbot has become a trend in recent years (Accenture, 2016), Lokman and Zain (2010) state that its origins date back to 1966, when Professor Joseph Weizenbaum introduced the first chat robot, called ELIZA, whose behaviour was based on the simple principle of searching and creating outputs according to the keywords of the given inputs, subjected to the so-called decomposition (transformation) rules, and therefore later it became an inspiration for other chatbots. In 1995, there was a major breakthrough in this technology when Dr. Richard S. Wallace came up with his modern version of ELIZA, named A.L.I.C.E., whose name is derived from the Artificial Linguistic Internet Computer Entity. It then gave rise to a new Artificial Intelligence Markup Language (AIML), based on XML (eXtensible Markup Language) dialect, creating naturally speaking software agents. Furthermore, the authors mention that the idea of whether machines can think and how to verify this fact came in 1950, the mathematician Alan Turing, whose test consists in recognising whether the evaluator (real person) recognises whether they are conversing with a chatbot or a human individual. More precisely, everything takes place in two separate rooms, in one room there is an evaluator and in the other a human and artificial one. The interviewer asks questions to which they receive an answer. If a chatbot conversation was not detected, the machine passed the Turing test. Although A.L.I.C.E. did not pass this test, it won the Loebner Prize three times, in the years 2000, 2001 and 2004. The Loebner Prize has been an annual competition since 1991 based on passing the Turing test. Wakefield (2019) explains the rules of the game, whereby each machine is asked the same 20 questions with varying degrees of complexity, conversations last 25 minutes and the winner is the one who can convince more than half of the evaluators that they are human. However, so far, this has never succeeded, so the machine that managed to outsmart most of the evaluators has won the prize. Russel and Norvig (2010) mention strict criticism from Shieber (1994) regarding the usefulness of this test in the Loebner Prize competition. From ELIZA, through A.L.I.C.E. and other successful chatbots, such as the current five-time Loebner prize winner of the Mitsuku chatbot, created by Steve Worswick (Wakefield, 2019). In today's digital world, chatbots are becoming a common part of all types of companies.

3.2. Connection with Artificial Intelligence

The term Artificial Intelligence (hereinafter "AI") cannot be clearly defined. It is an interdisciplinary science "about the creation of machines or systems that will use a procedure in solving a certain task, which - if carried out by man - would be considered a manifestation of their intelligence" (Minsky, 1967). This definition is based on the Turing test and can be freely translated so that the complexity of solved tasks requires the use of human intelligence.

In this case, it is necessary to focus on the question of what the complexity and intelligent solutions are. Čermák (2018) states that complexity is characterised by the number of all possible solutions and the second attribute is limited by knowledge. He adds that artificial intelligence deals with the search for boundaries, including the representation of acquired knowledge and processes, the acquisition and use of it in solving problems, and uses various approaches and algorithms to find the basis of very complex tasks.

The basic question of whether machines can think had already been addressed in the 17th century by philosophers such as Descartes, Pascal, Hobbes, whose ideas only moved on a theoretical level and they were unable to turn it into reality. Furthermore, Čermák (2018) emphasises 1950, the year where Alan Turing came up with his test, whereby he gathered a number of pieces of evidence regarding intelligent machines, and subsequently refuted them. A conference led by John McCarthy was held in 1956 at Dartmouth College, bringing together experts interested in the possibility of implementing human thinking on machines (computers). The author mentions other important milestones in the history of artificial intelligence development, including A. Newell, H. Simon and their programme based on heuristic search techniques - the Logic Theorist, a system that mimics human thinking in solving problems in state space by reducing differences - General Problem Solver (GPS).

In 1958, John McCarthy created a language for artificial intelligence - LISP.

In the early 1970s, the PROLOG language was created by A. Colmerauer. Furthermore, various universal systems were designed during this period that were unable to solve highly specialised tasks. These include Planner, for example. The fundamental problem regarding artificial intelligence, namely the representation, use and processing of knowledge, began to be pointed out.

This led to the development of expert systems whose task is to simulate the decision-making process of specialists in solving complicated tasks using a knowledge base. Successful pioneers of expert systems included MYCIN and PROSPECTOR.

In 1981, the 5th Generation Computer Project for non-numerical information processing was announced in Japan. These computers worked with extensive knowledge bases and required learning mechanisms. Furthermore, T. Kohonen introduced the "electronic typewriter" in 1988. It involved the translation of voice into English text via Kohonenon neural networks. In 1990, L. Adleman began to create the concept of computer DNA and demonstrated the subsequent feasibility of basic mathematical operations and calculations.

Shah (2017) states the issue of natural language processing is linked to chatbot and artificial intelligence which can be found under the abbreviation NLP (Natural Language Processing). Chatbots are able to function using predefined rules based on language structures (so-called rule-based) or using a statistical model of natural language processing, which deals with the so-called machine learning.

4. Chatbot Application Areas

Chatbot has largely found its application in the last few years, more precisely the biggest breakthrough of its widespread deployment came in 2016, when Facebook and Microsoft began to officially support the use of robots within their platforms (Khorozov, 2017). Business

Insider Intelligence (2016) presents the results of a survey conducted by Oracle, and according to which, in 2016 approximately 80% of surveyed American companies owned or planned to launch a chatbot by 2020 at the latest. Nicastro (2018) states that Inbenta, based on its survey of consumer and business chat robot usage and perception, rated a 50% preference for chatbot communication when shopping online over customer support calls, with 72% of shoppers finding its services to be error-free and very helpful. In the Czech Republic, the Feedyou agency is proud of several cases of successful chatbot implementations in the corporate environment, which since 2014 has been trying to show how this technology can benefit today's businesses. In areas such as HR, customer support, sales or even GDPR, it has helped companies such as ČEZ, a. s., STRV, s. r. o., Fincentrum, a. s., Knorr-Bremse, s. r. o. and others (Feedyou, 2019).

In order to be able to realistically consider the introduction of technology as successful or effectively fulfilling its purpose (not only because it is a trend), it is necessary to regularly measure its effectiveness. In this respect, a unified approach has not yet been developed, that companies could use to assess their chatbot, which is the subject of the following part of the paper. Other passages deal with the effectiveness of IS/ICT in general and further present in detail the approaches to measuring the effectiveness of chatbot, which are based on foreign studies dealing with this issue.

4.1. ICT/IS Effectiveness

Molnár (2000) states that it only makes sense to examine systems for which a purpose can be defined in terms of information system effectiveness (hereinafter "IS") and information technology (hereinafter "IT"), i.e., information and communication technologies (ICT). He then calls these systems as target behaviours. He also explains the relationship between information system and information technology, where information system represents the need for information, while information technology represents the satisfaction of this need and hence the abbreviation IS/IT, i.e., ICT. Furthermore, the author adds that the evaluation of efficiency does not only address the issue of needs and their fulfilment, but also the expectations of the involved parties. From a company-wide point of view, these can be:

- owners who see the introduction of IS/ICT as a permanent appreciation of the assets invested in the company,
- managers who are able to effectively manage the company on the basis of IS/ICT, without spending extra resources entrusted to them for administration,
- employees to whom IS/ICT offers benefits in the form of a better, more efficient and fully integrated work environment,
- customers to whom the use of IS/ICT brings higher added value of the required product or service.

It is important to note that the choice and combination of indicators always depends on the specific case, and to emphasise that the most relevant relationship for evaluating effectiveness is the monitoring of effectiveness aspect, which is directly measurable by the degree to which objectives are achieved, i.e., as follows:

Effectiveness = achieved goal value / planned goal value.

5. Determining the Criteria for Selecting a Suitable Tool for Measuring Chatbot Effectiveness and Designing Suitable Tools

To fulfil the paper's aim, it is necessary to choose a suitable approach for measuring chatbot effectiveness. It is selected using an analytical decision support tool called Expert Choice 2000. According to Expert Choice (2020), the first step in multi-criteria decision-making is to define the goal that should be achieved.

5.1. Determining the Criteria for Selecting a Suitable Tool for Measuring the Effectiveness of a Chatbot

Subsequently, it is necessary to establish selection criteria. This was selected on the basis of a careful study of professional studies dealing with the issue of chatbot evaluation and the advice of experts from ČSOB. The five most important areas are selected as criteria, which, according to the already mentioned theoretical background and expert determination, should not be missing in the right approach to measuring chatbot effectiveness. These include:

- user friendliness - evaluating the impression of the chatbot (incl. chat interface) on the user and whether they are satisfied with their services during the interaction,
- information ability and equipment - finding out and supplementing the state of the chatbot knowledge base so that the produced outputs can satisfy the user's needs,
- language level and equipment - evaluation of the chatbot's ability to create correct and verbally diverse outputs in terms of spelling and grammar,
- humanity - assessing whether the chatbot behaves like a human,
- business aspect - finding out what added value chatbot brings for a company and the metrics associated with it.

5.2. Determining Individual Criteria Weights

The established criteria can be considered important, but not to the same extent. Therefore, it is necessary to determine appropriate weights for each of them. For this, questionnaire survey results were used, in the form of a pairwise comparison method performed within the company. More precisely, the research involved a total of six selected managers and analysts, interested in this issue, and therefore capable of relevant assessment (they cover the administration, operation, support and all processes related to a chatbot). The survey's aim was to find out the importance that managers attach to the defined criteria, on the basis of which their final weights were determined, i.e., the expert opinion.

The questionnaire was created according to the Saaty method of pairwise comparison and the form of its processing was inspired by the Expert Choice 2000 programme itself. The data obtained from the performed research were processed into partial Saaty matrices. First, a matrix was created for each expert separately, whereby the output was the calculation of the partial and total geometric diameter and subsequent weights for the first to fifth criteria. These calculated weights were transferred to a common matrix showing their relationship from the first up to the sixth respondent. Then, an arithmetic mean was calculated from the

individual weights for each criterion, giving the values of the resulting (uniform) weights, which can be seen in Table 1.

Table 1. Determined weights of criteria and their final order. Source: own processing.

Criterion	Weight	Sequence
User friendliness	0.214	3.
Information ability and equipment	0.345	1.
Language level and equipment	0.099	4.
Humanity	0.045	5.
Business point of view	0.297	2.

As can be seen, of all five criteria, respondents consider the most important information ability and equipment - to satisfy the needs of existing or potential clients. Therefore, ensuring information capability and equipment represents added value for the customer and immediately behind it is the business aspect, which is formed by metrics evaluating the added value for the company. The weights of both criteria separately are around one third of the five criteria and therefore together represent a nearly two-thirds preference over them. Therefore, metrics focused on these two aspects should definitely not be missing in a suitable approach to measuring chatbot effectiveness.

User friendliness is seen as the third most important criterion, this requires an evaluation on how the chatbot acts on the user and how satisfied they are with its services. For this reason, it is necessary to focus on ensuring the possibility of gaining the most pleasant and effective experience that the user receives during the chatbot interaction.

In terms of importance, language and equipment are in the fourth place. This means assessing the chatbot's ability to produce correct and verbally diverse outputs from the viewpoint of spelling and grammar, thanks to which the user is able to capture an accurate interpretation of the transmitted information.

Humanity is considered to be the least important criterion. In the case of artificial intelligence, humanity testing plays an essential role, the chatbot is designed to be able to fulfil a specific task. The user already knows in advance that they are conversing via a chatbot and not a live operator, so the company pays more attention to other, in this case more important, criteria.

5.3. Choice of Alternatives

According to combinations of the keywords "chatbot", "effectiveness", "measurement", "assessment", "evaluation", "metrics", professional scientific databases such as Springer, Science Direct, Web of Science have found little the number of publications whose content would be usable for the purposes of the paper. A total of seven studies were selected by the method of analysis and subsequent synthesis, which dealt with at least two areas of measurement, i.e., selection criteria and included useful metrics. By discussing the most relevant findings, four were selected from seven studies, which offered the most comprehensive approach to measuring the chatbot effectiveness, i.e., dealt with at least four

of the five required measurement areas. The following alternatives were chosen to select a suitable approach to measuring chatbot effectiveness:

- Kuligowska (2015),
- Maroengsit et al. (2019),
- Peras (2018),
- Radziwill and Benton (2017).

6. Conclusions – Evaluating the Selection of an Appropriate Approach to Measuring Chatbot Effectiveness

Using the multi-criteria decision-making process implemented in the vAHP software product Expert Choice 2000, the following two graphs were created (see Figures 1 and 2) showing the suitability of selected approaches to measuring the effectiveness of the chatbot.

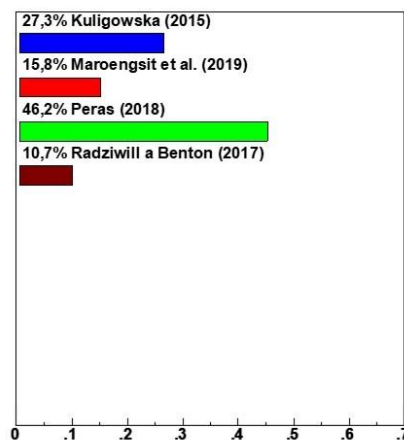


Figure 1. The result of selecting a suitable approach to measuring chatbot effectiveness in percentage terms. Source: own processing in the Expert Choice 2000 programme.

Figure 1 shows the differences in the suitability of individual approaches in percentage expression. Based on the multi-criteria analysis results, it is clear that the best rated approach is from Peras (2018), which achieves almost 50% fulfilment of the evaluated criteria compared to other alternatives. On the contrary, only 10% of the criteria were met by Radziwill and Benton (2017), which was described as insufficient and therefore unsatisfactory in terms of the three out of five criteria.

The most suitable approach out of the four analysed was the method of measurement created by the author Peras (2018), who divided the process of evaluating the effectiveness of chatbot into a total of five perspectives. Basically, the defined aspects fully capture the chosen criteria, and therefore, with one exception, it always got a better score compared to other alternatives. The mentioned exception is the visible fluctuation recorded in the criterion "Information ability and equipment", which was given the highest importance by the participants forming the expert opinion of the individual scales (Figure 2, second value).

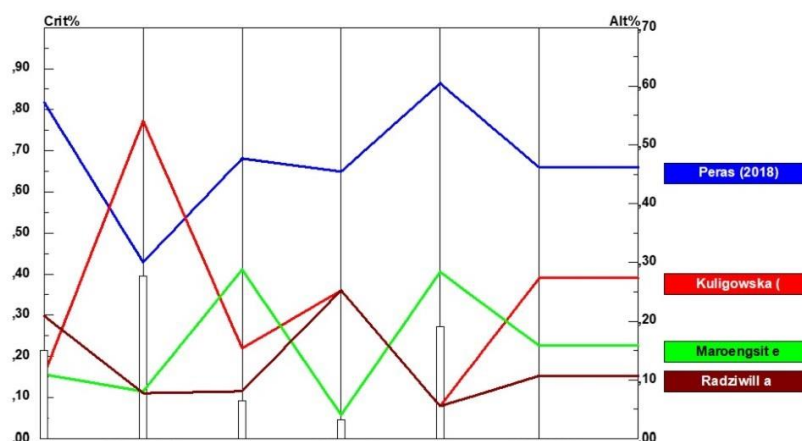


Figure 2. Graphical representation of the selection of a suitable approach to measuring chatbot effectiveness (according to individual criteria - User friendliness, Information ability and equipment, Language level and equipment, Humanity, Business aspect). Source: own processing in the Expert Choice 2000 programme.

In this case, it was surpassed by Kuligowska (2015), who directly deals with evaluating the knowledge base equipment, and in terms of overall results, it finished in second place. In other respects, its measurement method was comparable to the remaining two approaches, and the largest decline was registered in the commercial aspect due to the absence of its consideration. Third place went to Maroengsit et al. (2019), which took one third of what the preferred approach from Peras (2018) and for two criteria was described as unsatisfactory. The approach from Radziwill and Benton (2017) has become the least useful comparison of competitions, which is insufficient from the viewpoint of a total of three criteria and its biggest problem lies in the absence of the implementation method for its proposed attributes and more detailed elaboration into partial metrics.

The 2018 approach from the Croatian author D. Peras was chosen to analyse the approach to measuring chatbot effectiveness.

Acknowledgments: The paper was written with the support of the specific project 2021 grant "DETERMINANTS OF COGNITIVE PROCESSES IMPACTING THE WORK PERFORMANCE" granted by the University of Hradec Králové, Czech Republic and thanks to help of student Andrea Kotoučková.

References

- Accenture. (2016). Chatbots in Customer Service. Accenture Interactive: *Part of Accenture Digital*.
https://www.accenture.com/t00010101T000000__w__/_br-pt/_acnmedia/PDF-45/Accenture-Chatbots-Customer-Service.pdf
- Brandtzaeg, P. B., & Følstad, A. (2017). Why people use chatbots. In I. Kompatsiaris, & J. Cave (Eds.), *International conference on internet science* (pp. 377-392). Cham: Springer International Publishing, Lecture Notes in Computer Science, 10673. <https://doi.org/10.1007/978-3-319-70284-1>
- Bureš, V., Jašíková, V., Otčenášková, T., Kolerová, K., Zubr, V., & Marešová, P. (2012). A comprehensive view on evaluation of cluster initiatives. In *8th European Conference on Management Leadership and Governance ECMLG-12* (pp. 74-79).
- Business Insider Intelligence. (2016). 80% of businesses want chatbots by 2020. *Businessinsider.com*.
<https://www.businessinsider.com/80-of-businesses-want-chatbots-by-2020-2016-12>
- Čermák, P. (2018). *Umělá inteligence: Studijní opora pro kombinované studium*. Olomouc: Moravská vysoká škola Olomouc, o. p. s. <https://mvso.cz/wp-content/uploads/2018/02/Um%c4%9b%l%3%a1-intelligence-studijn%3%ad-text.pdf>

- Expert Choice. (2020). *The Analytic Hierarchy Process: Structured Decisions: Decision Making for Better Decisions*.
<https://www.expertchoice.com/ahp-software>
- FEEDYOU. (2019). *Portfolio*. <https://feedyou.ai/success-stories/>
- Khorozov, A. (2017). Trends Driving the Chatbot Growth. *Chatbots Magazine*.
<https://chatbotsmagazine.com/trends-driving-the-chatbot-growth-77b78145bac>
- Kotoučková, A. (2020). Měření efektivnosti chatbota. *Diplomová práce*. Univerzita Hradec Králové.
- Kuligowska, K. (2015). Commercial chatbot: performance evaluation, usability metrics and quality standards of embodied conversational agents. *Professionals Center for Business Research*, 2.
<https://doi.org/10.18483/PCBR.22>
- Lokman, A. S., & Zain, J. M. (2010). Chatbot Enhanced algorithms: a case study on implementation in Bahasa Malaysia human language. In *International Conference on Networked Digital Technologies* (pp. 31-44). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-14292-5_5
- Maroengsit, W., Piyakulpinyo, T., Phonyiam, K., Pongnumkul, S., Chaovalit, P., & Theeramunkong, T. (2019). A Survey on Evaluation Methods for Chatbots. In *Proceedings of 2019 7th International Conference on Information and Education Technology (ICIET 2019)* (pp. 111-119). <https://doi.org/10.1145/3323771.3323824>
- Minsky, M. L. (1967). *Computation: Finite and Infinite Machines*. *Prentice Hall Series in Automatic Computation*. Englewood Cliffs.
- Molnár, Z. (2000). Efektivnost informačních systémů. *Systémová integrace*. Grada.
- Nicastro, D. (2018). 8 Ways to Measure Chatbot Program Success. *CMS WiRE*, Channel: Customer Experience.
<https://www.cmswire.com/customer-experience/8-ways-to-measure-chatbot-program-success/>
- Peras, D. (2018). Chatbot Evaluation Metrics: Review Paper. In *36th International Scientific Conference on Economic and Social Development – "Building Resilient Society"*. Varazdin Development and Entrepreneurship Agency (VADEA) (pp. 89-97).
- Radziwill, N., & Benton, M. (2017). *Evaluating Quality of Chatbots and Intelligent Conversational Agents*.
<https://arxiv.org/abs/1704.04579>
- Rieke, T. D. (2018). The relationship between motives for using a Chatbot and satisfaction with Chatbot characteristics in the Portuguese Millennial population: an exploratory study (*Dissertation*). University of Porto. Faculty of Economics. <https://repositorio-aberto.up.pt/bitstream/10216/116509/2/296743.pdf>
- Russel, S., & Norvig, P. (2010). *Artificial Intelligence: A modern Approach* (3rd ed.). Prentice Hall.
- Shah, N. (2017). Which Is Best for You: Rule-Based Bots or AI Bots? *Chatbots Magazine*.
<https://chatbotsmagazine.com/which-is-best-for-you-rule-based-bots-or-ai-bots-298b9106c81d>
- Shawar, B. A., & Atwell, E. (2007). Chatbots: Are they Really Useful? *LDV Forum*, 22, 29-49.
- Shieber, S. M. (1994). Lessons from a Restricted Turing Test. *Communications of the ACM*, 37(6), 70-78.
<https://doi.org/10.1145/175208.175217>
- Wakefield, J. (2019). *The hobbyists competing to make AI human*. BBC. <https://www.bbc.com/news/technology-49578503>

Gender Pay Gap in the Czech Information and Communication Technology Professionals

Lea NEDOMOVA, Milos MARYSKA and Petr DOUCEK*

Prague University of Economics and Business, Prague, Czech Republic; nedomova@vse.cz;
milos.maryska@vse.cz; doucek@vse.cz

* Corresponding author: doucek@vse.cz

Abstract: The policy to ensure an equal pay for equal work is consistently applied neither in all EU Member States nor in all sectors of the economy. This article analyzes the gap in average gross earnings between women and men in the Czech Republic working in two groups of ICT Professionals (ICT Specialists - CZ_ISCO 25, ICT Technicians - CZ_ISCO 35). We analyzed wage data obtained from Trexima, a.s. for the time period of 2008-2019. The resulting data are adjusted for inflation and converted to the 2008 base as well as converted to EUR, using the average exchange rate of the given year. We analyzed the data for each group by age and achieved education. Overall, we can say that the gender pay gap among ICT Professionals is decreasing, although this decrease is smaller than that in the entire Czech economy. In terms of the gender pay gap, the group under 30 has the minimal gender pay gap and so does the category of ICT Technicians during several years.

Keywords: gender pay gap; ICT; gender aspects in ICT; average wage

JEL Classification L63; J16

1. Introduction

The International Labor Organization declared the “Equal Remuneration Convention” on an equal pay for equal work in 1951, i.e. almost 70 years ago (Whitehouse & Smith, 2020). Since then, all world's economies have tried, less or more successfully, to fulfill this declaration. There are studies in all sectors of the economy and in virtually all countries in the world that show inequality in pay for equal work. Usually, this inequality is based on the gender of the worker. As a rule, men are paid more for the same work than women.

2. State of Art

Inequality in pay for the same work is a frequently analyzed issue in the entire developed world. There are many studies focusing on this issue in the United States (e.g. Duffin, 2020) and in the European Union. Some studies and articles are sector-oriented (e.g. a pay gap among physicians – Ganguli et al., 2020; Cohen et al., 2020), other studies focus on this problem in the entire economy, such as Peters, Drobe, and Abendroth (2020); Maldonado (2020) or analyze earnings in the entire EU (Langmeeser, Orlowski, & Rusek, 2020). The study Bergmann, Scheele, and Sorger (2019) analyzes the gender pay gap in different sectors and compares the situation in two very close European countries – Austria and Germany. As to comparable studies in Slovakia, we can mention, e.g. Mitková (2018), where the author

analyzes the gender pay gap between men and women working in public and private sectors. The ICT sector gender pay gap in Poland is analyzed in Gomolka (2018).

The Czech Republic is no exception; this topic is often analyzed there as well. The Faculty of Business Administration and the Faculty of Informatics and Statistics of the University of Economics in Prague have been focusing on this issue for a long time. Vltavská et al., (2019) analyze the gender pay gap in student earnings and in starting salaries and e.g. article (Forman, 2019) focuses on inequality in pay in the public administration. This article compares data from 2018 from individual ministries of the Czech Republic and concludes that a gender pay gap exists at the central offices of the Czech Republic as well. For instance, elaborations (Marek & Doucek, 2016; Bílková, 2017) analyze the size and changes in the gender pay gap in the Czech economy. Not too many studies tackle the gender pay gap among ICT Professionals in the Czech economy; however, this issue has been analyzed by a group of employees of the Faculty of Informatics and Statistics of the University of Economics for a long time now, e.g. in (Marek & Doucek, 2018; Nedomova, Maryska, & Doucek, 2017; Nedomova & Doucek, 2015; Marek, Doucek, & Nedomova, 2018).

The gender pay gap is also examined by Eurostat that every two years publishes information about its trend. The results from 2018 are provided in Figure 1.

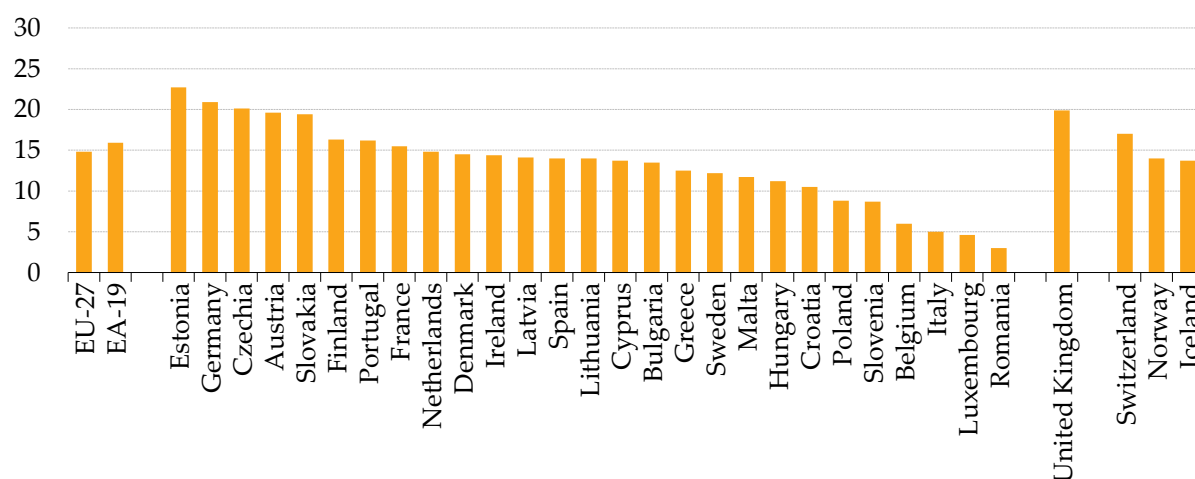


Figure 1. Gender pay gap in average wages in 2018 in EU Member States. Eurostat (2020)

Figure 1 shows that based on Eurostat's data, the Czech Republic is one of the countries with the biggest gender pay gap in the entire European Union – 21.8%. Only Estonia has a bigger gender pay gap than the Czech Republic – 25.3%, while the European Union's average is "only" 16.2%. In their study (Boll & Lagemann, 2014), they try to explain the cause of this gap in individual EU Member States and conclude that the gap in the Czech Republic stems from the economic sector – work description, age and education; however, the biggest part of the gap is referred to in their study as "Unexplained Gap" for which the authors did not find any explanation during their research. We will add to this static view from 2018 (the published data are from 2018) the data in Figure 2, where we show the trend of the gender pay gap in the Czech economy during 2008-2018.

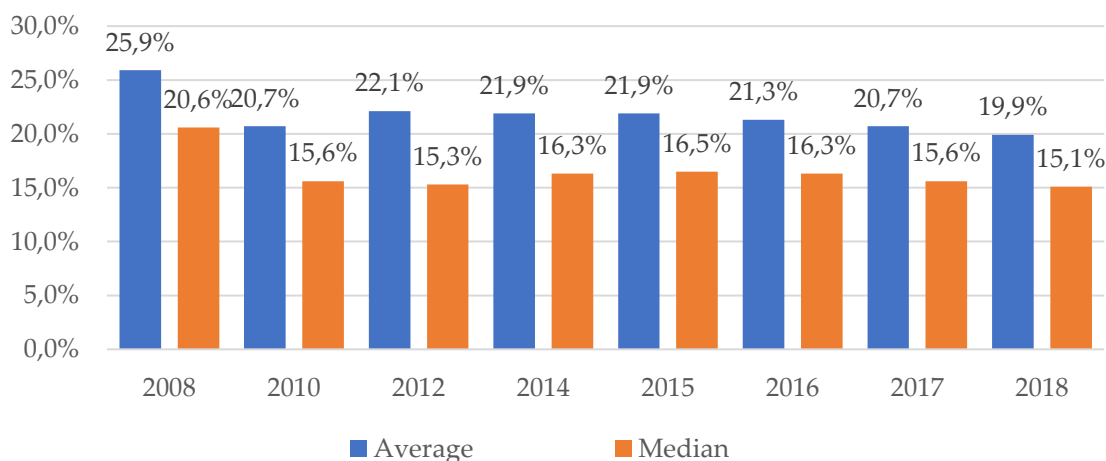


Figure 2. Gender pay gap in 2008-2018 in the Czech Republic. Own processing based on (Úřad vlády České republiky, 2018)

The gender pay gap in 2016 differs from that of Eurostat by 0.5 percentage point, yet we can see that it is significant, in spite of this inconsistency. We can clearly see that the gap in average wages diminishes by 6 percentage points but the gap in median wages oscillates between 15 and 16%, even though it diminished in the past three years, even if only by 0.8 percentage point. As compared to 2008, this gap represents 5.5 percentage points. It is, however, a gap for the entire Czech economy. Nevertheless, our goal is to analyze the gender pay gap among ICT Professionals and its trend in the Czech Republic. For the purposes of our research, we have formulated the following research questions:

RQ1: What was the trend of the gender pay gap among ICT Professionals in the Czech Republic during 2008-2019?

RQ2: What was the trend of the gender pay gap in the two groups of ICT professions in the Czech Republic during 2008-2019?

3. Methodology

To answer these research questions, we used the methods that can be divided into the following three areas:

- Input research data and their collection;
- Classification of ICT professions; and
- Data analysis.

3.1 Input Research Data and Their Collection

The input data file that we used for our analysis comes from Trexima, a.s. that processes the AEIS (Average Earnings Information System) on a yearly basis (ISPV, 2020). The survey is harmonized with the European Union's structural survey called "The Structure of Earnings Survey" conducted based on Commission Regulation no. 1916/2000. This file contains data about earnings in the second quarter of each year because it includes the highest number of available workhours and a minimum number of national holidays and thus these earnings

reflect the most the basic salaries of wages. The main monitored indicators in terms of earnings include gross monthly wages and hourly earnings. In addition to gross monthly wages, we also analyzed different wage components, i.e. bonuses, extra pay and reimbursements. We also analyzed the number and structure of workhours, e.g. overtime and hours not worked, e.g. sickness and vacation. The administrator of the Average Earnings Quarterly Survey is the Ministry of Labor and Social Affairs (MLSA). In our analyses, we worked with a sample of data for ICT Professionals ranging from 21,950 records in 2008 to 60,439 records in 2018.

3.2 Classification of ICT Professions

When analyzing wages and salaries in ICT, it is very important to divide employees into groups based on their performed work. To do so, we used the CZ-ISCO classification (CZSO, 2020a) that breaks down ICT Professionals into the following two main groups:

- ICT Specialists (CZ_ISCO 25) and
- ICT Technicians (CZ_ISCO 35).

ICT Specialists (CZ_ISCO 25) mostly perform creative work. In most cases they are creative workers with a university education – a bachelor's or a master's degree. Their work description usually includes ICT research, planning, design, complete application testing or partial program testing, consultations, improvement of IT systems, their hardware and software; processing of related documentation, including principles, policies and procedures; design, development, checking, maintenance and the support of operation of databases and other information systems to ensure optimal performance and data integrity and security (CZSO, 2020a).

ICT Technicians (CZ_ISCO 35) represent a group of professions with less creativity and this is why they usually have a high school education with technical specialization. Their work description usually includes the support of regular operation of computer and communication systems and networks, performance of technical tasks related to telecommunications and the transmission of image and sound and other types of telecommunication signals (CZSO, 2020a).

3.3 Data Analysis

The data from the survey on wages and salaries in the Czech Republic from 2008-2018 had to be first adjusted for inflation – the annual inflation rates during the analyzed years are provided in Table 1. We converted the wage data to the 2008 base, using the annual inflation rate coefficients, which became the comparative base for our further analyses.

Table 1. Annual inflation rate in the Czech Republic and annual average CZK/EUR exchange rate.
Own processing based on (CZSO, 2020b; CNB, 2020)

Item/Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Inflation Rate	6.3%	1.0%	1.5%	1.9%	3.3%	1.4%	0.4%	0.3%	0.7%	2.5%	2.1%	2.8%
CZK/EUR	24.94	26.45	25.29	24.59	25.14	25.97	27.53	27.28	27.03	26.33	25.64	25.67

To achieve data comparability, it was also necessary to convert the wages and salaries shown in source data in Czech Crowns to EUR. For this conversion, we used average annual exchange rates that are also provided in Table 1.

We used the average of converted monthly gross wages.

The median better reflects the reality on the Czech labor market because the average is very often influenced by a very high income in the group of workers whose monthly income is over 4,000 EUR; unfortunately, we did not have the median income for the entire analyzed period. This category represents about 1.5% of the analyzed records in 2019 and their percentage in the analyzed data goes up every year. To compare income and to identify the gender pay gap, we chose two criteria – age and education. For the comparison by age, we chose three age groups – up to 30, 30-50 and over 50. For the comparison by education, we used the following categories - high school(H_S), university – bachelor (Bc), master (Master) and doctoral (Ph.D.). We did not use elementary and vocational education because such education is not really represented in the professions of ICT Professionals.

The data adjusted for inflation and converted to EUR were then processed and analyzed, using MC Excel tools and statistical functions for analyzing time series. To approximate the trend of wages, we used the method of linear regression together with the method of least squares. In the method of linear regression, we used the general function $y = ax + b$, where a represents the identified trend during the analyzed time period. All performed regression analysis calculations are at the 5% confidence level.

4. Results & Discussion

The first results that we achieved in our gender pay gap research included information about how many ICT Professionals worked in the Czech economy. Figure 3 shows ICT Professionals' number and share on the number of economically active people over time.

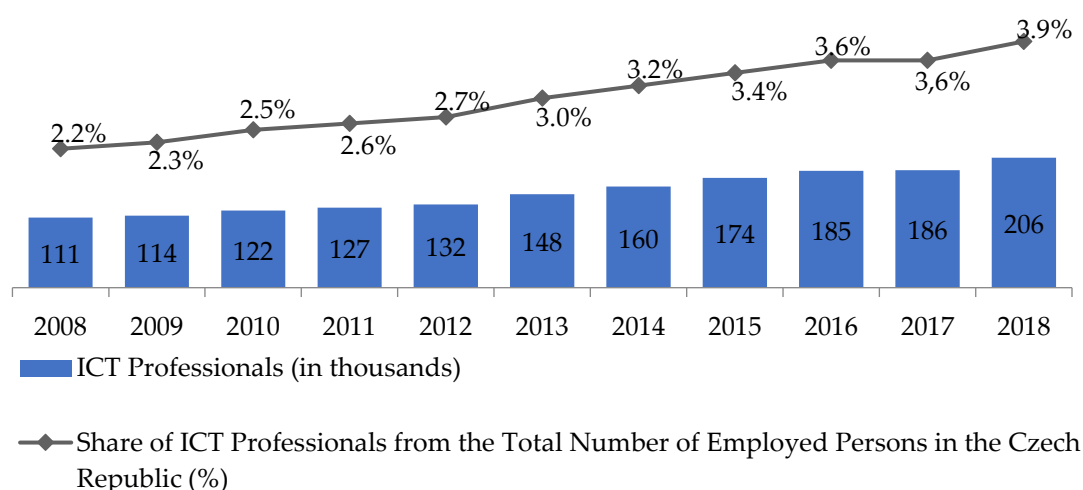


Figure 3. Ratio Between the Number of ICT Professionals and the Total Number of Workers in the Czech Republic. Own processing based on (CZSO, 2020c)

The practically constantly growing number of ICT Professionals and their share on the number of employees in the Czech economy show that the penetration of ICT into the

economy as a whole is also growing. The goal of this article is not to find out whether or not their number is sufficient. One thing is their total number, another thing is the percentage of women in total and in individual groups of profession. The trend of these data is shown in Figure 4.

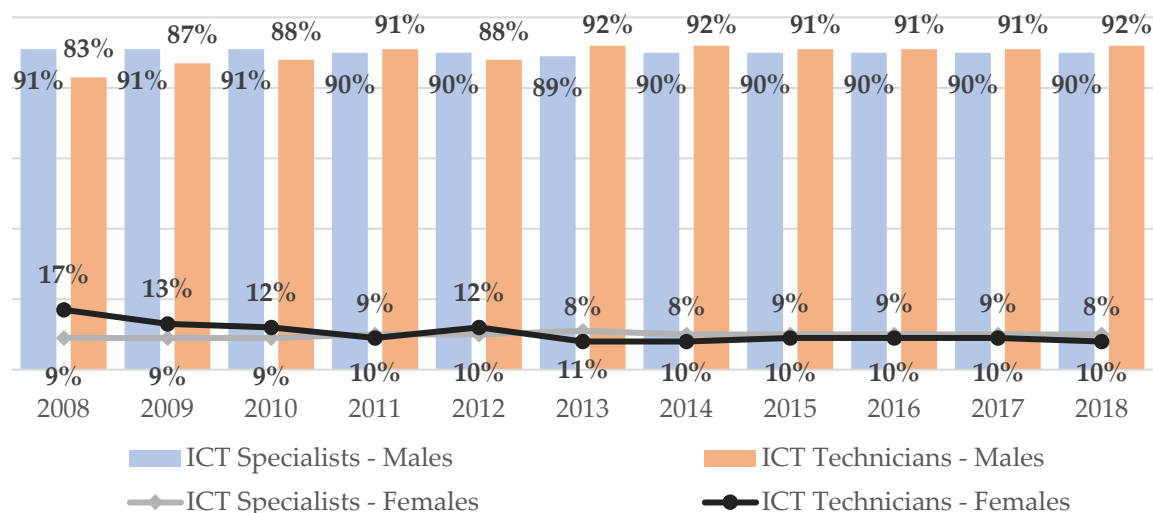


Figure 4. Ratio of Number of ICT Professionals based on the Sex and Profession authors, sources: (CZSO,2020c)

Figure 4 shows that female ICT Specialists during the analyzed time period represented 10% and female ICT Technicians 8%, which is even less by two percentage points. Thus, women in the category of ICT Professionals are a significantly minority group. Their income as compared to men's income is discussed below.

The gender pay gap among ICT Professionals is provided as an aggregate characteristic in Figure 5.

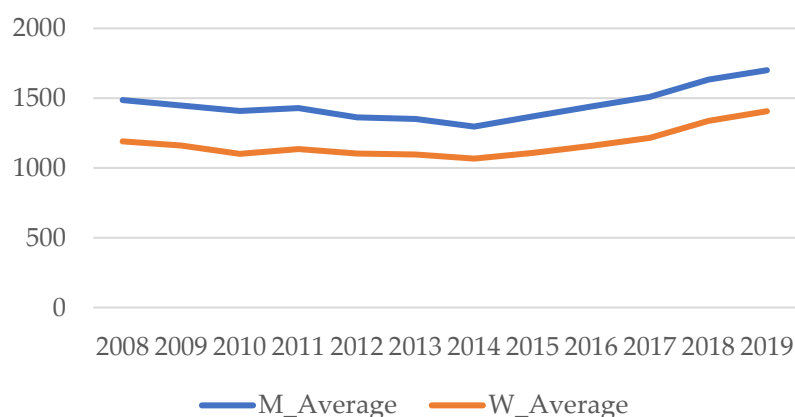


Figure 5. Income of female and male ICT Professionals – average and median. Own processing based on (Trexima, 2020)

Figure 5 clearly shows the gender pay gap because the average gross wages of women are significantly lower than the wages of men. Furthermore, it is clear from Figure 5 that the wages of ICT Professionals were permanently going up starting in 2014. The gender pay gap is shown in Figure 6.

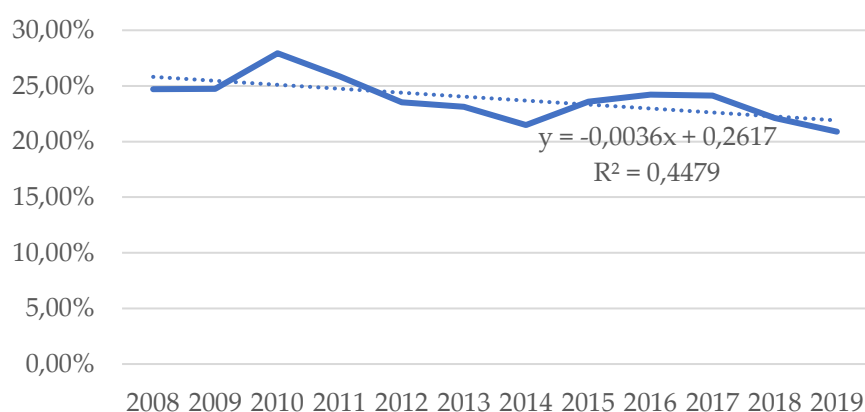


Figure 6. Trend of the gender pay gap among ICT Professionals – average. Own processing based on (Trexima, 2020)

Figure 6 shows the percentage changes in the gender pay gap during the analyzed time period. We can see that the gap in **average wages dropped from 24.70% to 20.90% – i.e. by 3.8 percentage points**. The approximation of the trend of the gender pay gap using the linear function shows a very slowly decreasing trend (the slope is -0.0036, the confidence level of the estimate is not very high, only 44.8%). Based on this trend, the gender pay gap would disappear in approximately 72.7 years. Over the last three years, the gender pay gap has been diminishing faster.

The increase in the gender pay gap in 2010 was caused by a higher share of the business sector in the data sample.

RQ1: What was the trend of the gender pay gap among ICT Professionals in the Czech Republic during 2008-2019?

The gender pay gap among ICT Professionals shows a decreasing trend. This trend is in line with the overall policy of both the EU and the Czech Republic. However, the decreasing rate of this negative phenomenon is very small. Despite this decrease, the gender pay gap in average wages is still higher than that in the entire Czech economy, e.g. in 2018, the gender pay gap in the Czech economy was 19.9%, while it was 22.12% among ICT Professionals.

3.1 Gender Pay Gap by Age

Age is one of the two factors that we used to analyze the gender pay gap. We will analyze it in greater depth, breaking it down to ICT Specialists and ICT Technicians.

ICT Specialists - ISCO 25

Figure 7 shows the trend of the gender pay gap among ICT Specialists.

Our findings are quite surprising. In general, the gender pay gap decreased starting in 2008 in all three categories. The biggest gender pay gap equality is among young ICT Specialists under the age of 30. The main reason is that due to the lack of ICT Specialists on the Czech market, new employees are hired under the same conditions. The decrease in this category represented a total of 9.88 percentage points during the analyzed time period! We can see a decreasing trend in the last year as well. The gender pay gap among ICT Specialists aged between 30 and 50 decreased during the analyzed time period by 6.93 percentage points. The gender pay gap among ICT Specialists over 50 decreased during the analyzed time

period by 8.38 percentage points, although it slightly increased during the last year. The overall trend during the analyzed time period shows a decrease in the gender pay gap among ICT Specialists.

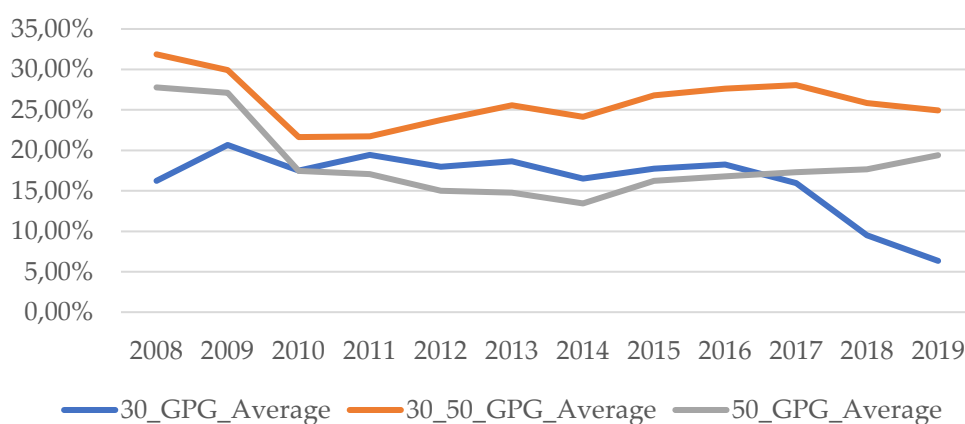


Figure 7. Trend of the gender pay gap among ICT Specialists – average wage. Own processing based on (Trexima, 2020)

ICT Technicians - ISCO 35

Figure 8 shows the trend of the gender pay gap among ICT Technicians.

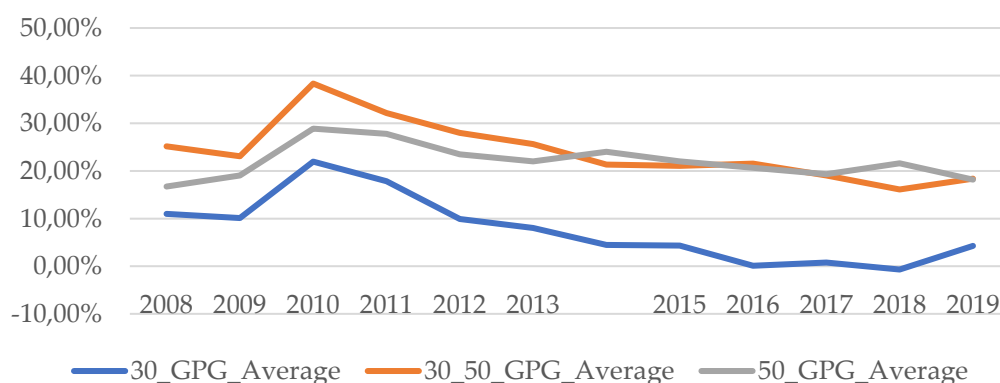


Figure 8. Trend of the gender pay gap among ICT Technicians – average wage. Own processing based on (Trexima, 2020)

The trend of the gender pay gap among ICT Technicians by age shows a decrease in two age groups. Important is mainly the decrease all the way to 0% among young ITC Technicians under 30. The increase in 2019 to 4.28% is not very significant in view of the overall trend. We can see a very similar trend in the age group between 30 and 50, where the gender pay gap during the analyzed time period decreased by 6.85 percentage points – from 25.20% to 18.38% in 2019. The only negative thing is the increase in the gender pay gap in the age group over 50 by 1.47 percentage points. Overall, ICT Technicians show a positive trend towards reducing the gender pay gap, especially in the younger age group.

3.2 Gender Pay Gap by Education

We also analyzed the trend of the gender pay gap in terms of achieved education. As mentioned in the methodology, we identified four levels of education for which we

performed our data analysis. Our data analysis is interesting at first glance for two reasons. First of all, there was a minimum number of ICT Professionals with a bachelor's degree on the Czech labor market in 2008 and 2009. A large number of graduates based on the Bologna Declaration (three years of IT education to obtain a bachelor's degree and two years to obtain a master's degree) did not appear on the Czech labor market until 2010. Another interesting finding is that the number of employees with a PhD degree is so low (dozens as compared to thousands in other categories) that even a randomly selected individual can very significantly influence the average wage and thus the gender pay gap.

ICT Specialists - ISCO 25

The data are provided in Figure 9.

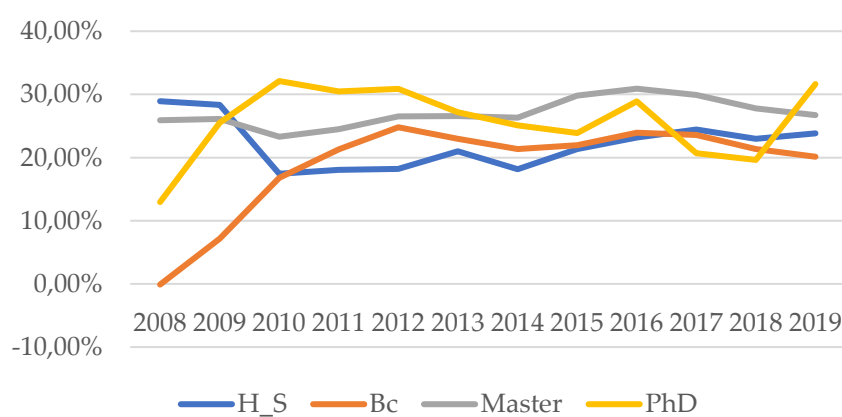


Figure 9. Trend of the gender pay gap among ICT Specialists by education – average wage. Own processing based on (Trexima, 2020)

We will mainly look at the trend of the gender pay gap among ICT Specialists with high school education, a bachelor's degree and a master's degree that our data analysis shows. ICT Specialists with high school education show a significant decrease in the gender pay gap in 2010 to 17.44%. This decrease by 10.89 percentage points is a result a change in the sample, in which the number of records from the non-business sector increased at the expense of those from the business sector. Subsequently, the gender pay gap increased to 23.94% in 2019. The gender pay gap among ICT Specialists with a bachelor's degree shows a slightly growing trend by 3.33 percentage points starting in 2010 and the gender pay gap among ICT Specialists with a master's degree shows an increase by 0.81 percentage point during the entire analyzed time period. We did not analyze the trend of the gender pay gap among ICT Specialists with a PhD degree due to the small amount of data.

ICT Technicians - ISCO 35

The gender pay gap among ICT Technicians is analyzed in Figure 10.

This analysis shows an increase in the gap in average wages during the analyzed time period. ICT Technicians with high school education are the only category where the gender pay gap dropped by 0.61 percentage point. ICT Technicians with a bachelor's and master's degree show the biggest gap that is about the same – approximately 25%.

We did not analyze the trend of the gender pay gap among ICT Technicians with a PhD degree due to the small amount of data.

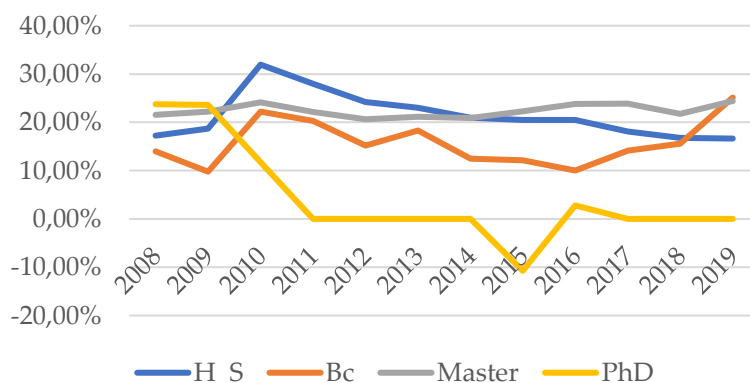


Figure 10. Trend of the gender pay gap among ICT Technicians by education – average wage. Own processing based on (Trexima, 2020)

RQ2: What was the trend of the gender pay gap in the two groups of ICT professions in the Czech Republic during 2008-2019?

Table 2 shows the result of our analysis of the gender pay gap by age.

Table 2. Gender pay gap among ICT Professionals by age. Own processing based on (Trexima,2020)

	Category	ICT Specialists	ICT Technicians
Age	under 30	-9.88%	-6.68%
	30-50	-6.95%	-6.85%
	over 50	-8.38%	+1.47%

Our analysis by age shows a decrease in the gender pay gap practically in all categories. A very significant change is an almost non-existing gender pay gap among young, newly hired ICT Technicians, which was almost zero during 2016-2018 (it was actually negative in 2018). ICT Specialists also show the lowest gender pay gap in the age group under 30. The overall highest gender pay gap exists in the age group between 30-50 among both ICT Specialists and ICT Technicians.

Table 3. Gender pay gap among ICT Professionals by achieved education. Own processing based on (Trexima,2020)

	Category	ICT Specialists	ICT Technicians
Education	High school	-5.08%	-0.61%
	Bachelor's degree	+3.23% since 2010	+11.13%
	Master's degree	+0.81%	+ 2.84%
	PhD	Not analyzed	Not analyzed

The analyzed trend of the gender pay gap by achieved education is not as unambiguous as that by age. Overall, we can say that our analysis shows a growing gap in the average wage of women and men, with the exception of those with high school education, where the gap is very slowly diminishing. ICT Specialists with a bachelor's degree show the highest increase because a bachelor's degree in ICT was not common until after 2010. Up until then, the

number of ICT Specialists with a bachelor's degree was very small and this is why we did not analyze the years 2008 and 2009.

4. Conclusion

When analyzing the average wages in ICT Professionals in order to describe the trend of the gender pay gap, we identified a gradual decrease in the gap in the average gross wage of women and men - the answer to RQ1. The negative result of our analysis is that the decrease in this gap among ICT Professionals is slower than that in the entire Czech economy.

The gender pay gap among Czech ICT Professionals in terms of age and achieved education provides the answer to RQ2. The very positive finding is that the gender pay gap among young workers under the age of 30 dropped to almost zero during the analyzed time period and is about 5% in both groups of ICT Professionals.

When analyzing the data, we felt that it was necessary to expand the analyzed dimensions of the gender pay gap for the sector in which ICT Professionals work. The structure of data used for the analysis has an impact on average wages and thus on the entire gender pay gap. The percentage of records from the business sector and the non-business sector is important. We will take the impact of this dimension into account in our next research.

Another factor that could (and should in the context of the Czech Republic) have an impact on the gender pay gap is the difference between Prague or Central Bohemia and other regions, especially the border regions in the north of the Czech Republic. We could take the number of IT Specialists in individual regions into account in our analyses.

In addition, we would like to also take into account the impact of Covid-19 on the gender pay gap and to analyze the average wage of ICT Professionals in this context.

Acknowledgments: Paper was processed with support from institutional-support fund for long-term conceptual development of science and research at the Faculty of Informatics and Statistics of the University of Economics, Prague (IP400040).

References

- Bergmann, N., Scheele, A., & Sorger, C. (2018). Variations of the same? A sectoral analysis of the gender pay gap in Germany and Austria. *Gender, Work & Organization*, 26(5), pp. 668-687. <https://doi.org/10.1111/gwao.12299>
- Bílková, D. (2017). Vývoj genderové mzdové nerovnosti v České republice za posledních 20 let. *Politická ekonomie*, 65(5), 623-646. <https://doi.org/10.18267/j.polek.1167>
- Boll, C., & Lagemann, A. (2019). The Gender Pay Gap in EU Countries – New Evidence Based on EU-SES 2014 Data. *Intereconomics*, 54(2), 101-105. <https://doi.org/10.1007/s10272-019-0802-7>
- Cohen, M., & Kiran, T. (2020). Closing the Gender Pay gap in Canadian Medicine. *Canadian Medical Association Journal*, 192(35), E1011-E1017. <https://doi.org/10.1503/cmaj.200375>
- Duffin, E. (2020). *Female to male earnings ratio of workers in the United States from 1990 to 2019*. <https://www.statista.com/statistics/203459/female-to-male-earnings-ratio-of-workers-in-the-us/>
- CNB Česká národní banka. (2020). *Kurzy devizového trhu*. https://www.cnb.cz/cs/financni-trhy/devizovy-trh/kurzy-devizoveho-trhu/kurzy-devizoveho-trhu/prumerne_mena.html?mena=EUR
- CZSO Český statistický úřad. (2020a). *Klasifikace zaměstnání (CZ-ISCO)*. https://www.czso.cz/csu/czso/klasifikace_zamestnani_-cz_isco-
- CZSO Český statistický úřad. (2020b). *Inflace - druhy, definice, tabulky*. https://www.czso.cz/csu/czso/mira_inflace

- CZSO Český statistický úřad. (2020c). *IT odborníci*. <https://www.czso.cz/csu/czso/ict-odbornici>
- Eurostat. (2020). *Gender pay gap statistics*. https://ec.europa.eu/eurostat/statistics-explained/index.php/Gender_pay_gap_statistics
- Forman, M. (2019). Gender Pay Gap in the State Administration of the Czech Republic. In O. Dvouletý, M. Lukeš, & J. Misař (Eds.), *Proceedings of the 7th International Conference Innovation Management, Entrepreneurship and Sustainability (IMES 2019)* (pp. 208-219). Prague University of Economics and Business. https://imes.vse.cz/wp-content/uploads/2019/07/Conference_Proceedings_IMES_2019.pdf
- Ganguli, I., Sheridam, B., Gray J., Chernew, M., Rosethal, M. B., & Nerpash, H. (2020). Physician Work Hours and the gender Pay Gap -Evidence for Pirmary Care. *New England Journal of Medicine*, 383(14), 1349-1357. <https://doi.org/10.1056/NEJMsa2013804>
- Gomolka, A. (2018). Gender Pay Gap in the ICT Sector in Poland in 2010-2016. In R. Veselica, G. Dukic, & K. Hammes (Eds.), *Proceedings of the 36th International Scientific Conference on Economic and Social Development (ESD) - Building Resilient* (pp. 813-822). Varazdin Development & Entrepreneurship Agency. https://www.esd-conference.com/upload/book_of_proceedings/Book_of_Proceedings_esdZagreb2018_Online.pdf
- ISPV. (2020). *Informační systém o průměrném výdělku*. <https://www.ispv.cz/>
- Landmesser, J., Orłowski, A. J., & Rusek, M. A. (2020). Gender Pay Gap Across the Income Distribution: Analysis for the EU. *Acta Physica Polonica*, A.138, 31-40. <https://doi.org/10.12693/APhysPolA.138.31>
- Maldonado, L. (2020). Decomposing the gender pay gap in the formal sector in Venezuela: a microdata analysis 1985–2015. *Applied Economics Letters*, 1-8. <https://doi.org/10.1080/13504851.2020.1784830>
- Marek, L., & Doucek, P. (2016). Vývoj mezd a příjmové nerovnosti u ICT odborníků v České republice. *Politická ekonomie*, 64(8), 922-938. <https://doi.org/10.18267/j.polek.1118>
- Marek, L., & Doucek, P. (2018). The Wages of Male and Female ICT Managers in the Czech Republic and the Slovak Republic. In K. S. Soliman (Ed.), *Proceedings of the 32nd Conference of the International-Business-Information-Management-Association (IBIMA) – Vision 2020: Sustainable Economic Development and Application of Innovation Management from Regional expansion to Global Growth* (pp. 3525-3533). Int. Business Information Management Assoc-IBIMA. <https://ibima.org/accepted-paper/the-wages-of-male-and-female-ict-managers-in-the-czech-republic-and-the-slovak-republic/>
- Marek, L., Doucek, P., & Nedomová, L. (2018). Development of ICT Professional Wages in Czech Republic. In P. Doucek, G. Chroust, & V. Oškrdal (Eds.), *Proceedings of the 26th Interdisciplinary Information Management Talks - IDIMT-2018 Strategic Modeling in Management, Economy and Society* (pp. 49-56). Trauner Verlag Universität. https://idimt.org/wp-content/uploads/proceedings/IDIMT_proceedings_2018.pdf
- Mitková, L. (2018). Occupational Segregation and Gender Pay Gap in Slovakia. In K. S. Soliman (Ed.), *Proceedings of the 31st International Business Information Management Association Conference (IBIMA) – Innovation Management and Education Excellence Through Vision 2020* (pp. 5023-5030). Int. Business Information Management Assoc-IBIMA. <https://ibima.org/accepted-paper/occupational-segregation-and-gender-pay-gap-in-slovakia/>
- Nedomova, L., & Doucek, P. (2015). Gender Aspects in ICT. In C. Niculescu, O. D. Negoita, & B. Tiganoaia (Eds.), *Proceedings of the 7th International conference of management and industrial engineering – Management – Key Driver for Creating Value* (pp. 508-516). University Politehnica Bucharest.
- Nedomova, L., Maryska, M., & Doucek, P. (2017). Unequal wage of men and women in ICT in the Czech Republic? *Gender, Technology and Development*, 21(1-2), 116-134. <https://doi.org/10.1080/09718524.2017.1385317>
- Peters, E., Drobe, J., & Abendroth, A. (2020). Equality Through Equal Opportunity Policies? Workplace Mentoring Programs, Female Quotas, and the Gender Pa Gap within German Workplaces. *Kolner Zeitschrift fur Soziologie und Sozialpsychologie*, 72(2), 225-263. <https://doi.org/10.1007/s11577-020-00695-y>
- Úřad vlády České republiky. (2018). *Zpráva za rok 2018 o rovnosti žen a mužů*. https://www.vlada.cz/assets/ppov/rovne-prilezitosti-zen-a-muzu/dokumenty/Material---Zprava-za-rok-2018-o-rovnosti_FINAL.pdf
- Vltavská, K., Mazouch, P., Juříková, K., & Lorencová, Š. (2019). Gender Pay Gap among University Students and Graduates: The Comparison of the Expectations and the Reality. In J. Fejfar, M. Fejfarova, M. Flegl, & I. Krejčí (Eds.), *Efficiency and Responsibility in Education 2019 (ERIE)* (pp. 310-315). Czech University of Life Sciences Prague. <https://erie.v2.czu.cz/en/r-14822-proceedings-2019>
- Whitehouse, G., & Smith, M. (2020). Equal pay for work of equal value, wage-setting and the gender pay gap. *Journal of Industrial Relations*, 62(4), 519-532. <https://doi.org/10.1177/0022185620943626>

Business Networking as a Tool of the Information and Knowledge Management of the Owners of Small and Middle Enterprises – Case of Study

Lucie NOVOTNA

University of Hradec Kralove, Hradec Kralove, Czech Republic, lucie@vzdelavacka

Abstract: This article sums up the results of my research and qualitative expert interviews with owners of small and medium-sized enterprises active in the Czech Republic. The qualitative sample of these interviews includes respondents through the whole field spectrum of entrepreneurial activities, which are enabled by the Trade Licencing Office of the Czech Republic and are classified in the CZ-NACE database. This research took place during the world COVID-19 pandemic when the strictest measures were adopted in the Czech Republic concerning grouping, entrepreneurship, and movement. The research also sums up the short-term and the long-term change ratio of offline and online networking and information tools, which occurred in individual companies because of these measurements. The research shows an interconnection of the management discipline of information and knowledge management and networking as tools of marketing, HR, business, and building of client-supplier networks, which create sources for companies, enhance their competitiveness and lower the risk of company closures in the time of economic boom as well as crisis.

Keywords: business networking; information and knowledge management; expert interview; COVID-19; small and middle-sized entrepreneurs

JEL Classification: D01; M21; M31

1. Introduction

Business Networking is a strategic behaviour of a company, which purposefully and regularly wins new contacts for its development and keeps existing contacts over a long period. Business networks are complex networks of reciprocally dependent exchange relations, in which companies and individual managers act. They consist of various involved persons, complicated interactions, and organisational structures, and processes of resource transformations (Henneberg et al., 2010). Russian and Finnish authors claim that an enterprise is not an island and is very dependent on its relationships. Relationships influence the given enterprise's success as well as failure. Relationships exist in dyads and as such, they form networks. (Ivanova-Gongne & Torkkeli, 2018). The contact sphere of a company is generally divided into client base, supplier contact chain, and partner companies or organisations. All these contacts create the company's environment and build a contact network with ties, which can have different depth and worth for the given company. Although companies act as units, when taking part in business networking activities, the

connections and relationships are based on the individual company employees. Ordinarily, it is the owner of a company, who performs business networking activities, as he/she has the greatest range of engagement and motivation for the growth and development of his/her company. These activities can be fulfilled by managers, who are appointed by the company owners, this model is seen within bigger or corporate businesses. In the case of the companies from the SME category, the owners are mostly the ones, who create networking activities and thus build local networks (Kubberød et al., 2019). Smaller companies do business networking often intuitively, they do not specifically create tools and conditions for measuring the benefits of these activities. Bigger companies (concerning their return, number of employees, length on the market, the volume of knowledge, and experience) often assign managers, who have clearly set goals, which they want to reach against the investment into such activities. Business networking, whether online or offline, is time-consuming. To activate a network of contacts for a company and get it ready to continuously deliver contracts, first-rate suppliers, information, knowledge, and further education, the company must keep in touch with individual contacts in its network. It is vital to keep positive reciprocal relations (interest in the needs of customers, suppliers, and business partners). "Successful building of networks among the players in any single relationship depends on their ability to efficiently create networks in other relationships. Networks are diverse and unique. Each participant sets his/her goals according to a unique manner. A business network is not a market. A business network is an arena, in which interdependent actors interconnect uniquely, and the business network adapts a wide variety of practices and structures within and among actors. All business players will be most probably willing to control their interactions with others, however, none of the business players has resources, skills, or knowledge to manage this perfectly." The practice of building new business networks remains a relatively unresearched field (Ford & Mouzas, 2013).

Business networking is a specific name for the better-known expression: networking. A Bangladeshi study in the field of the clothing industry, focusing on relationships in networks, innovativeness of business processes, and performance of export confirms the direct impact of networking on innovations. "The form of building networks (personal, intercompany) has a direct impact on business process innovations and the export performance" (Faroque et al., 2017). Networking or the creation of active networks is not only a specific skill for an entrepreneurial environment, networking is generally used in IT, HR, and also in many sport and leisure activities. We can say that a family also builds a network of contacts. An interesting part of my research are the connections and relations between networking and information and knowledge management as disciplines of modern science and management practice. Networking simplifies gaining knowledge, skills, and resources vital for the company's development and its survival, which would otherwise be difficult to obtain. Small and middle enterprises profit the most from creating networks, as they often lack sufficient resources and knowledge to deal with the environment, in which they operate. As small and middle enterprises often do not have sufficient in-house knowledge and resources, it is important to actively build and maintain proper networks to effectively gain needed resources" (Schoonjans et al., 2011).

Information and knowledge management has a broad spectrum of characteristics and definitions. One of the first authors, who focused on information and knowledge management in its current form was Mihály Polanyi. He talks about production factors as production limitations and he sees productivity and innovation in the man's ability to apply knowledge in the production process, he introduces the expression Knowledge worker (Tallinn University, 2010). "Knowledge management focuses on systematic approaches to searching, understanding, and using knowledge to create values" (Bureš, 2007). "Knowledge management means giving the right knowledge to the right people at the right time to enable them to make the best decisions" (Petrash, 1996). "Knowledge management is a process of identification, growth and efficient usage of existing in-house knowledge to reach the company's goals, and simultaneously build organisation culture, which enables further knowledge creation" (Susanssee, 2002). The basis of the KIM is the general scheme of hierarchy and creation of data, information, knowledge in pursuance of understanding and relations. A detailed explanation can be seen in Table 1 and Figure 1.

Table 1. Data, Information, Knowledge, Understanding, Wisdom. Adapted from and adjusted according to (Bureš, 2007).

Concepts	Explanation
Data	Symbols
Information	Data including answers to the questions: who? what? where? when?
Knowledge	The ability to use information in order to answer the question: how?
Understanding	The ability to answer the question: why?
Wisdom	To ask oneself questions, which are not easy to answer, to see the good and the evil, morality, principles

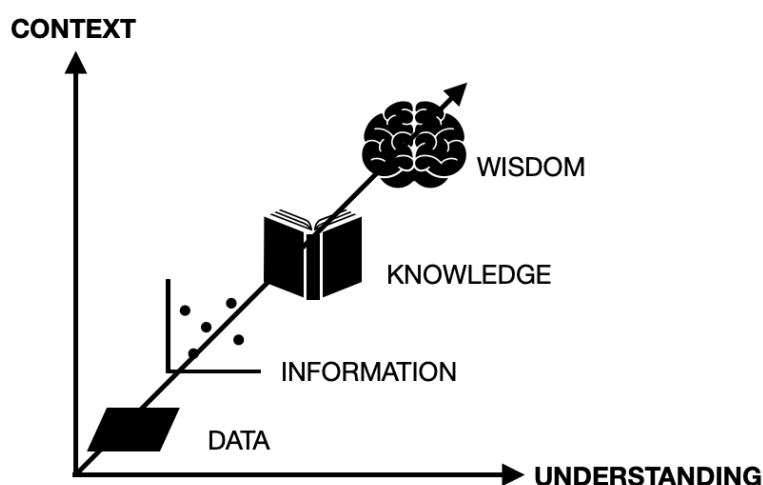


Figure 1. Data, information, knowledge, wisdom.

2. Methodology

The method of systematic research as per Prisma standards was used in my research (Prisma, 2021). Another method was expert interviewing via the online platform ZOOM (Prisma, 2021). An oral agreement has been given to all the expert interviews and the sound

form (Mp3), as well as the video form (Mp4), were recorded. The respondents are owners of small and middle-sized enterprises, who conduct business in various industries in the Czech Republic. The qualitative expert interview contains 16 interviews. In an expert interview, there are 9 question sets, 7 sets include on average 6 sub-questions, the 8th set examined the awareness of claims about networking and information and knowledge management. The 9th set served for the respondents' suggestions.

3. Results

Each expert interview lasted on average 80 minutes and the total net time of the interviews took over 1,280 minutes, i.e. 21 hours of net time, which were recorded on sound and video footage. The following results emerged from the expert interviews.

- Set of general questions,
- Information and knowledge management set,
- Networking basics set,
- Working with contacts,
- Offline networking,
- Online networking,
- Changes in tools in the time of COVID-19 pandemic,
- Set of YES/NO questions, claims,
- Additional information.

The set of general questions brings an overview about respondents of the qualitative research. 38% of the respondents (owners of small and middle enterprises) are own-account workers, 63% of the respondents in my research are owners of Juridical persons. 75% of the respondents have a university degree and 25% have secondary or vocational education. The respondents conduct business in the field of advocacy, IT technologies, the tourist industry, education and consulting, handcraft, finance, event agency, civil engineering, and accounting. 44% of the respondents have been active in their field of business for 5-10 years, 13% of respondents 10-15 years and 44% of respondents have been active for more than 15 years. 44% of the respondents own a company with up to 5 employees, 6% of the respondents own a company with up to 20 employees, 6% up to 50 employees, and 44% of the companies in my research employ over 50 people. 62% of the respondents have a given vision and company goals in writing and 37% of the respondents have a vision and company goal given verbally or none at all (19%).

The Information and knowledge management question set brought the following results. 44% of the respondents are aware of the core of the information and knowledge management and 56% of the respondents heard about this discipline for the very first time. 81% of the respondents were able to hierarchically sort the expressions – data, information, knowledge, wisdom. The most frequently confused expressions were data and information. An interesting trend in the research showed the non-existing connection between networking and information and knowledge management. The respondents generally gain information and knowledge from their own company experience with their clients, a smaller group gets

information from the internet, social networks, also from professional website and conferences, a smaller group from podcasts and books (e-book as well as print books). Only one of the respondents has a subscription for scientific articles from Oxford University, which are offered to the public against payment. None of the respondents stated to get information and knowledge dominantly from networking activities, after an additional question if they acknowledge networking as a tool to obtain information and knowledge, 81% of the respondents answered with a significant yes. Networking belongs to an important channel of information and knowledge for their business.

The Networking basics question set is displayed in Table 2. Many of the respondents do not perceive networking as a one-time and coincidental action but as a systematic and long-term activity. In Table 2, there are answers, how the respondents characterise networking and how they would translate this expression into the Czech language. Many of the respondents use the word network, regularity, contacts, maintaining relationships, connecting, the social aspect. The respondents are aware of the types of networking, they mention online and offline networking activities and they also distinguish networking according to its goal – professional and interest networking, managed and coincidental networking, thematic networking.

The respondents know two or three companies or organisations from their inland, which focus on professional networking activities. Minimum of the respondents possesses knowledge of networking companies abroad. Except for two private companies, the respondents name generally chambers and societies, which primarily have the goal to connect interest groups. It was usually the entering to business, when the respondents heard most often about business networking and they realized that it is necessary to find a tool and mechanism for generating income and maintaining contacts, which are vital for a functional company. 94% of the respondents use networking to develop their careers or to find employees for their team. Systematic education in networking as a skill undergo 43% of the respondents and thus often as being a part of a business club, where education in the field of networking belongs to the customer service.

The question set Care of contact sphere of the given companies shows that 75% of the respondents have a strategy how to take care of existing contacts. Work time, which the owners of small and middle enterprises from my research dedicate to work with contacts is in the following ratio. 0% of time devote to work with contacts 6% of the respondents, up to 10% of the time 13% of the respondents, up to 20% of the time goes for 25% of the respondents, up to 30% of work time 25% of the respondents, up to 40% of the worktime 0% of the respondents, up to 50% of the time 19% of the respondents, over 50% of the time 12% of the respondents. The question of maintaining companies' contacts showed the following results. Contacts in paper form are found by 6% of the respondents, contacts in e-mail or phone book by 31%, in a database by 19%, and in a CRM system by 44% of the respondents.

Table 2. Respondents' answers to networking.

Description of the expression Networking	Translation of the expression Networking
A targeted systematic building of relationships in business as well as non-business activities.	Building of contact networks.
Making and maintaining contacts.	Contact networking.
Creating network of contacts (relationships), connection, part of something, mutuality.	Building and supporting contacts, networking.
Connecting people based on common interest.	Network.
Connecting people (companies) for the purposes of education and contacts and business, social events in case of both.	Contact networking.
A network of contacts, which can help each other reciprocally, a mutual connection of people.	Network of people, who work together.
Socialisation for the purposes of getting contacts and information and experience exchange, and business development.	Networking.
Creating relationships, where mutual enrichment and sharing happen.	Purposeful creating of relationships.
Opportunity to obtain information, contacts, and inspiration.	Spider's net, you catch intentionally and unintentionally <u>information, contacts, opportunities.</u>
A business club, regular meetings, collective training from companies.	Mutual education.
A safety net for opportunities.	Connecting people among each other.
Purposeful creating of relationships with third parties, with the motivation and goal of receiving new contacts, doing business or its arrangement or just cognition.	Establishing of relationships.
Bonding people, establishing trust. Information-knowledge basis of creating.	Establishing of relationships
It is using other people's contacts, creating a broad social tie.	Social ties.
Establishing a contact portfolio and building relationships within the portfolio.	Camaraderie, I help you and you help me, make friends.
Regular meetings with value and depth with people who share interests or fields. Networking enables meetings, sharing of information and contacts, education.	Networking, joining networks and communities, which have a common interest or goal.

Offline networking means for the respondents mostly a personal meeting, a form of live action, a business club, or a professional chamber. Online networking means for the respondents a form of a meeting or event via web platforms – ZOOM, Google Meet, Microsoft Teams, Go to Meeting, Hangout, Messenger, Skype. Again, a remarkably interesting trend occurs, at first, the respondents do not make a connection between on-line networking and social networks, they are aware of this fact only after an additional question, they mostly use Facebook, LinkedIn, Instagram, YouTube.

The applied measures have brought the following changes in using online and offline tools within networking, communication, and work with information and knowledge in the companies. All branches reduced the ratio of meetings in person and they use more often meetings via online platforms or telephone, e-mail. Even the respondents, who create craft activities reduced the personal visits by their customers. Some of the branches had to switch from 100% offline functioning to 100% online functioning. These companies had to adapt all their business processes and related information and knowledge transfers using IT technologies. The directly affected companies, where more than 80% of activities are impacted have a significant loss of clientele and associated turnover of the company. Those companies, which subject of business is not closed or restricted still have unchanged clientele and enough contracts and orders. 90% of the respondents will keep their business IT solutions even at the time, when they will be able to get back to meetings in person with their contact sphere. These are often in-house project management systems or consulting using online platforms, which will expand their existing range of products and services.

The question set Claims is displayed by the means of Figure 2. The claims regard the confirmed hypothesis within business networking activities and the discipline of Information and Knowledge Management.

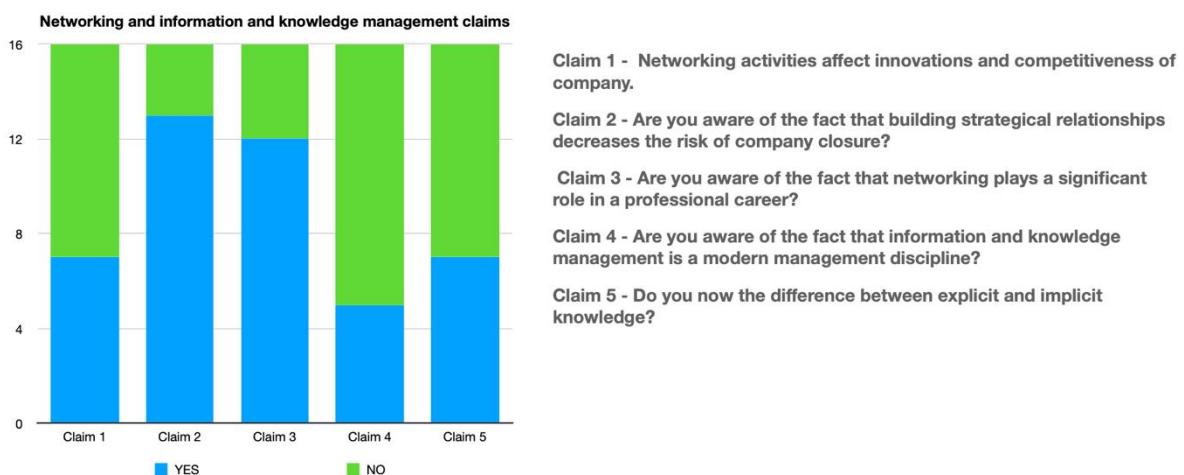


Figure 2. Networking and IZM claims.

4. Discussion

The strategy of using the networking tools and information and knowledge marketing tools in a management practice varies. The companies have different levels, which often correspond with their progress and development. The world-wide COVID-19 pandemic

contributed to a massive transfer of business activities and also the networking activities with data transfer and processing, information and knowledge, their sharing and passing on within companies into the on-line world. Most of the business interactions have been transferred and adapted to the online environment. Nevertheless, most of the respondents from my research are not willing to meet new contacts in non-personal meetings, a handshake is crucial for the company owners in the sphere of business cooperation and trust, the parameter, on which each successful business activity stands. Naturally, it is possible to find exceptions, for example, e-shops, which do not need to build relationships in person with their customers, although it can be said that they are nearing them and personifying via social networks. Modern technologies keep developing and shifting the limits; therefore, it is not out of the question that people may adapt to this sudden change in a greater measure. Owing to the pandemic development, the old habits of business activities will probably not return. Many companies and industries closed or will close due to this change and on the contrary, new sectors and industries will develop. An interesting consideration is, how will the future look like in other industries, which were not directly closed or restricted. It is possible to consider that the demand in some of the industries will decrease with a delay thanks to the connected and open economy, which prevails in the world nowadays. The deciding factor will be the households' behaviour and their consumption and willingness to treat themselves to other products and services above the basic needs.

5. Conclusions

The qualitative research in the form of interviews was very extensive. The respondents stated many interesting observations. I succeeded in collecting a high volume of data, which is possible to use for my further research. The tools, which are being used within existing contacts are considered the greatest advantage within the changes due to the COVID-19 pandemic as seen by the respondents. Saving time and transfer costs and meeting one another through web conferencing are evaluated by all the respondents as a positive change. When acquiring new contacts (most often clients), they do not consider online tools to be of high quality and do not want to follow the online path, except for the above-mentioned e-shop.

The fundamental finding of my research is the reciprocity of networking as a marketing management discipline, and information and knowledge management. The research proved networking to be a tool of information and knowledge management, as it is a channel for sharing and transfer of information, knowledge, education, and brings an innovation potential, and enhances the competitiveness of an individual as well as a company or organisation. Information and knowledge management is simultaneously considered a networking tool. Awareness of the infrastructure, system, processes, hierarchy of expressions, search, understanding, and distribution of knowledge contributes to the improvement of transmissions in the network and thus increases its overall value and benefits to individual players.

Acknowledgments: The work was supported by the internal project "SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept", 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic.

References

- Bureš, V. (2007). *Znalostní management a proces jeho zavádění: průvodce pro praxi*. Grada, Management v informační společnosti.
- Faroque, A. R., Morrish, S. C., & Ferdous, A. S. (2017). Networking, business process innovativeness and export performance: the case of South Asian low-tech industry. *Journal of Business & Industrial Marketing*, 32(6), 864-875. <https://doi.org/10.1108/JBIM-06-2015-0113>
- Ford, D., & Mouzas, S. (2013). The theory and practice of business networking. *Industrial Marketing Management*, 42(3), 433-442. <https://doi.org/10.1016/j.indmarman.2013.02.012>
- Hardwick, J., Cruickshank, D., & Anderson, A. R. (2012). Innovation in small business: comparing face-to-face with virtual networking. *Journal of Business Strategy*, 33(5), 51-58. <https://doi.org/10.1108/02756661211282795>
- Henneberg, S. C., Naudé, P., & Mouzas, S. (2010). Sense-making and management in business networks—Some observations, considerations, and a research agenda. *Industrial Marketing Management*, 39(3), 355-360. <https://doi.org/10.1016/j.indmarman.2009.03.011>
- Ivanova-Gongne, M., & Torkkeli, L. (2018). No manager is an island: culture in sensemaking of business networking. *Journal of Business & Industrial Marketing*, 33(5), 638-650. <https://doi.org/10.1108/jbim-07-2016-0154>
- Kubberød, E., Viciunaite, V., & Fosstenløyken, S. M. (2019). The role of effectual networking in small business marketing. *Journal of small business and enterprise development*, 26, 747-763. <https://doi.org/10.1108/JSBED-06-2019-0199>
- Petrash, G. (1996). Dow's journey to a knowledge value management culture. *European management journal*, 14(4), 365-373. [https://doi.org/10.1016/0263-2373\(96\)00023-0](https://doi.org/10.1016/0263-2373(96)00023-0)
- Prisma transparent reporting. (2021, January 21) <http://www.prisma-statement.org>
- Schoonjans, B., Van Cauwenberge, P., & Vander Bauwhede, H. (2013). Formal business networking and SME growth. *Small Business Economics*, 41(1), 169-181. <https://doi.org/10.1007/s11187-011-9408-6>
- Sunasse, N. N., & Sewry, D. A. (2002). A theoretical framework for knowledge management implementation. In *Proceedings of the 2002 annual research conference of the South African institute of computer scientists and information technologists on Enablement through technology* (pp. 235-245).
- Tallinn University. (2021). *Development of Information and Knowledge Management*. https://www.tlu.ee/~sirvir/Information%20and%20Knowledge%20Management/Development%20of%20IKM/development_of_knowledge_management_2.html
- ZOOM. (2021, January 21) <https://zoom.us>

Tax Revenues and External Shock. How Covid-19 Influenced Public Revenues in Poland and Czechia

Jarosław OLEJNICZAK¹ and Jan MACÍ^{2*}

¹ Wrocław University of Economics and Business, Wrocław, Poland; jaroslaw.olejniczak@ue.wroc.pl

² University of Hradec Králové, Hradec Králové, Czech Republic; jan.maci@uhk.cz

* Corresponding author: jan.maci@uhk.cz

Abstract: The unprecedented driving force of economic events in 2020 was, paradoxically, an uneconomic phenomenon – the COVID-19 virus. In order to overcome the unfavorable period, public policies around the world have sought, and in fact continue to seek, various support schemes. On the one hand, such schemes include restrictions on economic activity to prevent the spread of the virus, on the other hand, they impose a burden in the form of a loss of public revenue and, at the same time, a burden in the form of an increase in public spending. Therefore, based on public revenue data this paper seeks to capture the nature and extent of the impact of pandemics on public revenues, especially taxes in a mid-term period 2017-2020 in Poland and the Czech Republic. Our analysis reveals that the rate of fulfillment of public revenues during the year in the crisis year 2020 does not differ much from the last years of the pre-crisis years. In terms of tax collection, pandemic affected the collection of personal and corporate income tax the most.

Keywords: public revenues; rescue measures; taxes; tax structure

JEL Classification: H20; H25

1. Introduction

Undoubtedly, the major event of the year 2020 was the pandemic shock caused by the virus COVID-19. Practically all countries in developed and other economies were forced to hastily create rescue schemes, which were to cover the necessary time for businesses to overcome the unfavorable period. On one hand, these public schemes bought some time in order to protect employment and entrepreneurial activity as such. On the other hand, the same schemes have an unprecedented impact on public budgets.

The last of the global crises of 2008 was the subject of many analyses. Some of those analyses concerned the impact of the crisis on the functioning of the public finance system (Darvas, 2010; Staehr, 2010), the impact of the crisis on the level of budget revenues (including mainly taxes) (Mara et al., 2009; Reichardt, 2011; Tvrdoh, 2010) and the resilience of the tax system (tax mix) to the phenomena of the crisis and changes under its influence (Borůvková, 2017; Kukalová et al., 2018). Possible solutions regarding changes in tax arrangements to reduce the occurrence of similar crises in the future were also considered (Hemmelgarn & Nicodème, 2010). In addition, it should be noted that the literature on changes in the structure of the tax mix during the 2008 financial crisis pointed to the possibility of fiscal devaluation (Keen & Mooij, 2012) aiming to offset these tax cuts by the increase of VAT. However, not only

changes in the tax mix as a result of the crisis, but also the initial settings of the tax mix were taken into account by some authors. In the case of Ireland, one of the most affected countries, Keane (2015) demonstrates the importance of the issue of the tax mix. Excessive reliance on one sector of the economy (construction) and the move away from income-based taxes have proved to be crucial to the shortfall in tax revenues.

From another point of view, in times of crisis, some countries may take a targeted approach to reducing tax revenues through tax cuts in order to maintain household consumption and employment. According to Bouthevillain and Dufrénot (2011), tax cuts may not be very effective in order to support household consumption, while transfers are.

Naturally, some researchers and analysts have already tried to liken the current covid-crisis to the 2008 global financial crisis (Harding & Simon, April 29, 2020). However, it is important to note that the causes and nature of the crisis were different in 2008 than they are in 2020. In contrast, a number of articles have appeared in the early months of the covid-19 pandemic discussing, on the one hand, the measures taken by individual governments to support the economy (Dender et al., 2020; KPMG, 2020; OECD, 2020) and, on the other hand, the consequences of the pandemic for public finance systems (Andrew et al., 2020; Clemens & Veuger, 2020; Jaelani & Hanim, 2020).

From a short literature review, it is clear that for the study of similar events, the usual approach is in the form of analysis of partial economies. With our article, we want to contribute to the knowledge of the effects of the crisis on the tax revenues of the economies of Poland and the Czech Republic.

The choice of the Czech Republic and Poland for comparison is driven by several important factors. Among others, geographical proximity, similar GDP structure by sector (Eurostat, 2021), similar tax system (but with different rates (Olejniczak, 2015, p. 60)), similar level of cross-country tax revenue diversification index (RDI) (Compaoré et al., 2020, pp. 30–36), similar characteristics attributed to tax systems (high income country, Europe and Asia region and not small, fragile or resource rich country) (Compaoré et al., 2020, pp. 30–36)) as well as international economic linkages (strong links with the German economy (main trading partner), and between the two economies (Eurostat, 2021)). Also, Covid-19 in both countries emerged during the same period. On the other hand, each country has developed its own anti-crisis strategy, which is reflected in the amount of revenue obtained from individual taxes.

Based on the above stated, the aim of this article is to summarize, what rescue measures have been taken in two neighboring economies of the CEE area, specifically in Poland and the Czech Republic, and to reveal differences in public revenue development compared to the recent past. In addition, we want to assess which traditionally the most important components of tax revenue items were hit the hardest and which were the least affected.

The article continues as follows. The second chapter introduces Polish and Czech tax systems. The third chapter presents the research methodology, data, and research questions. The fourth chapter comprises research results. The last section is devoted to discussion and conclusions.

2. Tax System Features of Poland and the Czech Republic

In this chapter, there are introduced Polish and Czech tax systems, their main features, the structure of tax revenues, and the most important tax sources. Both the Polish and Czech tax systems are affected by harmonization at the level of the European Union, of which both countries have been members since 2004.

The structure of the economy is also presented in the basic points, with a view to assessing the possible effects of coronavirus on tax collection.

2.1. Poland

The existing system of general government revenue in Poland, and within it the tax system, results from the evolution of solutions introduced at the beginning of the 1990s during the system transformation. The literature indicates that the tax system in Poland is structurally similar to the trends in OECD countries (predominance of indirect taxes over direct taxes (Compaoré et al., 2020, p. 7)) but still requires improvement (Owsiak, 2016, p. 24). It should be noted that the most significant role within this system is played precisely by various taxes, of which the most efficient ones (VAT, PIT, CIT, excise duties) constitute state budget revenue. Tax revenues also include (according to the OECD methodology) social security contributions, but these do not constitute state (central) budget revenues in Poland. Indirect taxes account for 14.3% of GDP, direct taxes 7.8% of GDP and social contributions 13.3% of GDP. On the other hand, taking into account the structure by the government sector's level collects 49.5% of total tax revenue, local government 12.7% and social security funds 37.2% (European Commission, 2020, p. 126). When we look at the four main aggregate expenditures that go into calculating GDP, we can notice 57.5% share households' consumption, next 19.7% investment by businesses, then 18% government spending on goods and services, and 3% net exports of goods and services (exports 55.2%, imports 52.2%). Main tax rates are relatively high in Poland. VAT standard rate is 23% (with reduced rates 8% – e.g. recreational and cultural services and 5%) while average VAT rate in EU-28 is 21.5% (2017-2019). PIT base rate is 17% (progressive taxation), and CIT base rate is 19%.

2.2. The Czech Republic

The tax system of the Czech Republic bears the hallmarks of other, especially European, advanced tax systems. Therefore, as, for example, Vančurová, Láchová, and Zídková (2020, p. 3) states the Czech tax system can be considered standard.

Tax revenues come from direct and indirect taxes and, for example, the OECD ranks social contributions among Czech tax revenues. The latest European Commission publication *Taxation Trends in the EU*, i.e. for 2020, shows the following shares of these public revenues as a percentage of GDP for the year 2018: indirect taxes 12.5%, direct taxes 8.0%, and social contributions 15.6%. Thanks to the Czech budget setting of taxes, the largest share of public revenues is managed by the central government (68.4%), followed by local governments (15.2) and social security funds (16.0) (European Commission, 2020, p. 58).

With the inclusion of the basic macroeconomic indicator, i.e. GDP, it can be concluded for the years 2010-2019 that the growth of nominal GDP by 1 percentage point means an

increase in public revenues by approximately CZK 13 billion or 10 billion tax revenues (own calculation according to data from the Czech Statistical Office and the Czech National Bank – nominal GDP and tax revenues – and the Ministry of Finance of the Czech Republic – public revenues). As for the structure of GDP, a significant part consists of household consumption (long-term about 48%), government spending about 20%, investment about 27%, and net exports about 6% (of which exports add about 77%, imports, on the other hand, take about 71%). As for household consumption itself, the part that is mainly targeted by existing restrictions (i.e. recreation, culture, and sports; catering, accommodation services) represents some 15.5% of household consumption, which is about 7.3% of total GDP (own computations based on the data from Czech Statistical Office, 2021).

Finally, the statutory rates of taxation of the most important taxes according to the share of tax revenues are given: VAT (standard rate 21%, first reduced rate 15% and second 10%); personal income tax (PIT = 15%; 23%); corporate income tax (CIT = 19%). The environment of excise duties is more complex and therefore not mentioned here. Here it is probably possible to add that, for example, household consumption, which is strongly limited by restrictions (see above-mentioned recreation, culture, sports, catering, and accommodation services plus e.g. land public regular transport, hairdressing and barber services), very often falls within the second reduced VAT rate (i.e. a 10% rate).

3. Methodology

In order to reach our main goal, we used secondary data for the midterm period which is commonly stated as three to five years. In our case we considered the years 2017-2020; presented are the data for 2019 and 2020. Data from the following databases were used. As for the data for Poland, there were used data from the Central Statistical Office (CSO) and the Ministry of Finance. In case of the Czech Republic, data from the Ministry of Finance of the Czech Republic (MFCR), the Czech Financial Administration (Finanční správa), and from the Czech National Bank (CNB) were involved. Specifically, we used data on the monthly fulfillment of public revenues and data on traditionally the most significant tax revenues (i.e. VAT, excise duties, corporate income tax, personal income tax, and toll). In fact, toll does not belong to the most important tax revenues, but according to some authors (e.g. Askitas & Zimmermann, 2011), its collection makes it possible to infer the level of economic activity. On the contrary, with a more detailed look at tax collection, we do not work with social contributions. Therefore, we distinguish between public revenues, where social contributions are included, and tax revenues, where we work only with direct and indirect taxes.

Within the research, methods of descriptive statistics are used the most. Especially percentage analysis is applied. Such an analysis makes it possible to capture the basic features of changes, differences, and trends.

In particular, we consider the following research questions (RQ):

- *RQ1: Did the pandemic affect the rate of fulfillment of the public treasury revenues during the year?*
- *RQ2: Which public tax revenues were hit by the pandemic the most?*

Regarding the RQ1, our assumption is that the first parts of the year will not be affected by a pandemic, while the remaining parts of the year will. Therefore, we expect a higher share of public revenues in total revenues in the first part of the year.

Regarding RQ2, here, according to preliminary observations, we expect a lower decline in VAT collection (support measures aimed at maintaining the cash flow of economic entities, although data on the increase in bank deposits play in favor of a decline in VAT collection). However, due to the nature of support measures, a decline in income taxes is more likely to be expected.

4. Results of the Study

In this chapter, we firstly present and analyze the data for Poland and the Czech Republic separately. Secondly, approaches and impacts are finally compared within a common subchapter. The purpose of this chapter is to answer the research questions posed in Methodology and thus at the same time fulfill the research goal defined in Chapter 1.

4.1. Rescue Measures and Public Revenues in Poland

As part of its efforts to counteract the economic and social impact of the pandemic, the Polish government has been implementing packages of solutions called the Crisis Shield (rev. 1.0 to rev. 6.0) in the following months of 2020. These solutions covered many areas - directly and indirectly, related to supporting the activities of economic entities and protecting the health and lives of citizens. It should be noted that these measures were implemented both directly by the central government, local governments and by a specially established fund. As part of the activities undertaken, the following can be listed:

- New (postponed) deadlines for tax reporting (CIT, PIT, VAT).
- Tax rebates – at the request of the taxpayer after meeting the criteria for a decrease in income.
- Possibility of the retroactive settlement of tax losses in PIT and CIT (from 2020 in the settlement for 2019, for entities whose revenues achieved in 2020 fall by at least 50% in relation to the revenues achieved in 2019).
- Bad debt relief for creditor and debtor.
- Possibility to resign from paying simplified advance payments of income tax in 2020 and switch to settling advance payments on actual income.
- Suspension of proceedings under the Tax Ordinance Act and customs and fiscal inspections.
- Deduction of donations made for “the fight” against COVID-19.
- Real estate tax – municipalities have been authorized to take certain measures concerning real estate tax such as the introduction of exemptions from real estate tax for part of the year 2020 or postponement of property tax instalments.
- Temporary abolition of the prolongation fee for ZUS (social security fund) contributions and taxes when making use of the possibility of deferment or payment in instalments.

- Exemption of micro-companies (entities employing up to 9 persons) from ZUS contributions.
- Deferral of the payment of ZUS contributions.

The central government's 2020 budget was to be the first “balanced” budget in decades. This was due to the high one-off revenues planned for the 2020 year. Among other things, from the planned reform of the social security system and the sale of 5G frequencies. At the same time, the government assumed high GDP growth (3.7%), significant reduction of tax gaps in VAT, CIT and social security contributions. The effects of the pandemic on the planned balance of the state budget appeared both on the revenue and expenditure side (Figure 1), although here it can be noted that part of the expenditure was realized without the state budget (by local governments and specially established funds).

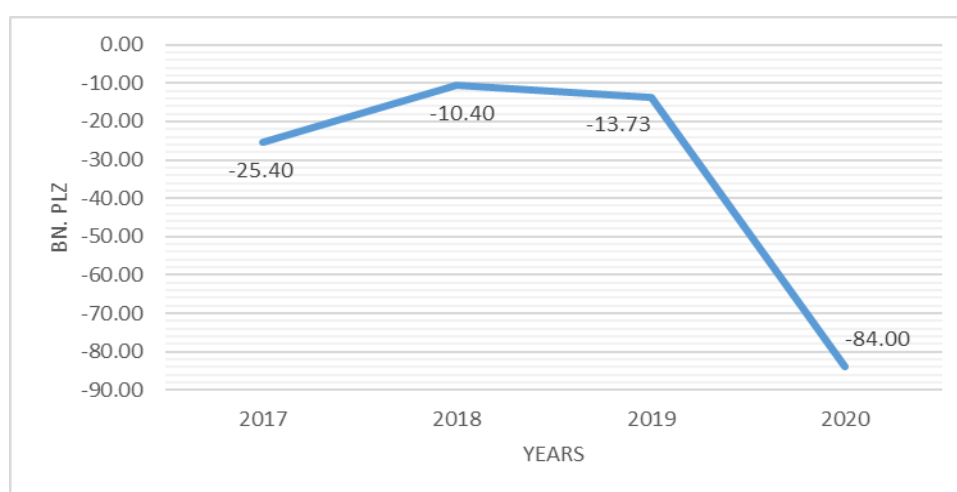


Figure 1. Medium-term development of the Polish central government balance (2017-2020).

(Source: MF, February 12, 2021)

In the autumn of 2020, the government presented an update to the state budget in which it indicated that revenues would fall by PLN 37 billion compared to the original assumptions, and expenditures would rise by PLN 72 billion. The biggest drop in revenue was expected in VAT (15%, or PLN 26.5bn) and excise duties (8.9%, or PLN 6.6bn). At the same time, non-tax revenue was forecast to rise by 4 billion zlotys. The main reason for the decline in VAT revenue (as the most efficient tax) indicated by the government was the expected economic slowdown at -4.6% of GDP. However, according to estimates in January 2021, the budget deficit could amount to PLN 84 billion with revenues close to the level in the budget law update.

Preliminary data from the Ministry of Finance for December 2020 indicate that the revenue projections for the last quarter of 2020, included in the amendment to the Budget Law, were too pessimistic. This was mainly due to higher VAT revenues (a decrease of only 5% compared to the original plan). In addition, revenues from excise duty and CIT were higher than expected. Nevertheless, in relation to 2019, the total level of tax revenue was similar (see Table 1).

Table 1. Polish cash performance – public revenues in 2020 and 2019 (own based on MF (February 12, 2021))

Month	Cumulative revenues (bn. PLN); 2020	Monthly change (bn. PLN / %)		Percentage of total revenues of the given year	Cumulative revenues (bn. PLN); 2019	Monthly change (bn. PLN / %)		Percentage of total revenues of the given year
		abs.	rel.			abs.	rel.	
January	40.27	40.27		10%	38.74	38.74		10%
February	69.93	29.66	-26%	17%	64.78	26.04	-33%	16%
March	96.20	26.27	-11%	23%	90.29	25.51	-2%	23%
April	129.64	33.44	27%	31%	129.97	39.68	56%	32%
May	157.07	27.43	-18%	37%	162.87	32.90	-17%	41%
June	197.39	40.32	47%	47%	192.18	29.31	-11%	48%
July	235.81	38.41	-5%	56%	228.77	36.59	25%	57%
August	268.91	33.10	-14%	64%	262.84	34.08	-7%	66%
September	304.51	35.60	8%	73%	296.03	33.18	-3%	74%
October	343.97	39.46	11%	82%	332.89	36.86	11%	83%
November	382.49	38.52	-2%	91%	367.11	34.22	-7%	92%
December	419.84	37.35	-3%	100%	400.54	33.43	-2%	100%

¹The data for the whole period considered (i.e. 2017–2020) are available on request from the authors.

Table 2. Collection of taxes during the year (cumulatively) (own based on MF, February 12, 2021)

Month	2020 (bn. PLN)						2019 (bn. PLN)					
	VAT	Excise duties	CIT	PIT	Financ. Instit.	Total tax rev.	VAT	Excise duties	CIT	PIT	Financ. Instit.	Total tax rev.
Jan	21.83	5.25	3.15	6.28	0.51	37.36	20.58	5.20	3.20	6.52	0.39	36.18
Feb	35.18	10.53	6.28	10.90	0.81	64.40	32.06	10.18	6.03	10.76	0.78	60.40
Mar	44.71	16.51	9.62	13.44	1.16	86.50	42.38	15.51	10.31	13.59	1.15	83.83
Apr	56.09	21.66	12.87	17.78	1.52	111.23	57.03	22.04	18.10	19.95	1.54	119.94
May	66.72	26.26	16.62	23.24	1.93	136.30	73.03	27.97	20.58	25.42	1.93	150.54
Jun	78.42	32.38	22.12	28.50	2.34	165.55	86.61	33.54	22.05	30.79	2.33	177.26
Jul	97.34	38.54	25.64	33.94	2.75	200.31	103.87	40.54	24.95	36.38	2.72	210.75
Aug	115.12	45.07	27.84	39.56	3.17	233.21	118.81	46.66	27.63	42.17	3.12	240.97
Sept	131.06	51.92	30.46	45.03	3.58	264.85	132.71	52.86	30.45	47.87	3.49	270.27
Oct	150.02	58.39	34.07	51.33	4.00	300.99	150.12	59.33	34.02	53.97	3.90	304.55
Nov	168.24	64.76	37.73	57.20	4.42	335.94	166.49	65.25	37.14	59.49	4.34	336.24
Dec	184.59	71.80	38.68	63.84	4.60	370.29	180.89	72.40	39.98	65.44	4.70	367.29
Dec y/y	2.05%	-0.83%	-3.25%	-2.44%	-2.13%	0.82%	3.40%	0.40%	15.43%	9.88%	4.28%	5.13%

¹ CIT = corporate income tax; PIT = personal income tax.

² The data for the whole period considered (i.e. 2017–2020) are available on request from the authors.

Fluctuations caused by restrictions introduced by the Polish government and support programs in the following months are visible in Table 1. It can be also seen in Table 1 that until March 2020 (before the pandemic), tax revenues were realized at a higher level than in 2019, while with the introduction of restrictions, there was a sharp decline in tax revenues.

This means that under the conditions of the economic slowdown and the two lockdowns, the tax system has not suffered a significant shock. Of course, the extent to which the economy and the tax system have withstood the pandemic in the long term cannot be determined at this point. In the first quarter of 2020, total tax revenues were higher than in 2019, but in the following months the cumulative revenue amounts were lower than in 2019 (Table 2). This fact was mainly influenced by the permanent reduction in PIT and excise tax revenues.

A month-by-month analysis of the data in relation to 2019 shows that in the case of VAT, April-July recorded lower monthly revenues than in 2019. At the same time, it was only in November and December that the sum of tax revenues reached and exceeded 2019 values.

The available general data on the implementation of tax revenues show that the most resistant to the impact of the pandemic (in terms of relation to the previous year) were the VAT, although as a result of the economic slowdown it deviated to the greatest extent in the level of revenues received from the originally assumed value.

4.2. Rescue or Support Measures and Public Revenues in the Czech Republic

The state apparatus of the Czech Republic – especially through the Ministry of Finance and the Ministry of Industry and Trade, but also of lower territorial units – has taken a number of measures in response to the pandemic situation. The measures were aimed, in particular, not only not to worsen the cash flow of the companies and individuals affected by the shock, but also to delay and spread the filling of tax returns over time.

Given the overall scope, at least selected support measures are briefly listed below (sources: Ministry of Finance of the Czech Republic (MFCR, 2021) and Financial Administration (2021)). Most of them were valid for the year 2020. However, due to the persisting unfavorable situation, some of them are likely to be refreshed and applied for 2021 as well.

- Deadline for filing *personal and corporate income tax returns postponed* by three months (i.e., not 1st May 2020 but 1st July 2020); further postponed until 18th August;
- individually *forgiven tax-related fines* if the reason for the fine was coronavirus;
- *liberation package* – all payments of VAT, income taxes, and road tax which were due in the period of emergency are deferred to those entrepreneurs who are explicitly targeted by state restrictions;
- *loss carryback* – the entrepreneur can claim the tax loss from the current year (2020) up to two years back; by means of a corrective tax return, this can additionally reduce the tax liability for previous years and thus the entrepreneur can recover part of the taxes already paid;

- *compensatory bonus* in the amount of CZK 500 per day for self-employed and partners of small limited liability companies directly or, in certain circumstances, indirectly affected by the crisis (business prohibited or restricted due to government restrictions; namely hospitality, culture, sports, accommodation, retail or services);
- support programs: COVID, COVID II, COVID III, COVID Plus, COVID – Rental, COVID – Gastro, COVID – Accommodation, COVID – Culture and others; these programs provide state guarantee for loans (both operational and investment), or direct financial support, e.g. to pay rent;
- employment protection programs: Antivirus A, Antivirus B, and Antivirus C; closed companies up to 100% wage compensation; up to 80% wage compensation due to quarantine;
- etc.

To sum it up, some measures have a direct impact on reducing public revenues (e.g. the liberation package, carry loss), some measures help maintain economic activity and are more reflected on the side of public expenditure.

In other words, on the one hand, the above-mentioned measures improve or improved cash flow in the private sector, on the other hand, they naturally worsen the cash flow, respectively the budget and thus the debt burden of the public sector. In any case, public finances thus fulfill their main role for crisis periods, i.e. the stabilizing role. See the central government balance for the years 2017 to 2020 in Figure 2.

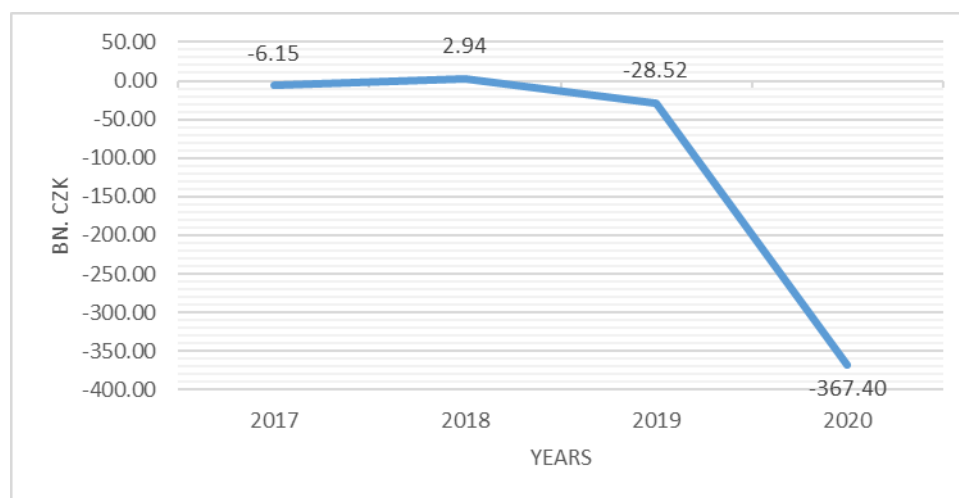


Figure 2. Medium-term development of the Czech central government balance (2017-2020).
(Source: MFCR, January 3, 2020; January 5, 2021)

It is obvious from Figure 2 that the Czech state budget was hit hard by the pandemic situation. The year-on-year deterioration amounts to approximately CZK 339 billion. Now, let's have a look for a closer analysis of the revenues themselves.

Table 3 below shows Czech monthly cash performance. At first glance, there is a noticeable annual decrease in public revenues (not only tax revenues) by almost CZK 48 billion (-3.13%). Looking more closely, it is clear that in the course of 2020, the percentage of fulfillment does not differ much compared to previous years (i.e. the years 2017 to 2019; data

for the years 17 and 18 are data are available on request from the authors). That means a difference of max. 1 percentage point. However, the exceptions are June and July, when this difference is always at least 2 percentage points compared to previous years. This decline can be explained by the waiver of income tax advances. The rational assumption of faster revenue fulfillment in the first half of the year, and the subsequent slowdown in the second half of the year, where the pandemic would already have a significant effect, were not considerably reflected in the figures presented by Table 3 (the difference in the months of the first half is about 1 percentage point compared to 2019).

Table 3. Czech cash performance – public revenues in 2020 and 2019 (own based on MFCR, February 2, 2021)

Month	Cumulative revenues (bn. CZK); 2020	Monthly change (CZK / %)		Percentage of total revenues of the given year	Cumulative revenues (bn. CZK); 2019	Monthly change (CZK / %)		Percentage of total revenues of the given year
		abs.	rel.			abs.	rel.	
January	124.1	124.1		8%	121.76	121.76		8%
February	229.2	105.1	-15.31%	16%	217.38	95.62	-21.47%	14%
March	377.3	148.1	40.91%	26%	364.30	146.92	53.65%	24%
April	467.9	90.6	-38.83%	32%	470.93	106.63	-27.42%	31%
May	571.6	103.7	14.46%	39%	584.21	113.28	6.24%	38%
June	699.7	128.1	23.53%	47%	743.88	159.67	40.95%	49%
July	817.1	117.4	-8.35%	55%	863.30	119.42	-25.21%	57%
August	929.4	112.3	-4.34%	63%	969.80	106.50	-10.82%	64%
September	1,058.3	128.9	14.78%	72%	1,103.26	133.46	25.31%	72%
October	1,178.8	120.5	-6.52%	80%	1,221.07	117.81	-11.73%	80%
November	1,313.6	134.8	11.87%	89%	1,351.52	130.45	10.73%	89%
December	1,475.5	161.9	20.10%	100%	1,523.23	171.71	31.63%	100%

¹The data for the whole period considered (i.e. 2017–2020) are available on request from the authors.

In any case, the year-on-year figures (see line for December of Table 4 below) show that the effect of coronavirus had little effect on VAT and toll collection. From the point of view of VAT, it seems that households have not reduced their consumption too much ($y/y = -1.2\%$). Or it might be possible that households have shifted their consumption from the items affected by restrictions – often subject to a 10% VAT rate – to other available items often subject to a 15% or 21% VAT rate. There is also a very small impact on toll (-0.5%). However, there is a lot more tolled kilometers compared to 2019 (+868 km; a toll was collected on about 1,100 km of 1st class roads and 1,300 km of highways in 2020). In contrast, the effect of coronavirus on corporate and personal income tax collection had the greatest impact (CIT -12.2% , PIT -6.0%). For these taxes, the anti-crisis measure in the form of a waiver of income tax advances in the second quarter of the year have the greatest effect (see June and July of 2020 in comparison to June and July 2019, especially for CIT in Table 4).

In conclusion, given that the total tax revenues for 2020 decreased by approximately CZK 60 billion, it is possible to deduce from the relationship derived in the introduction an approximate 6% decline in the Czech economy in 2020.

Table 4. Collection of taxes during the year (cumulatively) (own based on CNB, 2021)

	2020 (bn. CZK)						2019 (bn. CZK)					
Month	VAT	Excise duties	CIT	PIT	Toll	Total tax rev.	VAT	Excise duties	CIT	PIT	Toll	Total tax rev.
Jan	47.39	13.33	1.53	23.04	0.86	89.11	44.88	14.08	0.86	20.73	0.86	84.14
Feb	72.19	26.10	2.97	43.58	3.02	155.07	65.74	25.05	2.25	39.25	2.86	142.01
Mar	97.78	39.16	41.35	65.13	4.30	256.49	92.49	36.54	40.55	62.00	5.11	245.23
Apr	132.97	50.02	41.23	61.38	6.85	303.60	135.04	49.01	43.97	67.38	6.46	313.83
May	155.99	63.40	40.86	73.45	8.01	360.47	167.52	64.50	45.94	86.59	7.59	393.47
Jun	187.98	74.54	74.39	93.38	9.11	460.15	200.15	79.85	99.07	112.80	9.02	524.36
Jul	234.21	87.89	74.47	114.33	10.25	543.26	244.02	93.72	104.88	135.27	10.28	614.40
Aug	268.63	102.77	81.30	138.85	11.37	627.07	276.3	106.83	104.16	156.13	11.26	683.98
Sept	301.17	117.89	116.74	161.11	13.03	734.86	307.15	121.08	145.19	178.28	12.40	795.18
Oct	350.11	133.27	119.82	182.53	13.78	824.35	354.88	136.36	146.95	198.35	13.61	884.10
Nov	387.91	145.80	120.69	204.39	14.90	902.15	393.46	152.05	146.55	218.84	14.74	964.46
Dec	426.45	162.49	160.55	231.72	15.75	1,026.91	431.58	167.14	182.90	246.64	15.83	1,086.18
Dec y/y	-1.2%	-2.8%	-12.2%	-6.0%	-0.5%	-5.5%	4.4%	-0.2%	5.1%	12.2%	2.3%	5.4%

¹ CIT = corporate income tax; PIT = personal income tax.

² The data for 2017 and 2018 are a part of the Appendix.

5. Discussion and Conclusions

At the beginning of this research, we expected that it would be possible to observe a significant decline across public revenues (e.g. deferral of income tax payments, deferral of consumption and overall economic activity and the related decline in VAT collection). This general assumption has only been partially confirmed. In fact, the basic expectations were actually inaccurate due to measures to save jobs and support the consumption of households.

A comparative analysis of the Czech Republic and Poland's tax revenues in 2019 and 2020 indicates that there are differences in the resilience of their tax systems to the effects of a pandemic. The data show a relatively greater sensitivity of the Czech tax system to the effects of the pandemic. The Czech Republic recorded a decrease in central government tax revenue in relation to 2019, while Poland slightly exceeded its 2019 level. The performance of VAT in Poland and the extensive loss of PIT and CIT revenues in the Czech Republic were of great importance here.

Thus, answering RQ1, we can conclude that indeed the pandemic had a negative impact on budget revenues in both countries but a much more substantial impact on the Czech tax system's efficiency. Indication of this situation's reasons is currently not possible due to lack of detailed financial and macroeconomic data. In addition, in order to get a complete picture, it would be necessary to analyze the impact of subsequent lockdowns, as in each country the process occurred at a different time and on a different scale.

In response to RQ2, it can be pointed out that in both countries it was direct taxes PIT and CIT that proved to be the least revenue-efficient during the pandemic. However, when

analyzing the scale of y/y revenue decreases from PIT and CIT, it should be remembered that it was in the area of these taxes that both countries introduced tax preferences. Therefore, at the moment it is impossible to estimate what part of the decrease in these incomes is caused by taxpayers taking advantage of tax preferences and what part is caused by the decrease in their activity in the economy.

During the Great Recession, society gained knowledge on how to proceed with regulatory measures to the financial sector. A possible benefit of the Covid Crisis may be some permanent changes in tax legislation. As Tax Foundation, respectively Bunn (March 18, 2020) or Asen (February 13, 2020) points out, for example, loss carryover provisions (i.e. in the form of carryforward and carryback) enable businesses to smooth their risk and income throughout cycles. Therefore, especially the loss carryback, which is not so commonly implemented, should have a stronger place in the tax code.

Acknowledgments: The work was supported by the internal project “SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept”, 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic”.

References

- Andrew, J., Baker, M., Guthrie, J., & Martin-Sardesai, A. (2020). Australia's COVID-19 public budgeting response: the straitjacket of neoliberalism. *Journal of Public Budgeting, Accounting & Financial Management*, 32(5), 759–770. <https://doi.org/10.1108/JPBAFM-07-2020-0096>
- Asen, E. (2020, February 13). *Net Operating Loss Carryforward and Carryback Provisions in Europe*. Tax Foundation. <https://taxfoundation.org/net-operating-loss-tax-provisions-europe-2020/>
- Askitas, N., & Zimmermann, K. F. (2011). Nowcasting Business Cycles Using Toll Data. *Journal of Forecasting*, 32(4), 299–306. <https://doi.org/10.1002/for.1262>
- Borůvková, A. (2017). Changes in the Typology of Tax Mixes in EU Member States during the Crisis Relative to Implicit Tax Rates. In *Theoretical and Practical Aspects of Public Finance 2017* (pp. 14–19). University of Economics, Prague. <https://kvf.vse.cz/wp-content/uploads/page/158/TPAVF-2017-final.pdf>
- Bouthevillain, C., & Dufrénot, G. (2011). Are the effects of fiscal changes different in times of crisis and non crisis? The French case. *Revue d'économie politique*, 3(3), 371–407. <https://doi.org/10.3917/redp.213.0371>
- Bunn, D. (2020, March 18). *Tax Policy and Economic Downturns*. Tax Foundation. <https://taxfoundation.org/government-revenue-most-hit-recession/>
- Clemens, J., & Veuger, S. (2020). *Implications of the Covid-19 pandemic for state government tax revenues* (NBER Working Paper 27426). National Bureau of Economic Research. <https://doi.org/10.3386/w27426>
- CNB. (2021). *Total taxes revenue* [Data set]. Retrieved January 26, 2021 from https://www.cnb.cz/cnb/STAT.ARADY_PKG.PARAMETRY_SESTAVY?p_sestuid=1410&p_strid=ABA&p_lang=EN
- Compaoré, A., Ouedraogo, R., Sow, M., & Tapsoba, R. (2020). *Fiscal Resilience Building: Insights from a New Tax Revenue Diversification Index* (IMF Working Paper No. 20/94). IMF, Social Science Research Network
- Czech Statistical Office. (2021). *GDP by the expenditure approach* [Data set]. Retrieved January 25, 2021 from https://apl.czso.cz/pll/rocnka/rocnkavyber.makroek_vydaj_en
- Darvas, Z. (2010). The impact of the crisis on budget policy in Central and Eastern Europe. *OECD Journal on Budgeting*, 10, 1–42. <https://doi.org/10.1787/16812336>
- Dender, K. V., O'Reilly, P., & Perret, S. (2020). COVID-19 and Fiscal Policies: Tax and Fiscal Policy in Response to the Coronavirus Crisis: Strengthening Confidence and Resilience. *Intertax*, 48(8/9), 736–742.
- European Commission. (2020). *Taxation Trend in the European Union. Data for the EU Member States, Iceland and Norway. 2020 Edition*. Directorate-General for Taxation and Customs Union, European Commission, Publications Office of the European Union. <https://doi.org/10.2778/49030>
- Eurostat. (2021). *Database – International trade in goods* [Dataset]. Retrieved February 4, 2021 from <https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/database>

- Financial Administration. (2021). *Nouzový stav (COVID-19)*. <https://www.financnisprava.cz/cs/financni-sprava/media-a-verejnost/nouzovy-stav>
- Harding, M., & Simon, H. (2020, April 29). *Consumption tax revenues under Covid-19: Lessons from the 2008 global financial crisis*. OECD. The Forum Network. <https://www.oecd-forum.org/posts/consumption-tax-revenues-under-covid-19-lessons-from-the-2008-global-financial-crisis>.
- Hemmelgarn, T., & Nicodème, G. (2010). *The 2008 Financial Crisis and Taxation Policy* (CESifo Working Paper Series 2932). http://publications.europa.eu/resource/cellar/324e06da-a6d5-4f58-8766-5672b0d33f9c.0001.03/DOC_2
- Jaelani, A., & Hanim, T. F. (2020). Sustainability of Public Finance During The COVID-19 Outbreaks in Indonesia. *Al-Amwal Jurnal Ekonomi dan Perbankan Syari'ah*, 12(1), 109–123. <https://doi.org/10.24235/amwal.v1i1.6557>
- Keane, C. (2015). Irish Public Finances through the Financial Crisis. *Fiscal Studies*, 36(4), 475–497. <https://doi.org/10.1111/j.1475-5890.2015.12077>
- Keen, M., & Mooij, R. de. (2012). *"Fiscal Devaluation" and Fiscal Consolidation: The VAT in Troubled Times* (NBER Working Paper No. 17913). National Bureau of Economic Research. <https://doi.org/10.3386/w17913>
- KPMG. (2020). *Tax developments in response to COVID-19*. <https://home.kpmg/xx/en/home/insights/2020/04/oecd-tax-developments-in-response-to-covid19.html>
- Kukalová, G., Moravec, L., Jecminek, J., & Martásková, B. (2018). Financial crisis influence on tax mix changes. In J. Nešleha, F. Hampl, & M. Svoboda (Eds.), *European Financial Systems 2018. Proceedings of the 15th International Scientific Conference* (pp. 355–363). Masaryk University.
- Mara, E., Inceu, A. M., Cuceu, I., & Achim, M. V. (2009). The impact of economic crisis on the fiscal revenues. *Annals of Faculty of Economics*, 3, 252–257.
- MFCR. (2021). *Koronavirus (COVID-19)*. Ministry of Finance of the Czech Republic. <https://www.mfcr.cz/cs/aktualne/koronavirus-covid-19>
- MFCR. (2021, February 2). *Měsíční pokladní plnění státního rozpočtu v roce 2020*. Ministry of Finance of the Czech Republic. <https://www.mfcr.cz/cs/verejny-sektor/statni-rozpocet/plneni-statniho-rozpocetu/2020/mesicni-pokladni-plneni-statniho-rozpocet-37413>
- MFCR. (2021, January 5). *Plnění státního rozpočtu ČR za leden až prosinec 2020*. Ministry of Finance of the Czech Republic. <https://www.mfcr.cz/cs/aktualne/tiskove-zpravy/2021/pokladni-plneni-sr-40434>
- MFCR. (2020, May 29). *Poslanci schválili protikrizový daňový balíček*. Ministry of Finance of the Czech Republic. <https://www.mfcr.cz/cs/aktualne/tiskove-zpravy/2020/poslanci-schvalili-protikrizovy-danovy-b-38612>
- MFCR. (2020, January 5). *Výsledek hospodaření státního rozpočtu v roce 2019 je o 11,5 mld. lepší než očekávání*. Ministry of Finance of the Czech Republic. <https://www.mfcr.cz/cs/aktualne/tiskove-zpravy/2020/pokladni-plneni-sr-37026>
- MF. (2021, February 10). *Szacunkowe wykonanie budzetu państwa w okresie styczeń - grudzień 2020 r.* Ministerstwo Finansów. <https://www.gov.pl/web/finanse/szacunkowe-wykonanie-budzetu-panstwa-w-okresie-styczen--grudzien-2020-r>
- OECD. (2020). *Tax and fiscal policy in response to the Coronavirus crisis: Strengthening confidence and resilience*. OECD Publishing, Paris. https://read.oecd-ilibrary.org/view/?ref=128_128575-o6rakt0aa&title=Tax-and-Fiscal-Policy-in-Response-to-the-Coronavirus-Crisis
- Olejniczak, J. (2015). Instrumenty podatkowe polityki fiskalnej. In L. Patrzalek (Ed.), *Polityka fiskalna w warunkach globalizacji* (pp. 41–92). Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.
- Owsiak, S. (2016). System podatkowy Polski w okresie transformacji – próba oceny. *Annales Universitatis Mariae Curie-Skłodowska. Sect. H – Oeconomia*, 50(1), 15–24. <https://doi.org/10.17951/h.2016.50.1.15>
- Reichardt, A. (2011). Poland and the global economic crisis: Observations and reflections in the public sector. *Journal of Finance and Management in Public Services*, 10(1), 38–48.
- Staehr, K. (2010). The global financial crisis and public finances in the new EU countries from Central and Eastern Europe: Developments and challenges. *Public Finance and Management*, 10(4), 671–712.
- Tvrdoň, M. (2010). Consequences of the global economic crisis on the Czech economy. *Scientific papers of the University of Pardubice. Series D*, 17(2/2010), 339–351. <http://hdl.handle.net/10195/38507>
- Vančurová, A., Láchová, L., & Zídková, H. (2020). *Daňový systém ČR 2020*. Wolters Kluwer.

The Aspect of Ethics Determined by Technological Impact

Marcin PASKA

Wroclaw University of Science and Technology, Poland, marcin.paska@pwr.edu.pl

Abstract: The aim of the article is to identify the issue of ethics as a major and crucial factor that accompanies the development and use of technology. The considerations related to the presented topic constitute an attempt to fill the research gap, in which ethics is perceived as an element that permeates and determines the process of adaptation and use of technology. This article points out on multidimensional technological impact that has influence on society and industry, which consequently also affects aspects of ethics. The content of this paper indicates necessity to build an appropriate ethical framework for the emerging technology, which in the field of science, despite its great dynamics, has started to develop relatively not long ago. This paper invites a discussion on how the development of technology and its actual use, could bring the discourse about ethics in field where the technology is implemented. Content of article is the very basis for further work.

Keywords: technology; adaptation; technological impact; ethics

JEL Classification: O14

1. Introduction

The processes of globalization and the development of new technologies unify the world. They seem to be strengthened by modern technologies and innovative solutions. The digital age is no longer the distant future, it is happening here and now (Hochuł, 2017). This impact of technology seems to be what is changing the way how society operate (Harari, 2017). Each time when new technological are developed, new ethical issues are also introduced. (Park et al., 2019). Literature related with technology acceptance models (Davis, 1985; Ajzen & Fishbein, 1980) try to present major factors that are responsible for technology adoption. Probably, a technology that does not meet the ethical criteria of a society is going to face a difficult process of acceptance, regardless of its potentially tremendous positive potential for long-term socio-economic development (Kuleshov et al., 2020). It brings with it opportunities and threats in the field of ethics. The present day is a dynamic development, in which information and knowledge determine a new stage of civilization progress, and the products of digital technology of this period create conditions for increasing human intellectual capabilities, which are the basis of creativity and innovation (Kowalczyk, 2017). Before the user actually uses a technology, he or she assesses the technology in terms of aspects such as the ease of use of the technology and the usability of the technology (Davis, 1985). Technology is to support the user in action, bring him better and faster solutions, reducing physical and mental effort during the task. The technology user is a form of relationship that is reflected in everyday life. The content of this article is a reflection on the ethical form of technology.

The technology of itself, as Miller points out, is obviously morally and politically neutral. The author argues that it is neither good nor bad - while its actual use brings about moral or other values (Miller, 2020). As argued by Raab, there is now a confusing debate about the ethics of technologies that use data extensively and intensively (Raab, 2020).

2. Technology Development

Undoubtedly, the industrial reality that takes part in the accelerated digital transformation opens binary doors to new possibilities. Thus, it blurs its boundaries with virtual reality through automated production processes and applied robotics. The interest of industrial companies, intertwined with the global market economy, sees robotics and automation as a map leading to development. The effect of the development of the manufacturing industry, in its intended causative effect, appears to be the need to adapt and integrate new technologies. New technology and new resources are directly responsible for achieving success, which is to increase efficiency, flexibility, quantitative and qualitative efficiency in operation. Technology acceptance models should also take into account the ethical aspects of technology in terms of how technology shapes the image of today's world.

New computer technologies contribute to the intensification of the processes of globalization of economic activities. The effect of globalization, scientific discoveries, development and technological progress today has a significant impact on the manufacturing industry. It is being reflected that it is time to rethink the way industrial products are made. Hozdić and Butala (2020) indicate that a new approach to industrial production is needed that would solve new challenges and circumstances resulting from the escalation of uncertainty, dynamics and complexity of industry driven by turbulent market, political, economic and social conditions (Hozdić et al., 2020). Industry 4.0 is the use of intelligent processes and products supported by autonomous collection and points, and with comprehensive integration, resulting in smart payments, effective and efficient (Buer, 2018).

Scientists indicate that the manufacturing industry is currently undergoing a major change due to the rapid development and advancement of digital technologies and the reduction of technology-related costs (Monostori et al., 2016). The field of computer science, information and communication technologies, which are the pillars of cyber-physical systems, is progressing exponentially. Cyber-Physical Systems are systems of cooperating computing units that are in relation to the surrounding physical world and its current processes, providing access to data during its processing via the Internet (Kant, 2016). The dormant potential of the CPS can influence and permeate almost every aspect of human life. Concepts such as autonomous cars, robotics, smart buildings, smart electricity grids, smart manufacturing and implanted medical devices are just a handful of examples that are already in use. The modern philosophy of broadly understood production, which is identified with the fourth industrial revolution, takes the form of both a key and a door behind which innovative approaches to industrial production are to be hidden (Gajsek et al. 2019). At the same time, it should be borne in mind that along with opportunities, there are also risks and threats, also in the field of ethics.

The fourth industrial revolution or Industry 4.0 is changing the strategies of companies and transforming their organizational structure, business models are changing, and value chains and supply chains are also transforming. The contemporary trend of changes directly affects processes, products, skills and relationships with all business stakeholders. In order to maintain a positive impact on business and society, it is necessary to properly manage the opportunities created by the revolution (Büchi et al., 2020). Modern processes are implemented with the support of a digital infrastructure that enables the collection of significant knowledge from supervised resources through the use of an intelligent approach to data control and fusion, as well as by adopting machine learning and continuous improvement procedures (Diez-Oliván, 2019).

3. Technology Adaptation

Professor Piotr Grajewski points out that the current stage of human development is characterized by a dynamic growth rate of the available set of knowledge and information. Additionally, the author emphasized the hitherto unknown - on such a large scale - pace of changeability of realities and conditions in which modern society lives. This pace is a cause of adaptation difficulties for many people. In fact, it results from the possibility of learning new techniques and using the potential of the achievements of modern civilization (Grajewski, 2016).

This content also allows to see the challenge facing global civilization in the perspective of overcoming difficulties of adapting changing social, political and economic models through the adaptation of technology. The previous industrial revolution that took place in the nineteenth century penetrates the essence of ethical issues, as this revolution created hitherto unknown conditions and problems that none of the then existing social, economic and political models could cope with.

Such a picture of the situation also resonates with the opinion of A. Toffler, who stated that the pace of changes in the contemporary world determines new qualitatively phenomena and problems, the essence of which cannot be fully described with the help of theories, truths and rules developed in past epochs. (Toffler, 1997) Therefore, the influence of technology forces man to develop completely new models and social, political and economic behavior. Models aimed at proper functioning, including ethical models for the resulting relationships.

The development of technology and information systems also determines the development of theories and models that are used to assess technology acceptance. Some of the most important works focused on this issue include The Theory of Reasoned Action (Ajzen & Fishbein, 1980), The Theory of Planned Behavior (Ajzen, 1985), The Motivational Model (Davis, 1991), Decomposed Theory of Planned Behavior (Taylor & Todd, 1995), Innovation Diffusion (Rogers, 1962), Social Cognitive Theory (Bandura, 1986), Model of PC Utilization (Thompson, 1991), The Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), and Technology Acceptance Mode (Davis, 1985).

Summarized, these models aim to describe the motivational processes that mediate between system characteristics and user behavior. And as Professor Ejdyś (2018) points out, technology acceptance can be identified as a process in which a stimulus is given being a

function and possibility of the system, it interacts with people, acting on their motivation, thus prompting them to use the system. The indicated relationship leads to an answer that becomes the actual use of the system. Models contain a wide range of constructs, such as perceived ease of use, perceived utility, social norms, attitudes towards technology, and more, and try to capture the factors that determine the adoption of a given technology. Among the models mentioned, there is a reflection on the ethical dimension of these technologies, which may lead to the implementation of a new factor that the models do not take into account, which is trust in technology. When it comes to ethics and technology, scientists like Mark Ryan are asking, whether technology can be trusted, or instead, it should be place a greater emphasis on ensuring that organizations using technology, and individuals within those organizations, are trustworthy (Ryan, 2020).

Accepted technology enters into relationships with humans and shapes reality. Our lifestyle is changing as technology affects our lives, transforming the ethical standards of our behavior. The causative effect of technology acceptance is therefore the influence of technology on the way we operate today.

4. Technological Impact

Contemporary society, which consists of business practitioners, scientists, doctors, politicians, drivers and representatives of all other sectors of the economy, lacks a transparent understanding of how new technologies (emerging technologies) shape the developed social, economic and political models. When confronting the next progress of the industrial revolution, man should remain vigilant regarding the ethical relationship with technology and its explosive potential. Different economies in the world are trying to describe what they are best at when it comes to digital convergence, and create strategies and compete with each other.

The presented interpretation of the indicated issue is the basis for an attempt to introduce a new concept of technological impact in the environment in which technology is harnessed to work. The technological impact can be presented as the causative effect of the technology acceptance process that determines the functioning and behavior of social, economic and political models in the environment in which this process takes place.

Undoubtedly, the broadly understood technology is a catalyst for human and industrial development. The time of pioneering steam propulsion, the Cincinnati meat processing line, the Harry Ford production line, the Modicon 084 logic controller are undoubtedly the spark that set off the land of great industrial revolutions in human history (Paska, 2017).

Looking through the lens of history, we can also see successes that have been supported by the technological achievements of the current years. The ethical business challenges were noticed by George (2003), which are the clear result of introducing computer and information technologies to business (George, 2003). The business world and economic models also resonate with the process of accepting technology and using it for established benefits. In a pilot study on the process of technology acceptance, carried out by Tworek and Paska (2020), the authors stated that technology acceptance determines the degree of effectiveness of modern organizations. In another publication, Paska (2019) states that access to new

technologies and its dynamic development increase the perimeter of the boundaries of innovative space in which manufacturing companies, for justified economic reasons, have a chance to implement their processes more effectively.

Ethics that deals with emerging technologies is of interest to a much wider population - also beyond the ethical community. Munoko, Brown-Liburd, and Vasarhelyi (2020) note that academia, professionals, policy makers and developers of these technologies are increasingly aware of the legitimate ethical concerns arising from the use of these technologies.

5. Ethics and Technology

The one of the important issues that results from the interaction and dependence between man and technology is developing issue of ethics and trust to technology (Wernaart, 2021; Sarbadhikari & Pradhan, 2020; Kapeller et al., 2020; Kuc-Czarnecka & Olczyk, 2020; Tavani, 2015). According to Stahl, the concept of ethics is even more controversial and open than the concept of AI (Stahl, 2021). The implemented technology is undoubtedly what helps society to function better and more effectively. Ethical perspectives on information processing and the use of new technologies are needed (Hildebrandt, 2015). Technology helps to operate more efficiently in many aspects and on many different levels of human life. Through the influence of technology on our lives, arises this foundation for raising relevant and important questions, whether a technology such as artificial intelligence can be ethical? (Funk, 2020). If does and technology can be ethical, then what does it mean that technology is ethical? Perhaps the scientists' questions should be asked quite differently. Maybe the issue of ethical technology is an elusive subject. Only because the ethicality of technology in this matter remains beyond the possibility and opportunity to accurately measure it. Or, a person has not yet developed the appropriate tools to answer the question posed. However, it can definitely be said, even though the ethical aspects of technology remain elusive, impossible to measure or calculate accurately, technology can and do have an impact on everyone's life.

It can be stated quite intuitively that good technologies are those that support the values respected and nurtured in communities. One of these values is harmony (Berberich et al., 2020). In this regard, ethics is concerned with assessing to what extent and how technology contributes to the harmonization process (Zhu, 2020). Without a doubt, technology is the tool that determines how people interact with each other on a daily basis. Technology today plays an extremely important role in every society. Unfortunately, it is not transparently visible whether technology has a positive or negative impact on the world and how it actually affects our daily lives. Technology has a particularly high level of interpretive flexibility, which means that it is difficult to predict how it ultimately will be used (Stahl, 2021). This is what makes it so important to undertake research and discussions towards defining the principles and ethical framework for technology (Lütge et al., 2020; Stokes & Palmer, 2020; Shneiderman; 2020; Hagendorff, 2020; Buruk et al., 2020).

Paraphrasing the words of Sophocles "Nothing vast enters the life of mortals without a curse" - can also be expressed as the perspective of using technology (as something vast), which, apart from its advantages, is also a source of danger, flaws, conflicts or ethical challenges. The ethical challenges that attract the attention of scientists are may be invisible

in their consequences. This could be a time when the effects of an adapted technology may still be beyond our attention and for common human understanding.

Taught by experience, we know that the society of every civilization was much better at inventing tools than using them wisely. It is much easier for us to build power plants than to precisely describe each impact of this action on the functioning ecosystem and nature. However, we have entered an era in which we are already able to use technology that have a huge impact not only on our private life or professional life, but on the entire functioning of the ecosystem and nature.

The use of technology also resonates with great responsibility for its application. Perhaps it should even be emphasized that responsibility for this technology should be present even before the design stage. Modern engineers or programmers should be ethically prepared. Ethics courses should run parallel with their full education. At this point, Azimov's robotics code and principles are no longer just a futuristic novel, and perhaps provide the first ethical lessons. (Asimov, 1950)

An important aspect emphasized by undertaking research on the ethics of technology is the state of social competences that are related to technology. Society, in a collective perspective, in terms of technology development remains at a distance - which means that people may not understand how artificial intelligence works, but will participate in the consequences of its use, more or less consciously. It means that the algorithms that will have a chance to shape our everyday life will be able to make decisions for us - apart from our awareness of these things.

In many of Professor Harari's lectures, we can learn that biotechnology and information technology will give man the opportunity and power to influence the world inside of us (biochemical processes) and transform ourselves (Harari, 2018). Undoubtedly, creators and users need to realize that they are confronting the ethical use of technology with consequences. In this activity, there is a difficulty in assessing and grasping the challenges that new technologies bring us. And it has a global dimension. Technology, machine learning and artificial intelligence is what, in terms of ethics and more, can have a huge impact on the lives of each of us.

One of the most popular and frequently asked ethical questions in the relationship between technology and man is the question related to work and employment. Will the new technology take away our jobs? So there is an issue related to the form of the social security system, legal, political and economic issues. How will the day of a row worker in a factory look like when technology becomes unbeatable? When technology takes over every trade. The answer to this question is still the blurry picture that futurists deal with.

However, this risk is discussed in the largest economic forums of our globe. There is a risk that the industrial revolution, the development of automation, robotization, and harnessing artificial intelligence to work may remove billions of people from the labor market in the coming decades. Such a movement in society, in the voice of Harari (2018), may contribute to the emergence of a huge new, useless class, which will lead to social, economic and political changes. In other words, it could be argued that the concern is perfectly valid

that technology could directly displace certain workers from their jobs, thereby reducing the need for their manpower (Goos et al., 2019).

There is also a voice that counters such or similar statements. A defense shield for such fears are the parallels that took place in the nineteenth century. At that time, it was feared that the first forms of automated processes would be a source that would take the work of a significant proportion of employees. It is true that work which in its nature is routine work of repeating the same actions is actually being replaced by robots. Modern factories are filled with automated production processes, which has become commonly understood, for example due to economic conditions, in which such decisions lead to an increase in the efficiency of a production company. Ultimately, human work, regardless of the industry and profession, will most likely be replaced by an automated process - it is, in a way, a threat of future automation argued by the continuous development of machine learning and robotics. Robotics, which is supposed to replace humans and contribute to the creation of a new class of workers that will be economically irrelevant, may additionally be driven by the lack of mental resilience of human in the process of these transformations.

The experience of previous years of industrial revolutions also raises some optimism. In fact, many professions and jobs have been replaced by technology in its broadest sense. However, exactly the same technology is creating new jobs that were not there before the development of this technology. The key to the ethical relationship between technology and man is the adoption of a strategy and policy of action that puts the human being first, not the workplace. A model should be developed that follows the principle that people must be protected, not jobs.

Another ethical aspect of the impact of technology on the employee is the issue of human ability to adapt to the new conditions that the technology will create. New technology can indeed be a way of creating new jobs as it was in history. However, there is a challenge that the mere consequence of placing an employee in a new area of duties may be easier than the actual adaptation of the employee in terms of his competences, skills and abilities. The new technology should also be equated with the need to support the competences and skills of employees that go beyond the current event horizon (Paska, 2019). Another important issue of ethics and technology appears to be very sensitive and delicate when discussion takes place about the use of technology in military services (Agreda, 2020).

6. Ethical Framework as a Result of Technology Development

The dynamics of technology development leaves man behind and his actions in terms of responding to the impact of technology on human life. However, the European Union's venture allowed the publication on April 8, 2019 of the first principles and ethical framework for artificial intelligence, which are the result of the work of the European Commission. The publication consists of rules recommended by an independent group of fifty-two experts. This group includes scientists, lawyers and business practitioners, among others. The first version of this document was published on December 18, 2018 and was the subject of an open consultation with over 500 participants providing feedback. The purpose of the document is to promote a technology that can be trusted: artificial intelligence. According to the

commission, this technology should remain legal, ethical and solid both in terms of social and political conditions (European Commission, 2019). Another document that should be mentioned here, is the European Commission's "Ethics Guidelines for Trustworthy AI" (Pekka et al., 2018).

The actions taken by the European Commission provide further evidence that new digital technologies are becoming more common in the economy every day. This awareness resonates with the ethical mission that technologies are becoming increasingly capable of performing tasks that previously could only be performed by humans. So their use is becoming more and more common. The presence of technology exposes the expansion of relationships with humans, which is linked by the ethical dimension.

A document issued by the European Commission has gathered up-to-date evidence on the implications of technological innovation in the labor markets based on academic literature. The document presents three key challenges for European labor markets: digitization induces shifts in skill requirements, and workers' fate in changing labor markets crucially depends on their ability to keep up with the change; digitization is not a purely technological process, but requires an accompanying process of organizational change; digitization comes along with rising shares of alternative work arrangements, due to more outsourcing, standardization, fragmentation, and online platforms (Goos et al., 2019).

Table 1. The impact of digitization on labor markets – main mechanisms. Source: Goos et al. (2019).

Mechanism	Description	Impact
Displacement effect	Machines and technology are becoming more and more capable of performing increasingly complex and complicated tasks that previously only humans could perform. The risk is related to the scenario in which companies will increasingly use technology that will eventually replace human work. This scenario reduces the demand for manpower.	Reduces the need for labor
Productivity effect	Adaptation of new technology implies a growing demand for new machines and intangible capital, which increases the demand for knowledge-based tasks and for tasks related to the production, implementation, maintenance and modernization of applied technologies. This increases the demand for labor.	Increases the demand for labor
Capital accumulation effect	Adaptation of new technology implies a growing demand for new machines and intangible capital, which increases the demand for knowledge-based tasks and for tasks related to the production, implementation, maintenance and modernization of applied technologies. This increases the demand for labor.	Increases the demand for labor
Reinstatement effect	New technologies encourage the creation of new jobs for employees for two reasons: First, displacing employees from old jobs means there are more employees who can take over new, more productive jobs. Second, new machines and the growth of knowledge capital may directly require new tasks (eg, machine operation) or enable new tasks (eg, working on a platform). Creating new tasks directly counteracts the effect of displacements, increasing the demand for labor.	Increases the demand for labor

The challenges presented in the European document require appropriate policy responses at European, national and regional level. It is therefore justified to undertake activities aimed at reflecting on the impact of technological progress on the labor market. The

groundbreaking contribution of Acemoglu and Resrepo allows for the presentation of the impact of digitization on labor markets, which is presented in Table 1 above.

However, in the publication by Hagendorff (2019), he points out that the ethics of the smart intelligentsia very often fails. The author emphasizes that there is no reinforcing mechanism. Additionally, it points out that when ethics is integrated with institutions, it only serves as a marketing strategy. The author concludes that reading ethical guidelines has no significant impact on developers' decision making (Hagendorff, 2019) The researcher says that the ethical guidelines have no impact on human decision-making in the field of artificial intelligence and machine learning.

Leading companies in technology development see technology, machine learning or artificial technology as tools embedded in everyday life, in business, administration, medicine and other industries. Such enterprises should be distinguished by the adopted policy regarding the implementation of artificial intelligence by implementing ethical principles in applications and processes of artificial intelligence. Then only such systems can be systems built on principles based on trust. Some of the most important ethical factors that can be seen as the foundations of a trustworthy system are: explainability, fairness, robustness, transparency, privacy (Doorn, 2020; Parker et al., 2019; Davis, 2005; Winfield & Jirotko, 2018; Jobin et al., 2019; Robinson, 2020; Larsson & Heintz, 2020) Another ethical challenge in the field of technology development is the need to broaden the approach to digital ethics, bringing together a range of cultural, social and structural perspectives on ethical issues related to the use of technology (Aggarwal, 2020; Hongladarom & Ess, 2007).

6. Conclusions

It is important to emphasize that technology reliability is a key aspect of the reliability of modern organizations (Tworek et al., 2020). Technology is able to increase efficiencies, provide greater insight into business processes, and create competitive advantages for adopters. With that said, there are some ethical concerns with the technology, which, if left unresolved, could negate the anticipated benefits (Munoko et al., 2020).

The article is an attempt to raise an interesting issue and focus on ethical aspect of using technology that is present in the business and private space. The content aims to provoke reflection on the causative effects of technology in the field of ethics that accompanies the process of technology acceptance. The content of the article emphasizes the essence of ethics in the space of technology development. Undoubtedly, technology is changing the face of modern businesses. The scope of the literature analysis on this subject shows that the aspects of technology are not given much attention in this regard (Doorn, 2019). Along with this change, it is important to adopt appropriate roles and rules which will be consistent with the established ethics policy. The review of the literature on the subject makes it possible to identify the needs to start and conduct research that integrates ethics with technology. As it was pointed out by Hagendorff (2019) there is crucial calls for applied ethics, which are meant to harness the "disruptive" potential of new technologies. It is important to identify the right research directions that will allow to define ethical technology in the business space.

The content of the article indicates the need to support ethics in terms of adopting legal framework conditions and establishing appropriate technology audit mechanisms (Munoko et al., 2020). It is also important to implement appropriate curricula at universities in order to improve skills and competences related to the integration of technology and ethics (Antoniou, 2021; McDonald & Pan, 2020). Stahl and his research team (2021), combining technology with ethics, distinguish research directions: related to the application of machine learning, social and political issues arising from the use of technology, and the study of the nature of reality and humanity.

The article encourages to understand and evaluate ethics perceptions and possible management mechanisms that could be used to solve ethical problems. It is an aspect of research that permeates the socio-economic, cultural and political context that determines the image of society (Cath, et al., 2016). Undoubtedly, the combination of technology and ethics should be based on the foundation and goal, which is to create a technology that follows an ideal ethical principle or set of ethical principles in guiding its behavior (Anderson, 2011). The development of technology and its range of possibilities explains the need to establish precise guidelines at many levels of functioning society (Buruk et al., 2020). It is clear that content of article is the very basis for further work.

References

- Aggarwal, N. (2020). Introduction to the Special Issue on Intercultural Digital Ethics. *Philosophy & Technology*, 33, 547–550. <https://doi.org/10.1007/s13347-020-00428-1>
- Agreda, A. G. (2020). Ethics of autonomous weapons systems and its applicability to any AI systems. *Telecommunications Policy*, 44, 101953. <https://doi.org/10.1016/j.telpol.2020.101953>
- Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. NJ: Prentice Hall.
- Anderson, S.L. (2011). Machine metaethics. In M. Anderson, & S. L. Anderson (Eds.), *Machine ethics* (pp. 21–27). <https://doi.org/10.1017/CBO9780511978036.004>
- Antoniou, J. (2021). Dealing with Emerging AI Technologies: Teaching and Learning Ethics for AI. In *Quality of Experience and Learning in Information Systems. EAI/Springer Innovations in Communication and Computing*. Springer, Cham. https://doi.org/10.1007/978-3-030-52559-0_6
- Asimov, I. (1950). *The Evidable Conflict*. Street & Smith.
- Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice- Hall Inc
- Berberich, N., Nishida, T., & Suzuki, S. (2020). Harmonizing Artificial Intelligence for Social Good. *Philosophy & Technology*, 33, 613–638. <https://doi.org/10.1007/s13347-020-00421-8>
- Buruk, B., Ekmekci, P. E., & Arda, B. (2020). A critical perspective on guidelines for responsible and trustworthy artificial intelligence. *Medicine, Health Care and Philosophy*, 23, 387–399. <https://doi.org/10.1007/s11019-020-09948-1>
- Büchi, G., Cugno, M., & Castagnoli, R. (2020). Smart factory performance and Industry 4.0. *Technological Forecasting & Social Change*, 150, 119790. <https://doi.org/10.1016/j.techfore.2019.119790>
- Buer, S. (2018). The link between Industry 4.0 and lean manufacturing: mapping current research and establishing a research agenda. *Journal International Journal of Production Research*, 56(8). <https://doi.org/10.1080/00207543.2018.1442945>
- Char, D. S., Shah, N. H., & Magnus, D. (2018). Implementing machine learning in health care – addressing ethical challenges. *N. Engl. J. Med.*, 378, 981–983. <https://doi.org/10.1056/NEJMp1714229>
- Cath, C. J. N., Wachter, B., Mittelstadt, B., Taddeo, M., & Floridi, L. (2016). Artificial Intelligence and the “Good Society”: The US, EU, and UK Approach. *Social Science Research Network*. <https://doi.org/10.1007/s11948-017-9901-7>
- Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 319–339. <https://doi.org/10.2307/249008>

- Davis, F., Bagozzi, R., & Warshaw, P. (1992). Extrinsic and Intrinsic Motivation to Use Computers in the Workplace. *Journal of Applied Social Psychology*, 22(14), 1111–1132. <https://doi.org/10.1111/j.1559-1816.1992.tb00945.x>
- Davis, M. (2005). *Engineering Ethics*. Ashgate Publishing.
- Diez-Olivan, A., Del Ser, J., Galar, D., & Sierra, B. (2019). Data Fusion and Machine Learning for Industrial Prognosis: Trends and Perspectives towards Industry 4.0. *Information Fusion*, 50, 92–111. <https://doi.org/10.1016/j.inffus.2018.10.005>
- Directorate-General for Communications Networks, Content and Technology (European Commission). (2019). Grupa ekspertów wysokiego szczebla ds. sztucznej inteligencji 2019.
- Doorn, N. (2020). Artificial intelligence in the water domain: Opportunities for responsible use. *Science of Total Environment*, 755. <https://doi.org/10.1016/j.scitotenv.2020.142561>
- Ejdys, J. (2018). *Zaufanie do e-commerce*. Oficyna Wydawnicza Politechniki Białostockiej, Białystok.
- European Commission. (2019). *European Commission's High-Level Expert Group on Artificial Intelligence. Ethics guidelines for trustworthy AI*. Brussels: European Commission. <https://ec.europa.eu/futurium/en/ai-alliance-consultation>
- Funk, M. (2020). What Is Robot Ethics? ...And Can It Be Standardized? *Frontiers in Artificial Intelligence and Applications*, 335, 469–480.
- Gajsek, B., Marolt, J., Rupnik, B., Lerher, T., & Sternad, M. (2019). Using Maturity Model and Discrete-Event Simulation for Industry 4.0 Implementation. *International Journal of Simulation Modelling*, 18(3), 488–499. [https://doi.org/10.2507/IJSIMM18\(3\)489](https://doi.org/10.2507/IJSIMM18(3)489)
- George, R. (2003). *The ethics of information technology and business*. Malden: Blackwell Publishing.
- Goos, M., Arntz, M., Zierahn, U., Gregory, T., Carretero, G., Gonzalez, V., & Jonkers, K. (2019). The impact of Technological innovation on the Future of Work. *EUR - Scientific and Technical Research Reports, Information Society Innovation and growth*. <https://ec.europa.eu/jrc/sites/jrcsh/files/jrc117212.pdf>
- Harari, Y. N. (2017). Reboot for the AI revolution. *Nature*, 550, 324–327. <https://doi.org/10.1038/550324a>
- Hagendorff, T. (2019). *The ethics of AI Ethics: an evaluation of guidelines*. <https://arxiv.org/ftp/arxiv/papers/1903/1903.03425.pdf>
- Hagendorff, T. (2020). Publisher Correction to: The Ethics of AI Ethics: An Evaluation of Guidelines. *Minds and Machines*, 30. <https://doi.org/10.1007/s11023-020-09517-8>
- Hildebrandt, M. (2015). *Smart Technologies and the End(s) of law*. Cheltenham, Edward Elgar.
- Hochuł, A. (2017). Identyfikacja źródeł innowacyjnych możliwości przedsiębiorstwa 4.0. In L. Kowalczyk, & F. Mroczko (Eds.), *Innowacyjność to cyfryzacja i rozwój, Wałbrzych: Prace Naukowe Wyższej Szkoły Zarządzania I Przedsiębiorczości*.
- Hongladarom S., & Ess. C. (2007). *Information technology ethics: cultural perspectives*. Idea Group Reference.
- Hozdic, E., Kozjek, D., & Butala, P. (2020). A Cyber-Physical Approach to the Management and Control of Manufacturing Systems. *Strojniški vestnik - Journal of Mechanical Engineering*, 66(1), 61–70.
- Jobin, A., Marcello, L., & Vayena, E. (2019). The global landscape for AI ethics guidelines. *Nature Machine Intelligence*, 1, 389–399. <https://doi.org/10.1038/s42256-019-0088-2>
- Kapeller, A., Gelzmann, H., Fosh-Villaronga, E., & Hughes, A. (2020). A Taxonomy of Ethical, Legal and Social Implications of Wearable Robots: An Expert Perspective. *Science and Engineering Ethics*, 26, 3229–3247. <https://doi.org/10.1007/s11948-020-00268-4>
- Kowalczyk, L. (2017). Cyfryzacja w procesie postępu cywilizacyjnego i jej współczesna rola w innowacyjności. In L. Kowalczyk, & F. Mroczko (Eds.), *Innowacyjność to cyfryzacja i rozwój, Wałbrzych: Prace Naukowe Wyższej Szkoły Zarządzania I Przedsiębiorczości*.
- Kuleshov, A., Ignatiev, A., Abramova, A., & Marshalko, G. (2020). Addressing AI ethics through codification. In *Proceedings - 2020 International Conference Engineering Technologies and Computer Science, EnT 2020*, 9140627 (pp. 24–30). <https://doi.org/10.1109/EnT48576.2020.00011>
- Larsson, S., & Heintz, F. (2020). Transparency in AI. *Internet Policy Review*, 9, 1–16. <https://doi.org/10.14763/2020.2.1469>
- Lütge, C., Poszler, F., Acosta, A., Danks, D., Gottehrer, G., Miher-Popa, L., & Neseer, A. (2021). AI4People: Ethical Guidelines for the Automotive Sector – Fundamental Requirements and Practical Recommendations. *International Journal of Technoethics*, 12(1). <https://doi.org/10.4018/IJT.20210101.0a2>
- Kuc-Czarnecka, M., & Olczyk, M. (2020). How ethics combine with big data: a bibliometric analysis. *Humanities and Social Sciences Communications*, 7, 137. <https://doi.org/10.1057/s41599-020-00638-0>

- McDonadl, N., & Pan, S. (2020). Intersectional AI: A Study of How Information Science Students Think about Ethics and Their Impact. In *Proceedings of the ACM on Human-Computer Interaction*, 4. <https://doi.org/10.1145/3415218>.
- Miller, B. (2020). Is Technology Value-Neutral? *Science, Technology & Humal Values*, 46(1), 53-80. <https://doi.org/10.1177/0162243919900965>
- Monostori, L., Kada, B., Bauernhansl, T., Kondoh, S., Kumara, S., Reinhart, G., Sauer, O., Schuh, G., Sihn, W., & Ueda, K. (2016). Cyber-physical systems in manufacturing. *CIRP Annals - Manufacturing Technology*, 65, 621–641. <https://doi.org/10.1016/j.cirp.2016.06.005>.
- Munoko, I., Brown-Liburd, H., & Vasarhelyi, M. (2020). The Ethical Implications of Using Artificial Intelligence in Auditing. *Journal of Business Ethics*, 167, 209-234. <https://doi.org/10.1007/s10551-019-04407-1>
- Park, S. H., Kim, Y. H., Lee, J. Y., Yoo, S., & Kim, C. J. (2019). Ethical challenges regarding artificial intelligence in medicine from the perspective of scientific editing and peer review. *Science Editing*, 6, 91-98.
- Paska, M. (2017). Inteligentne fabryki i ich technologia. In L. Kowalczyk, & F. Mroczko (Eds.), *Innowacyjność to cyfryzacja i rozwój*. Wałbrzych: Prace Naukowe Wyższej Szkoły Zarządzania i Przedsiębiorczości.
- Paska, M. (2019). Inżynieria produkcji - bezpieczeństwo i ewaluacja zautomatyzowanych procesów produkcyjnych. In L. Kowalczyk, & F. Mroczko (Eds.), *Kreatywność i innowacyjność w zarządzaniu i pedagogice w erze cyfrowej*. Wałbrzych: Prace Naukowe Wyższej Szkoły Zarządzania i Przedsiębiorczości.
- Pekka, A.-P., Bauer, W., Bergmann, U., Bieliková, M., Bonefeld-Dahl, C., Bonnet, Y., & Bouarfa, L. (2018). *The European Commission's high-level expert group on artificial intelligence: Ethics guidelines for trustworthy AI*. Working Document for stakeholders' consultation. Brussels (pp. 1–37).
- Raab, C. (2020). Information privacy, impact assessment, and the place of ethics. *Computer law & security review* 37, 105404. <https://doi.org/10.1016/j.clsr.2020.105404>
- Robinson, S. C. (2020). Trust, transparency, and openness: How inclusion of cultural values shapes Nordic national public policy strategies for artificial intelligence (AI). *Technology in Society*, 63, 101421. <https://doi.org/10.1016/j.techsoc.2020.101421>
- Ryan, M. (2020). In AI We Trust: Ethics, Artificial Intelligence, and Reliability. *Science and Engineering Ethics*, 26, 2749-2767. <https://doi.org/https://doi.org/10.1007/s11948-020-00228-y>
- Sarbadhikari, S., & Pradhan, K. (2020). The Need for Developing Technology-Enabled, Safe, and Ethical Workforce for Healthcare Delivery. *Safety and Health at Work*, 11, 533-536. <https://doi.org/10.1016/j.shaw.2020.08.003>
- Shneiderman, B. (2020). Bridging the gap between ethics and practice: Guidelines for reliable, safe, and trustworthy human-centered AI systems. *ACM Transactions on Interactive Intelligent Systems*, 10, 26.
- Stahl, B. C., Andreou, A., Brey, P., Hatzakis, T., Kirichenko, A., Macnish, K., Laulhe Shaelou, S., Patel, A., Ryan, M., & Wright, D. (2021). Artificial intelligence for human flourishing – Beyond principles for machine learning. *Journal of Business Research*, 374-388. <https://doi.org/10.1016/j.jbusres.2020.11.030>
- Stokes, F., & Palmer, A. (2020). Artificial Intelligence and Robotics in Nursing: Ethics of Caring as a Guide to Dividing Tasks Between AI and Humans. *Nursing Philosophy*, 21. <https://doi.org/10.1111/nup.12306>.
- Taylor, S., & Todd, P. A. (1995). Understanding Information Technology Usage: A Test of Competing Models. *Information Systems Research*, 6(4), 144–176. <https://www.jstor.org/stable/23011007>
- Tavani, H. (2015). Levels of Trust in the Context of Machine Ethics. *Philos. Technol.*, 28, 75–90. <https://doi.org/10.1007/s13347-014-0165-8>
- Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal Computing Toward a Conceptual Model of Utilization. *MIS Quarterly* 15(1), 125-143. <https://www.jstor.org/stable/pdf/249443.pdf>
- Tworek, K., Bienkowska, A., & Zabłocka-Kluczka, A. (2020). *Organizational reliability: Human resources, information technology and management*. Routledge.
- Tworek, K., & Paska, M. (2020). Technology acceptance influence on performance of manufacturing organizations. In Khalid S. Soliman (Ed.), *Proceedings of the 35th International Business Information Management Association Conference (IBIMA): 1-2 April 2020, Seville, Spain* (pp. 7996-8007). International Business Information Management Association.
- Wernaart, B. (2021). Developing a roadmap for the moral programming of smart technology. *Technology in Society*, 64. <https://doi.org/10.1016/j.techsoc.2020.101466>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478. <https://www.jstor.org/stable/pdf/30036540>.
- Qin, Z. (2020). Ethics, society, and technology: A Confucian role ethics perspective. *Technology in Society*, 63, 101424. <https://doi.org/10.1016/j.techsoc.2020.101424>

A Modification of the Vehicle Routing Problem

Jan PELIKÁN

University of Economics, Prague, Czech Republic; pelikan@vse.cz

Abstract: There are many modifications of the standard vehicle routing problem (VRP). VRP consists in optimization of vehicle routes which contain given set of nodes. The matrix of node distances and demand of goods are specified. In VRP proposed in the paper nodes are suppliers (shops, manufactures, producers...) with different prices of offered goods. The price list of goods of producers is given and the distance matrix of nodes too. The first node is depot of vehicles to which goods are delivered. In the first node is located a buyer with a given list of demanded quantity of goods. Buyer has to minimize total costs which is sum of transportation costs and costs of purchased goods (which depends on suppliers' nodes). Goal is to find optimal routes though nodes which are supplier of some purchased goods. The mathematical model is proposed which is demonstrated by numerical example. In addition to the model a heuristic method is shown.

Keywords: vehicle routing problem; integer programming; heuristic method

JEL Classification: C44

1. Introduction

Traditional formulation of vehicle routing problem (VRP) assumes n nodes, where the first node represents the depot and the remaining ones the customers. The merchandise is transported using the routes starting and ending in the depot. The transport itself is realized by the vehicles with certain capacity and the customer-node requests are given by the volume used for the containment of the requested merchandise in a given vehicle. The route length depends on the order of the nodes of a given route and can be calculated using the distance matrix between each pair of nodes. Instead of the node distance one can also calculate the transport cost of a given vehicle from one node to another. The aim is to minimize the total sum of route distances or eventually to minimize the transport cost of the routes using given vehicles.

The solution procedure of VRP must ensure the following two conditions:

- a) All nodes are included at least in one of the routes.
- b) The sum requests of all nodes of a route must not exceed the capacity of the vehicle for this route.

This problem can be formulated as integer linear programming model and solved using appropriate software tools. VRP and in general, linear integer programming problems, belong among NP hard problems, i.e. if the number of nodes is higher, in reality more than approx. 30 nodes, it is impossible to obtain optimal solution using standard LP integer solvers (branch and bound method) in a reasonable time. Except for mathematical models one can

use heuristic methods such as nearest neighborhood method, insert method or savings method, which can help to obtain a suboptimal solution in reasonable time.

There are many modifications of the conventional form of VRP, which arise as a results of merchandise transport in praxis (Laporte, 1992). The following ones belong among the most interesting ones – VRP involving vehicles with different capacities and transport cost; VRP with more than one depot; split delivery VRP; VRP involving stochastic demand in nodes; VRP with time windows, where the time of vehicle arrival in the node must be inside to a certain time interval denoted as time window (Braysy & Gendreau, 2005; Desrochers et al., 1992), and others.

The traditional VRP problem is described in the literature enough, heuristic methods are proposed, and a survey of these approaches is summarized in (Laporte, 1992).

2. Problem Formulation and Mathematical Model

In the vehicle routing problem studied in this paper there are n nodes where first node is depot. The first node is depot of vehicles to which goods are delivered. In the first node is located a buyer with a given list of demanded quantity of goods. Buyer has to minimize total costs which is sum of transportation costs and costs of purchased goods (which depends on suppliers' price list). Other nodes are suppliers (shops, manufactures, producers...) with different prices of offered goods. The price list of goods of producers is given and the distance matrix of nodes too. Buyer (in the first node) has to minimize total costs which is sum of transportation costs and costs of purchased goods (which depends on suppliers' price list). Goal is to find optimal routes though nodes which are supplier of some purchased goods. The optimal solution contains a decision which product is purchased from certain supplier.

The mathematical model assumes the demanded product to be available in every node. In case there is a product that is not available in a given node, we set the product price to be prohibitively high.

Parameters of the model:

- n number of nodes, node 1 is depot,
- d_{ij} vehicle transport costs from node i to node j ,
- m number of products: P_1, P_2, \dots, P_m ,
- q_k customer demand for k -th product,
- c_{ki} price per unit of the k -th product in the i -th node,
- W vehicle capacity,
- $M > 0$ prohibitive value.

Variables of the model:

- x_{ij} binary variable, equals 1 if the vehicle travels from node i to node j , where $i \neq j$,
- y_{ik} binary variable, equals 1 if product k is loaded in node i ,
- z_i binary variable, equals 1 if the vehicle visits node i ,
- u_i anticyclic conditions variable in (6).

Objective function (1) is defined as a sum of the transport costs and the product costs. Function (1) is being minimized. Equation (2) means that if the node i is entered then $z_i=1$, et vice versa. Condition (3) assures that once the vehicle enter a node it will have to leave it. Equation (4) prescribes that the k -th product has to be picked up in one of the nodes. If the product is picked up in the i -th node the vehicle has to pass through (5). Conditions (6) and (7) state that the vehicle capacity will not be exceeded. At the same time (6) prevents partial cycles.

The mathematical model (1) – (8) can be modified for the case of split demand, i.e. the demand of the k -th product q_k can be divided into several fractions and these fractions are transported by different vehicles from different nodes.

Mathematical model:

$$f(x) = \sum_{i=1}^n \sum_{j=1}^n d_{ij} x_{ij} + \sum_{i=2}^n \sum_{k=1}^m c_{ki} q_k y_{ik} \rightarrow \min \quad (1)$$

$$\sum_{j=1}^n x_{ij} = z_i, \quad i = 2, 3, \dots, n, \quad (2)$$

$$\sum_{i=1}^n x_{ij} = \sum_{i=1}^n x_{ji}, \quad i = 1, 2, \dots, n, \quad (3)$$

$$\sum_{i=2}^n y_{ik} = 1, \quad k = 1, 2, \dots, m, \quad (4)$$

$$\frac{1}{M} \sum_{k=1}^m y_{ik} \leq z_i, \quad i = 2, 3, \dots, n, \quad (5)$$

$$u_i + \sum_{k=1}^m q_k y_{jk} - W(1 - x_{ij}) \leq u_j, \quad i = 1, 2, \dots, n, j = 2, 3, \dots, n, i \neq j, \quad (6)$$

$$u_j \leq W, \quad j = 2, 3, \dots, n, \quad (7)$$

$$x_{ij} \text{ is binary}, i, j = 1, 2, \dots, n, i \neq j, \quad (8)$$

$$y_{ik} \text{ is binary } i = 2, 3, \dots, n, k = 1, 2, \dots, m,$$

$$u_i \geq 0, \quad x_{ii} = 0, \quad i = 1, 2, \dots, n.$$

3. Numerical Example

The number of nodes is 11, whereas node 1 is the depot. The vehicle capacity is $W=100$. The aim is to pick up and transport five products P_1, P_2, \dots, P_5 in amount $q = (24, 35, 42, 20, 45)$ to the node 1.

The product unit costs in each node are given in Table 1.

Table 1. Product costs

c_{kj}	$j=2$	3	4	5	6	7	8	9	10	11
$k=1$	18	10	13	8	12	5	4	13	2	3
2	19	15	14	6	12	5	4	9	5	2
3	17	12	15	7	18	4	2	11	5	6
4	19	15	18	6	9	3	5	4	14	5
5	8	19	2	4	6	3	5	4	6	4

Table 2. Transport cost matrix d_{ij}

0	13	6	55	93	164	166	168	169	241	212
13	0	11	66	261	175	177	179	180	239	208
6	11	0	60	97	168	171	173	174	239	209
55	66	60	0	82	113	115	117	117	295	265
93	261	97	82	0	113	115	117	118	333	302
164	175	168	113	113	0	6	4	2	403	374
166	177	171	115	115	6	0	8	7	406	376
168	179	173	117	117	4	8	0	3	408	378
169	180	174	117	118	2	7	3	0	409	379
241	239	239	295	333	403	406	408	409	0	46
212	208	209	265	302	374	376	378	379	46	0

We will decide in which node each product is purchased so that total costs, i.e. sum of the transport and the product cost, is minimized.

Result of the mathematical model (1)-(8) are two routes 1-4-3-1 and 1-7-8-1 with travel costs 463 units. Product P_1 is picked up in node 3, product P_5 in node 4, product P_4 in node 7 and both products P_2 and P_3 in node 8. The product costs are equal to 614 units and considering the transport costs, the total costs amount to $463 + 614 = 1,077$ units. Those final costs provide the minimal value.

4. Heuristic Method

Due to NP hardness of VRP it needs to be proposed heuristic methods. Next, a heuristic method is formulated and also illustrated by an example.

We will create the routes in the form $1 - i_1 - i_2 - \dots - i_s - 1$. In the first step we will find the first node i_1 , in the second step we will insert other nodes i_2, i_3, \dots, i_s in the initial route $1 - i_1 - 1$.

We denote a set PP the set of products which were not assured by the routes created so far. In the beginning of the heuristic we set $PP = P = \{P_1, P_2, \dots, P_m\}$. We apply step 1 and step 2 to all routes until all products are covered, i.e. set PP is empty. Costs of the product P_k purchased at the node i we will denote $pc_{ik} = c_{ik} * q_k$.

Gradually we create routes until all products are assigned to some route node, i.e. the set PP is empty.

Route creation:

Step 1: {the first node $i1$ choice}

Value $\Delta_{i1} = \min_{i=2,3,\dots,n} \Delta_i$, where $\Delta_i = \sum_{k=1}^m pc_{ik} + d_{1i} + d_{i1}$, $i = 2, 3, \dots, n$, means costs if all products from PP are purchased only at this node $i1$ and these costs are minimal over

set of nodes. The first node of the route is denoted $i1$. Due a limited capacity of vehicle it can be purchased only a part of PP at node $i1$. Next, we will choose those products from PP which are the cheapest and capacity of vehicle is not exceeded. The set of these products is denoted $PF \subset PP$. Put $PP := PP - PF$.

Step 2. {insert other nodes for products from PF }

For product P_k from PF :

Let $\rho_r = \min_{i=2,3,\dots,n} cp_{i1,k} - cp_{i,k,i}$, for $r = 2, 3, \dots, n$. If $\rho_r < 0$, then product costs of P_k are cheaper at node r than at node $i1$. But, by inserting the node r in route increase transportation costs of the route. So, we try insert node r such a way to minimize an increase of transportation costs. Let σ_r is the minimal increase of transportation costs by inserting the node r in the route. Total costs will decrease only if $\rho_r + \sigma_r$ is negative. We insert the node r in the route if $(\rho_r + \sigma_r)$ is minimal for all nodes r and at the same time is negative.

5. Example (Continuation of the Section 3)

There are 11 nodes and 5 products. Distance matrix is in Table 2, product unit costs see Table 1 and quantity of products $q = (24, 35, 42, 20, 45)$. Capacity of vehicle is $V=100$. Put $PP = \{P_1, P_2, \dots, P_5\}$. Costs of the product P_k purchased at the note i we will denote $pc_{ik} = c_{ik} * q_k$ and are shown in Table 3.

Table 3. Value $pc_{ik} = c_{ik} * q_k$

Node	2	3	4	5	6	7	8	9	10	11
P ₁	432	240	312	192	288	120	72	312	120	96
P ₂	665	525	490	210	420	175	140	315	175	70
P ₃	765	540	675	315	810	180	90	495	225	270
P ₄	380	300	360	120	180	80	100	60	280	100
P ₅	360	855	90	180	270	135	225	180	270	180

Route 1:

Step 1:

Minimal value of Δ_i is $\Delta_8=963$ (see Table 4) then the node $i1=8$, so we have initial route $1 - 8 - 1$. Transportation costs of this route are $d_{18}+d_{81} = 168 + 168 = 336$.

Table 4. Value $\Delta_i = \sum_{k=1}^5 pc_{ik} + d_{1i} + d_{i1}$

Node i	2	3	4	5	6	7	8	9	10	11
Δ_i	2,628	2,462	2,037	1,203	2,296	1,022	963	1,700	1,552	1,140

The capacity of vehicles is $V=100$, therefore we have to pick up the products by descending value $pc_{ik} = c_{ik} * q_k$ not to exceed capacity of vehicle V . Table 5 contains chosen products with their costs and volume. Transportation costs route 1 are 336, costs of products P_1 , P_2 and P_4 assured by this route are 262 (see Table 5). Total costs are $336+262=598$. Put $PF = \{P_1, P_3, P_4\}$. $PP = PP - PF = \{P_2, P_5\}$. In step 2 we try decrease the costs of route 1.

Table 5. Products assured in the route 1

Product	Costs	Volume
P_1	72	24
P_3	90	45
P_4	100	20
Sum	262	89

Step 2:

Product costs of P_4 are cheaper at node 7 and node 9 than at node $i_i=8$. Decrease of product costs at node 7 are 20, decrease at node 9 are 40 (see Table 3). By inserting node 7 in route 1 increase transportation costs by 6, by inserting node 9 in route 1 increase transportation costs by 4 (see Table 2). Inserting node 7 decrease total costs (transportation plus product costs) by $20-6=14$, inserting node 9 decrease is $40-4=36$. Finally, we insert node 9. So, route 1 is in the form 1 – 9 – 8 – 1. Route assures products P_1 , P_3 and P_4 . Transportation costs of the route are 340, product costs are 222, total costs are $340 + 222 = 562$.

Route 2:**Step 1:**

It remains to ensure products $PP = \{P_2, P_5\}$.

Table 6. Value $\Delta_i = \sum_{k=1}^5 p c_{ik} + d_{1i} + d_{i1}$ is product costs for products P_2 and P_5

Node	2	3	4	5	6	7	8	9	10	11
Δ_i	1051	1392	690	576	1018	642	701	833	927	674

A node with cheapest costs of both products P_2 and P_5 is node 5 (see Table 6). Therefore, second route will be 1 – 5 – 1 and the capacity of the vehicle will not be exceeded. Transportation costs are 186 and product costs are 390. Total costs are $186 + 390 = 576$.

Step 2:

Product P_5 is cheapest at the node 5, but for the product P_2 are lower costs in the nodes 7, 8, 10 and 11 (see Table 3). Changes in costs by insertion another node in the route are shown in Table 7. Because by inserting each of the nodes 7, 8, 10, 11 they will rise total costs, no node will be inserted in the route 1 – 5 – 1. This is stop of the method.

Result is two routes:

Route 1: 1 – 9 – 8 – 1, with costs 562.

Route 2: 1 – 5 – 1, with costs 576.

Total costs for both routes are $562 + 576 = 1138$.

Table 7. Changes in costs by insertion another node in the route

Node	Transportation costs	Product costs	Total costs
7	+95	-35	+60
8	+99	-70	+29
10	+388	-35	+353
11	+328	-140	+188

6. Conclusions

In this paper we have considered a new modification of vehicle routing problem. The mathematical model and heuristic method are proposed, on numerical example are both illustrated.

References

- Braysy, O., & Gendreau, M. (2005). The vehicle routing problem with time windows, Part I. Route construction and local search algorithms. *Transportation Science*, 39(1), 104–118. <https://doi.org/10.1287/trsc.1030.0056>
- Desrochers, M., Desrosiers, J., & Solomon, M. M. (1992). A new optimization algorithm for the vehicle routing problem with time windows. *Operations Research*, 40, 342–354. <https://doi.org/10.1287/opre.40.2.342>
- Laporte, G. (1992). The vehicle routing problem: An overview of exact and approximate algorithms. *European Journal for Operations Research*, 59, 345–358. [https://doi.org/10.1016/0377-2217\(92\)90192-C](https://doi.org/10.1016/0377-2217(92)90192-C)

The Level of Energy Poverty in Poland Compared to other European Union Countries

Arkadiusz PIWOWAR

Wrocław University of Economics and Business, Wrocław, Poland, arkadiusz.piwowar@ue.wroc.pl

Abstract: Energy poverty that affects households is an adverse economic phenomenon with negative economic, social and environmental consequences. This paper presents a comparative analysis of indicators characterizing energy poverty in Poland and other European Union countries. Data from the Eurostat database were used for this purpose. The time range of the analysis covered the period of 2009-2018. As it results from the analyses, Poland is one of the countries where the situation related to the households (with income below 60% of the median income) declaring the inability to keep home adequately warm significantly improved in the investigated period. The average level of this indicator in the EU in 2018 was 7.3%. Against this background, the current level of the discussed indicator in Poland is favourable (in 2018 in Poland the value of the indicator was 5.1%). The findings may be important from the point of view of shaping public policy aimed at reducing the phenomenon of energy poverty in Poland.

Keywords: energy poverty; expenditures on energy; energy needs; family economics; Poland

JEL Classification: I32; Q41; G50

1. Introduction

Energy poverty is a term used when households suffer from insufficient funds for covering their basic energy needs (Castaño-Rosa et al., 2019; Primc & Slabe-Erker, 2020). According to the IAE (International Energy Agency), it is estimated that 1.3–2.6 billion people in the world experience energy poverty (Doukas & Marinakis, 2020). A large part of the population in the rural regions of Sub-Saharan Africa and the India subcontinent lives without access to electricity (Samarakoon, 2019; Gupta et al., 2020). The problem of energy poverty occurs also in Asia (inter alia in Cambodia) (Khanna et al., 2019). Energy poverty has to be understood in the context of social, physical, psychological and technological conditions (Libor & Bouzarovski, 2018). In the literature on the subject, the relationships between energy poverty and the issues of socio-economic development are emphasized (Wei et al., 2018). This problem does not only concern countries with a relatively underdeveloped economy, but also countries with stable foundations and a relatively stable macroeconomic situation. While in countries located in Africa the problem is, among other things, low energy generation capacity and infrastructure for the electricity distribution, in Europe this problem is related primarily to energy purchasing costs (Monyei et al., 2018; Olang et al., 2018). As mentioned earlier, the problem of energy poverty, a serious social issue, affects many European countries (Mayer et al., 2018; Boemi & Papadopoulos, 2019; Dobbins et al., 2019). In southern European countries, this problem exists too – despite mild winters, many people do not satisfy their

energy needs in terms of thermal comfort at home (Castaño-Rosa et al., 2020a; Gouveia et al., 2018; Betto et al., 2020). Despite a favourable (mild) climate, also Portugal is considered one of the most vulnerable countries in the European Union in terms of energy poverty (Horta et al., 2019). The economic and social consequences associated with energy poverty are also addressed in Latin American countries (Pablo et al., 2019).

The problem raised in this study is more and more broadly discussed and studied, although it is not yet recognized fully both in the European Union and in individual countries. This applies not only to empirical research, but also to the legal bases in the investigated scope (Mędrzycki & Szyrski, 2018; Sareen et al., 2020). Financial conditions (economic poverty) and a low level of energy efficiency of buildings are at the root of the problem of energy poverty. The energy consumption is also by occupants' behaviour causing pre- or re-bounce effects (Calì et al., 2016). Measuring energy poverty is difficult, as there are many elements that have a real, direct and indirect impact on the phenomenon under study (Thomson et al., 2017). The purpose of this study is to show changes in energy poverty in Poland as compared with other European Union countries. To analyze energy poverty, it is necessary to develop the state of the matter from an international perspective (Castaño Rosa et al., 2020b). In addition, expenses on the purchase of energy in Polish households were presented, based on statistical data. Economic categories (i.e. incomes and expenses) were used to analyse and evaluate this situation.

2. Methodology

In the literature on the subject, there are many indicators for measuring energy poverty. There can be distinguished objective and subjective indicators, based on the feelings of residents (Romero et al., 2018). The basic indicator for assessing the extent of the problem of energy poverty is the percentage of households (with an income below 60% of the median income) declaring the inability to keep home adequately warm. Further in the paper, the situation in Poland was compared with the other EU-28 countries, based on this indicator. The analysis carried out is of relative nature. The main time range of the analyses covered the period of 2009-2018. The numerical data were taken from the Eurostat database and official statistics in Poland.

3. Results and Discussion

In Europe, the issue of energy poverty is particularly important in countries of Central and Eastern Europe, which is associated with a relatively low income of residents of this area in comparison with Western European countries as well as with natural conditions and their consequences in the area of energy management (relatively high amplitude of temperature fluctuations during the year, length of the heating season, etc.) (Streimikiene & Balezentis, 2019; Druică et al., 2019; Tsanov & Shopov, 2018). Central and Eastern European countries are characterized by a relatively low share of energy expenses in the household expenses in the EU (Figure 1). Encumbrance with energy expenditures in this part of Europe is lower than in other EU countries (an exception is the Czech Republic).

Eurostat data for 2017 show that 19.5% of the population in Poland was at risk of poverty and social exclusion. On the EU scale, this placed Poland on the 12th position among all EU-28 countries – counting from the country with the lowest scale of this problem. In 2018, households in the European Union (EU) spent over 2,065,042.3 million Euro (current prices) on "housing, water, electricity, gas and other fuels". Share of housing, water, electricity, gas and other fuels in total household expenditure in the EU Member States in 2017 and 2018 are shown in Figure 1.

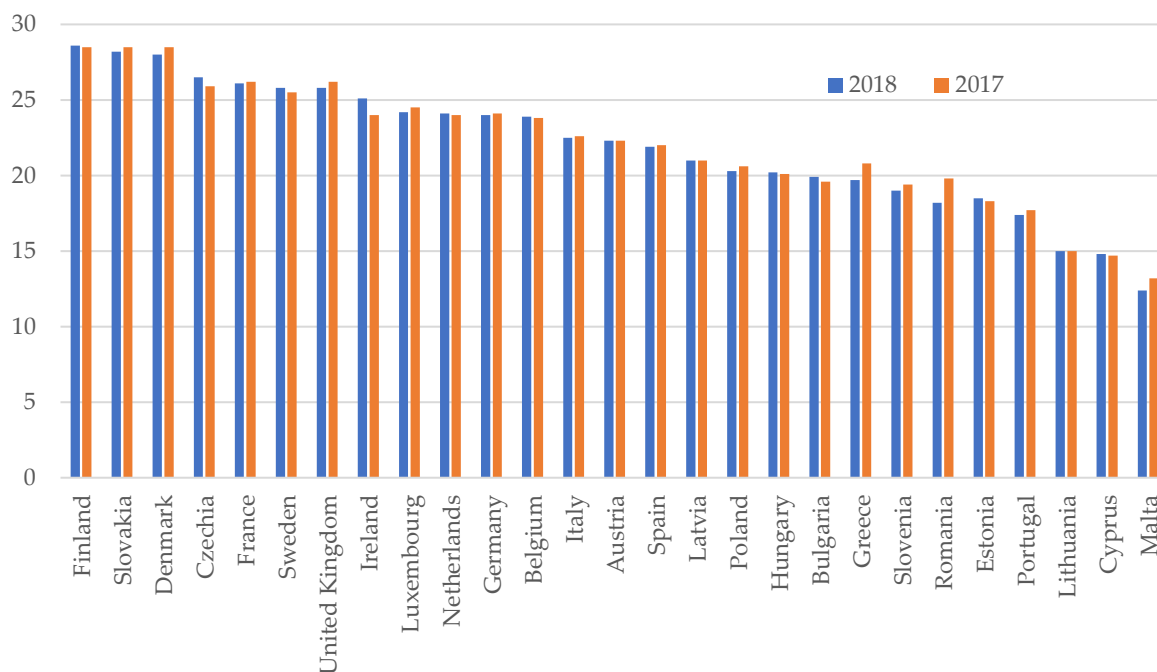


Figure 1. Share of housing, water, electricity, gas and other fuels in total household expenditure in the EU Member States in 2017-2018* (%) (Eurostat, 2020e)

*Note: Croatia – data not available

Based on Figure 1, it can be concluded that the share of these expenses in the Czech Republic (25.9% in 2017 and 26.5% in 2018) is higher than the average (24.1% in 2017 and 23.9% in 2018) in the European Union. Between 2017 and 2018, the share of "housing, water, electricity, gas and other fuels" in total household expenditure decreased or not changed in most Member States. In particular, the highest increase was recorded in Ireland (1.1 pp). In contrast, the share of "housing, water, electricity, gas and other fuels" in total household expenditure dropped in Romania (1.6 pp). In Poland it decreased by 0.3 percentage points (from 20.6% in 2017 to 20.3% in 2018). It is worth noting that the EU countries differ significantly not only in terms of the share of expenses related to house maintenance (including energy purchase costs), but also in terms of electricity consumption and prices (Figures 2 and 3).

The issues related to energy poverty are also associated with low energy efficiency of households (Tsanov and Shopov 2018). There is a need for modernization and erection of buildings that will meet the requirements for low energy demand. Energy poverty is a

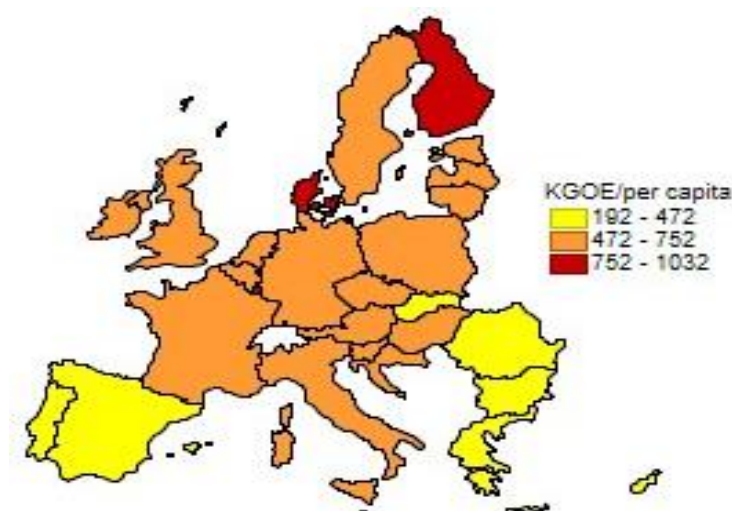
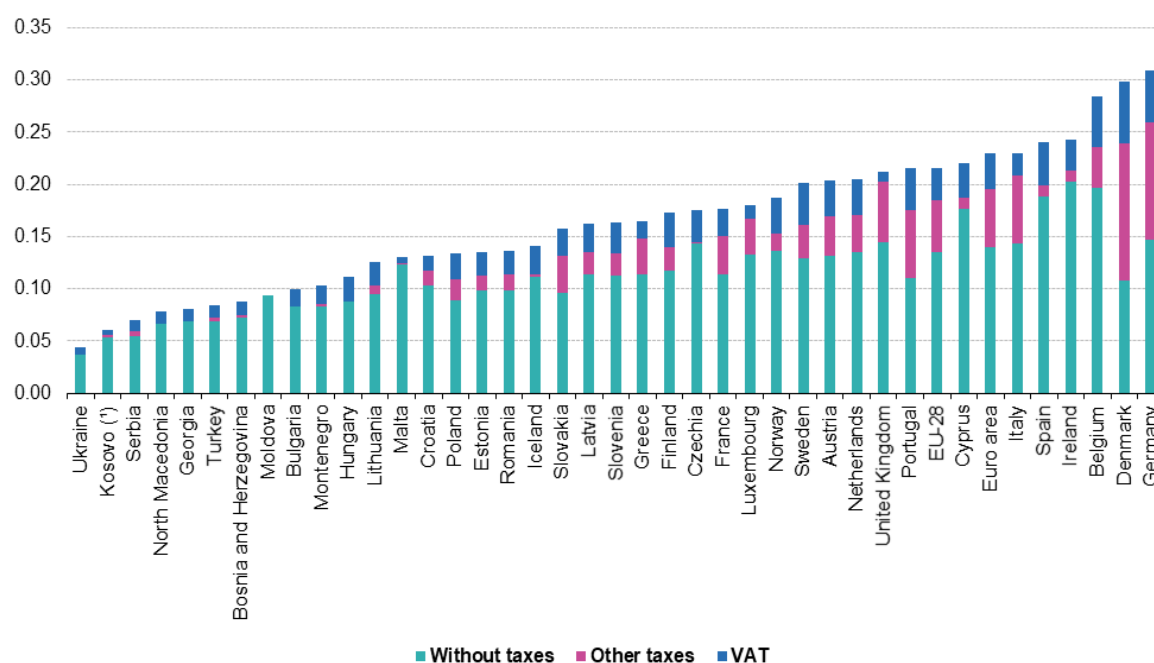


Figure 2. Final energy consumption in households per capita in EU-28 in 2018 (kg of oil equivalent/capita) (Eurostat, 2020b)



(*) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo Declaration of Independence.

Figure 3. Electricity prices for household consumers in EU-28, and other countries in Europe, first half 2019 (EUR per kWh) (Eurostat, 2020a)

structural problem that results, inter alia, from low standards in the area of energy-efficient buildings (Primc et al. 2019). This problem does not only concern the periods during which accommodation spaces must be heated. Climate change and, consequently, hotter summer months in this area of Europe are making intensive cooling of accommodation spaces necessary. This involves higher expenditures on electricity, which, given the high and still rising energy prices, may cause increased pressure in the area of energy poverty. Rural areas are particularly at risk of energy poverty (Aristondo & Onaindia, 2018).

The basic indicator in the examined problem area is "Inability to keep home adequately warm - EU-SILC survey". This indicator is part of the EU Sustainable Development Goals

(SDG) indicator set. It is used to monitor progress towards SDG 7 on affordable and clean energy and SDG 1 on ending poverty in all its forms everywhere (Eurostat, 2020c). Table 1 summarizes numerical data concerning the above subject matter in the EU-28 countries in the period of 2009-2018.

Table 1. Percentage of households in the EU-28 countries (with an income below 60% of the median income) declaring the inability to keep home adequately warm in 2009-2018 (Eurostat, 2020d)

Specification	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Belgium	5.1	5.6	7.1	6.6	5.8	5.4	5.2	4.8	5.7	5.2
Bulgaria	64.2	66.5	46.3	46.5	44.9	40.5	39.2	39.2	36.5	33.7
Czechia	5.2	5.2	6.4	6.7	6.2	6.1	5.0	3.8	3.1	2.7
Denmark	1.5	1.9	2.3	2.5	3.8	2.9	3.6	2.7	2.7	3.0
Germany	5.5	5.0	5.2	4.7	5.3	4.9	4.1	3.7	3.3	2.7
Estonia	1.7	3.1	3.0	4.2	2.9	1.7	2.0	2.7	2.9	2.3
Ireland	4.1	6.8	6.8	8.4	10.0	8.9	9.0	5.9	4.4	4.4
Greece	15.7	15.4	18.6	26.1	29.5	32.9	29.2	29.1	25.7	22.7
Spain	7.2	7.5	6.5	9.1	8.0	11.1	10.6	10.1	8.0	9.1
France	5.5	5.7	6.0	6.0	6.6	5.9	5.5	5.0	4.9	5.0
Croatia	no data	8.3	9.8	10.2	9.9	9.7	9.9	9.3	7.4	7.7
Italy	10.8	11.6	17.8	21.3	18.8	18.0	17.0	16.1	15.2	14.1
Cyprus	21.7	27.3	26.6	30.7	30.5	27.5	28.3	24.3	22.9	21.9
Latvia	16.4	19.1	22.5	19.9	21.1	16.8	14.5	10.6	9.7	7.5
Lithuania	24.1	25.2	36.2	34.1	29.2	26.5	31.1	29.3	28.9	27.9
Luxembourg	0.3	0.5	0.9	0.6	1.6	0.6	0.9	1.7	1.9	2.1
Hungary	8.9	10.7	12.2	15.0	14.6	11.6	9.6	9.2	6.8	6.1
Malta	11.1	14.3	17.6	22.1	23.9	22.3	14.1	6.6	6.3	7.6
Netherlands	1.3	2.3	1.6	2.2	2.9	2.6	2.9	2.6	2.4	2.2
Austria	2.9	3.8	2.7	3.2	2.7	3.2	2.6	2.7	2.4	1.6
Poland	16.3	14.8	13.6	13.2	11.4	9.0	7.5	7.1	6.0	5.1
Portugal	28.5	30.1	26.8	27.0	27.9	28.3	23.8	22.5	20.4	19.4
Romania	22.1	20.1	15.6	15.0	14.7	12.9	13.1	13.8	11.3	9.6
Slovenia	4.6	4.7	5.4	6.1	4.9	5.6	5.6	4.8	3.9	3.3
Slovakia	3.6	4.4	4.3	5.5	5.4	6.1	5.8	5.1	4.3	4.8
Finland	1.3	1.4	1.8	1.5	1.2	1.5	1.7	1.7	2.0	1.7
Sweden	1.7	2.1	1.9	1.7	0.9	1.1	1.2	2.6	2.1	2.3
United Kingdom	5.8	6.1	6.5	8.1	10.6	9.4	7.8	6.1	5.9	5.4
EU - 28 countries	9.3*	9.5	9.8	10.8	10.7	10.3	9.4	8.7	7.8	7.3

Note: *(27 countries)

In 2018, a relatively high percentage of the population at risk of energy poverty (taking into account the analysed indicator) lived in Bulgaria (33.7%) and Lithuania (27.9%). In the analysed period, a distinct reduction in the percentage of the population declaring the inability to keep home adequately warm took place in: Bulgaria (by 30.5 pp); Romania (by 12.5 pp) and Poland (by 11.2 pp). The overall level of poverty in the analysed subjective and temporal scope decreased in the European Union countries by 2 pp – from the level of 9.3% in 2009 to 7.3% in 2018. Against this background, the current level of the discussed indicator in Poland is favourable – in 2018 it was 5.1%.

4. Conclusions

Apart from the problem of smog, energy poverty is one of the most important problems at the meeting point of the following areas: energy – efficiency – ecology – economy. The

analyses show that the situation in Poland in terms of energy poverty, examined by the indicator selected in this study (Inability to keep home adequately warm - EU-SILC survey), improved significantly over the period of 2009-2018. In 2018, the value of the indicator in Poland was 5.1%, while its average level in the EU was 7.3%. The costs associated with the purchase of energy by households are important from the point of view of the considerations made in this study. At the beginning of January 2020, the Energy Regulatory Office in Poland approved tariffs for the sale of electricity to household consumers. According to the new tariffs, the price of electricity for individual consumers will increase in 2020 by 11.6 percent on average. Such a situation may result in difficulties in satisfying the energy needs of many households in Poland, and thus increase the scale of energy poverty. If the phenomenon of energy poverty is deepened, it can be expected that relatively poorer social groups will use fuels of lower quality to satisfy their basic energy needs. This means that the problem may also appear in the area of low-altitude emissions.

Acknowledgments: This study was conducted and financed in the framework of the research project “Socio-economic, environmental and technical determinants of the energy poverty in rural areas in Poland”, granted by the National Science Centre in Poland, program OPUS, grant No. 2018/31/B/HS4/00048.

References

- Aristondo, O., & Onaindia, E. (2018). Counting energy poverty in Spain between 2004 and 2015. *Energy Policy*, 113, 420-429. <https://doi.org/10.1016/j.enpol.2017.11.027>
- Betto, F., Garengo, P., & Lorenzoni, A. (2020). A new measure of Italian hidden energy poverty. *Energy Policy*, 138, 111237. <https://doi.org/10.1016/j.enpol.2019.111237>
- Boemi, S. N., & Papadopoulos, A. M. (2019). Monitoring energy poverty in Northern Greece: the energy poverty phenomenon. *International Journal of Sustainable Energy*, 38(1), 74-88. <https://doi.org/10.1080/14786451.2017.1304939>
- Calì, D., Osterhage, T., Streblow, R., & Müller, D. (2016). Energy performance gap in refurbished German dwellings: Lesson learned from a field test. *Energy and Buildings*, 127, 1146-1158. <https://doi.org/10.1016/j.enbuild.2016.05.020>
- Castañó-Rosa, R., Solís-Guzmán, J., & Marrero, M. (2020a). Energy poverty goes south? Understanding the costs of energy poverty with the index of vulnerable homes in Spain. *Energy Research & Social Science*, 60, 101325. <https://doi.org/10.1016/j.erss.2019.101325>
- Castañó Rosa, R., Solís Guzmán, J., & Marrero, M. (2020b). Midiendo la pobreza energética. Una revisión de indicadores. *Revista Hábitat Sustentable*, 10(1), 9-21. <https://doi.org/10.22320/07190700.2020.10.01.01>
- Castañó-Rosa, R., Solís-Guzmán, J., Rubio-Bellido, C., & Marrero, M. (2019). Towards a multiple-indicator approach to Energy Poverty in the European Union: A review. *Energy and Buildings*, 193, 36-48. <https://doi.org/10.1016/j.enbuild.2019.03.039>
- Dobbins, A., Fuso Nerini, F., Deane, P., & Pye, S. (2019). Strengthening the EU response to energy poverty. *Nat Energy*, 4(2-5). <https://doi.org/10.1038/s41560-018-0316-8>
- Doukas, H., & Marinakis, V. (2020). Energy poverty alleviation: effective policies, best practices and innovative schemes. *Energy Sources, Part B: Economics, Planning, and Policy*, 15, 45-58. <https://doi.org/10.1080/15567249.2020.1756689>
- Druică, E., Goschin, Z., & Ianole-Călin, R. (2019). Energy Poverty and Life Satisfaction: Structural Mechanisms and Their Implications. *Energies*, 12(20), 3988. <https://doi.org/10.3390/en12203988>
- Eurostat. (2020a). *Electricity prices for household consumer* [Data set]. Retrieved January 25, 2021, from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Electricity_prices_for_household_consumers_first_half_2019_\(EUR_per_kWh\)F1.png&oldid=459599](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Electricity_prices_for_household_consumers_first_half_2019_(EUR_per_kWh)F1.png&oldid=459599)
- Eurostat. (2020b). *ESMS Indicator Profile* [Data set]. Retrieved January 25, 2021, from https://ec.europa.eu/eurostat/databrowser/view/sdg_07_20/default/table?lang=en

- Eurostat. (2020c). *Final energy consumption in households per capita* [Data set]. Retrieved November 9, 2020, from https://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=sdg_07_20
- Eurostat. (2020d). *Inability to keep home adequately warm - EU-SILC survey* [Data set]. Retrieved November 9, 2020, from https://ec.europa.eu/eurostat/web/products-datasets/product?code=ilc_mdcs01
- Eurostat. (2020e). *Share of housing, water, electricity, gas and other fuels in total household expenditure* [Data set]. Retrieved January 25, 2021, from <http://appsso.eurostat.ec.europa.eu/nui>
- Gouveia, J. P., Seixas, J., & Long, G. (2018). Mining households' energy data to disclose fuel poverty: Lessons for Southern Europe. *Journal of Cleaner Production*, 178, 534-550. <https://doi.org/10.1016/j.jclepro.2018.01.021>
- Gupta, S., Gupta, E., & Sarangi, G. K. (2020). Household Energy Poverty Index for India: An analysis of inter-state differences. *Energy Policy*, 144, 111592. <https://doi.org/10.1016/j.enpol.2020.111592>
- Horta, A., Gouveia, J. P., Schmidt, L., Sousa, J. C., Palma, P., & Simões, S. (2019). Energy poverty in Portugal: Combining vulnerability mapping with household interviews. *Energy and Buildings*, 203, 109423. <https://doi.org/10.1016/j.enbuild.2019.109423>
- Khanna, R. A., Li, Y., Mhaisalkar, S., Kumar, M., & Liang, L.J. (2019). Comprehensive energy poverty index: Measuring energy poverty and identifying micro-level solutions in South and Southeast Asia. *Energy Policy*, 132, 379-391. <https://doi.org/10.1016/j.enpol.2019.05.034>
- Libor, G., & Bouzarovski, S. (2018). The socio-demographic dimensions of energy poverty: a case study from Bytom, Poland. *Urban Development Issues*, 57(1), 63-77. <https://doi.org/10.2478/udi-2018-0018>
- Mazurkiewicz, J., & Lis, P. (2018). Diversification of energy poverty in Central and Eastern European countries. *Virtual Economics*, 1(1), 26-41. [https://doi.org/10.34021/ve.2018.01.01\(2\)](https://doi.org/10.34021/ve.2018.01.01(2))
- Mędrzycki, R., & Szyrski, M. (2018). Energy Poverty as a European Union and Polish Legal Issue. *Białostockie Studia Prawnicze*, 23(2), 125-138. <https://doi.org/10.15290/bsp.2018.23.02.09>
- Meyer, S., Laurence, H., Bart, D., Middlemiss, L., & Maréchal, K. (2018). Capturing the multifaceted nature of energy poverty: Lessons from Belgium. *Energy Research & Social Science*, 40, 273-283. <https://doi.org/10.1016/j.erss.2018.01.017>
- Monyei, C. G., Adewumi, A. O., Obolo, M. O., & Sajou, B. (2018). Nigeria's energy poverty: Insights and implications for smart policies and framework towards a smart Nigeria electricity network. *Renewable and Sustainable Energy Reviews*, 81, 1582-1601. <https://doi.org/10.1016/j.rser.2017.05.237>
- Olang, T. A., Esteban, M., & Gasparatos, A. (2018). Lighting and cooking fuel choices of households in Kisumu City, Kenya: A multidimensional energy poverty perspective. *Energy for Sustainable Development*, 42, 1-13. <https://doi.org/10.1016/j.esd.2017.09.006>
- Pablo, Q. S., Paloma, T. D. L. P., & Francisco, J. T. (2019). Energy Poverty in Ecuador. *Sustainability*, 11(22), 6320. <https://doi.org/10.3390/su11226320>
- Primc, K., & Slabe-Erker, R. (2020). Social policy or energy policy? Time to reconsider energy poverty policies. *Energy for Sustainable Development*, 55, 32-36. <https://doi.org/10.1016/j.esd.2020.01.001>
- Primc, K., Slabe-Erker, R., & Majcen, B. (2019). Constructing energy poverty profiles for an effective energy policy. *Energy Policy*, 128, 727-734. <https://doi.org/10.1016/j.enpol.2019.01.059>
- Romero, J. C., Linares, P., & López, X. (2018). The policy implications of energy poverty indicators. *Energy Policy*, 115, 98-108. <https://doi.org/10.1016/j.enpol.2017.12.054>
- Samarakoon, S. (2019). A justice and wellbeing centered framework for analysing energy poverty in the Global South. *Ecological Economics*, 165, 106385. <https://doi.org/10.1016/j.ecolecon.2019.106385>
- Sareen, S., Thomson, H., Herrero, S. T., Gouveia, J. P., Lippert, I., & Lis, A. (2020). European energy poverty metrics: Scales, prospects and limits. *Global Transitions*, 2, 26-36. <https://doi.org/10.1016/j.glt.2020.01.003>
- Streimikiene, D., & Balezentis, T. (2019). Innovative Policy Schemes to Promote Renovation of Multi-Flat Residential Buildings and Address the Problems of Energy Poverty of Aging Societies in Former Socialist Countries. *Sustainability*, 11(7), 2015. <https://doi.org/10.3390/su11072015>
- Thomson, H., Bouzarovski, S., & Snell, C. (2017). Rethinking the measurement of energy poverty in Europe: A critical analysis of indicators and data. *Indoor and Built Environment*, 26(7), 879-901. <https://doi.org/10.1177/1420326X17699260>
- Tsanov, V., & Shopov, G. (2018). Material standard of living and energy poverty in Bulgaria: state and development. *Economic Studies*, 27(6), 3-20.
- Wei, Y. M., Liao, H., Wei, Y. M., & Liao, H. (2018). The Interaction of Energy Poverty and Economic Development'. In Y.M. Wei, H. Liao (Eds.), *Energy Economics: Understanding and Interpreting Energy Poverty in China* (pp. 175-193). Emerald Publishing Limited.

Digital Gap in EU Countries and its Impact on Labour Productivity and Global Competitiveness

Tetiana POLOZOVA¹, Irina KOLUPAIEVA^{2*} and Iryna SHEIKO³

Kharkiv National University of Radio Electronics, Kharkiv, Ukraine; tetiana.polozova@nure.ua;
iryna.kolupaieva@nure.ua; irina.sheiko@nure.ua

* Corresponding author: iryna.kolupaieva@nure.ua

Abstract: Nowadays digitalization has become a global trend that allows countries and individuals to get a number of benefits for economic and social development. Every country is trying to promote digital innovation through regulatory policies. However, the results of such policies vary for different countries, creating digitalization gaps. The aim of the research is to assess the gaps in digitalization process and productivity among EU-members countries, and to evaluate how such gap impact on competitiveness of the country. On the basis of DESI index and labour productivity data for EU-members four clusters were formed. Also, on the base of International DESI index and Global Competitiveness Score EU-members and seven global developed countries were divided into four clusters. As a result, leaders, perspective countries, followers and transition countries were identified reflecting the digital and labour productivity divide between them. Leading positions are occupied by North Europe countries, while number of Eastern Europe countries located at opposite side. Results of cluster analysis shows the linkage between digital development and human development due to co-movement of DESI and Human Development Index.

Keywords: digitalization; labour productivity; competitiveness; k-means clustering; Information Development Index; Human Development Index

JEL Classification: C38; O57; P51

1. Introduction

All countries at global level provided actions to improve their digital development. Although digitalization is spreading globally, there are global and regional leaders in ICT and digital development, that can be proved by different global rankings. Existing gaps motivate developing countries to bridge the global economic disparities caused by technological and digital gaps (Bilozubenko et al., 2020). On this reason analysis and comparing of digital economy parameters of different countries is actual, especially if countries represent the same region or join together like European Union. The digital division between countries can also be assessed at the individual level, covering the use of ICT by the population and business (Chipeva et al., 2018), as well as at the household level (Lucendo-Monedero et al., 2019), which is necessary for understanding the sources, landscape and magnitude of differences.

Milošević et al. (2018) created a multivariate Composite I-distance Indicator (CIDI) to measure digital economy performance. They found, that Denmark tops the ranking list, followed by Sweden and Netherlands, lowest ranked countries are Romania and Bulgaria.

Androniceanu et al. (2019) divide EU countries on five clusters with leading Nordic countries and Romania and Bulgaria outsiders. Authors collected 10 indicators from Eurostat's Digital Economy and Society database.

Mardikyan et al. (2015) investigated disparities between groups of countries (continents) in terms of ICT accessing and using at global level. They found significant difference in digital activity between developed and developing countries and between OECD member and not member countries.

Bilozubenko et al. (2020) defined five key indexes of digital development, and then on the base of such indexes EU countries were divided into three clusters: leaders, followers and outsiders.

Foster and Azmeh (2020) investigated national digital policies, with a focus on China, they proved that these policies often aim at facilitating global integration and linkages. Author's analysis shows that more interventionist approaches can be vital in countering structural challenges, such as power of digital platforms, limitations of domestic digital firms, limited ability to leverage digitalization for broad-based national development.

Van Ark et al. (2003) provides an analysis of the trends in labour productivity and employment growth at EU and USA during the 1990s. The main findings are that the inverse relationship between employment and productivity growth has been much more prominent in manufacturing industries than in services industries. The employment-reducing effects of productivity growth have remained considerably stronger in Europe than in the USA.

Biagi (2013) provides literature review concerning ICT and productivity. The author concludes that ICT had a major role in the U.S. productivity acceleration observed in the period 1995-2005. Sweden and Finland took full advantage of the opportunities offered by digital technologies, while others, such as Germany, France and Italy to a lesser extent, the UK, did not. Biagi also pointed out, that ICT is largely responsible for the divergence in productivity paths observed between 1995 and 2005 for the U.S. and the E.U. (Biagi, 2013). Also, author found large variation in the impact of ICT on productivity within the EU members.

A lot of indexes evaluate digital development all over the world. The Digital Economy and Society Index (DESI) is an integrated index that summarizes dimensions and estimates digital competitiveness. The DESI index includes 5 main areas: connectivity, human capital, use of internet services, integration of digital technology, digital public services (DESI, 2020).

The International Digital Economy and Society Index (I-DESI) mirrors and extends the EU28 Digital Economy and Society Index (DESI) by utilizing 24 datasets to enable trend analysis and comparison of the digital performance of 45 countries. Analysis showed that EU28 Member States compare well with 17 non-EU countries and top EU28 countries have digital performances at the same or higher levels than the best global competitors. Indeed,

Denmark was the leading country in the I-DESI index. EU28 Member States perform best, relative to the 17 non-EU countries, in the Connectivity dimension (examining the deployment and take-up of fixed and mobile broadband) and in the Citizen Use of the Internet dimension.

Significant studies dedicate the issues of impact of digitalization development on progress in global rankings of the country: Information development Index, Global competitiveness ranking, Human development Index.

A lot of researches also connects the development of human capital, parameters of labour market with digital progress (Amuso et al., 2019; Ark Van et al., 2003; Nambisan et al., 2019; Polozova, 2015; Terziyan, 2018). It will be useful to investigate the effect of digitalization process in EU-members on their progress in global rankings, such as Global Competitiveness Ranking (WEF, 2018), Human development ranking (UND, 2018), Information development Index (IDI, 2018).

The purpose of the paper is to assess the gaps in digitalization process and productivity among EU-members countries, and to evaluate how does such gap impact on competitiveness of the country.

2. Methodology

To define the digital gaps within EU-members such methods as cluster analysis and classification were used. Such methods allow to identify important patterns, to determine causality. The difference among such methods lies in the fact that classification uses predefined clusters in which objects are assigned, while clustering identifies same characteristics between objects and then group of similar objects form cluster. Classification needs to define main factors to provide division on clusters.

There are a lot of parameters that are used to describe digital economy performance. Thus, the basis for clustering is a feature description of objects. Object X (digital economy of EU-member) consists a set $X = (x_1, x_2, \dots, x_n)$ of discrete values of attributes (a discrete set of X).

To provide cluster analysis at first, we have to define the key factors for division of EU-members. In works (Androniceanu et al., 2019; Bilozubenko et al., 2020; Balcerzak & Pietrzak, 2017) the key classification factors were aspects of digitalization process. But the issues of economic effects of digitalization process need to be investigated deeply.

Scientists pay a lot of attention to the impact of information technology and digitalization on productivity. OECD report (OECD, 2016) proposes the process (figure 1) through which ICT investments are complemented with investments in knowledge-based capital (KBC) to support digital innovation, which in turn improves business effectiveness (e.g. higher productivity, profitability, and market share) and leads to higher aggregate productivity growth. On the basis of such scheme we can use labour productivity as one of the key factors to provide cluster analysis. Together with digitalization index productivity allows us to divide EU-members not only on digital clusters, but also on productivity.

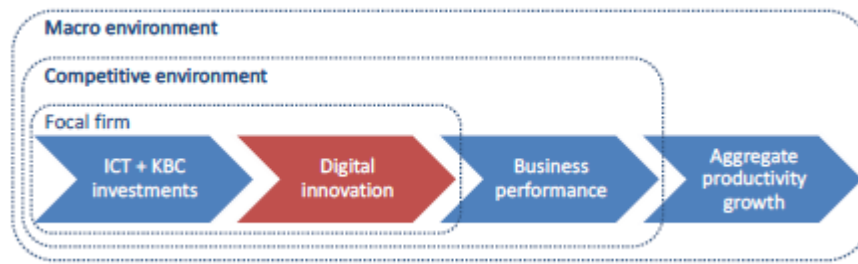


Figure 1. From ICT investments to aggregate productivity growth. Source: OECD, 2016

Another important step is of our study is comparing EU-members with group of global developed countries. We propose to provide cluster analysis on the basis of DESI International index with Global Competitiveness Score. Such cluster division will show gaps in economic and competitiveness effects on digital processes for EU countries and global competitors.

In our research we use DESI and DESI International Indexes.

Figure 2 presents correlation between digitalization indexes (DESI and DESI International) and Labour productivity (a), Global Competitiveness Score.

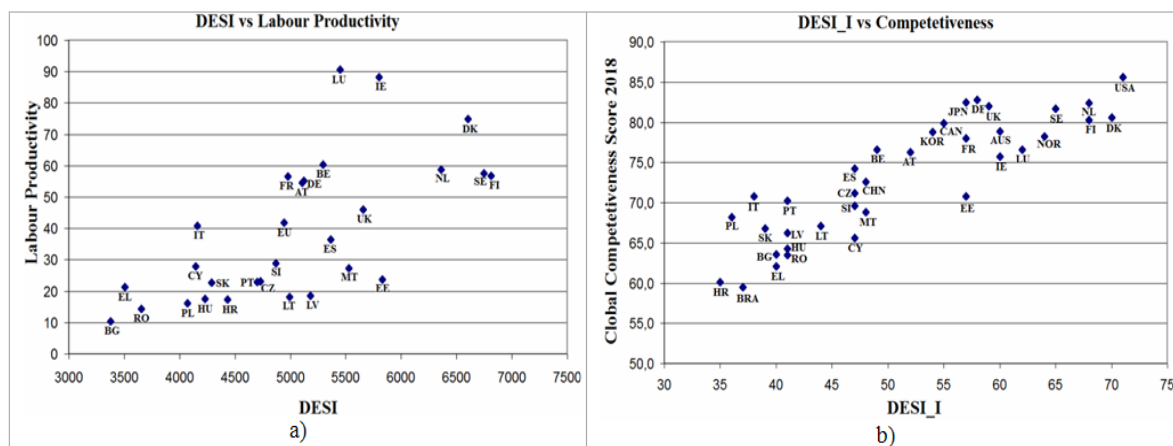


Figure 2. Correlation between DESI Indexes and Labour productivity (a), Global Competitiveness Score (b).

The correlation between factors is rather strong: between DESI and labour productivity 0.67; between DESI International and Global Competitiveness Score 0.84. Authors (Abonyi & Feil, 2007) proved that if initial data for cluster analysis are correlated, hyperellipsoidal clusters can be effectively used to represent correlated data, and local linear models can be easily extracted from the parameters of these clusters.

Data that we used in our research consists:

1. DESI 2019 Index with labour productivity Euro per hour (Eurostat, 2019). On the base of this data we expect to determine digital-productivity clusters for EU-members.
2. DESI International Index 2018 with Global Competitiveness Ranking Score (WEF, 2018). To compare digital performance of EU-members we add data of eight high developed countries: USA, China, Korea Rep., Japan, Australia, Canada, Norway and Brazil, that represent different regions. Clusters will be made on the basis of Global Competitiveness rating score (WEF, 2018).

3. Information development Index (IDI, 2018), Human development index (HDI, 2018). We need these indexes to check co-movement in digital development and progress in IT sector and human development

Descriptive statistics of variables is shown in Table 1.

Table 1. Description of variables and descriptive statistics

Name of variable	Description	Valid cases	Mean	Min	Max	STD
DESI	Digital Economy and Society Index (DESI)	29	4,636.2	2,613.29	7,231	1,001.9
DESI_CON	Dimension of Connectivity of DESI	29	4,685.6	2,726.51	7,844	1,171.6
DESI_HC	Dimension of Human Capital of DESI	29	4,132.9	1,744.39	6,582	984.2
DESI_U	Dimension of Use of Internet Service of DESI	29	4,567.2	2,170.69	7,634.1	1,184.2
DESI_IDT	Dimension of Integration of Digital technology of DESI	29	3,737.9	1,528.36	7,432	1,290.3
DESI_PUB	Dimension of Digital Public Service of DESI	29	6,108.9	2,062.14	8,933	1,508.9
L_PR_H	Real labour productivity in hour, Euro	29	38.93	10.40	90.70	22.50
DESI_I	International Digital Economy and Society International Index (DESI_I)	36	51.19	35.0	71.0	10.69
CON	Dimension of Connectivity of DESI_I	36	62.06	46.0	74.0	6.15
SKILLS	Dimension of Human Capital of DESI_I	36	42.81	24.0	66.0	11.16
USE	Dimension of Use of Internet Service of DESI_I	36	49.58	27.0	74.0	11.91
IDT	Dimension of Integration of Digital technology of DESI_I	36	42.83	10.0	83.0	20.89
PUB	Dimension of Digital Public Service of DESI_I	36	59.61	26.0	86.0	15.29
COMP	Global Competitiveness rating score	36	73.11	59.5	85.6	7.33

Given the specifics of the data set, for the country clusterization, a k-means algorithm is used (Abonyi & Feil, 2007). The k-means algorithm uses the unscaled squared Euclidean distances for the distance measure.

To provide cluster analysis we have used Statistica software, the method of k-means clustering (k is the number of clusters). The program starts with k random clusters, and then move objects between those clusters with the goal to minimize variability within clusters and to maximize variability between clusters. Thus, k distinctive clusters are formed. In k-means clustering, the program tries to move objects (e.g., cases) in and out of groups (clusters) to get the most significant results.

Presented analysis, grounded on theoretical framework, leads to determine main research hypotheses:

H1: there is a significant gap within EU-members in digital development and labour productivity

H2: digital development of EU-members can improve country's global rankings: Global Competitiveness Score, Information development Index, Human development index.

These hypotheses should be checked in the research.

3. Results

3.1. Digitalization and Labour Productivity

To divide EU_members countries on several groups in accordance of digital development and labour productivity level cluster analysis was used.

Usually, as the result of a k-means clustering analysis, we would examine the means for each cluster on each dimension to assess how distinct our k clusters are. Ideally, we would obtain very different means for most, if not all, dimensions used in the analysis. The magnitude of the F values from the analysis of variance performed on each dimension is another indication of how well the respective dimension discriminates between clusters.

Cluster analysis shows, that there is significant gap between EU-members in digital performance and in labour productivity. The correlation between these two parameters is positive cases: higher digitalization index has higher level of productivity.

Clusters are represented in 2-dimension scale at figure (Figure 3, Figure 4). The form of clusters is chosen to cover all cases. The center of each cluster is marked by dot; also, the nearest case (country with minimal diagonal distance from respective cluster center) is marked.

Due to results of cluster analysis four clusters were formed:

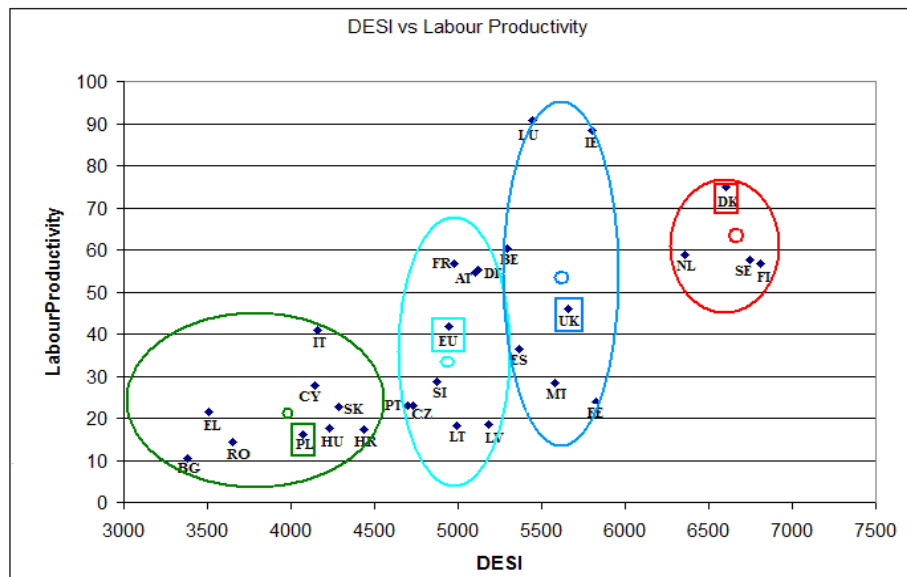
- leading cluster includes 4 countries: Denmark, Finland, Sweden and Netherlands;
- perspective cluster includes 7 countries: Luxembourg, Ireland, UK, Belgium, Spain, Malta and Estonia;
- follower cluster consists 9 countries: France, Austria, Germany, EU (average level), Slovenia, Czech Republic, Lithuania, Latvia, Portugal;
- transiting cluster represents 9 countries: Italy, Slovakia, Cyprus, Croatia, Hungary, Poland, Romania, Greece and Bulgaria.

Even that the same countries, specifically, Romania and Bulgaria place in a lower position compared to other European countries by all digitalization indicators, these countries also offer the greatest potential. Recent McKinsey report (Novak et al., 2018) discusses how digitization can accelerate economic development of Eastern and Central European countries. Authors found, that region has a great potential in digitalization, including high human development and education level, high level of infrastructure, great industrial capabilities. But authors also pointed out important challengers: brain drain of young IT specialists, intellectual-property protection, absence of basic digital skills for large part of population.

Due to results of cluster analysis we can find countries, which allocated too far from cluster centers. Transiting and leading clusters are most concentrated. In leaders maximum Euclidian distance from the mean has Netherlands, in transiting cluster - Bulgaria. In perspective cluster countries that have maximum distances from respective cluster center are Ireland, Estonia and Belgium. In followers cluster such "remote" countries are Portugal and Lithuania.

Results of DESI-labour productivity division shows the main problem of clustering - the difference in scale between DESI Index and labour productivity. Due to small variation of productivity within each cluster the main role of referring each case (country) to definite cluster belongs to DESI Index.

Results of DESI-labour productivity shows an existence of digital gaps within EU.



○ - mean (center) of cluster; PL - cluster member with minimum distance from cluster mean.

Abbreviation used: EU-European Union, AU -Austria, BE- Belgium, BG- Bulgaria, HR – Croatia, CY – Republic of Cyprus, CZ - Czech Republic, DK - Denmark, EE-Estonia, FI-Finland, FR-France, DE-Germany, EL - Greece, HU-Hungary, IE-Ireland, IT-Italy, LV-Latvia, LT-Lithuania, LU-Luxembourg, MT-Malta, NL-Netherlands, PL-Poland, PT-Portugal, RO-Romania, SK-Slovakia, SI-Slovenia, ES-Spain, SE-Sweden, UK- United Kingdom

Figure 3. Results of cluster analysis DESI-Labour productivity for EU-members

3.2. Digitalization and Global Competitiveness

The next step of investigation is analyzing how digital development can support global competitiveness. So that, we make cluster analysis on two parameters: international DESI index (DESI_I) and Global Competitiveness Rating 2018 Score (WEF, 2018).

We define the same numbers of clusters 4 and provide clustering of EU countries with developed countries from different regions: USA, China, Japan, Korea, Canada, Australia, Norway and Brazil. Now DESI International Index and Global Competitiveness Score have the same scale, that make cluster analysis easier. As a result, we receive more concentrated clusters (Figure 4).

Due to cluster analysis we can make some conclusions.

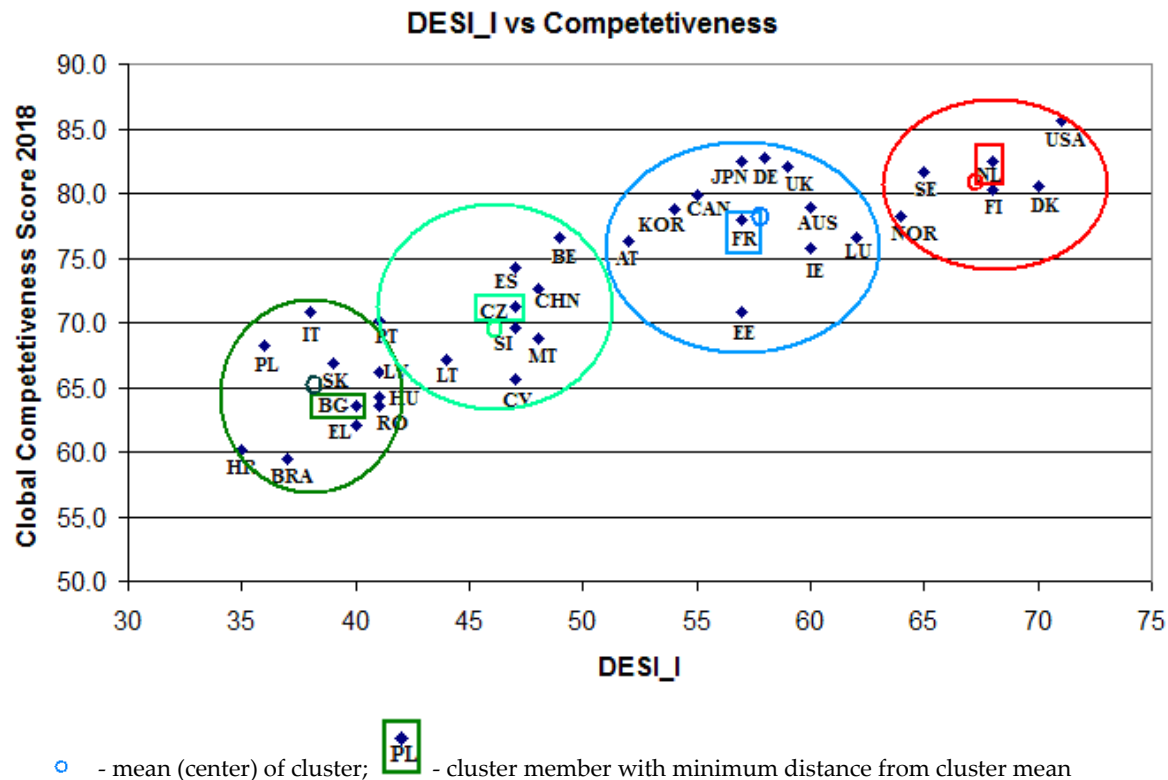
Leaders save their positions in leading cluster: USA and Norway join Denmark, Finland, Sweden and Netherlands.

Most of countries in transiting cluster also remain their positions: with the exception of Cyprus, that goes up to followers cluster and Latvia goes down to transition from followers. Brazil also appears in transition cluster.

High score at global competitiveness ranking allows UK, Luxembourg, Ireland to improve positions in perspective cluster and to Austria, France and Germany to move up to this cluster. Canada, Japan, Korea, Australia appear at perspective cluster.

Belgium, Malta and Spain go down to follower cluster.

Most of non-EU countries belong to leading and perspective clusters.



Abbreviation used for Non-EU Countries: AUS -Australia, BRA-Brazil, CAN-Canada, CHN-China, JPN-Japan, KOR- Rep. of Korea, NOR-Norway, USA

Figure 4. Results of DESI_I-Global Competitiveness Score cluster analysis for EU members and global developed countries. Source: constructed by authors

3.3. Summary Grouping of EU Members

In Table 2 countries are grouping according four DESI-productivity clusters (Figure 3). Also, to compare the progress of each country in global competitiveness ranking the clustering results of DESI_I with Global Competitiveness Score are shown (Figure 4).

Due to represented data, we can make a conclusion, that most of EU-members remain the same digitalization cluster for DESI-productivity cluster analysis and DESI International - Global Competitiveness Ranking 2018 Score.

So, European countries are competitive at global digital market, and such digital development improves their positions in Global Competitiveness Ranking. Also we can conclude that members of leading cluster have higher positions in IDI and HDI Rankings, then countries of transition cluster. Of course, ICT development and digital development has a lot of same parameters that is why higher digital developed country has higher positions in IDI ranking. UK, Germany and Ireland in HDI and IDI Ranking does not correspond the general tendency - they have higher positions in IDI ranking, but not belong to leading cluster.

But digital development is one of the many factors that determine ICT and human development. That is why the co-movement of such ranking is not proved and needs further investigations.

Table 2. Values of Global Competitiveness Ranking, ICT development Index and Human development Index for EU countries with the distribution by clusters

EU member due to DESI-productivity clusters	Cluster in DESI_I global rating (DESI_I vs Global Competitiveness Ranking 2019 Score)	Global Competitiveness Ranking 2019 Score	Position in 2019 ICT development Index (IDI)	Position in 2019 Human development Index (HDI)
Leading cluster				
Denmark	leading	80.6	4	11
Finland	leading	80.3	22	15
Sweden	leading	81.7	11	7
Netherlands	leading	82.4	7	10
Perspective cluster				
UK	perspective	82.0	5	14
Ireland	perspective	75.7	20	4
Malta	follower	68.8	24	29
Estonia	perspective	70.8	17	30
Belgium	follower	76.6	25	17
Luxembourg	perspective	76.6	9	21
Spain	follower	74.2	27	26
Follower cluster				
EU	–	–	–	–
Germany	perspective	82.8	12	5
Austria	perspective	76.3	21	20
Czechia	follower	71.2	43	27
Lithuania	follower	67.1	41	35
France	perspective	78.0	15	24
Slovenia	follower	69.6	33	25
Portugal	follower	70.2	44	41
Latvia	transiting	66.2	35	41
Transiting cluster				
Croatia	transiting	60.1	36	46
Hungary	transiting	64.3	48	45
Slovakia	transiting	66.8	46	38
Poland	transiting	68.2	49	33
Cyprus	transiting	65.6	28	32
Italy	transiting	70.8	47	28
Romania	transiting	63.5	58	52
Greece	transiting	62.1	38	31
Bulgaria	transiting	63.6	50	51

4. Discussion

Based on the proposed feature description and clustering methods, the EU countries were divided into four clusters according to the level of digital development and labour productivity. As a result, leaders, perspective countries, followers and transition countries were identified reflecting the digital and labour productivity division between them. Leading positions are occupied by North Europe countries, that correspond with other researches (Bilozubenko et al., 2020; Androniceanu et al., 2017, 2019; Chakravorti & Chaturvedi, 2017; Chipeva et al., 2018; Lucendo-Monedero et al., 2019). Two intermediate clusters - perspectives and followers consists 16 countries. Luxembourg and Ireland characterized with highest level of labour productivity, and they don't win leading

positions in digital development. That is why they appears in perspective cluster. Also, EU-members were compared with global developed countries depending on DESI international Index and score in Global Competitiveness ranking. The results of clusterization show that leaders and transition countries save their position, but intermediate clusters consist of some changes.

Results of cluster analysis show the linkage between digital development and human development due to co-movement of DESI and Human Development Index.

As the results of our investigation we can prove the correctness of our first hypothesis and partially proved second hypothesis (Table 4).

But our research did not reach significant results with regard to the effects of digitalization process on labour market; more evidence is still needed to examine the impact of digitalization innovations on job creation, employment/unemployment level, required skills changing.

The problem of reducing labour productivity needs special attention and can be the content of further investigation. Also, special attention should be paid to the questions of digitalization policies and regularities of different European countries and their role in creating digital gaps.

Table 4 - Results of research hypotheses testing

Research hypothesis	Proved / rejected
H1: there is a significant gap within EU-members in digital development and labour productivity	Proved. Results of cluster analysis show difference in intensity if digitalization processes and level of labour productivity among EU-members
H2: digital development of EU-members can improve country's global rankings: Global Competitiveness Score, Information development Index, Human development index	Partially Proved. By DESI International and Global Competitiveness Score cluster analysis we have define 4 clusters for EU members and 8 developed countries. Members of leading cluster has higher positions in IDI and HDI Rankings, that countries of transition cluster, but further investigations in this area still need

5. Conclusions

The studies carried out prove that there are gaps in the digitalization process among EU members. Cluster analysis helped to form four clusters: in the first case, based on the digitalization index and labor productivity, in the second case – taking into account the global competitiveness score. There is a group of Northern European countries leading in the digitalization process, while a number of Eastern and Central European countries are at the bottom of this ranking. So, Results of cluster analysis show difference in intensity if digitalization processes and level of labour productivity among EU-members. Digital development of EU-members can improve country's global rankings - all members of leading cluster save their positions in global competitiveness score clusterization. The same is true for transiting cluster: the members of this cluster are the same for two cluster analysis.

Results of cluster analysis show the linkage between digital development and human development due to co-movement of DESI and Human Development Index. Members of leading cluster has higher positions in IDI and HDI Rankings, that countries of transiting cluster. But digital development is only one of the many factors that determine information sector and human development. That is why the co-movement of such ranking needs further investigations.

For further investigations one can analyze digital policies of EU-members and their effects on economic and digital performance of the country, also it will be useful to continue research in a field of digital impact on labour market.

References

- Abonyi, J., & Feil, B. (2007). *Cluster Analysis for Data Mining and System*. Birkhauser Verlag AG.
- Amuso, V., Poletti, G., & Montibello, D. (2019). The Digital Economy: Opportunities and Challenges. *Global Policy*, 11(1), 124-127. <https://doi.org/10.1111/1758-5899.12745>
- Androniceanu, A., Georgescu, I., & Kinnunen, J. (2019). Digitalization Clusters within the European Union. In *IBIMA, 33rd IBIMA Conference, Granada, Spain 10-11 April, 2019* (pp. 1321-1331).
- Antonelli, C. (2003). The digital divide: understanding the economics of new information and communication technology in the global economy. *Information Economics and Policy*, 15(2), 173-199. [https://doi.org/10.1016/S0167-6245\(02\)00093-8](https://doi.org/10.1016/S0167-6245(02)00093-8)
- Ark Van, B., Inklaar, R., McGuckin, R. H., & Timmer, M. P. (2003). *The Employment Effects of the "New Economy": A Comparison of the European Union and the United States* (EPWP #03 – 02). Economics Program Working Paper Series. University of Groningen and The Conference Board.
- Balcerzak, P. A., & Pietrzak, B. M. (2017). Digital Economy in Visegrad Countries. Multiple-criteria Decision Analysis at Regional Level in The Years 2012 and 2015. *Journal of Competitiveness*, 9(2), 5-18. <https://doi.org/10.7441/joc.2017.02.01>
- Bilozubenko, V., Yatchuk, O., Wolanin, E., Serediuk, T., & Korneyev, M. (2020). Comparison of the digital economy development parameters in the EU countries in the context of bridging the digital divide. *Problems and Perspectives in Management*, 18(2), 206-218. [https://doi.org/10.21511/ppm.18\(2\).2020.18](https://doi.org/10.21511/ppm.18(2).2020.18)
- Biagi, F. (2013). *ICT and Productivity: A Review of the Literature* (JRC Working Papers on Digital Economy 2013-09). Joint Research Centre. <https://doi.org/10.2788/32940>
- Chakravorti, B., & Chaturvedi, R. S. (2017). *Digital planet 2017: How competitiveness and trust in digital economies vary across the world*.
- Chen, W., & Wellman, B. (2004). The Global Digital Divide – Within and Between Countries. *IT & Society*, 1(7), 39-45. <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.207.1713>
- Chipeva, P., Cruz-Jesus, F., Oliveira, T., & Irani, Z. (2018). Digital divide at individual level: Evidence for Eastern and Western European countries. *Government Information Quarterly*, 35(3), 460-479. <https://doi.org/10.1016/j.giq.2018.06.003>
- Digital Economy and Society Index (DESI). (2020). <https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi>.
- European Commission. (2015). *A Digital Single Market Strategy for Europe* (A Communication Paper SWD (2015) 192). European Union.
- Foster, C., & Azmeh, S. (2020). Latecomer Economies and National Digital Policy: An Industrial Policy Perspective. *The Journal of Development Studies*, 56(7), 1247-1262. <https://doi.org/10.1080/00220388.2019.1677886>
- ITU. (n.d.). *The ICT Development Index (IDI): Methodology, indicators and definitions*. International Telecommunication Union. https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/ITU_ICT%20Development%20Index.pdf
- European Commission. (2021). *The Digital Economy and Society Index (DESI)*. <https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi>

- Kinnunen, J., Androniceanu, A., & Georgescu, I. (2019). Digitalization of EU Countries: a Clusterwise Analysis. In *The 13th International management conference "Management Strategies for High Performance" 31st October – 1st November, 2019, Bucharest, Romania*.
- Lucendo-Monedero, A. L., Ruiz-Rodriguez, F., & Gonzalez-Relano, R. (2019). Measuring the digital divide at regional level. A spatial analysis of the inequalities in digital development of households and individuals in Europe. *Telematics and Informatics*, 41, 197-217. <https://doi.org/10.1016/j.tele.2019.05.002>
- Mardikyan, S., Aycicek, E., Mehmet, Y., Ordu, D., & Şimşek, B. (2015), Examining the Global Digital Divide: A Cross-Country Analysis. *Communications of the IBIMA* (Vol. 2015). Article ID 592253. <https://doi.org/10.5171/2015.592253>
- Milošević, N., Dobrota, M., & Barjaktarovic Rakocevic, S. (2018). Digital economy in Europe: Evaluation of countries' performances. *Zbornik Radova Ekonomskog Fakulteta u Rijeci*, 36(2), 861-880. <https://doi.org/10.18045/zbfri.2018.2.861>
- Nambisan, S., Wright, M., & Feldman, M. (2019). The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. *Research Policy*, 48(8), 1-9. <https://doi.org/10.1016/j.respol.2019.03.018>
- Novak, J., Purta M., Marciniak, M., Ignatowicz, K., Rozenbaum, K., & Yearwood, K. (2018). The rise of Digital Challengers – How digitization can become the next growth engine for Central and Eastern Europe. *Digital McKinsey*. McKinsey & Company.
- OECD. (2016). *Stimulating digital innovation for growth and inclusiveness: The role of policies for the successful diffusion of ICT* (OECD Digital Economy Papers, No. 256). OECD Publishing, Paris. <https://doi.org/10.1787/5jlwqvhg3l31-en>
- Polozova, T. V. (2015). Formation of feature space for diagnostics of innovative investment capability of an enterprise. *Actual Problems of Economics*, 170(8), 450–460.
- Terziyan, V., Gryshko, S., & Golovianko, M. (2018). Patented intelligence: Cloning human decision models for Industry 4.0. *Journal of Manufacturing Systems*, 48, 204–217. <https://doi.org/10.1016/j.jmsy.2018.04.019>
- United Nations Development Programme (UND). (2018). *2018 Statistical Update: Human Development Indices and Indicators*. <http://hdr.undp.org/en/content/human-development-indices-indicators-2018>
- WEF. (2018). *The Global Competitiveness Report*. World Economic Forum. <https://www.weforum.org/reports/the-global-competitiveness-report>

Time Series Movements in Art Prices

Alena POZDÍLKOVÁ*, Jaroslav MAREK and Marie NEDVĚDOVÁ

University of Pardubice, Pardubice, Czech Republic; alena.pozdilkova@upce.cz, jaroslav.marek@upce.cz;
marie.nedvedova@upce.cz

* Corresponding author: alena.pozdilkova@upce.cz

Abstract: The aim of our paper is to understand the price behavior of artworks, mainly graphics sold in one selected Czech auction house. The publicly available information obtained from internet auction systems provide price time series of monitored painters works. We focused on the prediction of the price development using linear regression methods. Approach presented in our paper provided finding an artist whose painting prices are rising statistically significantly. We worked with a dataset of total of 398 paintings by 10 Czech painters. Authors with at least 11 auctioned paintings will be used for statistical analysis. We did not focus on art auctions with the most expensive paintings, but on paintings and graphics that are affordable for the general population. The graphics dominated the data collected. The goal of our study is to estimate the annual change in works of art in the Czech Republic and compare with respect to inflation in the period from 2014 to 2020. In the final discussion, an assessment of the further price development of works of art is also discussed.

Keywords: Art work prices; time series; trend component

JEL Classification: Z11; E27; D44

1. Introduction

Comparing investment expectations for selected stocks, bonds, real estate, the development of currency pairs, etc. formulates investors' investment portfolio, cf. (Szumilo, 2018). However, investing can also be collector-oriented. Financial products are more accessible and have more publicity; thus, analyzes of the evaluation of the investment potential of works of art are not often published. But even for a small investor, works of art, especially graphics, are available at auctions of various auction houses. Therefore, in this article, we focused on the analysis of fine art prices at auctions in the Czech Republic.

The heterogeneity of the characteristics of works of art and the low frequency of trade in the same works of art are viewed as major obstacles to market analysis. The global development of the art market can be traced through the amount of money invested in the world art auctions, which provides a reasonable way to construct various art price indices. Collecting time series allows then to estimate the relative increase in prices.

We are inspired by the survey from Ashenfelter (2002), in which the estimated returns of art from 14 various studies are presented on page 12. The smallest estimate is 0.5 percent and the largest is 5.0 percent per year. Two of these 14 analyzes are presented in the articles (Mei, 2003) and (Stein, 1977). The results (Mei, 2003) on the return and risk characteristics of works

of art and the correlations between artistic and financial assets have implications for long-term investors. Stein (1977) calculated appreciation above 1.6 percent for pre-World War II painting from the USA.

Another study of Garay (2019) analyzed 5,961 artworks executed by 69 Venezuelan artists, which were sold at auctions between years 1969 and 2014. Author used a hedonic price regression. Hedonic price regression was also used in Chanel (1995). The results showed that art market is correlated with economic indicators; however, it is very difficult to predict in long-term forecasts.

In Bialynicka-Birula (2018), the European art market in the period 2002–2015 was examined. It was found that sales on the global art market generally increased, but the art market was considerably affected by the economic recession in 2009.

In Candela (1997), a price index for Italian art market auctions was computed. He found out that in period 1983-1994, art prices increased in the same line as inflation. Art price indices, such as representativeness, liquidity or capacity were described in one part of (McAndrew, 2010). Author indicated advantages and disadvantages of repeat sales and indices like hedonic price indices or hybrid models.

Another interesting aspect is how an artist's death affects the price of her works of art. This aspect was studied by (Itaya, 2016). In our article, we have similar situation, assessing, how much a death of one of our selected authors Olbram Zoubek can affect the price of his works.

Art auctions are also monitored from the point of view of price development during the auction from the starting price to the final price, see Onofri (2009). An oft-cited article on the development of art prices is Agnello (1996), which focuses on the US market and an estimate of its annual growth. Obtaining such an estimate for the Czech art market is the aim of this article.

Our goal is to analyze a relatively short period of development of prices of works of art by selected Czech painters. Time series analysis can help us predict the future prices of arbitrary commodities and works of art. The web systems of several Czech auction houses were used for source data mining. In our random selection, the most prestigious works does not fugue. On the other hand, it does not include unknown and secondary authors. In our study, we compared a total of 398 paintings by following 10 painters: František Tavík Šimon, František Tichý, František Gross, Josef Jíra, Kristian Kodet, Jiří Načeradský, Bohuslav Reynek, Jan Slavíček, Zdeněk Sýkora and Olbram Zoubek. We selected only authors who had at least 10 paintings available. We drew from publicly available data from the Platýz auction houses (Platyz, 2020). The influence of different image characteristics was removed in our analyzes by the transformation of the auctioned price into a price per square centimeter. Thus, from the searched prices of the works of the selected painter, we calculated the average price per square centimeter. Of course, the variability over time in such art prices is affected not only by movements in prices but rather by the quality of the objects. Using the ordinary squares method, we estimated the trend component for the selected author, which we subject to further statistical testing.

The main goal of our analyzes is to estimate the price trend for the selected artist and to assess its statistical significance. Our calculations also allow us to estimate the average annual appreciation of a given artist.

2. Methodology

2.1. Basic Idea

Through the parsing of the art auction website, we acquired data for the past year containing the author identifier, the painting or graphics price, the picture area and the date of the sale. For auctioned items, the kind of artwork were obtained during parsing. For each author that appeared in at least two auctions, we calculated the average value and the standard deviation of the price of a one square centimeter of painting.

These values can be accumulated over a longer period. This gives us time series of prices for all the authors with more items. This data can be studied using basic methods for time series processing. Testing of statistical hypothesis in the reference period allow to evaluate the statistical significance of the trend. Of course, such a grip through the average price per unit area does not consider the quality of the artwork. Also, the price of a work of art does not increase linearly with the area. The quality of the regression model used could be small, especially for authors with a small number of images with different artistic quality and large variability in image size.

2.2. Formatting of Mathematical Components

We considered a linear regression model in the form of

$$y = \beta_0 + \beta_1 x, \quad (1)$$

where x is the month from date 1.1.2014 and y is average 1 cm² prize of painting. The model given as $y = \beta_0 + \beta_1 x$ describes the dependence between the time and the prize of painting.

We calculated an ordinary square estimate $\hat{y} = \beta_0 + \beta_1 x$ of the regression line using well know formulas for β_0 a β_1 estimates.

Further, we worked with a confidence domain for regression line, i.e.,

$$b_0 + b_1 x \mp t_{n-2}(\alpha) s \sqrt{\frac{1}{n} + \frac{(x - \bar{x})^2}{\sum x_i^2 - n\bar{x}^2}}, \quad (2)$$

Our recent research focused on significant positive trend testing. Thus, we tested the hypothesis $H_0: \beta_1 = 0$ based on statistics:

$$T = \frac{|b_1 - \beta_1|}{SE_{\hat{\beta}}} = \frac{b_1}{s} \sqrt{\sum x_i^2 - n\bar{x}^2} \sim t_{n-2}, \quad (3)$$

where

$$s^2 = \hat{\sigma}^2 = \frac{SS_{res}}{n-2}, \quad SS_{res} = \sum_{i=1}^n (y_i - \hat{y}_i)^2 = \sum_{i=1}^n e_i^2 \quad (4)$$

The quality of estimated regression line is given by the index of determination

$$R^2 = 1 - \frac{SS_{res}}{SS_{tot}}, \quad (5)$$

where

$$SS_{tot} = \sum_{i=1}^n (y_i - \bar{y})^2. \quad (6)$$

3. Data and Results

Furthermore, we performed an analysis of art price time series in the Czech Republic using the regression analysis.

3.1. Data

Firstly, we collected data for time series construction. The example of measured values for chosen author is given in Table 1. The total number of painters analyzed was 25. Overall, in the period between January 1st, 2001 and December 31th, 2020, we loaded 345 sales in 25 auction days. From the obtained data in the structure of Table 2, we can get basic statistical characteristics (number of items, average painting area price of a given author, standard deviation in an obtained random sample of paintings). An example of these variables is given in Table 2.

We used following painters: František Tavík Šimon, František Tichý, František Gross, Josef Jíra, Kristian Kodet, Jiří Načeradský, Bohuslav Reynek, Jan Slaviček, Zdeněk Sýkora and Olbram Zoubek.

An example of obtained data is presented in Table 1. This example is for author J. Slaviček and 14 selected paintings between 2014 and 2020. The size of the painting and its price can be seen in the table.

Table 1. Source data J. Slaviček.

Date	Size	Price	Date	Size	Price
15.11.2018	26x33	73,000	14.01.2020	31x40	15,500
09.06.2014	27x35	39,000	08.10.2018	40x50	9,500
19.01.2017	23x33	19,000	12.11.2019	15x29	14,000
22.05.2018	50x70	37,000	16.05.2019	39x49	9,000
19.01.2017	19x30	33,000	11.05.2020	36x54	18,500
19.07.2018	19x22	24,000	08.10.2020	45x55	31,000
07.06.2016	23x35	19,000	23.11.2016	54x65	45,000

In Table 2 average prices of 1cm² for selected author J. Slaviček are shown.

Table 2. An example of summary data: J. Slaviček.

Time	5/14	5/17	11/17	12/17	6/18	9/18	2/19	4/19	6/19	4/20
J. Slaviček: Price of 1cm ²	4.71	4.80	9.52	10.57	12.53	23.6	25.42	41.87	57.41	57.89

3.2. Regression Analysis

We present the estimates of regression line for every author separately and also together. Authors with statistically increasing price per 1 cm² of painting are depicted in solid line.

Dotted lines form confidence domain for the regression line that are constructed for level of confidence 5 percent.

In Figures 1-5, we can see the dependence of the price on the time. Regression lines as well as $(1-\alpha)$ -confidence domain with $\alpha = 5\%$ were constructed. Regression line for all painting is presented in Fig. 6, which shows an increase in price.

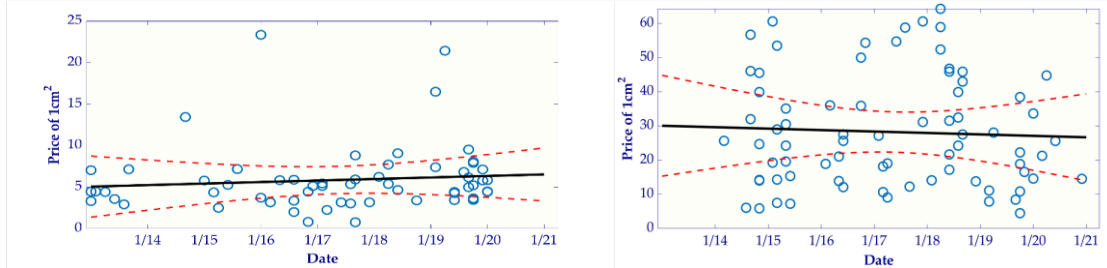


Figure 1. Regression line: Šimon and Tichý.

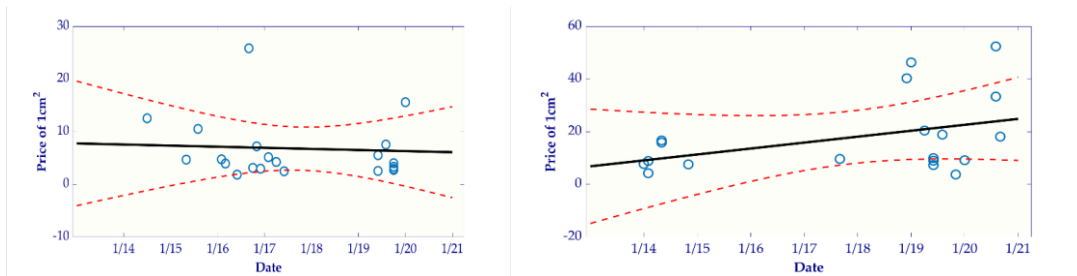


Figure 2. Regression line: Gross and Jíra.

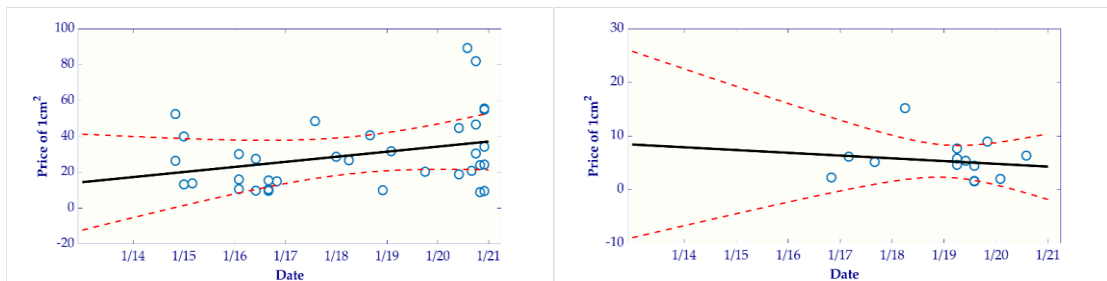


Figure 3. Regression line: Kodet and Načeradský.

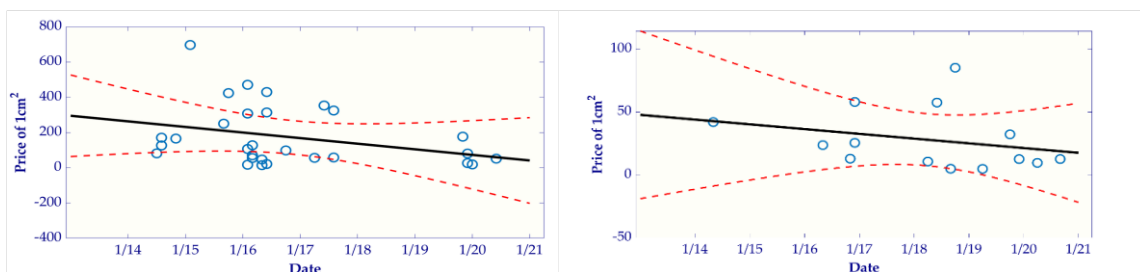


Figure 4. Regression line: Reynek, and Slaviček.

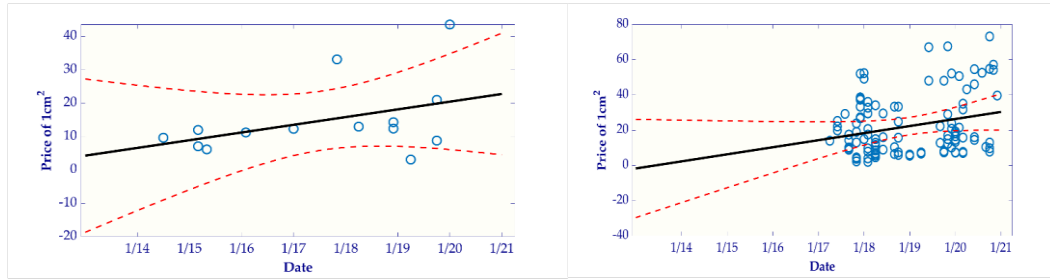


Figure 5. Regression line: Sýkora and Zoubek.

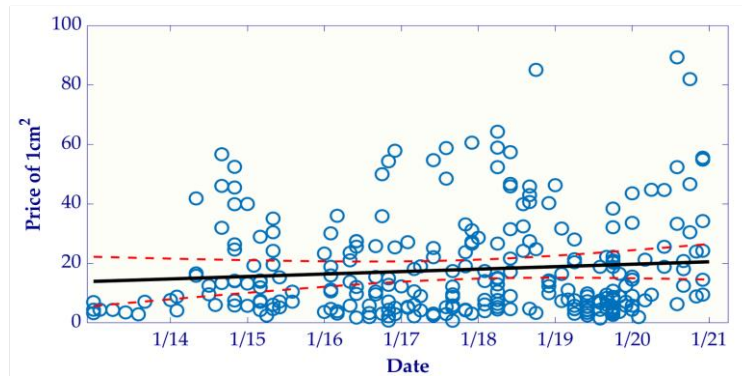


Figure 6. Regression line: all paintings.

Figures 1-5 illustrate the trend in prices for individual artists from our sample. For 13 artists, obtained values from individual auctions of their works can be seen in graphs, and the estimated trend line. Also, the confidence domain for the trend is shown.

Figure 6 shows the evolution of trend component of the time series between 2014 and early 2021 for the artists considered in this study.

Table 3 presents the estimated appreciation. The estimated annual growth in the prices of works of art in the Czech Republic is 4.003 percent.

Table 3. Results

	Year of birth	Year of death	R2	T1	Number of works	Work technique	Annual change
František T. Šimon	1877	1942	0.010	0.7749	61	Graphics	2.81%
František Tichý	1896	1961	0.003	-0.4334	77	Graphics	-1.58%
František Gross	1909	1985	0.004	-0.2838	22	Graphics	-3.42%
Josef Jíra	1929	2005	0.163	1.8222*	19	Graphics	9.06%
Kristian Kodet	1949	-	0.105	1.9639*	35	Oil	7.62%
Jiří Načeradský	1939	2014	0.025	-0.5830	15	combined technique	-12.01%
Bohuslav Reynek	1892	1971	0.110	-1.8582*	30	Graphics	-43.46%
Jan Slaviček	1900	1970	0.076	-0.9912	14	Oil	-17.75%
Zdeněk Sýkora	1920	2011	0.173	1.5827	14	Graphics	11.29%
Olbram Zoubek	1926	2017	0.067	2.7984*	111	Graphics	15.24%
sum			0.010	1.6522*	398		4.003%

¹The symbol * indicates a test in which the zero hypothesis $\beta_1 = 0$ was rejected.

4. Discussion

This article represents our pilot contribution to art market monitoring. In this contribution, a new way of obtaining data on the art market was introduced. Programmed Python procedures have been successfully employed for retrieving data from an art auction website for over 8 years. The designed and implemented platform enables automated data collection from the Platýz auction houses and their automatic processing within the long-term operation. Platform functionality can also be expanded in the future and, if necessary, vertical and horizontal scaling can be used to increase platform performance. The obtained time series allowed us to draw price graphs and perform selected statistical analyses.

The prices of works by Josef Jíra, Kristian Kodet and Olbram Zoubek statistically significantly increased, the prices of works by Bohuslav Reynek statistically significantly decreased.

From Table 3, we can see annual increases for works by František T. Šimon, Josef Jíra, Kristian Kodet, Zdeněk Sýkora and Olbram Zoubek - only increases of works by Josef Jíra, Kristian Kodet and Olbram Zoubek were statistically significant. The largest annual increase of 15.24 percent was with Olbram Zoubek. This price development was probably influenced by his death in 2017.

Annual increase of works by Josef Jíra was 9.06% and annual increase of works by Zdeněk Sýkora was found to be 11.29%.

5. Conclusions

Knowledge of the expected annual interest rate of share and risks for financial investing on a stock exchange is sometime at our disposal. Estimates of the behavior of works of art prices, however, are not very available. In this work, we have attempted such estimates.

Through the parsing of the auction website, we have acquired data for several painters in the past 12 years containing the average size price in every sailed item.

However, further developments will be affected by inflation. The average inflation rate for 2019 was 2.8% and in 2020 it was 3.2% (ČZSO, 2021). This value was the highest since 2012, when it reached 3.3%. Between 2014 and 2016, the average inflation rate in the Czech Republic was at a very low level, as in most countries of the European Union (Hedvicakova, 2017; Hedvicakova & Soukal, 2012). The inflation target is 2%. But 2020 was affected by the Covid pandemic. This pandemic has also affected the art market. Due to restrictive measures, a number of auctions of works of art did not take place, and thus there was a massive drop in both the number of auctions and the funds spent. The situation with the Covid pandemic will affect the development of the art market this year as well as in the whole economy. Rising inflation can positively affect the art market as a store of value or, conversely, it can also negatively affect it, because there will be a decline in the purchasing power of the population (Svobodová & Hedvičáková, 2015). The labor market will also significantly affect the art market. Due to the pandemic, the unemployment rate is rising and people are starting to save more for the next period. The forecast for the next period is therefore uncertain and much

will depend on the measures of the Czech government. However, non-economic factors are also entering the art market, which may not be logical, but rather emotional.

The estimated annual increment of works of art prices in the Czech Republic was 4.003 percent. This value is higher than the inflation rate in the Czech Republic, which was between 1 and 3 percent in the years 2014 to 2020. In Scandela (1997) annual increment of works of art prices in Italy was found to be approximately the same as the interest rate. In Ashenfelter and Graddy (2002) and Ashenfelter and Graddy (2003), many authors and their real returns for art prices were compared. These values were found to lie between 0.55 percent and 5 percent for all cited authors, in publication Ashenfelter and Graddy (2003), this value was even 8 percent for one author, however, it was viewed as a unique value. These computed values correspond to the results of our research. In paper Pozdílková (2016) deals with analysis of the expected annual interest rate of mutual fund. The calculated estimate was around two percent.

Another interesting result of our research was a fact that the price trend is significant for most of the painters analyzed.

Acknowledgments: This contribution has been supported by the institutional support of the University of Pardubice, Czech Republic.

References

- Agnello, R. J., & Pierce, R. (1996). Financial returns, price determinants and genre effects in American art investment. *Journal of Cultural Economics*, 20(4), 359–383.
- Ashenfelter, O., & Graddy, K. (2002). *Art Auctions: A Survey of Empirical Studies* (June 2002). National Bureau of Economic Research.
- Ashenfelter, O., & Graddy, K. (2003). Auctions and the Price of Art. *Journal of Economic Literature*, 41(3), 763–786. <https://doi.org/10.1257/002205103322436188>
- Bialynicka-Birula, J. (2018). Changes in the global art market. *Oeconomia Copernicana*, 9(4), 695–714. <https://doi.org/10.24136/oc.2018.034>
- Chanel, O. (1995). Is Art-Market Behavior Predictable. *European Economic Review*, 3(3-4), 519–527.
- Hedvicakova, M. (2017). Key Study of Bank Accounts for Young People with Using Multi-Criteria Optimization and Fuzzy Analysis. *Applied Economics*, 49(36), 3599–3610, <https://doi.org/10.1080/00036846.2016.1265073>
- Hedvicakova, M., & Soukal, I. (2012). Retail Core Banking Services Costs Optimization. *Procedia Technology*, 1, 177–182. <https://doi.org/10.1016/j.protcy.2012.02.033>
- Jun-ichi, I., & Heinrich, W. U. (2016). Price and death: modeling the death effect in art price formation. *Research in Economics*, 70(3), 431–445. <https://doi.org/10.1016/j.rie.2016.07.005>
- McAndrew, C. (2010). *Fine art and high finance: expert advice on the economics of ownership*. Bloomberg Press.
- Mei, J., & Moses, M. (2003). Art as investment and the underperformance of masterpieces: Evidence from 1875–2002. *American Economic Review*, 92(5), 1656–1668. <https://doi.org/10.1257/000282802762024719>
- Onofri, L. (2009). Old master paintings, export veto and price formation: an empirical study. *European Journal of Law and Economics*, 28, 149–161. <https://doi.org/10.1007/s10657-008-9094-2>.
- Pozdílková, A., & Marek, J. (2016). Investment Funds - Estimation of Appreciation. In L. Balko (Ed.), *Aplimat 2016: 15th Conference on Applied Mathematics: proceedings* (pp. 938–946). Slovenská technická univerzita v Bratislave.
- Scandela, G., & Scorcio, A. E. (1997). A Price Index for Art Market Auctions. *Journal of Cultural Economics*, 21, 175–196.
- Stein, J. P. (1977). The Monetary Appreciation of Paintings. *Journal of Political Economy*, 5, 1021–1035.
- Svobodová, L., & Hedvičáková, M. (2015). Doing Business in the Countries of Visegrad Group. *Procedia Economics and Finance*, 34, 453–460. [https://doi.org/10.1016/S2212-5671\(15\)01654-8](https://doi.org/10.1016/S2212-5671(15)01654-8)
- Szumilo, N., Wiegmann, T., Łaskiewicz, E., Pietrzak, M., Bernard, M., & Balcerzak, A. P. (2018). The real alternative? A comparison of German real estate returns with bonds and stocks. *Journal of Property Investment & Finance*, 36(1), 19–31. <https://doi.org/10.1108/JPIF-02-2017-0012>

- Garay, U. (2019). Determinants of art prices and performance by movements: Long-run evidence from an emerging market. *Journal of Business Research*, 127, 413-426. <https://doi.org/10.1016/j.jbusres.2019.03.057>
- ČZSO. (2021, January 17). <https://www.czso.cz/csu/xs/prumerna-rocni-mira-inflace-v-cr-v-roce-2020-byla-32>.
- Platyz. (2020, January 17). *Aukce obrazů i prodej*. Retrieved January 17, 2021 from <https://www.galerieplatyz.cz>.

Altruism and the Privacy Calculus

Tomáš SIGMUND¹ and Jiří KORČÁK^{2*}

¹ Prague University of Economics and Business, Prague, Czech Republic, sigmund@vse.cz; jiri.korcak@vse.cz

* Corresponding author: jiri.korcak@vse.cz

Abstract: This paper analyses the privacy calculus as an explanation of privacy thinking and behavior and extends its concepts with altruistic thinking which is becoming more relevant these days as companies create patterns of behavior, users' profiles and categories and one's behavior affects many others, e.g., concerning health issues. Privacy calculus attempts to explain the privacy paradox according to which people express their concern about privacy but behave differently. Our results show that students respect altruistic principles, are aware of both individual and social benefits and risks of privacy disclosure, but their real behavior in the online environment is influenced by these ideas a little only. The reason why the respondents' intention does not comply with their behavior may consist in their distrust and confusion concerning technology. The movement of explainable technology proves relevance of these ideas. Our results are relevant for companies formulating their privacy statements and respecting users' preferences regarding their privacy.

Keywords: privacy paradox; privacy calculus; altruism; privacy disclosure; benefits and risks in exchange of privacy

JEL Classification: D82; M14; M31

1. Introduction

Privacy is a topic, that nowadays arouses fear, stress, anxiety and even protests. However, thoughts about private sphere of life can be found even in earlier works of great authors and philosophers, as Plato or Aristotle. Laws concerning private property like private households or real estates are found in Code of Hammurabi from about 1754 BC. Humankind has been for sure for a long time interested in this opposition of two realms –the private realm and the public realm. These two realms are in obvious contrast and one excludes the other. Private realm is the world of our own personal, intimate, and sometimes even embarrassing information. On the other side, in the public realm no information belongs to no individual and information is not under private protection (Swanson, 1992; Nissenbaum, 2010).

Technological progress has blurred the borderline between these two realms and world wide web changes the way people look on private information. Thanks to Nissenbaum (2010) we can take better view on how people deal with their personal information and are willing to transform it into public data in certain contexts. Arguments like "I have nothing to hide" are common and the degree of private to public transformation deepens (Solove, 2011). Why is this change of thinking occurring in our times of great technological progression is still the topic of debates and needs further research. In addition to this lack of interest in privacy, there are other reasons people share their personal information on the internet (George, 2004). Susan Waters (2011) made a research on why people disclose personal information on

Facebook and found multiple reasons. She ascertained multiple dimensions of disclosure such as “habitual behaviour” and “keeping up with trends”, but those notions are rather vague. We think that those reasons could be broken up to smaller psychological areas to help us understand why people impair their privacy. Altruistic part of human behaviour could tell us more about these issues.

1.1. Online Privacy

Online privacy combines in its concept people, information about them and technology. People carry out many types of social interaction in the online environment and reveal much information. There are areas that are very sensitive in the area of privacy, especially health information or religious information.

Privacy can be defined as the right to be left alone (Warren & Brandeis, 1890). However, it is associated with many problems like contextual and cultural dependence, virtual identity etc. And that is why we can say with D. Solove (2006) “Privacy is in disarray and nobody can articulate what it means”.

1.2. Altruism

We will work with definition of altruism published by Thomas Nagel (1970) that says: “By altruism I mean not abject self-sacrifice, but merely a willingness to act in the consideration of the interests of other persons, without the need of ulterior motives.” From this definition we can ascertain that truly altruistic behaviour can be seen when individual acts without ulterior motive, just helping other people. Batson et al. (1988) formulate the hypothesis that altruism is an egoistic act, aiming at self-rewarding, and at helping others as a side product. The main motive for helping others would afterwards be the warming, glowing feeling of giving (Andreoni, 1989; Andreoni, 1990). Some argue that this motive could exist on its own, without altruistic nature of an individual (Andreoni, 2007), but it is also possible that good feeling from giving and altruism are complementary aspects. Moreover, these two aspects could be linked, because altruistic identity of an individual is necessarily connected to warm and glowing feeling of giving and generous acts.

Employing altruistic motives in the privacy consideration is a new idea which has not been considered so far. But there are reasons justifying its use in the privacy context. Many situations including the health crisis of Covid-19 relate private information to public context. Private information can help or harm others. Secondly, private information is used by many companies to make users’ profiles, segments, and patterns of behaviour. Private information is a source of information about the general public. Users are becoming aware of it.

1.3. ICT and Privacy

The development of digital technologies, social networking, big data has changed the life of many people and has led to uncontrolled electronic panopticism (Smith & Collars, 2015). Users are permanently observed and information about them is collected and processed. Users express concerns about their privacy, but use technologies very intensively, motivated by popularity, usability, and low price of many services. This discrepancy between the

expressed concern and actual behavior is called the privacy paradox. There are many theories explaining the privacy paradox. There are rational theories using the cost-benefit comparison of online disclosure. Other theories question the human rationality arguing that man's decision making is biased, irrational and heuristic.

1.4. Privacy Calculus

One of the cost-benefit theories is called privacy calculus. This theory as described by Laufer and Wolfe (1977) anticipates that people before deciding about disclosing their private and personal information weight possible future consequences of such decision. Disclosing personal information can lead to future gain of utility, and thus could be beneficial despite the risk taken. Benefits gained through information disclosure can be both material and abstract (monetary benefits, faster access via GPS guidance, better social relationships etc.). Risks can take form of losing access to information, inability of controlling information transmission and subsequent risks of unauthorized access. (Dinev & Hart, 2006). Privacy calculus assumes that people consider their decisions economically and disclose their private information while considering future utility against potential risk, calculating if disclosure is beneficial or not.

1.5. Economic relevance of online privacy

Before the pandemic and even more during it the use of technologies and online services has intensified. That has increased the concern of users about their personal information disclosed online. Responsible personal information handling affects company's reputation and influences its competitive potential. Especially during the pandemic online services are necessary for the smooth running of the economy. Users use them if they trust them. That is why it is necessary to study users' opinion on privacy in the online environment.

2. Methodology

We used a questionnaire to test users' relations to privacy disclosure risks and benefits and the role of altruism in decisions about privacy. The role of altruism in privacy thinking is relatively new as privacy is usually related to the subject considered as isolated. The questionnaire was distributed per email in December 2020 and January 2021 to students of University of economics. Out of 771 students that received the questionnaire, 159 (21%) responded but only 55 (7%) of responses were usable for further analysis as only they included all information and all answers needed. For the analysis of the results statistical methods of descriptive and inferential statistics were used. We calculated the mean (M), standard deviation (SD) and mode. Our sample consists of 28 men (51%) and 27 women (49%). We used the 6-point Likert scale in the answers; 1 meaning definitely yes, 6 meaning definitely no.

3. Results

In the first set of questions, we analyzed how students behave online. Students are careful online in the average values of the Likert scale, but rather do not read the privacy

statements of online services. Students sometimes use technical instruments to protect their privacy.

Table 1. Privacy protecting behaviour

	Disclosing private information online	Reading terms and conditions of privacy protection	Using technical means for privacy protection
M	3.5	4.3	3.1
SD	0.9	1.1	0.9
Mode	3	4	3

Students don't appreciate benefits of personalized approach on the average very much, only personalized help is welcomed.

Table 2. Benefits of privacy disclosure

	Personalized services	Personalized information	Cheaper products and services	Easier life	Personalized help
M	3.4	3.2	3.5	3	2.6
SD	1.3	1.1	1	1	0.9
Mode	3	3	3	3	2

The same holds true for risks related to privacy disclosure. All types of risks are evaluated similarly – students are not much afraid of them. However, in both categories there are students who appreciate the benefits more and are afraid of the risks. The mean is located in the middle of the Likert scale.

Table 3. Risks of privacy disclosure

	Bad feeling of fear	Revealing unintended consequences	Manipulation	Unwilling attention, misuse, blackmailing etc.
M	3.5	3.4	3.2	3.2
SD	1.3	1.2	1.2	1.3
Mode	4	3	3	3

The correlations were tested with the Spearman correlation coefficient. We found positive correlation between using technical instruments for privacy protection and fear of manipulation ($r_s = 0.3$; $p = 0.02$) and using technical instruments and fear of unwilling attention ($r_s = 0.29$; $p = 0.03$). Other relations were not significant at the 5% significance level. That means students do not evaluate the benefits and losses related to privacy disclosure when disclosing their private information with the exception of using technical instruments. Their use is related to the fears of manipulation and unwilling attention. Maybe the meaning of privacy has changed for the young generation and the young people consider other criteria when deciding about privacy disclosure, like habits, behaviour of others, trust in service providers etc. That will be the topic of our further research. Alternatively, students don't behave rationally and there is no pattern expressing their behaviour and the young generation is aware of benefits and risks of online privacy, but their behaviour doesn't express any pattern.

As for altruism, we found that students are empathic and altruistic ($M = 2.5$; $SD = 1.23$). The results are independent on gender ($X^2 = 5.5$, $p = 0.24$).

Table 4. Types of altruism

	Reciprocal service	Pure altruism (without reciprocity)	Good inner feeling	Popularity in society	Helping relatives or friends	Duty
M	3.1	2.7	2.1	3.3	1.7	3.9
SD	1.2	1.1	0.8	1.3	0.7	1.1
Mode	4	2	2	3	2	4

None of the types of altruism is correlated to gender. Unsurprisingly, students prefer their relatives and friends, the least popular type of altruism is the one based on duty. Apart from Students accept.

We investigated some advantages and disadvantages of privacy disclosure related to the community. Students disagree with manipulation of others and appreciate personalized services to other community members based on their personal information.

Table 5. Advantages and disadvantages of privacy disclosure for the community

	Revealing new sensitive information about the community	Manipulation of others	Personalizes services to other community members	Protection of other people
M	3.2	2.6	2.6	3.2
SD	1.2	1.3	0.9	0.9
Mode	4	2	3	3

We found correlation between using technical instruments for privacy protection and provision of personalized services to other people by using one's private information ($r_s = 0.351$, $p = 0.005$). That can be explained by students' attempt to disclose their private information to reliable providers only with the intention that the information will be used properly.

4. Discussion

We did not confirm the existence of privacy calculus in students' decision about privacy. There are other factors influencing their online privacy behaviour. However, we confirmed they consider benefits and losses for the whole community even though they do not adapt their online behaviour according to them, with the exception of using technical instruments that reflect the social benefits. Probably the altruistic approach is used in special contexts and is not a general approach.

A hint suggesting students' way of thinking may show the answers to questions asking if they think it is easy to misuse their online information. The mean answer was 2.1, standard deviation 0.9. That means students are skeptical about the online environment. 92% of answers were positive (definitely yes, rather yes, yes). Another question asked about their trust in effectivity of instruments of online privacy protection. Here the mean answer was 3.4 and standard deviation 0.9. Here 84% of answers were in the 3-6 category of the Likert scale.

That shows a little skeptical opinion, too. Daniel Solove (2008) also speaks of confusion on privacy. Stensson and Jansson (2014) as well. Confusion could explain students' irrational behaviour because they do not believe in the effects of their behaviour even though they are aware of them. Recent debates on explainable ICT (Adadi & Berrada, 2018) support this conclusion. There may be a difference between students' intention to consider both individual and social benefits and risks, but because they do not believe in effectiveness of such behavior they do not behave accordingly in reality.

Our research is relevant for terms and conditions of many internet services as it analyses users' concerns related to privacy and adopts a wider perspective considering the public interests which is relevant for services that use the private information for the whole society.

5. Conclusion

We live in a dynamic society where many new devices influence our life. Many of our concepts are under pressure and are subject to many changes or their hidden aspects become more visible. We analyzed the privacy calculus and its possible extension with altruistic thinking. Our results show that students respect altruism, are aware of advantages and disadvantages of privacy disclosure, consider them in their thinking, but this thinking does not affect their behavior. An explanation of this result may lie in students' distrust and confusion concerning technology operation.

References

- Adadi, A., & Berrada, M. (2018). Peeking Inside the Black-Box: A Survey on Explainable Artificial Intelligence (XAI). *IEEE Access*, 6, 52138–52160.
- Andreoni, J. (1989). Giving with Impure Altruism: Applications to Charity and Ricardian Equivalence. *Journal of Political Economy*, 97(6), 1447–1458. <https://doi.org/10.1086/261662>
- Andreoni, J. (1990). Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving. *The Economic Journal*, 100(401), 464–477. <https://doi.org/10.2307/2234133>
- Andreoni, J., Harbaugh, W. T., & Vesterlund, L. (2010). Altruism in experiments. In *Behavioural and experimental economics* (pp. 6–13). Palgrave Macmillan, London.
- Batson, C. D., Dyck, J. L., Brandt, J. R., Batson, J. G., Powell, A. L., McMaster, M. R., & Griffitt, C. (1988). Five studies testing two new egoistic alternatives to the empathy-altruism hypothesis. *Journal of personality and social psychology*, 55(1), 52–77. <https://doi.org/10.1037//0022-3514.55.1.52>
- Dinev, T., & Hart, P. (2006). An Extended Privacy Calculus Model for E-Commerce Transactions. *Information Systems Research*, 17(1), 61–80. <https://doi.org/10.1287/isre.1060.0080>
- George, J. F. (2004). The theory of planned behavior and Internet purchasing. *Internet Research*, 14(3), 198–212. <https://doi.org/10.1108/10662240410542634>.
- Laufer, R. S., & Wolfe, M. (1977). Privacy as a concept and a social issue: A multidimensional developmental theory. *Journal of Social Issues*, 33(3), 22–42. <https://doi.org/10.1111/j.1540-4560.1977.tb01880.x>
- Nagel, T. (1978). *The possibility of altruism*. Princeton: Princeton University Press.
- Nissenbaum, H. F. (2010). *Privacy in Context: Technology, Policy, and the Integrity of Social Life*. Stanford, Calif: Stanford Law Books.
- Stensson, P., & Jansson, A. (2014). Autonomous technology – sources of confusion: a model for explanation and prediction of conceptual shifts. *Ergonomics*, 57(3), 455–470. <https://doi.org/10.1080/00140139.2013.858777>
- Smith, E. J., & Kollars, N. A. (2015). QR panopticism: User behavior triangulation and barcode-scanning applications. *Information Security Journal: A Global Perspective*, 24(4–6), 157–163. <https://doi.org/10.1080/19393555.2015.1085113>
- Solove, D. J. (2008). *Understanding privacy*. Cambridge, Mass: Harvard University Press.
- Solove, D. J. (2012). *Nothing to hide: The false tradeoff between privacy and security*. Yale University Press.

- Swanson, J. A. (1992). *The public and the private in Aristotle's political philosophy*. Cornell University Press.
- Warren, S., & Brandeis, L. (1890). The Right to Privacy. *Harvard Law Review*, 4(5), 193–220.
<https://doi.org/10.2307/1321160>
- Waters, S., & Ackerman, J. (2011). Exploring Privacy Management on Facebook: Motivations and Perceived Consequences of Voluntary Disclosure. *Journal of Computer-Mediated Communication*, 17, 101–115.
<https://doi.org/10.1111/j.1083-6101.2011.01559.x>

Impacts of the Tax Package in 2021 on the Taxation of Employees and Self-Employed People in the Czech Republic

Jiří SLEZÁK* and Barbora KAHÁNKOVÁ

Technical University of Ostrava, Ostrava, Czech Republic; jiri.slezak@vsb.cz; barbora.kahankova@vsb.cz

* Corresponding author: jiri.slezak@vsb.cz

Abstract: The presented article focuses on the effects of the tax package on the taxation of employees' income and on self-employed people in the Czech Republic. As part of the adopted tax changes, the super-gross wage is abolished, a catering flat rate for employees is introduced, and, among other things, a flat tax is introduced for the self-employed. The aim of the contribution is to analyze these tax changes. Model examples show what the abolition of super-gross wage means for employees and whether this fact is beneficial for them, as stated by tax policy makers. Furthermore, the essence of the catering flat rate is introduced in order to determine when it is advantageous for employees and when for employers. Finally, the introduction of a flat tax is analyzed with regard to its advantage for the self-employed. Model situations have shown that the abolition of the super-gross wage represents in all cases an increase in the net wage for employees. In the case of catering and the introduction of a flat tax, the result depends on the amount of the catering flat rate or more precisely the amount of income and expenditure of the self-employed person.

Keywords: catering flat rate; flat tax; super-gross wage

JEL Classification: H24; K34

1. Introduction

The current time is characterized not only by permanent changes in society, but also by changes in the economy and politics. In 2020, a tax package was adopted in the Czech Republic, which contains a number of changes in the tax area which come into effect from 2021. One of the most significant changes is the abolition of the super-gross wage, which was introduced in 2008. The abolition of the super-gross wage was discussed since its inception, but the abolition occurs only now. The abolition of the super-gross wage could, in addition to simplifying the calculation of the employee's wage, also result in an increase in the amount to be paid (KPMG, 2020a). On current trends in labor taxation, for example in (Sokolovska, 2018). On the system of taxation of natural persons and the development of the national economy, for example in (Tikhonova et al., 2018).

Considering the fact that the tax liability is calculated from the super-gross wage, the effective taxation in 2020 is up to 20.1%. In addition, since 2013, taxpayers who have an income higher than 4 times the average monthly wage also pay a so-called solidarity surcharge of 7% (Ministerstvo financí, 2020a). The above fact is also the reason why the Czech

Republic ranks among the countries with the highest tax measurement of labor (Slezák et al., 2020). Reducing the tax burden could also affect the economic growth of the Czech Republic, more for example in (Alfonso & Alegre, 2008) or (King & Rebelo, 1990). The influence of wages and corporate income taxes, for example in (Fuest et al., 2018).

From 2021, the super-gross wage will be abolished and the tax liability will be determined directly from the gross wage, through a 15% tax rate. If an employee receives a gross salary in the minimum amount of CZK 141,764, he is taxed at a rate of 23%. Furthermore, the discount per taxpayer is increased to CZK 2,320, and to CZK 2,570 in 2020 (KPMG, 2020b).

In 2020, employers in the Czech Republic were able to provide their employees with two types of benefits related to catering, namely company meals directly at the workplace and the provision of meal vouchers (Portal.pohoda, 2020a).

Since 2021, the so-called catering flat rate has been added to the above-mentioned benefits, which represents a contribution to catering in the form of money. Given that some employers do not offer their employees meals at the workplace nor provide them with meal vouchers due to administration, a flat rate appears to be a beneficial advantage that could be achieved by many more employees. The tax package supplements § 6 par. 9 letter b) of the Act on Income Taxes with this cash contribution, which according to the Labour Code is exempted up to 70% of the upper limit of the meal allowance that can be provided to employees remunerated for a salary on a business trip lasting 5 to 12 hours. Such a contribution will also be tax deductible on the part of the employer. The upper limit of the meal allowance for a business trip lasting 5 to 12 hours was CZK 108 for 2020. The calculation of the total exempt amount for employees is 70% of CZK 108 = CZK 75.60 (Ministerstvo financí, 2020b).

Since 2021, the possibility of paying a flat tax of CZK 5,469 has been introduced for self-employed people, whose income amounts to a maximum of CZK 1,000,000 per year. The flat-rate tax includes a minimum health insurance contribution of CZK 2,393, income tax of CZK 100 and an increased minimum social insurance contribution of 15%, which corresponds to CZK 2,976, but these amounts change every year. (Finanční správa, 2020).

The benefits of the flat tax include reducing administrative burdens. It is not necessary to file a tax return or summary of income and expenses for the health insurance company and the social security administration. In addition to time savings, it also applies to financial savings, for example, to reduce expenses for tax advisors. Furthermore, thanks to the increase of 15% of the minimum social insurance, there is an increase in pensions for taxpayers, which pay only the minimum amount and at the same time there is an increase of the pension insurance and thus the pension system. On the contrary, the disadvantages include the impossibility of applying tax rebates and tax benefits for children, which is a significant problem for taxpayers applying the tax bonus (Portal.pohoda, 2020b).

Other innovations adopted in the tax area include the abolition of real estate acquisition tax and the related reduction of the deduction of interest on housing loans as a non-taxable part of the tax base, raising the limit for depreciation of fixed assets to CZK 80,000, or abolishing tax depreciation of intangible assets (KPMG, 2020b).

The aim of the contribution is to focus on the above-mentioned issues in 2021 in comparison with its previous adjustment in 2020 and to assess the benefits of the tax changes for employees, employers and the self-employed. Finally, all the conclusions are summarized.

2. Methodology

The methods used in this article correspond to its focus. It is mainly a method of description, analysis and comparison. Furthermore, the method of procedure was used, which is based on going from basic parts up to more complex categories. All the main and major findings, results and discussion are summarized mainly using the method of synthesis. More about these methods, for example in (Hendl, 2005).

In 2020, the calculation of the net wage consists of the gross wage, which is increased by social and health insurance, which is paid for the employee by the employer (the so-called super-gross wage). The amount of social insurance in 2020 is 24.8% and the health insurance rate is 9% (Krajňák, 2020a). Super-gross wages (SGW) for employees represent tax base according to § 6 – Income from dependent activity. After rounding the tax base up to CZK 100 (in the case of a monthly calculation), the tax liability is then calculated using the 15% tax rate. It is possible to deduct tax rebates (for example, a taxpayer discount of CZK 2,070) and a tax benefit for children from the tax liability calculated in this way. Furthermore, employees are obliged to pay social and health insurance (SHI) in the amount of 6.5% and 4.5% of gross wages (GW). Finally, the tax liability after tax rebates, tax benefits and social and health insurance contributions paid by the employee are deducted from the gross salary (Krajňák, 2020b).

The net salary in 2020 is calculated as follows:

$$\text{Net salary} = \text{GW} - (\text{SGW} * 0.15 - \text{tax rebates}) - \text{SHI} \quad (1)$$

The net salary in 2021 is calculated as follows:

$$\text{Net salary} = \text{GW} - (\text{GW} * 0.15 - \text{tax rebates}) - \text{SHI} \quad (2)$$

The minimum salary for 2021 in the amount of CZK 15,000 (in 2020 in the amount of CZK 14,600) and the average salary for social insurance purposes for 2021 in the amount of CZK 35,441 (in 2020 in the amount of CZK 34,835) was obtained from the Ministry of Labor and Social Affairs (MPSV, 2020a) and (MPSV, 2020b).

3. Results

In case of the abolition of the super-gross wage, two hypothetical situations are modeled (year 2020 x 2021), the aim is to determine whether the abolition of the super-gross wage is advantageous for employees or not. The first hypothetical situation shows the calculation of the net wage in 2020 for different income levels. The gross wage of CZK 15,200 represents the level of the minimum wage in the Czech Republic in 2021, the gross wage of CZK 35,441 represents the average wage in the Czech Republic in the same year. The second hypothetical situation is shown by the calculation of the net wage in 2021, for the same income levels as in

the previous case (for better comparability, no increase in these categories of wage income for 2020 is expected).

In case of the catering flat rate, three hypothetical situations are modeled, the aim is to determine how the given fact affects employees and the employer and which option is the most advantageous for the mentioned groups. The first hypothetical situation – Catering flat rate worth CZK 54. The second hypothetical situation – Catering flat rate worth 75.60 CZK. The third hypothetical situation – Catering flat rate worth CZK 90.

In case of the introduction of a flat tax, three hypothetical situations are modeled in order to determine whether a flat tax is advantageous or not for individual types of income of self-employed people (CZK 200,000, CZK 500,000 and CZK 800,000). Expenditure is in all situations set at a percentage of revenue of 40% and 60%. The tax base is determined as the difference between income and expenses and the tax rate is 15% of the tax base. Furthermore, we consider that the taxpayer applies only a taxpayer discount, so no other discounts or tax benefits are taken into consideration. The annual discount per taxpayer in 2021 is CZK 27,840. The pension insurance rate is 29.2% and is calculated from the tax base reduced by 50%. The minimum deposit for pension insurance is CZK 2,588 per month. The health insurance rate is 13.5% and is calculated from the tax base reduced by 50%. However, the minimum deposit for health insurance is CZK 2,393 per month (Finanční správa, 2020).

3.1. Abolition of the Super-gross Wage

Table 1 below contains the calculation of the net wage in 2020 and for comparison also in 2021, for a taxpayer who is only entitled to a taxpayer discount whose monthly amount in 2020 is CZK 2,070 and in 2021 is 2,320 CZK. Additional discounts are not considered.

Table 1. Calculation of net wage in 2020 and in 2021 in CZK

Text	2020	2021	2020	2021
Gross wage	15,200	15,200	35,441	35,441
Social insurance (24.8%)	3,770		8,790	
Health insurance (9%)	1,368		3,190	
Super-gross wage	20,338	15,200	47,421	35,441
Tax before discounts	3,060	2,280	7,125	5,325
Tax after discounts	990	0	5,055	3,005
Social insurance (6.5%)	988	988	2,304	2,304
Health insurance (4.5%)	684	684	1,595	1,595
Net wage	12,538	13,528	26,487	28,537

As can be seen from Table 1, in case of the abolition of the super-gross wage, the taxpayer's share of the net wage is increased in all analyzed cases. In case of a gross wage of 15,200, it is by CZK 990, which represents an increase of 7.3%. In case of gross wages of CZK 35,441, this is CZK 2,050, which represents an increase of 7.9%. No other tax rebates or tax benefits were taken into consideration. In case of a taxpayer who is entitled to further rebates (for example student, etc.) the tax savings would be greater, in some cases the taxpayer would not have to pay at all, and, conversely, the tax could be refunded.

Figure 1 shows the effects of changes in the calculation of salary for 2020 and 2021 for various types of gross salaries.

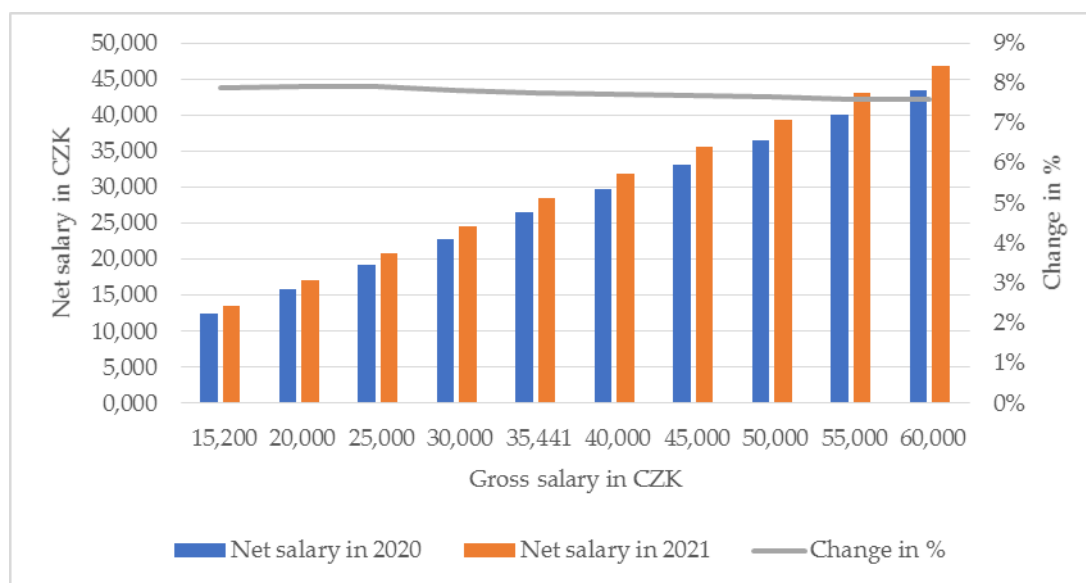


Figure 1. Impact of the change in the calculation of net salaries in 2020 and 2021 for various gross salaries

Figure 1 shows that the net salary is growing for all monitored incomes. It can be seen that with increasing gross salaries, net salaries increase. The increase in net salaries in 2021 is around 8%, depending on the amount of gross salaries.

To clarify the issue, Table 2 shows the calculation of tax in the annual settlement in comparison with the years 2020 and 2021, for the monthly minimum and monthly average salary for 2021. For the purposes of annual tax settlement, the taxpayer applies life insurance in the amount of CZK 12,000 as non-taxable part of the tax base, and paid CZK 10,000 in interest on the building society account.

Table 2. Impact of the abolition of the super-gross salary in the annual tax settlement in 2020 and 2021

Text	2020	2021	2020	2021
Partial tax base § 6	182,400	182,400	425,292	425,292
Tax base	244,052	182,400	569,042	425,292
Tax base after deducting non-taxable parts	222,052	160,400	547,042	403,292
Tax	33,315	24,060	82,065	60,495
Tax after discount	8,475	0	57,225	32,655
Deposits deducted	11,880	0	60,660	36,060
Amount overpaid	3,405	0	3,435	3,405

Table 3 shows the taxation situation if the taxpayer works as an employee and if the taxpayer works as a self-employed person, also an application and the minimum amount for social and health insurance and expenses of income (60% expenditure lump sum). The monthly minimum salary and the monthly average salary in 2021 were used as the starting amount.

Table 3. Taxation of employees and self-employed in 2021

Text	Employee	Self-Employed	Employee	Self-Employed
Annual income	182,400	182,400	425,292	425,292
Tax base	182,400	72,960	425,292	170,117
Tax	22,860	10,950	63,795	25,530
Tax after discount	0	0	35,955	0
Social and health insurance (employee)	20,064	59,772	46,783	59,772
Social and health insurance (employer)	61,652	0	143,750	0
Net income	162,336	122,628	342,554	365,520

Table 3 shows that from the point of view of taxation, it is difficult to determine what is more advantageous to the taxpayer, as it depends on the amount of annual income, expenses and the amount of insurance premiums that the self-employed person wants to claim. However, it can be said that with lower annual amounts, it is more advantageous to the taxpayer to work as an employee, as his taxation will be lower and thus higher net income. With higher annual amounts and in the case where the self-employed person intends to claim insurance premiums in minimum amounts, it is more advantageous to the taxpayer to do business. However, if the self-employed pays only a minimal amount of insurance premiums, this will have an impact on his pensions and unemployment benefits, which will be significantly lower than for employees. Conversely, if he claims higher premiums, his overall taxation may be higher than for employees. Compared to employees, self-employed persons are not entitled to nursing allowances and their administrative burden related to taxes is also increasing. Furthermore, self-employed persons do not have a legal right to leave, legal protection according to the Labor Code or Entitlement to sickness benefits in case of incapacity for work (if they do not pay it voluntarily). As already mentioned, it is not possible to clearly determine what is more advantageous to the taxpayer, for the reasons mentioned above. Compared to 2020, however, the differences in taxation have been reduced, as the abolition of the super-gross salary had no effect on taxation for the self-employed (Finance, 2016).

3.2. Introduction of a Catering Flat Rate

In case of applying a catering flat rate in the amount of CZK 54, the amount of CZK 54 is exempt income for employees, which will not be subject to social and health insurance in 2021, and the amount of CZK 54 is a tax-deductible expense for employers.

In case of applying a catering flat rate in the amount of CZK 75,6, the employee's amount of CZK 75.6 is exempt income, which in 2021 will not be subject to social and health insurance and for the employer the amount of CZK 75.6 represents a tax-deductible expense.

In case of applying a catering flat rate of CZK 90, the amount of CZK 75.6 is exempt income for employees, which in 2021 will not be subject to social and health insurance and the remaining CZK 14.4 represent income according to § 6 – Income from dependent activities and is subject to taxation and therefore will be necessary to pay for social and health insurance. For employers, the amount of CZK 90 represents a tax-deductible expense.

In the three model situations mentioned above, we have shown the meaning of the catering flat rate. For employers, it is always a tax-deductible expense, whatever its amount. On the other hand, the situation is a bit more difficult for an employee. If the employee is provided with a catering flat rate of CZK 75.6 or less, the entire amount is exempt from tax and social and health insurance. If a higher amount is provided to the employee, the value of the catering flat rate up to CZK 75.6 is again exempt, but any amount above the stated value is subject to taxation and social and health insurance. In the case of a catering flat rate of CZK 54 and assuming 21 working days a month, the employee will receive CZK 1,134 in addition to his net salary. In the case of a catering flat rate of CZK 75.6 and assuming 21 working days a month, the employee will receive CZK 1,587.6 in addition to his net salary. In the case of a catering flat rate of CZK 90 and assuming 21 working days a month, the employee will receive CZK 1,587.6 in addition to his net salary and the remaining CZK 302.4 will be part of his gross salary. It is expected that thanks to the introduction of a catering flat rate, more employees will be rewarded in this way, even those who have not yet received any similar benefit from employers. However, it is entirely up to the employer how and in what amount he will provide this benefit.

3.3. Introduction of a Flat Rate

Table 4 below shows the results of the hypothetical situations set out in Chapter 3 (percentage of revenue of 60%).

Table 4. Introduction of a flat rate

Text	2021	2021	2021	2021	2021
Income	200,000	400,000	600,000	800,000	1,000,000
Expenditure (60%)	120,000	240,000	360,000	480,000	600,000
Tax base	80,000	160,000	240,000	320,000	400,000
Tax	12,000	24,000	36,000	48,000	60,000
Tax after discount	0	0	8,160	20,160	32,160
Pension insurance	31,056	31,056	31,056	31,056	31,056
Health insurance	28,716	28,716	28,716	28,716	28,716

For taxpayers with income of CZK 200,000, the total annual levies amount to CZK 59,772, after conversion to months, the amount is CZK 4,981, which is CZK 488 less per month (CZK 5,856 per year) in comparison to flat rate and in this case a flat rate is disadvantageous to the taxpayer. For taxpayers with income of CZK 400,000, the total annual levies amount to CZK 59,772, after conversion to months, the amount is CZK 4,981, which is CZK 488 less per month (CZK 5,856 per year) in comparison to flat rate. For taxpayers with income of CZK 600,000, the total annual levies amount to CZK 67,932, after conversion to months, the amount is CZK 5,661, which is CZK 192 more per month (CZK 2,304 per year) in this case a flat rate is advantageous to the taxpayer. For taxpayers with income of CZK 800,000, the total annual levies amount to CZK 79,932, after conversion to months, the amount is CZK 6,661, which is CZK 1,192 more per month (CZK 14,304 per year) in this case a flat rate is advantageous to the taxpayer. For taxpayers with income of CZK 1,000,000, the total annual levies amount to CZK 91,932, after conversion to months, the amount is CZK 7,661, which is CZK 2,192 more

per month (CZK 26,304 per year) in this case a flat rate is advantageous to the taxpayer. The above mentioned can be illustrated in Figure 2.

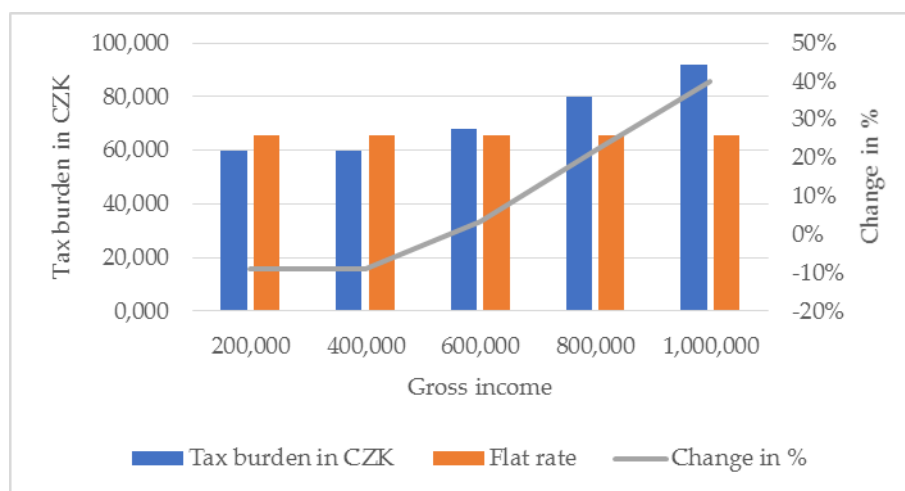


Figure 2. Introduction of a flat rate (60% of income costs)

Table 5 shows the situation where the taxpayer applies life insurance in the amount of CZK 12,000 and paid interest on a construction loan in the amount of CZK 10,000, and a similar result can be seen as in the previous case.

Table 5. Introduction of a flat rate (60% of income costs) – deducting non-taxable parts

Text	2021	2021	2021	2021	2021
Income	200,000	400,000	600,000	800,000	1,000,000
Expenditure (60%)	120,000	240,000	360,000	480,000	600,000
Tax base after deducting non-taxable parts	58,000	138,000	218,000	298,000	378,000
Tax	8,700	20 700	32,700	44,700	56,700
Tax after discount	0	0	4,905	16,860	28,860
Pension insurance	31,056	31,056	31,056	31,056	31,056
Health insurance	28,716	28,716	28,716	28,716	28,716

Table 6 shows the situation where the taxpayer pays a tax benefit for the first child in the amount of CZK 15,204.

Table 6. Introduction of a flat rate (60% of income costs) – tax benefit for the first child

Text	2021	2021	2021	2021	2021
Income	200,000	400,000	600,000	800,000	1,000,000
Expenditure (60%)	120,000	240,000	360,000	480,000	600,000
Tax base	80,000	160,000	240,000	320,000	400,000
Tax	12,000	24,000	36,000	48,000	60,000
Tax after discount	0	0	8,160	20,160	32,160
Tax or tax bonus	-15,204	-15,204	-7,044	4,956	16,956
Pension insurance	31,056	31,056	31,056	31,056	31,056
Health insurance	28,716	28,716	28,716	28,716	28,716

If the taxpayer claims a tax benefit for children, he needs to consider whether a lump sum is beneficial to him, as he will not be able to claim the tax bonus that can come to the

amount mentioned in Table 4. Even if he opted for the lump sum, it is suitable for the other parent to claim a tax benefit for children.

Table 7 below shows the results of the hypothetical situations set out in Chapter 3 (percentage of revenue of 40%).

Table 7. Introduction of a flat rate (percentage of revenue of 40%)

Text	2021	2021	2021	2021	2021
Income	200,000	400,000	600,000	800,000	1,000,000
Expenditure (40%)	80,000	160,000	240,000	320,000	400,000
Tax base	120,000	240,000	360,000	480,000	600,000
Tax	18,000	36 000	54,000	72,000	90,000
Tax after discount	0	8 160	26,160	44,160	62,160
Pension insurance	31,056	31,056	31,056	31,056	31,056
Health insurance	28,716	28,716	28,716	28,716	28,716

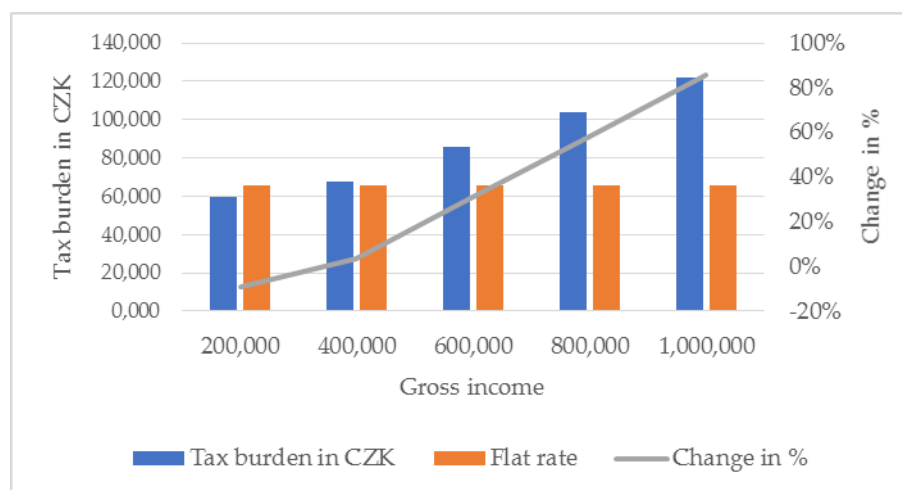


Figure 3. Introduction of a flat rate (60% of income costs)

For taxpayers with income of CZK 200,000, the total annual levies amount to CZK 59,772, after conversion to months, the amount is CZK 4,981, which is CZK 488 less per month (CZK 5,856 per year) in comparison to flat rate and in this case a flat rate is disadvantageous to the taxpayer. For taxpayers with income of CZK 400,000, the total annual levies amount to CZK 67,932, after conversion to months, the amount is CZK 5,661, which is CZK 192 more per month (CZK 2,304 per year) in this case a flat rate is advantageous to the taxpayer. For taxpayers with income of CZK 600,000, the total annual levies amount to CZK 85,932, after conversion to months, the amount is CZK 7,161 which is CZK 1,692 more per month (CZK 20,304 per year) in this case a flat rate is advantageous to the taxpayer. For taxpayers with income of CZK 800,000, the total annual levies amount to CZK 103,932, after conversion to months, the amount is CZK 8,661, which is CZK 3,192 more per month (CZK 38,304 per year) in this case a flat rate is advantageous to the taxpayer. For taxpayers with income of CZK 1,000,000, the total annual levies amount to CZK 121,932, after conversion to months, the amount is CZK 10,161, which is CZK 4,692 more per month (CZK 56,304 per year) in this case a flat rate is advantageous to the taxpayer. The above mentioned can be illustrated in Figure 3.

4. Conclusions

In the article, we tried to show, using model examples, how the adopted tax changes affect the taxpayer's net income. In case of the abolition of the super-gross wage, it was proved that it has a positive impact on the taxpayer's net income. His tax savings range in various cases from CZK 990 to CZK 2,050, depending on the amount of gross salary. In some cases, employees would not have to pay tax at all, if they applied the tax benefit to children, which was not analyzed in the article. When it comes to applying a catering flat rate, the most advantageous flat rate for employees is in the amount of CZK 75.6, it is exempt from taxes, and, in case of 21 working days a month it means an increase in net salary by CZK 1,587.6. If the employee requires a higher value of the catering flat rate, the above difference is part of the gross salary. Finally, we conclude that the introduction of a flat tax will not pay off for all self-employed people. The flat rate is beneficial only to self-employed persons who have an income of more than CZK 600,000, in the case of a 60% of income costs and more than CZK 400,000 in the case of a 40% of income costs. In the case of 80% of income costs, it will not pay off. However, this statement is rather illustrative, it always depends on the income of the self-employed, the amount of insurance premiums, the amount of non-taxable parts of the tax base or the amount of the tax burden on children.

Acknowledgments: This research is supported by Project SP2021/51 at VSB-Technical University Ostrava.

References

- Alfonso, A., & Alegre, J. G. (2008). Economic Growth and Budgetary Components: A Panel Assessment for the EU. *Empirical Economics*, 41(3), 703–723. <https://doi.org/10.1007/s00181-010-0400-9>
- Finanční správa. (2020, December 8). *Paušální daň přehledně – jak a kdy platit měsíční zálohy*. <https://www.financnisprava.cz/cs/financni-sprava/media-a-verejnost/tiskove-zpravy/tz-2020/pausalni-dan-prehledne-jak-a-kdy-platit-mesicni-zalohy-11052>
- Finance. (2016, August 19). *Hledáme práci: Jaký plat zaměstnanec odpovídá zisku OSVČ?* <https://www.finance.cz/zpravy/finance/355004-hledame-praci-jaky-plat-zamestnanec-odpovida-zisku-osvc/>
- Fuest, C., Peichl, A., & Sieglöcher, S. (2018). Do Higher Corporate Taxes Reduce Wages? Micro Evidence from Germany. *American Economic Review*, 108(2), 393–418. <https://doi.org/10.1257/aer.20130570>
- Hendl, J. (2005). *Kvalitativní výzkum: Základní metody a aplikace*. Praha: Portál, s.r.o.
- KPMG. (2020a, September 8). *Kdo vydělá na zrušení superhrubé mzdy?* <https://danovky.cz/cs/kdo-vydela-na-zruseni-superhrube-mzdy>
- KPMG. (2020b, December 1). *Daňový balíček 2021*. <https://danovky.cz/cs/danovy-balicek-2021>
- King, R. G., & Rebelo, S. (1990). Public Policy and Economic Growth: Developing Neoclassical Implications. *Journal of Political Economy*, 98, 126–151. <https://doi.org/10.3386/w3338>
- Krajňák, M. (2020a). Is Personal Income Tax on Dependent Activity in the Czech Republic Progressive? *Politická ekonomie*, 68(5), 534–553. <https://doi.org/10.18267/j.polek.1295>
- Krajňák, M. (2020b). Analytic Hierarchy Process in Czech Taxpayers' Decision-Making Regarding their Tax Liability. *Journal of Tax Reform*, 2(6), 142–156. <https://doi.org/10.15826/jtr.2020.6.2.079>
- Ministerstvo financí. (2020a, August 19). *Rozhovor Aleny Schillerové o zrušení superhrubé mzdy*. <https://www.mfcr.cz/cs/aktualne/v-mediich/2020/rozhovor-aleny-schillerove-o-zruseni-sup-39219>
- Ministerstvo financí. (2020b, December 9). *Na stravenkový paušál bude možné přispívat z FKSP*. <https://www.mfcr.cz/cs/aktualne/tiskove-zpravy/2020/na-stravenkovy-pausal-bude-mozne-prispivat-40158>
- MPSV. (2020a, December 14). *Minimální mzda*. <https://www.mpsv.cz/minimalni-mzda>
- MPSV. (2020b, December 18). *Tisková zpráva*. https://www.mpsv.cz/documents/20142/1248138/18_12_2020_TZ_Co_se_zmeni_od_1_1_2021.pdf/

- Portal.Pohoda. (2020a, November 10). *Připravovaná novinka na rok 2021: stravenkový paušál*.
<https://portal.pohoda.cz/dane-ucetnictvi-mzdy/mzdy-a-prace/pripravovana-novinka-na-rok-2021-stravenkovy-paus/>
- Portal.Pohoda. (2020b, October 19). *Paušální daň od roku 2021*. <https://portal.pohoda.cz/pro-podnikatele/uz-podnikam/pausalni-dan-od-roku-2021/>
- Sokolovska, O. V. (2018). Current Trends in Labor Taxation in an Open Economy. *Vestník Sankt-Peterburgského Universiteta-Ekonomika-ST Petersburg University Journal of Economic Studies*, 34(1), 77–94.
<https://doi.org/10.21638/11701/spbu05.2018.104>
- Slezák, J., Bielíková, A., & Hakalová, J. (2020). Tax Burdens in the Czech Republic and Other European Union Countries in 2008–2018. In M. Staničková, L. Melecký, P. Doležalová, & T. Powadová (Eds), *Proceedings of the 5th International Conference on European Integration 2020* (pp. 791–798). Ostrava: VŠB-TU Ostrava, Faculty of Economics. <https://www.ekf.vsb.cz/export/sites/ekf/icei/.content/galerie-souboru/ICEI-2020-Proceedings.pdf>
- Tikhonova, A., Goncharenko, L., Melnikova, N., & Malkova, Y. (2018). An Assessment of the Influence of the Current National Economy Development State upon Personal Income Taxation System. In Soliman K. S. (Ed), *Proceedings of the 32nd Conference of the International-Business-Information-Management-Association (IBIMA)* (pp. 7982–7986). Sevilla, Spain.

Spatial Modeling of Labor Markets in the Areas of Cracow-Balice and Wroclaw-Strachowice Airports

Agata SURÓWKA

Rzeszow University of Technology, Rzeszow, Poland; kmi@prz.edu.pl

Abstract: When describing data on statistical units the key issue is their mutual relations. They can be described in various ways, for example by means of spatial autocorrelation. The study of spatial connections allows to determine what influences their differentiation in the examined aspect. The article analyzes selected characteristics of the labor market in terms of spatial relationships in districts located in the areas of influence of two airports in Poland (Cracow-Balice and Wroclaw-Strachowice). The Moran's I autocorrelation coefficient was selected as the research tool, thanks to which it was possible to identify a given characteristic within the studied area and in relation to a specific location with the neighboring locations. The main issue can be presented in the form of questions: Are the neighboring districts located in the areas of impact of airports characterized by a similar situation? Is it possible to distinguish clusters of districts characterized by a similar specificity? The research hypothesis had both theoretical and practical dimensions. It was formulated as follows: the areas of influence of airports in Poland are characterized by a diversified spatial autocorrelation due to the specificity of the labor market. It was verified during the research procedure.

Keywords: labor market; spatial autocorrelation; quantitative methods; air transport

JEL Classification: R11; O11

1. Introduction

Air transport is a factor accelerating the processes of globalization of the world economy and its markets. It is also an important stimulus to level the chances of social and economic development of countries, regions and continents. It is also important for the growth of regional competitiveness or innovation. In the literature there are more and more positions that research on the impact of transport infrastructure on the economic development of the region is one of the most important ones carried out in the European Union. Apart from the above, there are obvious and strong interdependencies between economic and social development and the development of air transport. The economy and society generate demand for air cargo transportation and the increase in the mobility and mobility of the population supports the growth of the passenger transport market. Some authors showed that recently research into the impact of air transport on regional labor markets has been of great importance. The issue of the situation in the labor markets is important and has become a source of interest for many authors like Bal-Domańska and Sobczak (2018), Malinowski and Jablonska-Porzuczek (2020), Nikulin and Sobiechowska-Ziegert (2018), Szulc and Jankiewicz (2017), Cracolici et al. (2009). The studies (Sardadvar & Rocha-Akis, 2016; Shaikin, 2012; Siserova & Zudelova, 2015) showed that various analytical and research tools are used during

their conduct. Longhi (2007) as well as Cracolici et al. (2009) explained that for example to identify interdependencies spatial methods play an increasingly important role in contemporary research. Their application works well in issues that are located in a specific space (Shaikin, 2012; Szulc & Jankiewicz, 2017). Certainly, they include, among others research on the impact of air transport on regional labor markets. That research can be found in (Surówka, 2019). Verification of this type of phenomena using the tools of econometrics and spatial statistics is helpful in determining the significance of the spatial factor in explaining their variability and thus improves the quality of their description. The aim of the article is to try to identify, by means of the spatial autocorrelation analysis, spatial relationships occurring in districts located in the areas of impact of two selected airports in terms of selected variables characterizing the labor market.

2. Methods of Measuring Spatial Autocorrelation

According to scientific sources spatial autocorrelation is a relationship at different spatial points between different values of the same variable. As some authors rightly point out spatial autocorrelation is directed to many sides and described as the influence of a phenomenon or event on a point or points in space on the course of this event at a completely different point or points. According to the theories preached by geographers, such a dependence of the occurrence of the phenomenon decreases with the decreasing distance separating two points. Consequently, it leads to a correlation between two points in different locations in the value of the phenomena observed in them. Another definition indicates the occurrence of such a relationship when by observing a phenomenon at one point, one can notice an increased or decreased probability of such a phenomenon occurring at other neighboring points. As a relationship it defines the degree of intensity of the relationship between the values of two adjacent features. When the values of the neighboring areas are similar there is a positive autocorrelation. On the other hand, when the values are more diversified than the random distribution would indicate, then the phenomenon of negative autocorrelation is observed. However, the phenomenon of spatial autocorrelation is always associated with the occurrence of spatial dependence which may result from two reasons. The first indicates a close relationship between the analyzed units with others through their commune, voivodeship, village, regional or district affiliation. It can also be a territorial affiliation to the same geographical realm. The existence of a border on the map does not limit people and does not reduce their activity in most phenomena. The second reason points to the economic and social aspect and the dispersion of people's seats in the territorial unit, which largely depend on the location and distance from various objects with which they are associated. The most commonly used coefficients for estimating autocorrelation in space are the Geary and Moran's I autocorrelation coefficients. The existence of a global spatial autocorrelation is checked using the Moran's I statistics. The formula for calculating the Moran's I coefficient can be found in the literature (Kołodziejczyk & Kossowski, 2016). Looks like this:

$$I = \frac{n}{S_0} \times \frac{\sum_{i=1}^n \sum_{j=1}^n a_{ij} (y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^n (y_i - \bar{y})^2} \quad (1)$$

where:

n – number of units in space,

a_{ij} – individual elements of the neighborhood matrix A ,

S_0 – sum of all elements of matrix A ,

y_i – value of the phenomenon for the i -th unit,

\bar{y} – generalized arithmetic mean from all areas.

The neighborhood matrix is a key element in creating a spatial analysis of an emerging phenomenon. Another type is the spatial weight matrix. In addition to the matrix form it can take the form of a graph. It reflects the spatial relations that occur between the individual elements of a certain area, as well as the strength and closeness of their dependencies. The arrangement of numbers takes the shape of a square. In matrix notation the relations between the elements $i = 1, 2, 3, \dots, n$ and $j = 1, 2, 3, \dots, n$ are described in a binary system. This is the matrix of weights a_{ij} , $i = 1, \dots, n$, $j = 1, \dots, n$, in which

$$a_{ij} = \begin{cases} 1, & \text{gdy "i" i "j" they are neighbors} \\ 0, & \text{gdy "i" i "j" they are not neighbors} \end{cases} \quad (2)$$

The elements of the neighborhood matrix can take the form of two digits. Either one, when the two examined areas are adjacent to each other, or if there are no adjacent boundaries the field is completed with zero. Whether two areas are adjacent can be determined in various ways. The most common way of defining this issue is when two areas have a common border with each other. Another way to establish neighborhood is to determine the distance between the focal points of both areas. If the measured distance is less than the distance z , then the areas are assumed to be adjacent. The adjacency determined in this way forms the matrices of A .

Interpretation of this measure allows to determine the degree of spatial autocorrelation. Its occurrence depends on the position in relation to the value of the expression $-1 / (n-1)$. If it is greater than this expression, then it is said to observe a positive autocorrelation, and if it is less than it is said to be negative. When this value is close to $-1 / (n-1)$, the research assumes that the distribution of y values is random. In case the number n has a high value then the value of i can be zero, which means there is no spatial autocorrelation. In other words, if the statistic result $i > 0$ then there is a positive autocorrelation, and the values of the observed elements are similar. However, if the result $i < 0$, there is a negative autocorrelation, and the values of the examined units are different. If the result is zero, the checkerboard effect occurs. The significance of the spatial autocorrelation coefficient is very often tested. The hypothesis about the lack of spatial autocorrelation is verified and it is the null hypothesis H_0 and its existence, which is mentioned in the alternative hypothesis H_1 . For this purpose the $T(I)$ test is used:

$$T(I) = \frac{I - U(I)}{\sqrt{Var(I)}} \quad (3)$$

A detailed description of which can be found in the literature, for example Kołodziejczyk and Kossowski (2016). Assuming that the null hypothesis is true $I = U(I)$, the statistic of the $T(I)$ test has a distribution close to the standardized normal, but this convergence is slow. For this reason, this test is rarely used and another permutation with ordered statistics is used. Testing with it is performed by a k-fold process of permutating y_i values between regions. For each process the autocorrelation coefficient is calculated, and the empirical distribution of the $T(I)$ statistic is created from them.

Calculation of the coefficient of spatial autocorrelation Moran's I is used in detecting the spatial dependence along with its strength and character in the examined area. This method of finding dependencies is comprehensive and global. Determines the averaged pattern of dependence across the area. Importantly it is not sensitive to the existing deviations from the averaged autocorrelation model and does not inform in any way about its instability. This results in the lack of information about extremely strong positive or negative dependence and outliers. In order to thoroughly examine the analyzed space local statistics are carried out which involves calculating the value for each individual unit. This allows you to accurately examine whether a specific region consists of a low or high value of the analyzed variable. One of the methods of such research is the local Moran's I statistic, which is effectively used in the identification of agglomeration effects and divides them into sets of low and high values. It allows you to extract the so-called hot spots, i.e. areas where the phenomenon is characterized by a high value of a feature that are adjacent to areas with equally high indices of this feature or conversely with adjacent areas with particularly low values. The last stage of this research method is the preparation of a map of all objects together with the illustration of the occurring similarity (Kołodziejczyk & Kossowski, 2016).

3. Analysis of the Diversification of Regional Labor Markets in the Pressure Area of Cracow-Balice and Wrocław-Strachowice Airports – Results of Own Research

In the literature areas of impact of airports are also called isochrones or areas of influence. They are differently defined. In practical research, the most common definition is the fields surrounding airports to which passengers are attracted. Otherwise it is an area within a radius of 100 km or 1-2 hours by car from the airport (Kujawiak, 2016) explained the issue. This criterion (100 km) was taken into account by the author in her own research. At this point, a question should be asked how to identify the statistical units located in the studied areas. A helpful tool for their verification is the Geostatistics Portal that can be found in (Surówka, 2019). It was used in the conducted research. The study the text does not include its detailed procedure description. It can be found in literature (Surówka, 2019). Thanks to this approach it was possible to determine the districts located in the areas of the pressure of the ports under study (see table 1) and to obtain statistical information for 27 analyzed indicators which may characterize the situation on local labor markets.

Table 1. Districts and cities with district rights belonging to the 100 km isochrone for Wrocław-Strachowice and Cracow-Balice Airports

Wrocław-Strachowice Airport	Areas: bolesławiecki, dzierżoniowski, głogowski, górowski, jaworski, jeleniogórski, kamiennogórski, kłodzki, Legnicki, lubiński, lwówecki, milicki, oleśnicki, oławski, polkowicki, strzeleński, średzki, świdnicki, trzebnicki, wałbrzyski, wołowski, wrocławski, ząbkowicki, zlotoryjski, Jelenia Góra, Legnica, Wrocław, żagański, wschowski, sieradzki, wieluński, wieruszowski, brzeski, kluczborski, krapkowicki, namysłowski, nyski, oleski, opolski, prudnicki, strzelecki, Opole, gostyński, jarociński, kaliski, kępiński, kościański, krotoszyński, leszczyński, ostrowski, ostrzeszowski, pleszewski, rawicki, śremski, Kalisz, Leszno
Cracow-Balice Airport	Areas: radomszczański, bocheński, brzeski, chrzanowski, dąbrowski, gorlicki, krakowski, limanowski, miechowski, myślenicki, nowosądecki, nowotarski, olkuski, oświęcimski, proszowicki, suski, tarnowski, tatrzański, wadowicki, wielicki, Cracow, Nowy Sącz, Tarnów, dębicki, jasielski, mielecki, będziński, bielski, cieszyński, częstochowski, gliwicki, lubliniecki, mikołowski, myszkowski, pszczyński, rybnicki, tarnogórski, bieruńsko-lędziński, wodzisławski, zawierciański, żywiecki, Bielsko-Biała, Bytom, Chorzów, Częstochowa, Dąbrowa Górnicza, Gliwice, Jastrzębie-Zdrój, Jaworzno, Katowice, Mysłowice, Piekary Śląskie, Ruda Śląska, Rybnik, Siemianowice Śląskie, Sosnowiec, Świętochłowice, Tychy, Zabrze, Żory, buski, jędrzejowski, kazimierski, kielecki, pińczowski, staszowski, włoszczowski, Kielce

The following variables were selected for the analysis, with the help of which the situation in the local labor markets can be characterized (Surówka, 2019, 2020):

- X₁- number of registered unemployed remaining without work for more than 1 year
- X₂- percentage of registered unemployed aged 25-34
- X₃- percentage of registered unemployed over the age of 45
- X₄- percentage of the unemployed with higher education
- X₅- percentage of the unemployed with post-secondary or secondary vocational education
- X₆- percentage of the unemployed with basic vocational education
- X₇- job offers for disabled persons per 1,000 unemployed
- X₈- registered unemployment rate
- X₉- share of registered unemployed in the working age population
- X₁₀- share of the unemployed with higher education in relation to the number of people of working age
- X₁₁- share of registered unemployed graduates among the total unemployed
- X₁₂- employed per 1,000 population
- X₁₃- number of employed in hazardous conditions per 1,000 persons employed in the surveyed population
- X₁₄- injured in accidents at work per 1,000 employed persons in total
- X₁₅- average monthly gross salary
- X₁₆- average monthly gross salary in relation to the national average (Poland = 100)
- X₁₇- entities entered in the REGON register for 10 thousand population.
- X₁₈- newly registered units in the REGON register for 10 thousand population
- X₁₉- natural persons conducting economic activity per 1,000 population
- X₂₀- foundations, associations and social organizations per 1,000 inhabitants

X₂₁- newly registered foundations, associations and social organizations with 10,000 inhabitants

X₂₂- entities per 1,000 inhabitants of working age

X₂₃- foreign capital per capita in working age

X₂₄- non-working population per 100 working-age people

X₂₅- post-working age population per 100 people in pre-working age

X₂₆- post-working age population per 100 people of working age

X₂₇- net migration per 1,000 people

Their selection was dictated by the research experience to date and the possibility of obtaining statistical data that is explained by Surówka (2019) and Pancer-Cybuska et al. (2014). In order to detect the nature and strength of the observed spatial relationships in a given area the spatial autocorrelation coefficient Moran's *I* is used in scientific research. It has a global reach which makes it possible to determine the impact on space. By determining its value, it is possible to determine such a relationship in the following way: when the determined value is smaller than the expression $-1 / (n-1)$ we deal with a negative spatial autocorrelation, otherwise (the value of the coefficient is greater than this expression) with autocorrelation positive. However, it should be borne in mind that when close values appear, the distribution of *x* values is random in space. Besides, for large values of *n* (i.e. the number of spatial units) this often means no spatial correlation. This is due to the fact that the value of the expression does not differ significantly from zero. In order to determine the significance of the obtained results the autocorrelation coefficient significance test is most often used. In the course of the research procedure, using analytical and statistical programs, the values of the global measure Moran's *I* were determined and then the autocorrelation. A matrix of common boundary was used in the study. The results obtained are synthetically summarized in tables 1-2. Then the values of the expression $1 / (n-1)$ were determined, which were respectively -0.018 (for Wrocław-Strachowice Airport) and -0.015 (for the Cracow-Balice Airport) which in the next stage were compared with the determined values of the Moran's *I* coefficients. Thanks to this, it was possible to determine the autocorrelation according to the criterion:

For the Cracow Airport

- $I > -0,015$ positive autocorrelation, which in the table is marked with the symbol +
- $I < -0,015$ negative autocorrelation, which in the table is marked with the symbol -

For the Wrocław Airport

- $I > -0,018$ positive autocorrelation, which in the table is marked with the symbol +
- $I < -0,018$ negative autocorrelation, which in the table is marked with the symbol -

The results obtained are synthetically summarized in tables 2-3.

Table 2. Spatial analysis of regional labor markets in the area of impact of Cracow-Balice Airport isochrone based on the global Moran's I statistics (2011-2015).

	Variable X ₁				Variable X ₂				Variable X ₃			
	I	Z	p-value	AK	I	Z	p-value	AK	I	Z	p-value	AK
2015	0.178	2.59	0.0097	+	0.453	6.29	<0.000001	+	0.614	8.41	<0.000001	+
2014	0.319	4.47	0.0000	+	0.400	5.55	<0.000001	+	0.610	8.36	<0.000001	+
2013	0.369	5.15	<0.000001	+	0.318	4.46	0.0000	+	0.567	7.81	<0.000001	+
2012	0.394	5.48	<0.000001	+	0.266	3.79	0.0002	+	0.567	7.91	<0.000001	+
2011	0.426	5.89	<0.000001	+	0.184	2.66	0.0078	+	0.612	8.38	<0.000001	+
	Variable X ₄				Variable X ₅				Variable X ₆			
2015	0.178	2.64	0.0084	+	0.515	7.12	<0.000001	+	0.278	3.93	0.0000	+
2014	0.165	2.46	0.0139	+	0.518	7.19	<0.000001	+	0.300	4.24	0.0000	+
2013	0.157	2.34	0.0192	+	0.525	7.32	<0.000001	+	0.269	3.81	0.0001	+
2012	0.148	2.22	0.0264	+	0.515	7.12	<0.000001	+	0.305	4.29	0.0000	+
2011	0.170	2.53	0.0114	+	0.500	6.96	<0.000001	+	0.276	3.90	0.0000	+
	Variable X ₇				Variable X ₈				Variable X ₉			
2015	-0.005	0.136	0.8917	+	0.339	4.76	0.0000	+	0.507	7.01	<0.000001	+
2014	0.052	1.05	0.2947	+	0.358	5.01	0.0000	+	0.526	7.24	<0.000001	+
2013	0.113	1.81	0.070	+	0.347	4.86	0.0000	+	0.527	7.27	<0.000001	+
2012	0.026	0.79	0.4322	+	0.339	4.73	0.0000	+	0.501	6.94	<0.000001	+
2011	-0.005	0.136	0.8917	+	0.362	5.06	<0.000001	+	0.507	7.01	<0.000001	+
	Variable X ₁₀				Variable X ₁₁				Variable X ₁₂			
2015	0.478	6.67	<0.000001	+	0.505	6.94	<0.000001	+	0.312	4.44	0.0000	+
2014	0.478	6.67	<0.000001	+	0.578	7.91	<0.000001	+	0.330	4.68	0.0000	+
2013	0.481	6.70	<0.000001	+	0.574	7.86	<0.000001	+	0.348	4.923	0.0000	+
2012	0.459	6.38	<0.000001	+	0.532	7.32	<0.000001	+	0.359	5.06	<0.000001	+
2011	0.535	7.37	<0.000001	+	-	-	-	+	0.366	5.15	<0.000001	+
	Variable X ₁₃				Variable X ₁₄				Variable X ₁₅			
2015	0.476	6.71	<0.000001	+	-	-	-	-	0.117	1.86	0.0628	+
2014	0.477	6.72	<0.000001	+	0.570	7.85	<0.000001	+	0.103	1.74	0.0822	+
2013	0.491	6.89	<0.000001	+	0.560	7.70	<0.000001	+	0.104	1.76	0.0788	+
2012	0.508	7.09	<0.000001	+	0.560	7.73	<0.000001	+	0.100	1.69	0.0908	+
2011	0.480	6.72	<0.000001	+	0.616	8.46	<0.000001	+	0.064	1.20	0.2307	+
	Variable X ₁₆				Variable X ₁₇				Variable X ₁₈			
2015	0.117	1.86	0.0624	+	0.288	4.11	0.0000	+	0.255	3.71	0.0002	+
2014	0.103	1.74	0.0814	+	0.297	4.23	0.0000	+	0.327	4.64	0.0000	+
2013	0.104	1.76	0.0779	+	0.300	4.27	0.0000	+	0.291	4.18	0.0000	+
2012	0.100	1.69	0.0912	+	0.307	4.35	0.0000	+	0.278	3.99	0.0000	+
2011	0.064	1.20	0.2297	+	0.313	4.43	0.0000	+	0.300	4.28	0.0000	+
	Variable X ₁₉				Variable X ₂₀				Variable X ₂₁			
Lata	I	Z	p-value	AK								
2015	0.350	4.93	0.0000	+	0.150	2.23	0.0256	+	-0.006	0.122	0.9030	+
2014	0.355	4.98	0.0000	+	0.152	2.26	0.0241	+	0.030	0.600	0.5487	+
2013	0.353	4.95	0.0000	+	0.170	2.50	0.0124	+	0.063	1.058	0.2902	+
2012	0.358	5.02	0.0000	+	0.170	2.49	0.0127	+	-0.188	-0.053	0.9577	+
2011	0.360	5.05	<0.000001	+	0.176	2.57	0.0101	+	0.009	0.324	0.7458	+
	Variable X ₂₂				Variable X ₂₃				Variable X ₂₄			
2015	0.271	3.884	0.0001	+	-	-	-	-	0.151	2.229	0.0258	+
2014	0.277	3.96	0.0000	+	0.011	0.42	0.6756	+	0.228	3.25	0.0011	+
2013	0.276	3.95	0.0000	+	0.006	0.34	0.7334	+	0.344	4.81	0.0000	+
2012	0.280	3.99	0.0000	+	-0.019	-0.06	0.9498	-	0.476	6.59	<0.000001	+
2011	0.283	4.03	0.0000	+	0.015	0.503	0.6147	+	0.555	7.67	<0.000001	+

	Variable X ₂₅				Variable X ₂₆				Variable X ₂₇			
2015	0.499	6.87	<0.000001	+	0.418	5.78	<0.000001	+	-	-	-	-
2014	0.501	6.89	<0.000001	+	0.411	5.69	<0.000001	+	0.176	2.65	0.0080	+
2013	0.504	6.94	<0.000001	+	0.401	5.55	<0.000001	+	0.164	2.46	0.0137	+
2012	0.511	7.03	<0.000001	+	0.406	5.62	<0.000001	+	0.165	2.46	0.0137	+
2011	0.518	7.12	<0.000001	+	0.410	5.69	<0.000001	+	0.163	2.46	0.0141	+

In the course of in-depth analyzes it was possible to draw detailed and multi-threaded conclusions. Some of them were as follows. Analyzing the information in tables 2-3 we notice that almost all the characteristics have a positive spatial autocorrelation, and their values vary considerably. Moreover, for most of the characteristics a high stability of the spatial autocorrelation of regional labor markets can be observed within individual measures (2011-2015). Therefore, it may be considered justified to suppose that the tendency to focus the examined objects due to the features selected for examination characterizes the examined objects. In the study the significance of the obtained values was assessed using the autocorrelation coefficient significance test (Tables 2-3). As a result of the analysis, we can observe that in the entire period under consideration almost all characteristics of the Cracow Airport are statistically significant. The exceptions are X_7 , X_{15} , X_{21} and X_{16} . Therefore, the phenomenon of autocorrelation of the examined features can be considered statistically significant. These results are much more unfavorable in the area of influence of the Wrocław-Strachowice Airport. For a smaller number of variables, the determined Moran's I autocorrelation statistics can be considered important from the point of view of the research. These include X_1 , X_2 (2012), X_4 , X_7 , X_{12} , X_{14} , X_8 (2013), X_{19} (2012) and X_{21} (2011). Analyzing the feature of the number of registered unemployed persons who have been unemployed for more than 1 year we observe a tendency to concentrate within a given location areas with similar values of the analyzed variable in districts located in the pressure area of the Cracow-Balice Airport. However, as mentioned above, its absence is observed in the area of the isochrone at Wrocław-Strachowice Airport. This is confirmed, for example, in the negative autocorrelation in the period 2014-2015. Detailed analysis of the data of this feature for the Cracow-Balice Airport allows to distinguish groups of neighboring districts. The first group includes objects located in the south-eastern part of the study area. Its lowest level in the entire period under consideration is typical for the following districts: Staszowski, Jaworzno, Zory and Ruda Śląska. It should be noted that these are units that also belong to the area of influence of Katowice-Pyrzowice Airport. A group of the Wielicki, Mysłenicki and Suski districts also formed a separate group. They are located in the małopolskie voivodship. In the study some authors have shown that it is characterized by a large spatial differentiation in the level of long-term unemployment, understood as continuous unemployment for over a year. The increase in the significance of p-value level of the X_2 variable after 2012 may indicate the ongoing process of improving the situation on local labor markets due to the examined feature. Its lowest value in the entire research period is observed in Bielsko-Biala. Like the previous one another feature (percentage of registered unemployed aged over 45) is characterized by a positive spatial autocorrelation. The statistics of Moran's I fluctuate here in the ranges 0.497-0.529 (isochrone of Wrocław-Strachowice Airport) and 0.567-0.614

(isochrone of Cracow-Balice Airport). The hypothesis of its irrelevance is rejected with a p-value of 0.05. Based on the results it can be assumed that this phenomenon is empirically confirmed. It is also possible to identify global clusters of high and low values of this measure, which have a constant character. The first are the following objects: staszowski, buski, dabrowski, kazimierski and proszowicki. They are characterized by its lowest level. They are also characterized by the lowest percentage of employees in recent years. The labor market in the study was also defined by means of measures characterizing the unemployed according to the level of education (variables X_4 - X_6). When analyzing the results for the area of impact of the Cracow-Balice Airport we note that the lowest percentage of people with higher education is observed in Bytom. This object forms a separate group. A separate cluster was also created by the following districts: dąbrowski, kazimierski, proszowicki. The lowest increase in the unemployment rate for these facilities should be considered a positive symptom. Another group consists of the following districts: wadowicki, żywiecki, suski, nowotarski and tatrzański. They are characterized by the lowest level of long-term unemployment. When analyzing the statistical data for the variable percentage of the unemployed with post-secondary or secondary vocational education in the area where the Cracow-Balice Airport is located we can distinguish two groups. On the one hand there is one homogeneously compact area with low values located in the districts located in the south-western part of the studied area, and on the other hand, a similar cluster was observed for the rest of the districts. The first, less numerous, includes the following districts: tatarzański, suski, żywiecki, Bielski, Biesko-Biała, pszczyński, Jastrzębie-Zdrój, Żory, mikołowski, Katowice, Ruda Śląska and Gliwice. The second rest of the studied objects (except the dąbrowski district). The obtained results show the stability of the spatial autocorrelation of the level of the examined features in the period adopted for the study. In the course of the conducted research there was no statistically significant tendency to cluster districts for the variable characterizing job offers for disabled persons per 1,000 unemployed between adjacent districts. In the case of this variable one can distinguish small spatial clusters (clusters) of units with similar values on the impact ranges of both examined ports. Their occurrence is caused by the similar values of this indicator in the case of most objects.

Table 3. Spatial analysis of regional labor markets in the area of impact of Wrocław-Strachowice Airport isochrone based on the global Moran's I statistics (2011-2015).

	Variable X_1				Variable X_2				Variable X_3			
	I	Z	p-value	AK	I	Z	p-value	AK	I	Z	p-value	AK
2015	-0.102	-1.03	0.300	-	0.397	5.12	<0.000001	+	0.529	6.72	<0.000001	+
2014	-0.057	-0.48	0.634	-	0.409	5.25	<0.000001	+	0.528	6.70	<0.000001	+
2013	-0.002	0.201	0.841	+	0.175	2.39	0.0168	+	0.501	6.37	<0.000001	+
2012	0.076	1.149	0.250	+	0.087	1.30	0.1953	+	0.497	6.34	<0.000001	+
2011	-0.001	0.209	0.834	+	0.121	1.70	0.0886	+	0.533	6.75	<0.000001	+
	Variable X_4				Variable X_5				Variable X_6			
	I	Z	p-value	AK	I	Z	p-value	AK	I	Z	p-value	AK
2015	0.071	1.15	0.2498	+	0.280	3.73	0.0002	+	0.119	1.72	0.0855	+
2014	0.080	1.27	0.266	+	0.239	3.18	0.0015	+	0.138	1.94	0.0517	+
2013	0.068	1.11	0.268	+	0.241	3.23	0.0012	+	0.151	2.09	0.0367	+
2012	0.093	1.43	0.153	+	0.215	2.90	0.0037	+	0.167	2.28	0.0225	+
2011	0.068	1.11	0.268	+	0.183	2.51	0.0119	+	0.148	2.06	0.0396	+

	Variable X ₇				Variable X ₈				Variable X ₉			
2015	-0.004	0.18	0.8536	+	0.267	3.50	0.0005	+	0.175	2.38	0.0174	+
2014	0.017	0.46	0.6400	+	0.262	3.43	0.0006	+	0.183	2.46	0.0138	+
2013	0.042	0.78	0.4340	+	0.287	3.72	0.0002	+	0.201	2.68	0.0074	+
2012	-0.004	0.20	0.8414	+	0.302	3.90	0.0000	+	0.256	3.36	0.0008	+
2011	-0.004	0.18	0.8536	+	0.268	3.49	0.0005	+	0.213	2.82	0.0048	+
	Variable X ₁₀				Variable X ₁₁				Variable X ₁₂			
2015	0.193	2.63	0.0085	+	0.6203	7.76	<0.000001	+	0.0090	0.34	0.7334	+
2014	0.0917	1.35	0.1763	+	0.5663	7.11	<0.000001	+	0.0092	0.34	0.7331	+
2013	0.086	1.29	0.1971	+	0.5559	7.02	<0.000001	+	0.0107	0.36	0.7175	+
2012	0.1566	2.18	0.0295	+	0.563	7.07	<0.000001	+	-0.004	0.18	0.8564	+
2011	0.1206	1.70	0.0883	+	-	-	-	-	-0.004	0.18	0.8564	+
	Variable X ₁₃				Variable X ₁₄				Variable X ₁₅			
2015	0.196	2.81	0.0050	+	-	-	-	-	0.152	2.62	0.0089	+
2014	0.207	2.93	0.0033	+	0.014	0.42	0.6746	+	0.164	2.85	0.0044	+
2013	0.189	2.65	0.0080	+	0.108	1.57	0.1168	+	0.139	2.57	0.0102	+
2012	0.136	1.99	0.0464	+	0.062	0.99	0.3185	+	0.0988	1.95	0.0512	+
2011	0.235	3.26	0.0011	+	0.066	1.10	0.2723	+	0.110	2.08	0.0375	+
	Variable X ₁₆				Variable X ₁₇				Variable X ₁₈			
2015	0.110	2.08	0.0375	+	0.181	2.52	0.0118	+	0.333	4.37	0.0000	+
2014	0.165	2.85	0.0044	+	0.171	2.39	0.0167	+	0.294	3.91	0.0000	+
2013	0.139	2.57	0.0101	+	0.173	2.42	0.0156	+	0.036	1.38	0.1680	+
2012	0.099	1.95	0.0509	+	0.161	2.26	0.0236	+	0.305	3.99	0.0000	+
2011	0.110	2.08	0.0377	+	0.161	2.26	0.0239	+	0.370	4.83	0.0000	+
	Variable X ₁₉				Variable X ₂₀				Variable X ₂₁			
2015	0.120	1.71	0.0874	+	0.128	1.82	0.0681	+	0.134	1.87	0.0610	+
2014	0.120	1.71	0.0876	+	0.131	1.86	0.0633	+	0.147	2.06	0.0396	+
2013	0.118	1.69	0.0905	+	0.141	1.97	0.0484	+	0.169	2.31	0.0211	+
2012	0.112	1.62	0.1056	+	0.158	2.18	0.0295	+	0.172	2.32	0.0204	+
2011	0.113	1.63	0.1041	+	0.158	2.18	0.0294	+	0.074	1.14	0.2550	+
	Variable X ₂₂				Variable X ₂₃				Variable X ₂₄			
2015	0.167	2.34	0.0192	+	-	-	-	-	0.218	2.93	0.0034	+
2014	0.158	2.23	0.0258	+	0.159	2.27	0.0235	+	0.285	3.76	0.0017	+
2013	0.160	2.25	0.0245	+	0.180	2.56	0.0104	+	0.376	4.87	0.0000	+
2012	0.148	2.09	0.0336	+	0.179	2.53	0.0114	+	0.449	5.72	<0.000001	+
2011	0.149	2.11	0.0347	+	0.214	3.03	0.0024	+	0.457	5.808	<0.000001	+
	Variable X ₂₅				Variable X ₂₆				Variable X ₂₇			
2015	0.333	4.326	0.0000	+	0.124	1.767	0.0772	+	-	-	-	-
2014	0.322	4.190	0.0000	+	0.129	1.83	0.0668	+	0.184	3.13	0.0017	+
2013	0.304	3.981	0.0000	+	0.144	2.01	0.0442	+	0.210	3.42	0.0006	+
2012	0.318	4.149	0.0000	+	0.200	2.70	0.0070	+	0.247	3.96	0.0000	+
2011	0.315	4.102	0.0000	+	0.228	3.03	0.0025	+	0.233	3.85	0.0000	+

Table description: I- global Moran's I statistics, AK – spatial

By analyzing the results obtained for the Wrocław Airport we can draw the following conclusions. As far as the analysis of the trait of the percentage of registered young people aged 25-34 is concerned, we note that its highest characteristic level is for the leszczyński district, and the lowest for jeleniogórski district. In the case of this variable four clusters can be distinguished. One is composed of districts: milicki, trzebnicki, Wrocław i średzki. They are characterized by a positive birth rate in recent years. The second group includes districts located in the south-eastern part of the studied area (namysłowski, brzeski, strzeliński and

nyski). The systematically analyzed level of unemployment shows that for years the most difficult situation has been taking place in these districts. It is visible, for example, in the significant increase in the number of long-term unemployed. Another group consists of the following districts: kłodzki, wałbrzyski, kamieniogórski, jeleniogórski and lwówecki. On the other hand, taking into account higher education, there is a continuing downward trend for graduates of master's studies in the jeleniogórskim and wałbrzyskim subregions. In the course of research carried out by other authors it was noticed that the offer of study courses is modest, especially in the case of sciences. A positive feature is that the expenditure of Local Government Units on tourism per capita in the wałbrzyski and jeleniogórski subregions is much higher than in other subregions of the voivodeship. As a result of a detailed analysis of the value of the feature of the percentage of the unemployed with post-secondary or secondary vocational education in the area of influence of the Airport in Wrocław we can distinguish several groups. One of them consists of districts located in the south-eastern part of the studied area. These include: opolski, strzelecki, krapkowicki, prudnicki and nyski. Some of them are also located in the area of the Katowice-Pyrzowice Airport. These are also facilities with the highest percentage of people employed in hazardous conditions. The persistently high percentage of unemployed graduates in almost all surveyed counties should be considered a disturbing phenomenon. In terms of this feature the situation is most favorable in wieruszowski region.

4. Discussion and Conclusion

The pace of development of European countries depends on many different factors. One of the most important is the improvement of the situation on regional labor markets, which can be determined in the course of research and data analyzes. The article is a continuation of the author's own research in the field of regional development, innovation, the impact of air transport on local labor markets and competitiveness of European Union regions. The subject of interest in the text are the areas of influence of the Cracow-Balice Airport and Wrocław-Strachowice. In the course of such research the research hypothesis was positively verified. Therefore, the statement that the districts located in the areas of impact in the analyzed ports is characterized by a different (positive or negative) spatial autocorrelation of the situation on regional labor markets should be considered justified. Moreover, the examined objects are distinguished by statistically significant differentiation. The analysis of the features selected for the study allowed to indicate where this differentiation is particularly noticeable. In addition to the results included in the main content, we can also draw conclusions. In the analyzed period, the persistence of a high percentage of graduates among the unemployed in the areas of pressure in the ports under study should be considered a negative phenomenon. Moreover, the districts located near the analyzed ports have particularly low values of this measure. When analyzing the results of own research, it is possible to observe a certain similarity of districts in terms of selected indicators describing the situation on local labor markets in the south-eastern part of the studied area. The fact that the development of transport is conducive to the settlement of new residents in the studied

area is evidenced by for example the lowest migration balance. It can be said with certainty that the districts located near the port are the most attractive places.

References

- Bal-Domanska, B., & Sobczak, E. (2018). Educational Potential and the Situation of the Youth on the Labour Market in the European Union. In *Hradec Economic Days 2018* (Vol. 8, pp. 20-31).
- Cracolici, M. F., Cuffaro, M., & Nijkamp, P. (2009). A spatial analysis on Italian unemployment differences. *Statistical Methods and Applications*, 18(2), 275–291. <https://doi.org/10.1007/s10260-007-0087-z>
- Kołodziejczyk, A., & Kossowski, T. (2016). Wykorzystanie metody autokorelacji przestrzennej do analizy ubóstwa na obszarach wiejskich. *Wiadomości statystyczne*, 10(665), 22-32.
- Kujawiak, M. (2016). Analiza obszaru oddziaływania portu lotniczego – przegląd metod badawczych. In *Studia Oeconomica Posnaniensia, Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu*. (No. 4., pp. 112-124).
- Longhi, S., & Nijkamp, P. (2007). Forecasting Regional Labor Market Developments under Spatial Autocorrelation. *International Regional Science Review*, 30(2), 100–119. <https://doi.org/10.1177/0160017606298428>
- Malinowski, M., & Jabłońska-Porzuczek, L. (2020). Female activity and education levels in selected European Union countries. *Research in Economics*, 74(2), 153–173. <https://doi.org/10.1016/j.rie.2020.04.002>
- Nikulin, D., & Sobiechowska-Ziegert, A. (2018). Informal work in Poland - a regional approach: Informal work in Poland - a regional approach. *Papers in Regional Science*, 97(4), 1227–1246. <https://doi.org/10.1111/pirs.12306>
- Pancer-Cybulska, E., Cybulski, L., Olipra, Ł., & Surówka, A. (2014). *Transport lotniczy a regionalne rynki pracy w Polsce*. Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.
- Sardadvar, S., & Rocha-Akis, S. (2016). Interregional migration within the European Union in the aftermath of the Eastern enlargements: a spatial approach. *Review of regional research-jahrbuch fur regionalwissenschaft*, 3, 51-79.
- Shaikin, D. (2012). Population's economical activity as an indicator of labour potential development (The republic of kazakhstan case study). *Actual problems of economics*, 134, 531-538.
- Siserova, M., & Zudelova, M. (2015). Spatial Econometric Modelling of Internal Labour Mobility. In *Central European Conference on Finance and Economics (CEFE)* (pp. 663-670).
- Surówka, A. (2019). Taksonomiczna analiza zróżnicowania sytuacji na lokalnych rynkach pracy na obszarze ciężenia Lotniska Chopina w Warszawie jako metodologia zarządzania rozwojem regionalnym. *Economic and Regional Studies*, 12(4), 230-240. <https://doi.org/10.2478/ers-2019>
- Surówka, A. (2020). Comparative Analysis of the Dynamics of Indicator Changes GDP per Capita in the Regions of Greece, Germany and Romania. In *Proceedings of the International Scientific Conference Hradec Economic Days 2020* (Vol. 10, pp. 749-760). <https://doi.org/10.36689/uhk/hed/2020-01-085>
- Surówka, A. (2019). Portal Geostatystyczny jako narzędzie badawcze nierówności na lokalnych rynkach pracy. *Zeszyty Naukowe Uniwersytetu Rzeszowskiego Nierówności społeczne a wzrost gospodarczy*, 59(3), 162-172.
- Szulcl, E., & Jankiewicz, M. (2017). *The labour market situation in medium-sized urban centres of the Kujawsko-Pomorskie voivodeship and the problem of unemployment in the province* (11th ed). Professor.

Corporate Social Responsibility and Automotive Industry in the Czech Republic

Libuše SVOBODOVÁ^{1*} and Dorota BEDNARSKA-OLEJNICZAK²

¹ University of Hradec Kralove, Hradec Kralove, Czech Republic; libuse.svobodova@uhk

² Wrocław University of Economics and Business, Wrocław, Poland; dorota.bednarska-olejniczak@ue.wroc.pl

* Corresponding author: libuse.svobodova@uhk.cz

Abstract: The goal of the article is to analyse annual reports of the five most important businesses in the automotive industry in the Czech Republic and analyse their involvement in corporate social responsibility. The introduction part contains the explanation of basic concepts in the field of annual reports and corporate social responsibility. Results contains analysis of the annual reports of the selected companies and in the second part an analysis of the application of corporate social responsibility of analysed companies. The results of the analysis are evaluated at the end of the article. After the analysis, it can be evaluated that the best processed reports have a leader on the Czech automotive market, Škoda auto, JSC. Most of the analysed issues were reported by the companies. In the two companies are missing fight against corruption and bribery and in one respect for human rights. TATRA and Iveco are the less reporting companies about corporate social responsibility.

Keywords: automotive industry; Corporate Social Responsibility; reporting

JEL Classification: M14; M40

1. Introduction

Accounting can be defined as an activity leading to the determination of the state and changes of assets and their sources and the result of management for a certain period. It is in the interest of every business owner or investor to have an overview of whether his invested capital corresponds to the corresponding profit and whether the overall financial situation of the company is good. The primary task of accounting is therefore to provide a credible and active picture or financial situation of the company and for this purpose culminates several annual accounting works on the preparation of financial statements, which provides us with an overview of the financial situation. However, in connection with the end of the accounting period of companies, lot of companies do not prepare only financial statements. For reasons of legislative compliance also compile an annual report on a voluntary basis. The economic indicators of the company and data on the company's finances and performance form an integral part of the annual report. The annual report also includes information on the production of realized projections, business successes and recent corporate social responsibility. (Masiarová, 2020)

Corporate social responsibility (CSR) is generally understood as a voluntary obligation of companies to behave in a responsible way to the environment of society and the environment that affects their functioning. For this reason, the annual report can also be a

corporate tool for the marketing and promotion system, any corporate social responsibility is more attractive to investors and builds a better image for the public.

(Moravcikova et al., 2015) presented that CSR is a trend that appeals to change of business orientation from short-term to long-term goals and from maximum to optimum profit. CSR reports, respectively triple-bottom-line reports have become tool of communication for Corporate Social Responsibility. Those are a voluntary comprehensive reports involving not only economic data, but also information from environmental and social field. These reports talk about the company policy in relationship to the environment, sustainability, or there are directly focused on fulfilling the commitments accepted by the company within the concept of social responsibility.

With effect from the accounting period beginning in 2017, a new obligation is set to provide so-called non-financial information in the Czech Republic. The presentation of non-financial information is defined in the Accounting Act No. 563/1991 Coll. in § 32f and § 32g. § 32f defines the scope, where the accounting entity presenting non-financial information means:

- A large entity that is a corporation and is also a public interest entity if, at the balance sheet date, it exceeds the criterion of an average of 500 employees during the accounting period.
- A consolidating entity of a large group of entities that is also a public interest entity if, at the balance sheet date, it exceeds the criterion of an average of 500 employees during the accounting period on a consolidated basis.

§ 32g states that an entity presenting non-financial information shall provide non-financial information to the extent necessary to understand the development of the entity or group, its performance and position and the effects of its operations. Between annual financial reports according to accounting act for selected accounting entities belongs:

- Basic information about the company.
- Information about the expected development of the entity.
- Non-financial information,
 - environment,
 - social and employment issues,
 - respect for human rights,
 - fight against corruption and bribery.
- Financial Statements,
 - balance sheet,
 - profit and Loss,
 - attachment,
 - cash flow statement,
 - statement of changes in equity.
- Auditor's report on the audit of the financial statements.

Dahlsrud (2008) came up with interesting findings regarding the definition of the concept of CSR in “How Corporate Social Responsibility is defined”. According to the analysis of dozens of CSR definitions, Dahlsrud (2008) formulated five basic areas that appeared most frequently in the definitions. It's about:

- economic area,
- social area,
- environmental area,
- stakeholders,
- voluntariness.

Dahlsrud (2008) opinion is that although the existing definitions of CSR are formulated differently, they are in fact consistent, resp. they are congruent. He found that four of the five areas mentioned appeared in at least 80% of the definitions and three of the five areas even appeared in up to 97% of the definitions.

Based on several definitions, Tetřevová (2017) summarizes CSR as Corporate social responsibility representing such behavior of managers and other employees of the company, which respects not only the economic and technical interests of the company but also the interests of all corporate stakeholders and interweaves with all corporate activities.

(MacGregor Pelikánová, 2019) focused on CSR information in annual reports in the EU. She focused on the Czech case study. The 10 largest Czech companies are subjects of the legal duty to prepare and e-file with the Commercial Register their annual reports with CSR information, but this legal duty is set up in a rather general and vague manner. This leaves open a rather large discretionary space in its perception and satisfaction. The analysis was done between 2013-2017. Three of the analysed companies were from automotive industry.

(Myšková & Hájek, 2018) focused on sustainability and CSR in the text of annual reports. They focused on IT services industry. The companies studied do present activity relating to sustainable development in their annual reports. It can be seen from the results above that information on activities in the field of CSR are primarily included in the annual reports; however, CSR was presented with a negative overtone, which does not correspond with the assumption that including a presentation of sustainable development and especially CSR activities in annual reports would target a positive perception of the company by stakeholders. The analysis was done in 2014 and 2015.

Currently, increasing attention is being paid to the issues of sustainability and social responsibility. The measure of a company's success is not only its profitability, but rather its overall evaluation relies on quantitative and qualitative characteristics, increasingly reflecting the company's interaction with its surroundings. Therefore, a company's competitiveness is linked not only to economic outcomes, but also to how the company meets its stakeholders' expectations as to the activities it develops for reasons of CSR and sustainable development. (Crane & Glozer, 2016; Lim & Greenwood, 2017; Seele & Gatti, 2017).

According to KMPG study (2020) the Czech Republic is in the sustainability reporting rates lower than the global average (less than 77%). But there is the optimistic trend. While

in 2017 was the rate 51%, in 2020 66%. The best countries and jurisdictions with reporting are Japan, Mexico, Malaysia, India, US, Sweden, Spain and France.

Regulators of capital markets should use CSR information as guidelines to improve financial reporting quality and achieve better allocation of resources in capital markets. (Kareem AL Ani, 2021)

Accounting researchers have become increasingly interested in CSR, which has received notable attention in accounting and finance. Traditionally, CSR integrates social activities and business activities. (Moser & Martin, 2012) point out that the firms engage in socially responsible activities when they conduct business activities. Within the same framework, (Budianto & Suyono, 2020) believe that CSR is a genuine effort by business entities to minimise negative impacts and maximize the positive impact of its operations.

The necessity of communication and use of social media was presented in (Svobodová et al., 2019). Use of CSR is also connected with financial literacy. The portals in the Czech Republic were discussed in (Hedvicakova & Svobodova, 2018). The Czech Republic and its technological readiness is on an appropriate level (Svobodova & Hedvicakova, 2017). Evaluation of cluster initiatives that can be used also in CSR is presented in Bureš et al. (2012). Situation in Slovak automotive industry analysed (Richnák & Gubová, 2021). Based on the research, they found that the dominant position in green and reverse logistics in Slovakia was achieved by large production enterprises from the automotive industry, which operate in western Slovakia. The analysed enterprises in Slovakia use voluntary tools of environmental policy and the most important environmental tool is corporate social responsibility.

The main fields (economic, social and ecological) presented in previous articles focused on CSR are presented in Figure 1.

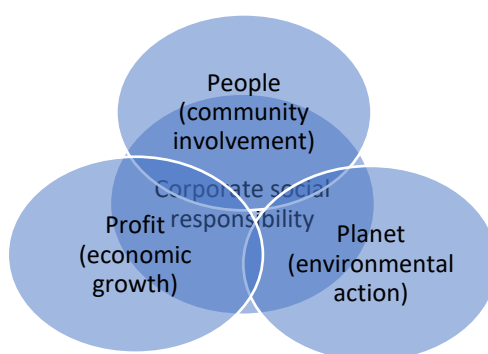


Figure 1. The main parts of Corporate Social Responsibility (own processing)

2. Methodology

The article consists of two parts. The first part is focused on introduction and literature review. The theoretical basis related to the issue of financial statements and annual reports will be clarified. It will be also described which parts of the financial statements consist of

and which entities are required to be audited. Subsequently, the basic approaches to corporate social responsibility will be described and their benefits will be explained.

The second part of the article contains the analysis of individual companies selected to analyse their annual reports and social responsibility. For these companies, selected requirements of the annual reports will be evaluated, whether they contain selected data and what is their overall transparency. Subsequently, the same companies will be described and compared their activities in the field of social responsibility.

At the end of the work will be summarized the basic findings from the analysis of annual reports and corporate social responsibility. From these findings, certain recommendations for individual car manufacturers will also emerge.

This work aims to compare and evaluate the annual reports of selected companies, especially in terms of completeness of financial statements and also to compare these companies' involvement in social responsibility.

The aim of the article is to analyse the reporting of selected companies in the framework of financial accounting and social responsibility. The automotive industry in the Czech Republic was chosen as the sector to be researched, in which the largest manufacturers include:

- Škoda Auto, JSC
- Hyundai Motor Manufacturing Czech, Ltd. (HMMC)
- Toyota Peugeot Citroën Automobile Czech Ltd. (TPCA)
- Tatra Trucks, JSC
- Iveco Czech Republic, JSC

The results of the research will include the results of the performed analyses of the annual reports of individual companies for the year 2014-2019, i.e. their completeness will be assessed according to the accounting act. In the tables 1 and 2 will be presented data only for 2019, because results are almost the same for all years. Differences will be mentioned in the text. The author chose the criteria of annual reports mainly according to the requirements stipulated by law. The criteria of non-financial information were divided in detail according to the obligations from the amendment to the accounting act of 2017, which imposes the obligation to report non-financial indicators to large companies. In the text will be companies presented without type of business according to law.

3. Results

Results part will describe the activities of social responsibility of individual automotive companies in the Czech Republic. According to the theoretical part, the author decided to divide these activities into three basic areas. At the same time, sub-areas have been created that will help to identify the company's social responsibility. The source of all used and analysed data is the websites of individual companies or their annual reports.

3.1. Summary of the Analysis of Annual Reports

Annual reports of Škoda Auto during the six-year period under review, they meet all selected requirements and, in addition, the company publishes many other activities in them, thus building a valuable image, thus becoming credible for current investors and at the same time attractive for new investors.

Annual reports of Hyundai Motor Manufacturing Czech for 2015 and 2016 contain all mandatory selected requirements, but the annual reports from 2017-2019 lack non-financial information on the fight against corruption and bribery in the company.

At Toyota Peugeot Citroën Automobile only the first three met all the requirements from the analysed annual reports; in 2017-2019 there was again a problem with the reporting of non-financial information, as there were no points to respect human rights and to fight corruption. Overall, not all of the company's annual reports are as comprehensive as the previous ones and are apparently prepared for the sole purpose of meeting legislative requirements.

From the legislative point of view, the company Tatra Trucks met all selected financial requirements of the annual reports. But as for the graphic design of the annual reports, apparently even for this company, the annual reports do not belong to promotional or marketing material, as they are just as formal as for Toyota Peugeot Citroën Automobile.

Annual reports of Iveco Czech Republic are more comprehensive and readable in terms of the content of non-financial information and information on the future development of the company than is the case with TPCA and Tatra. In addition to the non-fulfillment of the obligation to publish non-financial information on the fight against corruption and bribery in 2017-2019, the annual reports meet all selected requirements. (see Table 1) Overall, the annual reports of Škoda Auto and Hyundai Motor Manufacturing are prepared the best, worse are prepared the annual reports of Iveco Czech Republic and Toyota Peugeot Citroën Automobile.

Table 1. Details of the annual report of the analysed companies in 2019. (annual reports of Škoda, HMMC, TPCA, TATRA and IVECO)

Details of the annual report	Škoda	HMMC	TPCA	TATRA	IVECO
Basic information about the company	Yes	Yes	Yes	Yes	Yes
Information about the expected development of the entity	Yes	Yes	Yes	Yes	Yes
Non-financial information	Yes	No	No	Yes	No
environment	Yes	Yes	Yes	Yes	Yes
social and employment issues	Yes	Yes	Yes	Yes	Yes
respect for human rights	Yes	Yes	No	Yes	Yes
fight against corruption and bribery	Yes	No	No	Yes	No
Financial Statements	Yes	Yes	Yes	Yes	Yes
balance sheet	Yes	Yes	Yes	Yes	Yes
profit and loss	Yes	Yes	Yes	Yes	Yes
attachment	Yes	Yes	Yes	Yes	Yes
cash flow statement	Yes	Yes	Yes	Yes	Yes
statement of changes in equity	Yes	Yes	Yes	Yes	Yes
Auditor's report on the audit of the financial statements	Yes	Yes	Yes	Yes	Yes

In case that we compare results of annuals reports from 2014-2019, almost all items were the same. The difference was in Tatra Trucks. They didn't focus on respect for human rights and fight against corruption and bribery in 2014. From 2015 they report those information.

3.2. Summary of the Comparison of Social Responsibility

To clearly present the involvement of individual companies in social responsibility, three basic areas were determined according to the literature review in the article. This is an economic, social and environmental area. The social responsibility of selected companies was most pronounced in the social and environmental areas, for this reason these areas were divided into other points determined according to the published data of the analysed companies. The social area contains according to field of companies support for technical education, traffic safety, support for the disabled, support for disadvantaged children and support for regions. In the environmental area were included environmental protection and recyclability.

The company Škoda Auto more than 100% fulfilled all selected areas of social responsibility. Many long-term projects are aimed at each of the areas and in comparison with other automotive manufacturers in the Czech Republic, this company is clearly the most involved in the issue of social responsibility.

The Hyundai Motor Manufacturing Czech and Toyota Peugeot Citroën Automobile also focus on all selected categories of social responsibility, but in some areas they are only involved in one project.

The company Tatra Trucks fulfills one hundred percent only the economic area, in other areas it does not present specific activities. These are the areas of support for the disabled, support for the disadvantaged children and recyclability issues.

At Iveco Czech Republic the economic area of social responsibility is fulfilled, the other areas are fulfilled in part. In the social field, the company's involvement in activities supporting technical education, road safety and regional support is lacking. In the environmental field, addressing recyclability issues.

The fulfillment of selected areas of social responsibility of all analysed companies is clearly shown in the following table, (see Table 2).

Table 2: Selected areas of social responsibility of the analysed companies in 2019 (annual reports and websites of Škoda, HMMC, TPCA, TATRA and IVECO)

	Škoda	HMMC	TPCA	TATRA	IVECO
Economic area	Yes	Yes	Yes	Yes	Yes
Social area	Yes	Yes	Yes	Yes	Yes
support for technical education	Yes	Yes	Yes	No	Yes
traffic safety	Yes	Yes	Yes	Yes	No
support for the disabled	Yes	Yes	Yes	No	No
support for disadvantaged children	Yes	Yes	Yes	No	Yes
support for regions	Yes	Yes	Yes	Yes	Yes
Environmental area	Yes	Yes	Yes	Yes	Yes
environmental Protection	Yes	Yes	Yes	Yes	Yes
recyclability	Yes	Yes	Yes	No	No

4. Discussion and Conclusions

The aim of this article was to compare and evaluate the annual reports of selected companies, especially in terms of completeness of financial statements and at the same time to compare their involvement in social responsibility for these companies. From the results of the analysis of the annual reports of the companies of the automotive industry in the Czech Republic, it was found that only some companies prepare annual reports carefully and pay attention to the newly created obligations in financial reporting. Often even companies do not use the full potential of this document as a marketing and promotional tool. On the contrary most of the required data are by the automotive companies reported.

Corporate social responsibility in the automotive industry of the Czech Republic is mainly engaged in by companies with greater market power, as is evident especially in the case of Škoda Auto and HMMC which show a high level of environmental activity. They organize events not only for employees, but also for the general public and generally contribute to a positive public view of their socially oriented activities. Almost all companies reported all monitored issues and the level of corporate social responsibility is in the analysed companies on the high levels.

The area of environmental responsibility is currently particularly important in the automotive industry, as this industry is already making a significant contribution to the harmful effects of the environment in the form of emissions through its production. Unfortunately, it is the same with the product, which also pollutes the air during its use. It is precisely because of these facts that it is necessary for companies in this industrial area to adapt their production process and the development of new products towards environmental friendliness and sustainability.

(Russo-Spena et al., 2018) focuses on the similar issues as authors of the article. Based on a longitudinal study of CSR reports of companies operating in the automotive industry, the paper offers a detailed study of how disclosure practices are changing and which principles and approaches influence and drive the development of such disclosure. Based on a four-year report-based study, the findings enable us to identify three main trends in the CSR disclosure strategy of automotive firms. First, in line with the mainstream CSR literature, the present study confirms the trend towards the increasing environmental and social accountability. Second, it adds evidence to the emerging debate regarding the harmonization and standardization of reporting and discusses this aspect by mentioning the standards as exerting some normative pressures within the sector. Finally, it provides evidence on specific links emerging between issues and actors.

Acknowledgments: We would like to thank to project "SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept ", 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic" and to Anna Borkovcová.

References

Act no. 563/1991, *accounting*. Czech Republic. The Parliament of the Czech Republic.
<https://www.zakonyprolidi.cz/cs/1991-563>

- Budianto, R., & Suyono, E. (2020). Corporate Social Responsibility and Factors Affecting It: An Empirical Evidence from the Indonesian Capital Market. *International Journal of Economics and Business Administration*, 8(1), 239–253. <https://doi.org/10.35808/ijeba/422>
- Bureš, V., et al. (2012). A Comprehensive View on Evaluation of Cluster Initiatives. In J. Politis (Eds.), *Proceedings of the 8th European conference on management leadership and governance* (pp. 74–79).
- Crane, A., & Glozer, S. (2016). Researching Corporate Social Responsibility Communication: Themes, Opportunities and Challenges. *J. Manag. Stud.*, 53, 1223–1252. <https://doi.org/10.1111/joms.12196>
- Dahlsrud A. (2008). How corporate social responsibility is defined: an analysis of 37 definitions. *Corporate Social Responsibility and Environmental Management*, 15(1), 1–13. <https://doi.org/10.1002/csr.132>
- Decree No. 500/2002. Decree implementing certain provisions of Act No. 563/1991, on accounting, as amended, for accounting entities that are entrepreneurs accounting in the double-entry bookkeeping system
- Hedvicakova, M., & Svobodova, L. (2018). Web Portals Used in Financial Education as a Support of Financial Literacy. *Advanced Science Letters*, 24(4), 2948–2952. <https://doi.org/10.1166/asl.2018.11102>
- Hyundai Motor Manufacturing Czech. (2020). *Annual report 2019*. Hyundai Motor Manufacturing Czech. <https://or.justice.cz/ias/ui/vypis-sl-firma?subjektId=245382>
- Hyundai Motor Manufacturing Czech. (2021). Hyundai. <https://www.hyundai.cz/>
- Iveco Czech Republic. (2020). *Annual report 2019*. Iveco Czech Republic. <https://or.justice.cz/ias/ui/vypis-sl-firma?subjektId=126335>
- Iveco Czech Republic. (2020). *IVECO Czech Republic*. <https://www.ivecocr.cz/>
- Kareem AL Ani, M. (2021). Corporate social responsibility disclosure and financial reporting quality: Evidence from Gulf Cooperation Council countries. *Borsa Istanbul Review*, S2214845021000065. <https://doi.org/10.1016/j.bir.2021.01.006>
- KPMG. (2020). *The KPMG Survey of Sustainability Reporting 2020*. https://assets.kpmg/content/dam/kpmg/be/pdf/2020/12/The_Time_Has_Come_KPMG_Survey_of_Sustainability_Reporting_2020.pdf
- Lim, J. S., & Greenwood, C. A. (2017). Communicating Corporate Social Responsibility (CSR): Stakeholder Responsiveness and Engagement Strategy to Achieve CSR Goals. *Public Relat. Rev.*, 43, 768–776. <https://doi.org/10.1016/j.pubrev.2017.06.007>
- MacGregor Pelikánová, R. (2019). Corporate Social Responsibility Information in Annual Reports in the EU – A Czech Case Study. *Sustainability*, 11, 237. <https://doi.org/10.3390/su11010237>
- Masiarová, N. (2020). *Analysis of annual reports and social responsibility of selected companies*. Diploma thesis.
- Moravcikova, K., Stefanikova, L., & Rypakova, M. (2015). CSR Reporting as an Important Tool of CSR Communication. *Procedia Economics and Finance*, 26, 332–338. [https://doi.org/10.1016/S2212-5671\(15\)00861-8](https://doi.org/10.1016/S2212-5671(15)00861-8)
- Moser, D. V., & Martin, P. R. (2012). A Broader Perspective on Corporate Social Responsibility Research in Accounting. *The Accounting Review*, 87(3), 797–806. <https://doi.org/10.2308/accr-10257>
- Myšková, R., & Hájek, P. (2018). Sustainability and Corporate Social Responsibility in the Text of Annual Reports – The Case of the IT Services Industry. *Sustainability*, 10, 4119. <https://doi.org/10.3390/su10114119>
- Richnák, P., & Gubová, K. (2021). Green and Reverse Logistics in Conditions of Sustainable Development in Enterprises in Slovakia. *Sustainability*, 13(2), 581. <https://doi.org/10.3390/su13020581>
- Russo-Spena, T., Tregua, M., & De Chiara, A. (2018). Trends and Drivers in CSR Disclosure: A Focus on Reporting Practices in the Automotive Industry. *Journal of Business Ethics*, 151(2), 563–578. <https://doi.org/10.1007/s10551-016-3235-2>
- Seele, P., & Gatti, L. (2017). Greenwashing Revisited: In Search of a Typology and Accusation-Based Definition Incorporating Legitimacy Strategies: Greenwashing Revisited. *Bus. Strategy Environ*, 26, 239–252. <https://doi.org/10.1002/bse.1912>
- Svobodová, L., Černá, M., Olejniczak, J., & Bednarska-Olejniczak, D. (2019). Utilization of Social Media Network in Automotive Industry in the Czech Republic: Case-study. In Jedlička, P., Marešová, P., & Soukal, I. (Eds.), *Proceedings International scientific conference Hradec Economic Days 2019* (pp. 370–381). <https://doi.org/10.36689/uhk/hed/2019-02-038>
- Svobodova, L., & Hedvicakova, M. (2017). Technological Readiness of the Czech Republic and the Use of Technology. In M. Themistocleous, & V. Morabito (Eds.), *Information Systems* (Vol. 299, pp. 670–678). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-319-65930-5_53
- Škoda Auto. (2020). *Annual reports 2019*. Škoda Auto. <https://or.justice.cz/ias/ui/vypis-sl-firma?subjektId=47718>
- Škoda Auto. (2020). *Škoda Auto*. <https://www.skoda-auto.cz/>
- Škoda Auto. (2020). *Corporate Governance Škoda Auto*. <https://www.skoda-auto.cz/o-nas/corporate-governance>

- Škoda Auto. (2020). *Corporate social responsibility*. Škoda Auto. <https://www.skoda-auto.cz/o-nas/spolecenska-odpovednost-dopravni-bezpecnost>
- Tatra Trucks. (2020). *Annual report 2019*. Tatra Trucks. <https://or.justice.cz/ias/ui/vypis-sl-firma?subjektId=274834>
- Tatra Trucks. (2020). *Tatra Trucks*. <https://www.tatra.cz/>
- Tetřevová L., et al. (2017). *Social responsibility of companies in socially sensitive sectors*. Grada Publishing
- Toyota Motor Manufacturing Czech Republic. (2020). *Annual report 2019*. Toyota Motor Manufacturing Czech Republic. <https://or.justice.cz/ias/ui/vypis-sl-firma?subjektId=238739>
- Toyota Motor Manufacturing Czech Republic. (2020). *TPCA*. <https://www.tpca.cz/>

Corporate Education with Focus on Utilization of ICT – Case Study in the Czech Republic

Libuše SVOBODOVÁ^{1*} and Miloslava ČERNÁ¹

University of Hradec Kralove, Hradec Kralove, Czech Republic; libuse.svobodova@uhk;
miloslava.cerna@uhk.cz

* Corresponding author: libuse.svobodova@uhk.cz

Abstract: The computer competence is an inseparable part of crucial competences required from people at the digital age. It can be assumed that employers will build the corporate education/ training scheme, to meet the needs of companies reflecting unstoppable technological progress. The paper focuses on a real current situation on the local Czech scene in an approach of citizens to further education. A pilot study with 86 participants was conducted to demonstrate or refute the findings presented by national and transnational statistical institutions relating to the accessibility and utilization of Information and Communication technologies for study purposes. In this article, which is intended to be descriptive and exploratory in nature we present empirical results that show the answers to the research questions on preferable kinds and ways of education, as well as on study materials. The pilot study showed that individuals preferred combination of ICT and face-to-face. Surprisingly, in the age group 18-25, individuals preferred use of printed sources. Individuals in the age group 26-35 preferred computer/notebook most. Based on the findings, it is recommendable to use corporate education portals and enrich them with a section of the links with free accessible education portals, which respondents prefer.

Keywords: corporate education; ICT; technologies

JEL Classification: I20

1. Introduction

This paper focuses on corporate education, which is a specific part of the lifelong education. Current society, which is characterized by accelerated development, distribution and use of Information and Communication technologies, is often called Information society, Knowledge society or Learning society. 'Information' became and is up to now a crucial economic phenomenon with social and cultural consequences. Sociologist Bell (1976) used the term 'information society' in his *The Coming of Post-Industrial Society* book. He forecast unavoidable changes in the structure of society caused by the dependence on science and innovations. Not only structure of the society has been undergoing changes but also the whole system of education including further education has been undergoing significant changes reflecting different requirements on knowledge, skills and competences favouring performance results (Titmus, 1996).

A critical approach to knowledge and 'unknowledge' can be traced to the thirties of the last century, already at that time serious concerns were formulated relating to dominant focus

on economic outcomes, see more Köhn (2017). The terms Knowledge society and Information society are terms, which are often perceived as interchangeable (Burch, 2006). Knowledge society is considered a wider term that is related not only to the economic dimension but reflects desired transformations in the system of education both formal and informal, institutional and life-long.

It is evident that current society is a society of changes. The dynamic and even turbulent development requires continuous involvement of people into the learning process (Armstrong, 2009; Gómez et. al, 2016). Keeping the pace with the development is an issue for the educational institutions, because there is often inconsistency or discrepancy between current educational programmes and employers' requirements on potential employees' competences (Rabusicova & Rabusic, 2006; Cerkovskis & Titko, 2017).

Life-long education represents one of main components in creation of competitive economy. It is a wide concept covering activities aiming at getting knowledge and competences at various stages of human life enabling his/her further development in social and working life (Drucker, 1999).

The Computer competence is an inseparable part of crucial competences required from people at the digital age. It can be assumed that employers will build a system of education on the use of ICT, to meet the needs of companies reflecting unstoppable technological progress (Svobodova & Cerna, 2018; Cerna & Svobodova, 2013; OECD, 2016).

2. Methodology and Goal

Based on the literature review it can be stated that speed, affordability and flexibility rank among key features of the corporate education scheme as well as of performance support. Without utilization of Information and communication technologies, the concept of corporate education would hardly work. That is why we have focused on the real current situation on the local Czech scene to demonstrate or refute the findings presented by national and transnational statistical institutions relating to the accessibility and utilization of Information and Communication technologies for study purposes.

The core of the paper forms the approach of employees to ICT within the system of corporation education scheme.

In this article, which is intended to be descriptive and exploratory in nature, we present empirical results that show the answers to the research questions:

- RQ1: What kind of education fits the employed respondents (F2F, ICT support, both), and what is the correlation between age category and preferred way of learning?
- RQ2: What is the preferred format of sources (printed, spoken, computer, tablet, mobile) and correlation between age category and preferred format of studied material.
- RQ3: What kinds of ICT respondents use (LMS, intranet, web portals, mobile applications) and what is the correlation between age category and utilized ICT?

The study brings comparison between official data on the national basis and data gained from the field regional findings. The data from the regional search stem from the survey carried out among 86 Czech adults. Findings from the survey were compared with data

presented by the official Czech National Statistical Office. The Czech National Statistical Office uses elaborated methodology of the European Union on monitoring, measuring and evaluation of implemented strategies in the Lifelong education.

2.1. Conceptual Framework of the Research

The conceptual framework of the paper was worked out into methodological bases and procedures. The course of methodology is outlined in the following diagram, Figure 1.

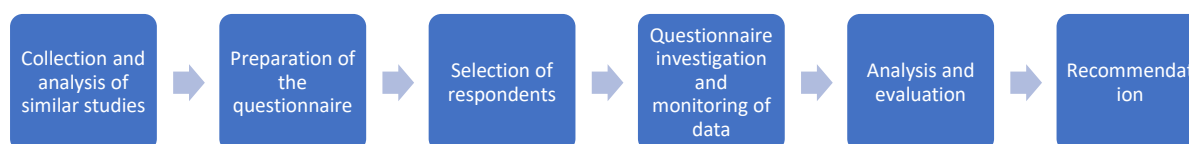


Figure 1. Methodology of research (own elaboration)

Firstly, studies on further education, and corporate education were collected and analysed, e.g. (Kim et. al., 2004; Coulson-Thomas, 2013; Sberbank, 2019; Fan & Wei, 2010; Hodges, 2009). The pilot questionnaire stemmed from the literature review and reports from statistical offices (Eurostat, 2020; CZSO, 2016; CZSO, 2017). When designing the pilot version of the research, selected criteria like age, economic status, income, utilized electronic devices and preferable ways of learning became key monitored areas. The age criterion might be found dubious but this is a natural matter. In this article, we focus on the age criterion and on various tools used in the process of education without intending to discriminate anyone. In order to illustrate the situation and sample of respondents, their economic status is monitored and recorded in the results section. This makes it clear that the sample of respondents covers the full range of population composition.

The questionnaire investigation was conducted in January 2019. Printed form of questionnaires was distributed and consequently filled in by respondents in hand. Filling in the form took the respondents 10 – 15 minutes. Respondents' answers from questionnaires were recorded into .xls. Then the data were placed into tables. Graphs were used for better visualization of gained data. Descriptive statistics was applied. Based on the gained findings, recommendation for employers, employees were formulated, and then adaptations in the questionnaire which is going to be used in the following stage of the project were made.

Methods and a data source should be described with enough details to allow others to replicate and build on published results. Datasets that are deposited in a publicly available database should be properly referred to. Be sure to include hypotheses you tested and indicate what types of descriptive statistics were used. In case of a scientific question, describe how the data were summarized and analyzed. New methods should be described in detail while well-established methods can be briefly described and appropriately cited.

3. Results

The sample consisted of 86 people. The largest group of respondents was at the age of 26 to 35 they formed one half of the whole sample, the 36-45 age-group represented one quarter of the sample, the youngest age group 18-25 formed about one fifth of the sample, remaining 5% were respondents 46-55 old, see Figure 2.

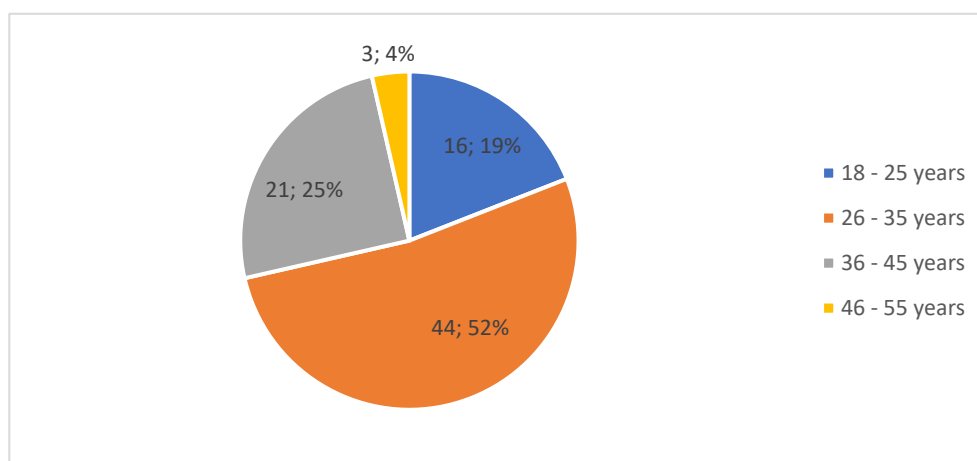


Figure 2. Age distribution

The sample was different not only in the age criterion but in the economic status criterion, as well, see Figure 3. The various age and status distribution represents actual composition of employed respondents. More than half of the respondents were employee in private sector. Parental maternity leave were only 5 respondents.

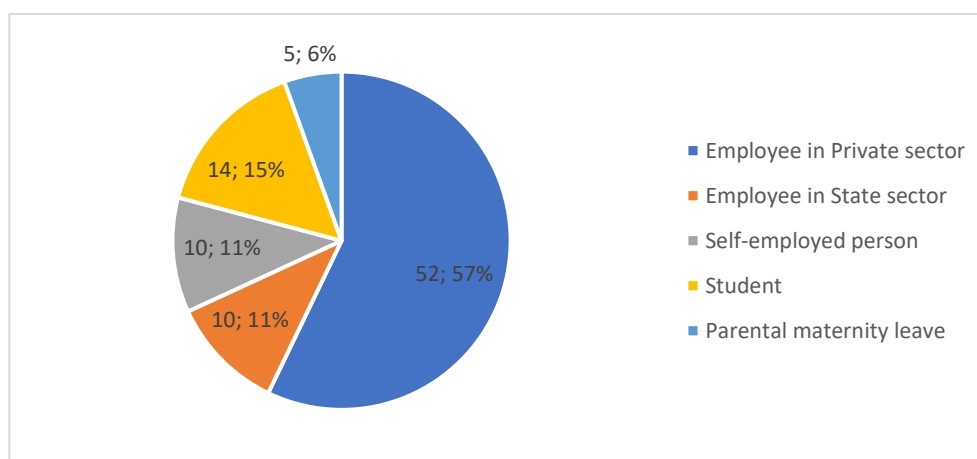


Figure 3. Economic status

The majority of respondents prefer face-to-face training in conjunction with the support of ICT. The smaller group of 22% of respondents prefer ICT support and only 16% of respondents select exclusively a face-to-face form of education, Figure 4.

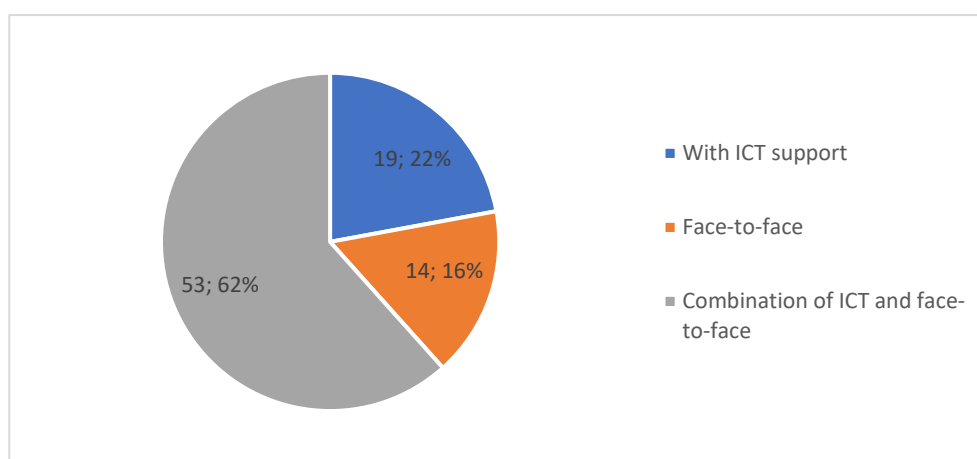


Figure 4. Ways of learning: with ICT support, face-to-face, combination of ICT and face-to-face

If the results are divided according to the age groups, the most respondents belonged to the age category 26-35 years, then to the age category 36-45 years and finally to the 18-25 years age category. Only 3 respondents ranked to the 46-55 years age category and 4 respondents did not write their age. The largest percentage of respondents (88%) from the youngest age category 18-25 preferred combination of ICT and F2F form of education, 12% of respondents selected only ICT way of education. With increasing age these preferences declined. In the 26-35 group, the combination of ICT and F2F still prevailed (56% to 28%). In the 36-45 group, the ICT and F2F education preferences fell again to about 53% and the F2F preference increased to 25% and 12.5% in the group prefer ICT-only education. There were only 3 respondents in the group 46-55. Two of them prefer ICT education and one did not, Figure 5.

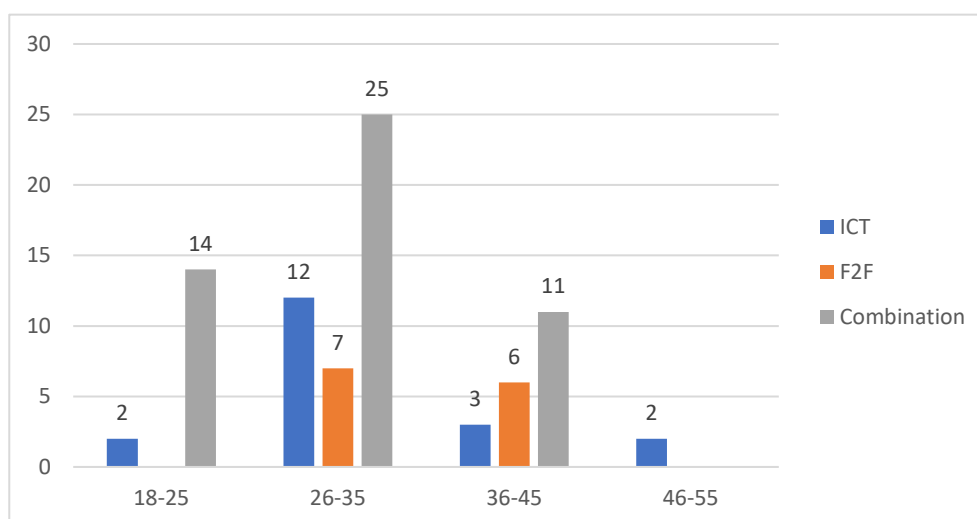


Figure 5. Preferred way of education

When it comes to the form of utilized sources, in total 70% of respondents prefer printed sources. It is true in individual age-categories, as well, except for the largest group of respondents from the 26-36 age category. Then computer/notebook was selected in 64% as the preferable source or electronic device for study purposes. Then there was a deep gap and

spoken sources followed with 33% occurrence. Surprisingly, utilization of mobiles was mentioned only in 20% responses and the tablet selected only 14% of respondents.

When we look at the utilization of printed and audio sources together with utilization of electronic devices like computer/notebook, tablet and mobile from the perspective of age categories, printed sources and utilization of computer dominate. Bigger discrepancies in answers were found in 18-25 and 36-45 age groups; however, findings in the 36-45 age group were quite balanced. Overall, as already mentioned and computer fit the studying most audio sources and tablets are less used. The mobile phone is most used in the 26-35 age group. Surprisingly, for the 18-25 age group, half of those surveyed prefer printed sources, see Figure 6.

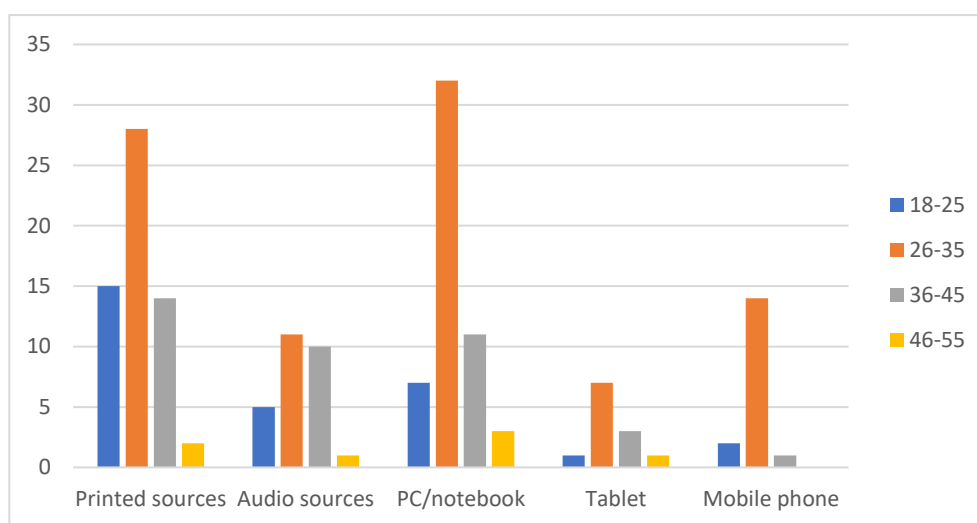


Figure 6. Technologies and education

The largest group of respondents, 71% use free educational web portals. 33% use the corporate learning environment, 30% use mobile apps, and 24% use educational virtual platforms. As for individual age groups, they all prefer education through other portals (websites) followed by educational portals with free access. Only after these options the company virtual environments are mentioned. The results (Figure 7) show that people within professional training prefer freely available materials to materials funded by the employer.

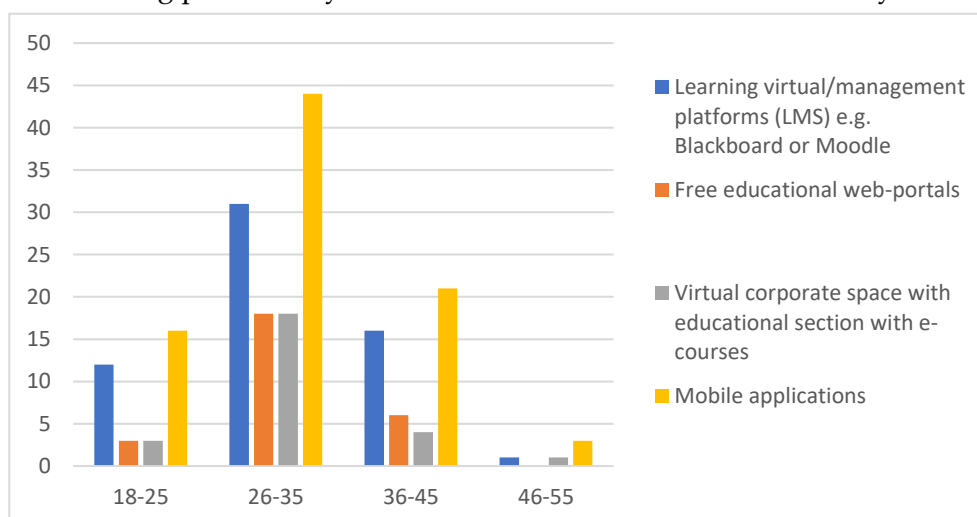


Figure 7. Study virtual environment

4. Discussion and Conclusion

Combination of face-to-face education and with utilization of ICT was the most preferable way of education in all followed age-groups.

Findings from the research revealed that, despite the fact that Czech educational authorities give formal support to adult education, reality 'in the field' is somewhat different (Rabusicova & Rabusic, 2006).

Results from Eurostat (2020) showed that the Czech Republic is in utilization of study materials on the Internet and in running communication on-line with lecturers and other students better than the average results of the whole EU28. Results also show that citizens are used to use the Internet on mobile, notebook or desk computer. Some of them are also used to using a tablet, but individuals do not use tablets so often. In informal education won computer and/or Internet and printed materials before other sources. Unfortunately, almost 30% people didn't participate in the in-formal education. Computer and/or Internet education are the most preferred ways of further education in respondents until the age of 54, in the older age category utilization of printed materials is more preferable.

Our pilot study shows that individuals prefer combination of ICT and face-to-face. Surprisingly in the age group 18-25, individuals prefer use of printed sources before others. Individuals in the age group 26-35 prefer computer/notebook the most. Based on the findings, it is recommendable to use corporate education portals and enrich them with a section of the links with free accessible education portals, which respondents prefer.

The following phase of the design of the corporate education portal should follow two directions: firstly compose a scheme and the elaborated offer of training programmes covering end-to-end online and offline employee training and secondly create a comprehensive way reporting of employees' learning activities and providing control over their personal progress.

Acknowledgments: We would like to thank to project "SPEV – ICT as Support Tool for Cognitive Processes", 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic" and to Anna Borkovcová.

References

- Armstrong, M. (2009). *Armstrong's Handbook of Human Resource Management Practice* (11th ed.). Kogan Page Limited, London.
- Bell, D. (1976). The Coming of the Post-Industrial Society. *The Educational Forum*, 40(4), 574-579.
- Burch, S. (2006). *The Information Society / the Knowledge Society*. <https://vecam.org/archives/article517.html>
- Cerkovskis, E., & Titko, J. (2017). Matching Competences and Modern Labour Market Needs: Students' Self-perception Study. In T. Studzieniecki, M., Kozina, & D. Skalamera Alilovic (Eds.), *Economic and Social Development* (pp. 228-236). https://www.esd-conference.com/upload/book_of_proceedings/Book_of_Proceedings_esdWarsaw2018_Online.pdf
- Cerna, M., & Svobodova, L. (2013). Insight into social networks with focus on corporation setting. In P. Jedlička (Ed.), *Hradecké ekonomické dny 2013* (pp. 24-30). https://uni.uhk.cz/hed/site/assets/files/1050/proceedings_2013_3.pdf
- Coulson-Thomas, C. (2013). Business Education and Corporate Learning. *Effective Executive. IUP Publications: Coulson-Thomas*, 16(3), 11-20.
- CZSO. (2016). *Education adults in the Czech Republic 2016*. CZSO. <https://www.czso.cz/csu/czso/vzdelavani-dospelych-v-ceske-republice-2016>

- CZSO. (2017). *Information society in figures – 2017*. CZSO. <https://www.czso.cz/csu/czso/information-society-in-figures-2014-2016>
- Drucker, P. F. (1999). Knowledge-Worker Productivity: The biggest challenge. *California management review*. 41(2), 79-94. <https://doi.org/10.2307/41165987>
- Eurostat. (2020). *Education and training*. Eurostat. <https://ec.europa.eu/eurostat/web/education-and-training/data/database>
- Fan, C. S., & Wei, X. (2010). Training and worker effort: A signalling perspective. *The Canadian Journal of Economics*, 43(2), 604-621. <https://doi.org/10.1111/j.1540-5982.2010.01585.x>
- Gómez-Mejía, L. R., Balkin, D. B., & Cardy, R. L. (2016). *Managing Human Resources* (8th ed.). Boston: Pearson.
- Hodges, A. (2009). *Corporate e-learning: How three healthcare companies implement and measure the effectiveness of e-learning* (Doctoral dissertation). The University of Alabama.
http://acumen.lib.ua.edu/content/u0015/0000001/0000180/u0015_0000001_0000180.pdf
- Kim, K., Collins Hagedorn, M., Williamson, J., & Chapman, C. (2004). *Participation in Adult Education and Lifelong Learning: 2000–1 (NCES 2004–050)*. U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office
- Köhn, J. (2017). The Division of Knowledge and Unknowledge. In J. Köhn (Ed.), *Uncertainty in Economics*. (pp. 125-137). Springer Berlin Heidelberg.
- OECD. (2016). *Skills Matter: Further Results from the Survey of Adults Skills*. OECD Skills studies. OECD publishing, Paris. <https://doi.org/10.1787/9789264258051-en>
- Rabusicova, M., & Rabusic, L. (2006). Adult Education in the Czech Republic – Who Participates and Why. *Czech Sociological Review*, 42(6), 1195–1218. <https://doi.org/10.13060/00380288.2006.42.6.05>
- Svobodova, L., & Cerna, M. (2018). Economic Aspects of Corporate Education and Use of Advanced Technologies. In T. Hao, W. Chen, H. Xie, W. Nadee, & R. Lau (Eds.), *Emerging Technologies for Education. SETE 2018* (Vol. 11284, pp. 117-126). Springer Berlin Heidelberg.
https://link.springer.com/chapter/10.1007/978-3-030-03580-8_13
- Titmus, C. J. (1996). *Adult Education: Concepts and Principles*. *International Encyclopedia of Adult Education and Training* (2nd ed.). Oxford, UK: Pergamon.

Identification of Strategic Position of E-commerce Enterprises in Fashion Industry

Zuzana SVOBODOVÁ

Mendel University in Brno, Brno, Czech Republic; zuzana.svobodova@mendelu.cz

Abstract: The importance of an effective strategy implementation is in e-commerce growing with a development of online shopping. Nevertheless, the practice shows the importance of strategy in e-commerce in the long-term is underestimated. The main purpose of the paper is therefore to identify the strategic position of selected e-commerce enterprises focused on the fashion goods and complementary goods, based on their strategic behavior. The strategic behavior is determined by using on the critical analysis of selected determinants of online shopping behavior. The main research methods to reach the main purpose of the paper are situational analysis and qualitative research using a critical analysis of determinants influencing customer behavior in online shopping. The methods of statistical induction are used to confirm research hypotheses. Finally, the strategic positions of selected e-commerce enterprises in fashion industry are determined. This study identified the strategic position of e-commerce enterprises in fashion industry is affected by determinants of online shopping behavior, however, these determinants are not reflected as equally important. It was also identified that e-commerce enterprises in fashion industry use a balanced strategy, nevertheless, it does not reflect the gradual progressive development of e-commerce industry.

Keywords: strategic behavior; strategic position; fashion industry; e-commerce enterprises; determinants of online shopping behavior

JEL Classification: M00; M39; M19

1. Introduction

The paper deals with the identification of strategic position in online sales of fashion goods and complementary goods in the e-commerce in the Czech Republic considering the identification of determinants of online shopping behavior in the online fashion goods (clothes and complementary accessories). Only limited studies have explored the issue of strategic approach in e-commerce and determinants of online shopping behavior are explored in selected studies (Darsono et al., 2019; Prashant, 2009; Svatošová, 2018; Svatošová, 2020; Richard et al. 2010; Svatošová; 2019b; Svobodová & Rajchlová, 2020; Kim et al., 2018). This study derives from the previous research study (Svobodová & Rajchlová, 2020) dealing with identifying of strategic position of e-commerce enterprises in electronics industry that confirmed these enterprises use the balanced strategic position. This paper therefore aims to confirm or reject if e-commerce enterprises use the same strategic position in other industries. This paper focuses on online fashion sales. The main research question of the study is: what

is the strategic position of enterprises in fashion industry when considering determinants of online shopping behavior?

2. Literary Research

World trade is changing every day, although the rate of change is not the same in all countries (Villa et al., 2018). Enterprises are abandoning traditional commercial methods and are subject to global computer network-based technologies that make it easier to connect with customers and accelerate business (Choshin & Ghaffari, 2017). Through certain strategies, it is possible not only to gain new customers, but also to persuade existing ones to keep returning to the online store, thus these strategies help to increase website attendance, build trust and customer relationships. Successful e-strategies evolve depending on how and what customers buy, how they respond to certain trends, as well as the technologies used in enterprises. Due to the ever-increasing number of online stores, it is essential to understand customer behavior when shopping online, not only to place an order, but also to ensure future loyalty (Chadt, 2017; Hallikainen & Laukkanen, 2018). Nevertheless, only insignificant studies (Zhao et al., 2020; Wang et al., 2010; Zhao et al., 2019) deal with the factors that impact the effective process of strategic management.

Determinants of online shopping behavior are crucial in the effective and successful process of strategic management in e-commerce (Onate, 2016; Yi, 2016; Svatošová 2018; Svatošová, 2020). Online shopping behavior is a key element in reaching business objectives and is affected by series of external and internal factors. Every enterprise should identify its strategic approach in e-commerce considering its portfolio and business environment, such as concepts, principles, and detailed plans for its development. It is also essential to explain methods for assessing the strategic approach (Chen et al., 2014; Svatošová, 2019a). The quality of services is an important factor influencing customer satisfaction. The feeling of trust, evoked by the exceptional level of service, convinces customers to revisit a specific store. Many studies suggest that the quality of electronic services depends primarily on the security of confidential information and on the performance of websites (Shafiee & Bazargan, 2018). As e-shops process a huge amount of information about their customers, their security is one of the most important specifics of online shopping.

Many potential customers do not complete their purchase precisely because of the lack of security that could lead to the transfer of sensitive information (such as credit card numbers). Therefore, as part of minimizing losses, many online retailers have implemented certain measures to verify the identity of the customer (Pílik et al., 2017). As customers are willing to share their experiences with business services and at the same time are interested in other consumers' satisfaction with the goods they are interested in, e-shops allow comments and ratings on their websites or social networks. As a result, they increase the chance of a site visitor becoming a customer (Chadt, 2017).

3. Methodology

3.1. Objectives and Research Methods

The main purpose of the study is to identify the strategic position of e-commerce enterprises oriented on the online sale of fashion goods and complementary goods. The partial aim is to identify the determinants of online shopping behavior in fashions and thus identify the strategic behavior of selected e-commerce enterprises.

The research methods are used to reach the aims of the study (based on the previous research study Svobodová and Rajchlová (2020)): Situational analysis – this method is used to identify the determinants of online shopping behavior in each e-commerce enterprise and current situation of enterprise; Quantitative research—this method calculates with the quantitative and numerical data and use a critical analysis of data on the scale 0–5 (0 – the worst evaluation, 5 – the best evaluation). Critical analysis and determined scoring is used for 11 identified determinants of online shopping behavior that have impact on strategic behavior of e-commerce enterprises in fashion industry.

3.2. Research Hypotheses

To reach the purpose of the study, the main research hypotheses are recognized, based on the findings of a previous studies (Svatošová, 2020; Svobodová & Rajchlová, 2020):

Research hypothesis (H1): E-commerce enterprises in fashion industry use a balanced strategy in most cases (using the critical analysis of determinants of online shopping behavior).

Research hypothesis (H2): The strategic position of e-commerce enterprises in fashion industry is not influenced by determinants of online shopping behavior (using the Kruskal–Wallis test, details see Results and Discussion).

Research hypothesis (H3): Determinants of online shopping behavior in fashion industry are rated as equally significant (using the Friedman test, details see Results and Discussion).

3.3. Research Sample

Due to the constantly growing interest in buying clothes and accessories over the Internet and the fact that this range is the most frequently offered e-shops in the Czech Republic, e-shops selling this type of fashion goods were chosen for the analysis and this research. Selected e-commerce enterprises had to meet the following criteria in particular: (1) Orientation exclusively to the B2C market in e-commerce the Czech Republic; (2) Legal form of enterprise – joint stock company or limited liability company; (3) Existence on the market for at least 7 years; (4) Membership in the Association for Electronic Commerce (APEK) / granted "APEK Certification - Certified Shop" or granted certificate "Verified by customers!" from Heureka.cz.

Due to the above-mentioned restrictive criteria, the popular shopping advisor Heureka.cz was used to select specific e-shops, which for individual e-shops states not only the overall rating from customers, but also whether the store has a "Verified by customers!"

certificate. As it was not possible to limit the list of e-shops only to those that offer clothing and accessories in fashion industry, the selection was considerably more difficult. Therefore, only e-shops that have at least 1,000 reviews from customers and a certificate were considered into research. If the e-shop focused on the sale of clothing and accessories in fashion industry, it was necessary in the next step to find out whether it met the other criteria mentioned. To supplement this, the author of the research was also interested in whether selected e-shops are evaluated on the website of the purchasing advisor Zboží.cz. The other information about research sample see Results and Discussion.

4. Results and Discussion

4.1. Main findings and Strategic Position Identification

The determinants of online shopping behavior are determined based on the previous studies (Svatošová, 2020; Svobodová & Rajchlová, 2020; Hallikainen and Laukkanen, 2018; Prashant, 2009; Richard et al., 2010), which identify the strategic behavior and further strategic position of e-commerce enterprises in the fashion industry: (1) *Reviews of e-shops*; (2) *Complaints*; (3) *Certificates and security*; (4) *Advertising and communication – on social networks, chat, phone line*; (5) *Product price*; (6) *Website – language possibilities, comparative possibilities, adaptation, disturbing elements*; (7) *Product description, filtering and goods ordering*; (8) *Payment methods*; (9) *Transport – number of transport options*; (10) *Discounts – in action, loyalty program and volume discounts*; (11) *Additional services – payments after testing of goods, extended return period of goods, possibilities of exchanging goods, free shipping*.

The identified determinants are scored on the scale 0–5 (1 – the worst evaluation, 5 – the best evaluation) using the critical analysis of data, i.e. the qualitative data are converted into the numerical value for each e-commerce enterprises in research sample. Finally, **61 e-commerce enterprises** have been selected that create the representative sample in fashion industry and divided according to their size (according the division of European Commission), as follows: “*micro enterprises (up to 10 employees, annual turnover up to EUR 2 mil., small enterprises (up to 50 employees, annual turnover up to EUR 10 mil.), medium enterprises (up to 250 employees, annual turnover up to EUR 50 mil.)*”. Details see Table 1. The study shows the larger enterprise is, the higher the scoring of identified determinants is reached.

Figure 1 illustrates the average evaluation of each determinant identified above and distinguished according to the size of enterprise. On average, based on critical analysis, large enterprises are scored higher than the other groups of e-commerce enterprises. Micro enterprises are scored as the worst group. The same results are reached in previous studies (Svatošová, 2018; Svatošová 2019a; Svatošová, 2020; Svobodová & Rajchlová, 2020). On average, the best results were scored for: review of e-shops (4.81), website (4.28), and complaints (4.27). The worst results were scored for: discounts (3.61), product price (3.63) and product description (3.66).

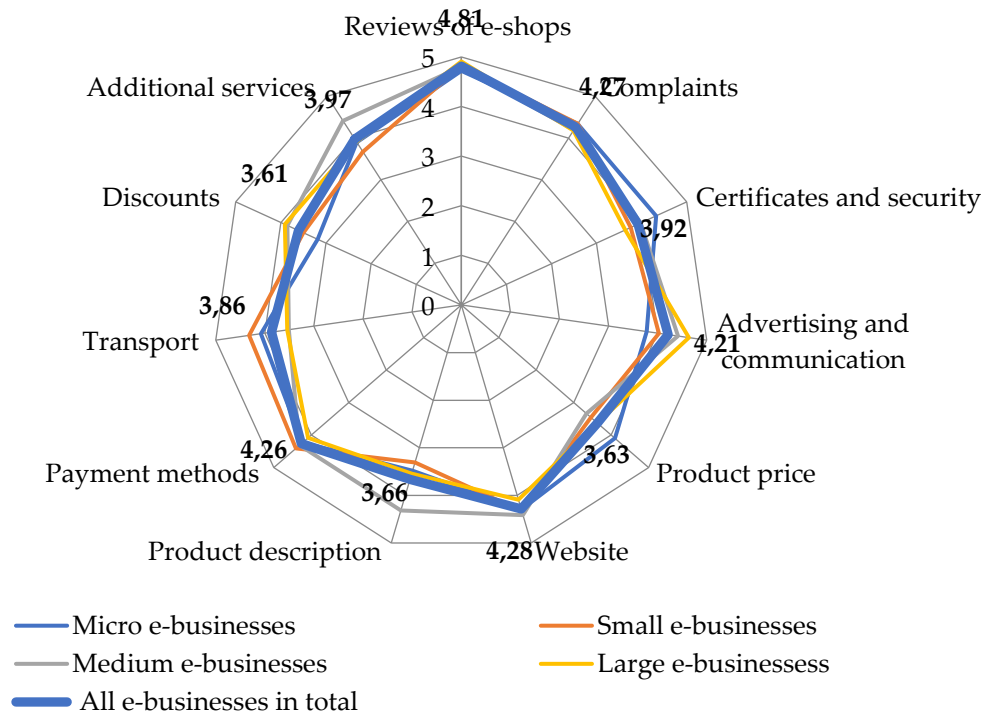


Figure 1. Quality of factors of online shopping behavior according to the business size. Source: own.

Finally, total of 11 determinants were assessed in the study. When all 11 determinants have been summarized for each e-commerce, it was possible to reach maximum 55 points. This final scoring has been used for determination of strategic position of e-commerce enterprises in fashion industry according to the following evaluation (Svobodová & Rajchlová, 2020):

- **“52–55 points: Progressive strategic position:** This strategy is characterized by the ability to respond quickly to current customer needs and the ability to adapt to new trends. They invest in innovations and new technologies, expand their portfolio, try to penetrate foreign markets, or buy other companies and develop. High profitability and low liquidity is typical here.
- **29–41 points: Balanced strategic position:** Enterprises with this strategy want to develop, but they do not have as much money to implement and do not take large risks.
- **15–28 points: Stabilization (conservative) strategic position:** These enterprises are characterized by a conservative approach and do not have enough capital for further development. They focus on the stabilizing the online market and customer base. High liquidity is typical for this strategy
- **0–14 points: Crisis strategic position:** With this approach, the business tries to stay in the market. It does not invest in innovation and new technological possibilities. Business struggles with the low profitability and liquidity, low market share, and customer base.”

Table 1 reflects the assessing the strategic position of enterprises in e-commerce allocated according to their size. In summary, a balanced strategic position prevails (44.26%) in all groups of enterprises in e-commerce. Then the e-commerce strategic behavior focused on

stabilization (conservative) strategic position (42.62%) prevails. Finally, only 9.81% of enterprises in e-commerce use a progressive strategic position. The crisis strategic position is used by only 4.91% of enterprises in e-commerce.

Table 1. Strategic position of enterprises in e-commerce in the fashion industry. Source: own.

Strategic Position of E-Enterprises	Progressive strategic position	Balanced strategic position	Stabilization (Conservative) strategic position	Crisis strategic position	In summary
Micro e-enterprises	0	1	2	0	3
Small e-enterprises	1	15	7	1	24
Medium e-enterprises	3	8	16	2	29
Large e-enterprises	1	3	1	0	5
E-enterprises in total (61)	5	27	26	3	61
E-enterprises in total (in %)	9.81%	44.26%	42.62%	4.91%	100%

4.2. Hypotheses Verification and Final Discussion

The previous chapter 4.1 identified the dominating strategic position of e-commerce enterprises in fashion industry is a balanced strategic position. Therefore, we can confirm the hypothesis H1: **E-commerce enterprises in fashion industry use a balanced strategy in most cases** (using the critical analysis of determinants of online shopping behavior). The same results have been reached in previous study (Svobodová & Rajchlová, 2020) with e-commerce enterprises with online sales of electronics. The other studies derived from a prerequisite the e-commerce enterprises should apply a progressive strategic position that reflect the gradual progressive development of e-commerce industry (Chen et al. 2014; Svatošová 2019b; Ballestar et al., 2018).

The Shapiro-Wilk test is used to decide if parametric or non-parametric test can be selected for hypotheses verification H2 and H3. This calculation identified the selection did not derive from a normal probability distribution at the significance level of $\alpha = 0.05$, since $p \leq \alpha$ (using the software Statistica), therefore only non-parametric tests can be used. The hypotheses H2 and H3 are verified at the significance level $\alpha = 0.05$, i.e. the minimum level where the null hypothesis cannot be confirmed, as $p \leq \alpha$. The confirmation of hypotheses is calculated by equating the p-value and the significance level α .

The hypothesis H2 is tested with a help of the Kruskal–Wallis test. Table 2 demonstrates an example for verification of the selected 11 determinants in e-commerce in relation to the strategic position of e-commerce enterprises, the example is reviews of e-shops. Based on testing, null hypothesis is rejected and therefore we can conclude: **the strategic position of e-commerce enterprises in fashion industry is influenced by determinants of online shopping behavior**. The similar results were reached in previous study (Svobodová & Rajchlová, 2020; Svatošová, 2020). Detail calculation of Statistica software of each determinant of online behavior of p-values is following:

- (1) Reviews of e-shops $p = 0.9877$;
- (2) Complaints $p = 0.8194$;
- (3) Certificates and security $p = 0.3278$;

- (4) Ad and communication $p = 0.9534$;
- (5) Product price $p = 0.7396$;
- (6) Website $p = 0.9828$;
- (7) Product description $p = 0.8990$;
- (8) Payment methods $p = 0.0029$;
- (9) Transport $p = 0.4719$;
- (10) Discounts $p = 0.0010$;
- (11) Additional services $p = 0.8986$;

Table 2. Kruskal–Wallis ANOVA founded on order; Example: Reviews of e-shops according to type of strategic position. Source: own (in the Statistica).

Dependent Variable: Type of Strategic position	Independent (Group) Variable: Type of Strategic Position Kruskal–Wallis Test: $H(4, N = 61) = 0.3312065, p = 0.9877$		
	Number of Valid	Sum of Order	Average Order
Progressive strategic position	3	5448	106.823529
Balanced strategic position	24	9,024.5	106.170588
Conservative strategic position	29	4,225.5	103.060976
Crisis strategic position	3	1,168.5	97.375

The hypothesis H3 is tested with a help of the Friedman's test at the significance level of $\alpha = 0.05$. Since $p = 0.0000$ i.e., $p \leq \alpha$, therefore, the null hypothesis is rejected, i.e. we can concluded that **determinants of online shopping behavior in fashion industry are not rated as equally significant**, see Table 3. The similar results were reached in previous study (Svobodová & Rajchlová, 2020). Nevertheless, the researches revealed the determinants of online shopping behavior should be reflected as equally important (Wang et al., 2010; Chenxu et al., 2017; Prashant, 2009; Yanes-Estévez et al., 2018; Richard et al., 2010;).

Table 3. Friedman's ANOVA and Kendall's compliance coefficient: Factors of online shopping behavior. Source: own in the Statistica).

Variables of Factors of Online Shopping Behavior	ANOVA Chi-Qu. ($N = 61$) = 27.70730 $p = 0.0000$ Compliance Coefficient = 0.00947, $r = 0.00471$			
	Average Order	Sum of Order	Average Mean	Standard Deviation
(1) Reviews of e-shops	7.784689	1,627.000	3.019139	1.424247
(2) Complaints	7.767943	1,623.500	3.000000	1.376311
(3) Certificates and security	7.851675	1,641.000	3.023923	1.419101
(4) Ad and communication	7.851675	1,641.000	3.038278	1.347529
(5) Product price	8.064593	1,685.500	3.124402	1.391536
(6) Website	7.995215	1,671.000	3.057416	1.389021
(7) Product description	8.913876	1,863.000	3.392344	1.340615
(8) Payment methods	8.985646	1,878.000	3.440191	1.299967
(9) Transport	7.971292	1,666.000	3.114833	1.439892
(10) Discounts	8.045455	1,681.500	3.095694	1.441297
(11) Additional service	7.796651	1,629.500	3.033493	1.408705

5. Conclusions

This paper extended the findings from the previous study (Svobodová & Rajchlová, 2020) focused on the enterprises in e-commerce in online sales of white electronics. This study revealed the strategic position of e-commerce enterprises in fashion industry is also influenced by determinants of online shopping behavior such as in the electronics industry. This result indicate determinants of online shopping behaviors are considered when designing and implementing strategy in the fashion industry in e-commerce. It was also identified that determinants of online shopping behavior are not valued as equally significant, nevertheless, according to previous studies they should be considered as equally important. Finally, enterprises in e-commerce use a balanced strategic position in most cases (44.26%). However, the strategic position should reflect the gradual progressive development of e-commerce industry. The progressive strategic position is applied only in 9.81% of cases. We can conclude, there is a difference between the progressive development of e-commerce and the strategic position of e-commerce enterprises in fashion industry, i.e. no wide-ranging strategic approach is applied in fashion industry in e-commerce. Although, the main goal of this study has been fulfilled, some limitations can be identified. This study is oriented only on e-commerce enterprises in the fashion industry and complementary accessories in the comparison with the study focused on e-commerce enterprises with online sales of electronics. Therefore, the other studies will focus on the other industries in e-commerce to deal with and compare the findings from these studies. The main benefit of this study is based on the critical analysis of determinants of online shopping behavior in the fashion industry and determination of strategic position of e-commerce enterprises in the selected industry.

Acknowledgments: This study is organized within the project IGA of MENDELU named as "Identification of determinants of online shopping behavior in the strategic behavior of enterprises in e-commerce" with the numbering FRRMS - IGA - 2021/004.

References

- Ballestar, M. T., Grau-Carles, P., & Sainz, J. (2018). Customer segmentation in e-commerce: Applications to the cashback business model. *Journal of Business Research*, 88, 407-414.
<https://doi.org/10.1016/j.jbusres.2017.11.047>
- Bandara, R., Fernando, M., & Akter, S. (2019). Explicating the privacy paradox: A qualitative inquiry of online shopping consumers. *Journal of Retailing and Consumer Services*, 52, 1-9.
<https://doi.org/10.1016/j.jretconser.2019.101947>
- Chadt, K. (2017) *Psychologie trhu v obchodu a službách*. Praha: Press21
- Chen, J. E., Pan, S. L., & Ouyang, T. H. (2014). Routine reconfiguration in traditional companies' e-commerce strategy implementation: A trajectory perspective. *Information & Management*, 51(2), 270-282.
<https://doi.org/10.1016/j.im.2013.11.008>
- Chenxu K., Yan, B., & Xu, R. (2017). A group-buying mechanism for considering strategic consumer behavior. *Electronic Commerce Research*, 17(4), 721-752. <https://doi.org/10.1007/s10660-016-9232-9>
- Choshin, M., & Ghaffari, A. (2017). An investigation of the impact of effective factors on the success of e-commerce in small- and medium-sized companies. *Computers in Human Behavior*, 66, 67-74.
<https://doi.org/10.1016/j.chb.2016.09.026>
- Darsono, J. T., Susana, E., Prihantono, E. Y., & Eley, S. K. (2019). Strategic Policies for Small and Medium Enterprises in marketing through E-commerce. *Entrepreneurship and Sustainability Issues*, 7(2), 1230-1245.
<https://doi.org/10.9770/jesi.2019.7.2>

- Hallikainen, H., & Laukkanen, T. (2018). National culture and consumer trust in e-commerce. *International Journal of Information Management*, 38(1), 97-106. <https://doi.org/10.1016/j.ijinfomgt.2017.07.002>
- Kim, H., Lee, D. & Ryu., M.H. (2018). An Optimal Strategic Business Model for Small Enterprises Using Online Platforms. *Sustainability*, 10(3), 1-11. <https://doi.org/10.3390/su10030579>
- Onate, C. G. (2016). E-commerce in Spain and the Strategy of Online Branding: The Apps as Platform for Shopping. *Revista Comunicacao Midiatica*, 11(3) 230–250.
- Pilík, M., Klimek, P., Jurickova, E., & Palka, P. (2017). Comparison Shopping Agents and Czech Online Customers' Shopping Behavior. *International Journal of Entrepreneurial Knowledge*, 4(2), 62-69.
- Prashant, P. (2009). The role of trust in e-commerce relational exchange: A unified model. *Information & Management*, 46(4), 213-220. <https://doi.org/10.1016/j.im.2009.02.003>
- Richard, M. O., Chebat, J. C., Yang, Z., & Putrevu, S. (2010). A proposed model of online consumer behavior: Assessing the role of gender. *Journal of Business research*, 63, 926-934. <https://doi.org/10.1016/j.jbusres.2009.02.027>
- Shafiee, M. M., & Bazargan, N. A. (2018). Behavioral Customer Loyalty in Online Shopping: The Role of E-Service Quality and E-Recovery. *Journal of Theoretical and Applied Electronic Commerce Research*, 13(1), 26-38. <https://doi.org/10.4067/S0718-18762018000100103>
- Svatošová, V. (2018). Importance of Strategy and Aspects of Strategic Development in Small and Medium-Sized Entrepreneurship. *Ekonomický časopis*, 66(4), 329-349.
- Svatošová, V. (2019a). Importance of Strategic Management of SMEs in E-commerce. *Ekonomický časopis*, 67(10), 1090-1110.
- Svatošová, V. (2019b). Strategic Approaches of SMEs in Economic Performance of E-commerce. In *Proceedings of the 16th International Scientific Conference: European Financial Financial Systems 2019* (pp. 574-583). Brno: Masaryk University.
- Svatošová, V. (2020). The Importance of Online Shopping Behavior in the Strategic Management of E-Commerce Competitiveness. *Journal of Competitiveness*, 12(4), 143–160. <https://doi.org/10.7441/joc.2020.04.09>
- Svobodová, Z., & Rajchlová, J. (2020). Strategic Behavior of E-Commerce Businesses in Online Industry of Electronics from a Customer Perspective. *Administrative Sciences*, 10(4), <https://doi.org/10.3390/admsci10040078>
- Villa, E., Ruiz, L., Valencia, A., & Picón, E. (2018). Electronic Commerce: Factors Involved in its Adoption from a Bibliometric Analysis. *Journal of Theoretical and Applied Electronic Commerce Research*, 13(1), 39–70. <https://doi.org/10.4067/S0718-18762018000100104>
- Wang, Y. J., Hernandez, M. D., & Minor, M. S. (2010). Web aesthetics effects on perceived online service quality and satisfaction in an e-tail environment: The moderating role of purchase task. *Journal of Business Research*, 63(9–10), 935–942. <https://doi.org/10.1016/j.jbusres.2009.01.016>
- Yanes-Estévez, V., García-Pérez, A. M., & Oreja-Rodríguez, J. R. (2018). The Strategic Behaviour of SMEs. *Administrative Sciences*, 8(4), 61. <https://doi.org/10.3390/admsci8040061>
- Yi, S. (2016). E-commerce strategy for agricultural product transaction market based on information asymmetry. *Agro Food industry Hi-tech*, 27(6), 138–143.
- Zhao, J., Liu, H., & Xue, W. (2019). PEST Embedded SWOT Analysis on China's E-Commerce Industry Development Strategy. *Journal of Electronic Commerce in Organizations*, 17(2), 55–68. <https://doi.org/10.4018/JECO.2019040105>
- Zhao, Y., Zhou, Y. & Deng, W. (2020). Innovation Mode and Optimization Strategy of B2C E-Commerce Logistics Distribution under Big Data. *Sustainability*, 12(8), 73–81. <https://doi.org/10.3390/su12083381>

Is Citizen Tracking Acceptable?

Jana SYROVÁTKOVÁ* and Antonín PAVLÍČEK

Prague University of Economics and Business, Prague, Czech Republic; jana.syrovatkova@vse.cz;
pavlicek@vse.cz

* Corresponding author: jana.syrovatkova@vse.cz

Abstract: Along with the extensive use of information and communication technology (ICT) gains importance also the issue of privacy. The main questions are: a) how much invasions of privacy and b) from whom is still acceptable. In this paper, we discuss the approval of invasion of privacy from state institutions (government and police). The research took place in the Czech Republic in October 2020, out of 429 respondents 302 were first-year university students. Paper answers whether people agree with invasion of privacy by state institutions. Alternatively, which interventions they consider to be tolerable and where their disagreement is significant. Due to the COVID epidemic, the question of automatic monitoring of the spread of the epidemic was included. Privacy intrusion was divided into 4 categories - police information, security, gathering information for scientific and other beneficial purposes, information about citizens interfering with privacy or without a clear purpose. The answers are further differentiated according to age and gender. The perception of individual intrusions on privacy by different groups is compared. Main findings include an agreement to share data for scientific purposes and strong disagreement with the automatic evaluation of tweets in order to monitor the spread of epidemics. Research shows that people generally disagree with automated invasions of privacy.

Keywords: e-government; tracking; survey

JEL Classification: H76; O38; H12

1. Introduction

The fundamentals of modern systematic surveillance of population were laid by cardinal Richelieu in 17th century, but culminated in the era of French Revolution. At that time, they did not have the current technological possibilities for monitoring and recording, instead it was achieved through the Comité de surveillance révolutionnaire - a network of informants and prosecutors. Seemingly innocuous data about citizens has been misused many times in the past. A sad example are membership lists of Sokol and The Jewish community, which were acquired by the Gestapo in 1939 and abused for liquidation of "unsuitable" persons. The Russian counterintelligence acted similarly in 1945, equipped with lists of Russian emigrants (Vokoun, 2020).

In connection with the expansion of information and communication technologies (ICT) and the possibilities of automated monitoring of citizens almost "at every step", the topic of privacy is widely discussed. There are appeals to privacy as a right to decide with whom to share what information. Great emphasis is placed on the protection of information about

one's own social ties, which have been misused many times in the past to persecute people who knew uncomfortable people (Vokoun, 2020).

One of the reasons of Bitcoin's popularity is its anonymity – it provides privacy of ownership, as well as of transactions - the payments are not traceable (Sudzina et al., 2019).

On the other hand, there is a very common approach: "He who does nothing wrong, has nothing to hide." Some security oriented apps can actually help user to record the details of his life in the protected Timeline, which contains information such as who, when, and where the user is meeting, just in case anything happens. User can add his friends to so called Safety Network so they can make sure user never goes missing (Noonlight, 2021). The app can be pre-programmed for how long user would like to be tracked. It can also store the details about his time – pictures, notes. If the user does not confirm his/her safety in regular intervals, it would automatically send an alert to the friends with exact location (Watchovermeapp, 2021). It can also make live stream, share the current location, and guardians can trace the user via GPS (BSafe, 2021).

At the Philippines users can install Android application AppLERT which can help victims of the natural or man-made disaster to seek help. Users can also notify others of the danger ahead through application or through Facebook. Application uses built-in GPS in the user's mobile phone (Fabito et al., 2016).

Terrorists and criminals are big phenomena in human society. Governments try to organize activities such as TAKEDOWN Project (EU H2020), which is focused on the understanding of Organized crimes and Terrorism phenomena with the aim to deliver cyber solutions by focusing on an advanced collaboration among citizens and Law Enforcement Agencies (Tundis et al., 2020).

It is very difficult to decide where the limit lies, what is acceptable and permitted surveillance and what is already an unwanted invasion of privacy. What some think is right, others will consider inadmissible. In the context of the COVID-19 epidemic, the European Data Protection Board approved a Request for mandate regarding geolocation and other tracing tools in the context of the COVID-19 outbreak, which directly explains what is and is not permissible epidemic surveillance (EDPB, 2020).

2. Methodology

We have collected data in November 2020 as a part of the larger survey focused on social networks and privacy. Respondents were the first-year students of Prague University of Economics and Business, Faculty of Finance and Accounting (N = 299) and various students of the Faculty of Informatics and Statistics (N = 130).

We had analyzed the perception of individual intrusions on privacy by different groups. The answers are further differentiated according to age and gender. For statistical analysis we had used t-test with $H_0: \mu_0 = 5.5$ resp. $\mu_0 = 50$ depending on question type and with $H_A: \mu_0 \neq 5.5$ resp. $\mu_0 \neq 50$. We had set confidence intervals for μ too.

For comparisons between types of respondents we had used t-test too. In that case was $H_0: \mu_1 = \mu_2$ and $H_A: \mu_1 \neq \mu_2$. We set also confidence intervals.

Results are summarized in the form of descriptive pie charts, bar charts and cobweb charts.

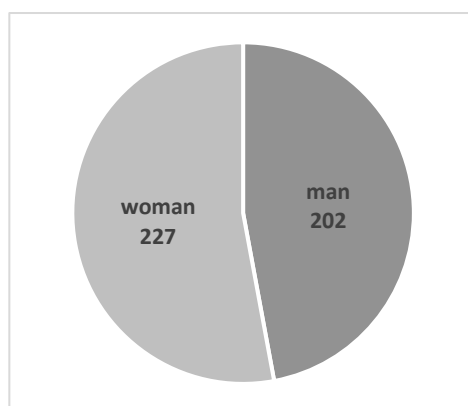


Figure 1. Gender of respondents

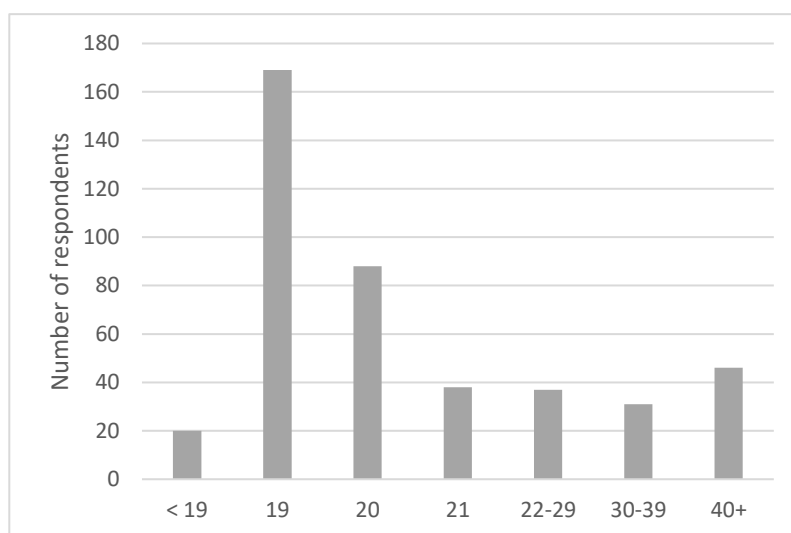


Figure 2. Age distribution of respondents.

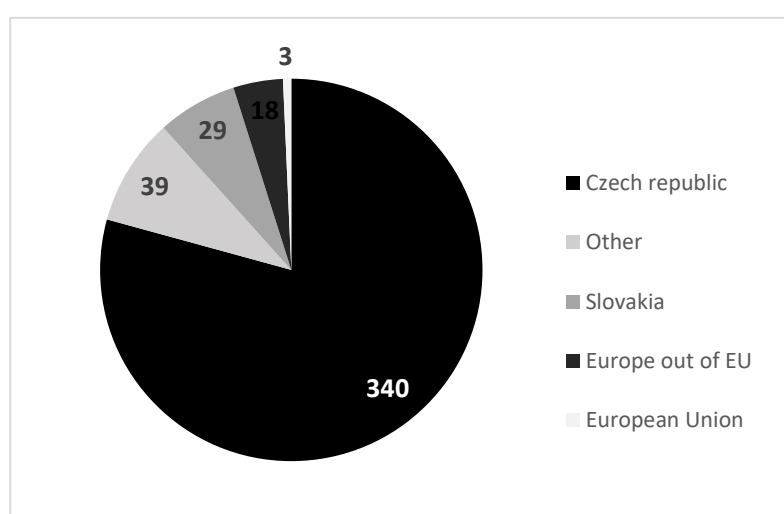


Figure 3. Birthplace of respondents.

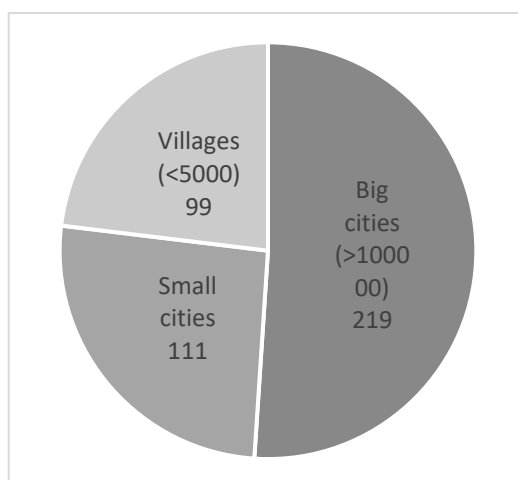


Figure 4. Urbanization of respondents

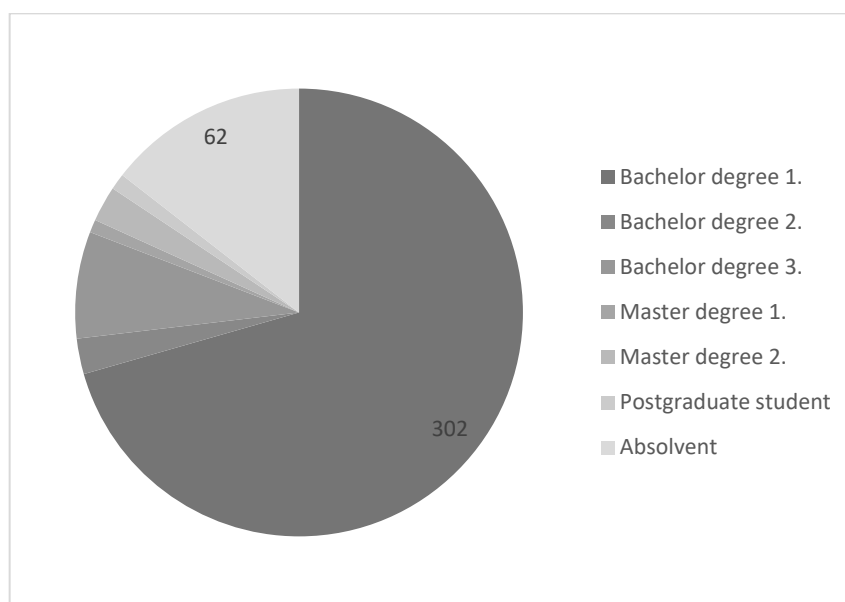


Figure 5. School year distribution of respondents

Article analyzes 10 questions related to 4 categories: a) scientific and other seemingly beneficial purposes, b) information about citizens interfering with privacy with or c) without a clear purpose, d) security, police information. We code questions Q1 to Q10. Respondents were asked how much they agree or disagree with the statement on likert scale of 1 to 10 from strongly agree to (1) to strongly disagree with the sentence (10).

2.1. Survey Questions

Science and altruism

- Q1 Movements of drivers' mobile phones (geolocation) should be monitored by the Ministry of Transportation to analyze the usage of transport infrastructure and to predict traffic congestion.
- Q2 All state-owned / managed data should be freely available for scientific and research purposes.

- Q3 Data from mobile applications, search engines and social networks should be used to solve serious social problems (security, unemployment, immigration, etc.).

Informing citizens

- Q4 The government should be able to monitor and analyze mobile phone location data to find out where individuals actually live and work.
- Q5 Automated detection of unusual (dangerous) behavior at airports / train/bus stations / in public transport may include profiling according to age, gender and ethnic origin or expressions of faith.

Safety

- Q6 Tweets or searches with words such as "vomiting", "temperature", "headache" should be used to monitor the spread of the viral disease epidemic.
- Q7 Encrypted communications (i.e. Telegram app) should be banned to make it easier for the government to detect security threats.

Police

- Q8 Drivers for whom the monitoring of the movement of their telephone detects a significant speeding or other dangerous behavior (violation of the entry ban, ...) should be automatically penalized. (data passed to the police)
- Q9 The police should have easy access to a list of telephone calls.
- Q10 The police should be able to monitor the movement of people through their mobile phone.

3. Results

The following graph shows a summary of all answers. It can be seen that people usually disagree with monitoring. For some questions it is less pronounced, for example Q1, while for Q4 the disagreement is really strong.

The basic statistical analysis of the whole dataset is in Table 1. In addition to t-statistics, the confidence interval for the mean is added to illustrate possible fluctuations of the mean value estimates of individual questions.

It is therefore clear from the results that hypothesis H0 for this question cannot be rejected for Q1. The answers are not significantly skewed to either side. Therefore, the data show that aside from the use of mobile phones for location tracking to prevent traffic, people are divided. All other equality hypotheses can be rejected because the test statistic is higher than 1.96. The most significant deviation is in question Q4 followed by question Q7 aimed at prohibiting encrypted communication. Other significant disagreements are issues related to police surveillance of mobile phones and twitter communication in order to combat epidemics.

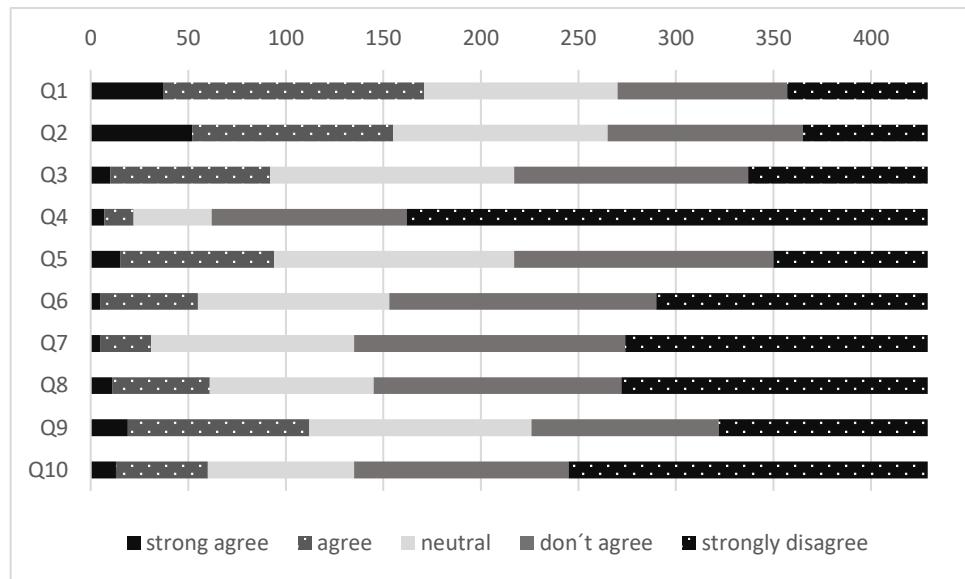


Figure 6. Summary chart of agreement and disagreement with the statements

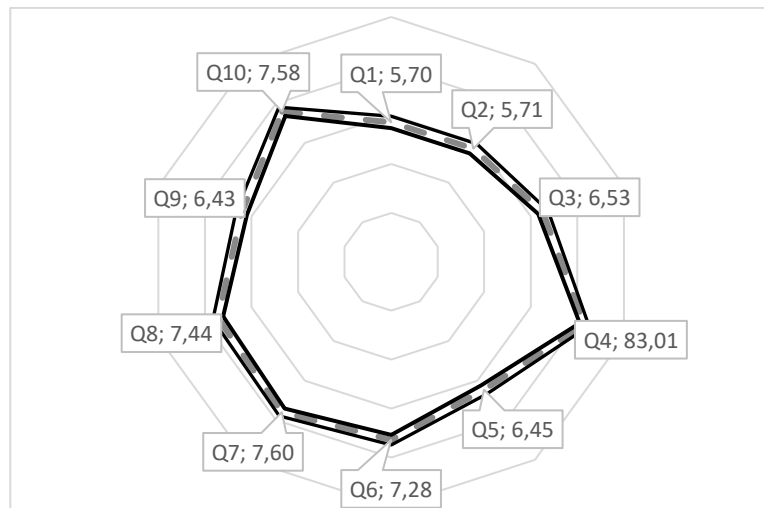


Figure 7. Confidence interval and mean for whole dataset

Table 1. Statistical analysis of the whole dataset

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Mean		5.70	5.71	6.53	83.01	6.45	7.28	7.60	7.44	6.43	7.58
sampling variance		6.38	6.54	5.11	446.29	4.88	4.72	4.04	5.41	6.09	5.55
t-statistics		1.63	1.71	9.43	32.36	8.95	16.94	21.59	17.25	7.82	18.31
confidence interval for the mean	min	5.46	5.47	6.32	81.01	6.25	7.07	7.41	7.22	6.20	7.36
	max	5.94	5.95	6.74	85.01	6.66	7.48	7.79	7.66	6.66	7.81

3.1. Analysis for Different Groups of Respondents

In the next part, we analyzed the data by gender and age. As the basic research took place among first-year students, they are all under the age of 20, while others are 21 and older. Also, in this analysis, we have focused on the mean value and hypotheses whether the mean value is significantly skewed to either side.

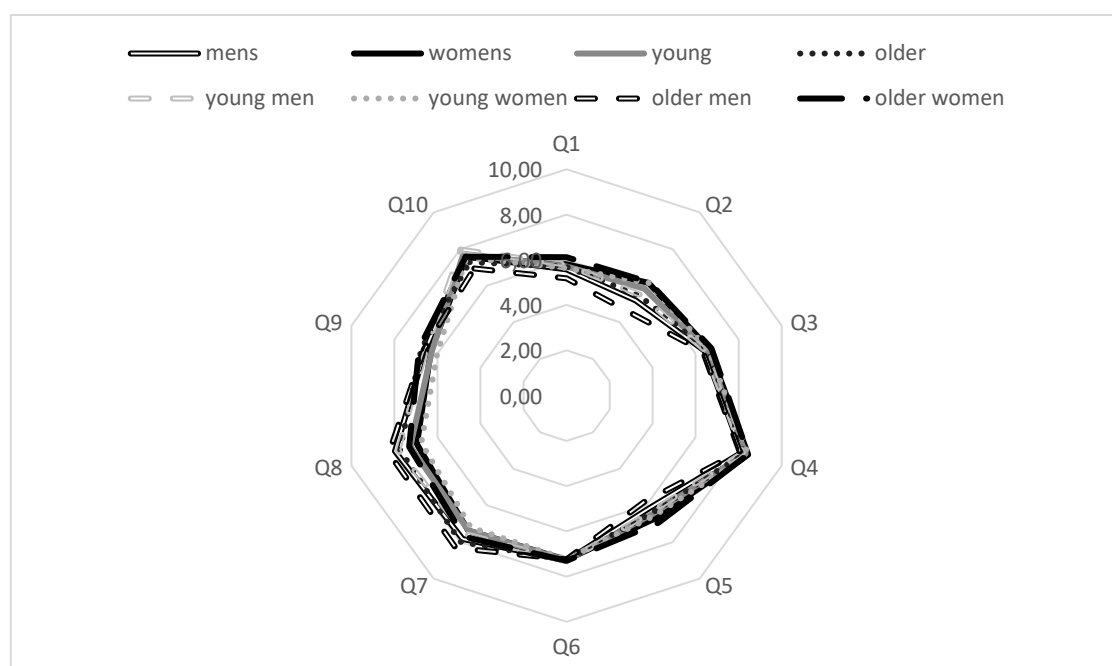


Figure 8. Differences of the mean depending of the sex and age

Table 2a. Differences of the mean depending of the sex and age

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Men	5.58	5.20	6.41	81.4	6.18	7.30	7.84	7.98	6.57	7.61
Women	5.81	6.17	6.63	84.4	6.70	7.26	7.38	6.96	6.31	7.56
Young	5.70	5.85	6.52	83.2	6.47	7.28	7.38	7.26	6.26	7.74
Older	5.69	5.46	6.55	82.6	6.42	7.28	7.99	7.75	6.74	7.29
young men	5.79	5.52	6.45	81.9	6.37	7.33	7.58	7.83	6.54	7.97
young women	5.63	6.15	6.58	84.4	6.57	7.23	7.20	6.75	6.01	7.54
older men	5.19	4.60	6.34	80.5	5.81	7.24	8.33	8.26	6.63	6.94
older women	6.12	6.20	6.73	84.4	6.94	7.30	7.71	7.32	6.84	7.59

Table 3b. Differences of the means depending of the sex and age

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Men	0.44	-1.68	5.57	19.40	4.38	11.65	16.41	17.39	6.04	12.30
Women	1.86	4.05	7.76	26.98	8.24	12.27	14.33	8.88	5.03	13.57
Young	1.33	2.38	7.52	26.80	7.17	13.58	15.53	12.46	5.07	16.36
Older	0.95	-0.18	5.67	18.23	5.35	10.08	15.75	12.38	6.41	8.95
young men	1.29	0.07	4.64	16.52	4.27	9.47	11.70	13.17	4.77	12.64
young women	0.60	3.37	6.00	21.69	5.87	9.71	10.33	5.99	2.47	10.64
older men	-1.02	-2.97	3.06	10.35	1.41	6.74	12.35	11.55	3.68	4.52
older women	2.42	2.30	4.90	15.95	5.92	7.45	10.27	6.98	5.42	8.39

Table 2b proves, that hypothesis of a neutral relationship to the relevant statement for a given group of respondents cannot be rejected. In one case, we even reject the hypothesis because the data are skewed to the opposite side, i.e. it can be said that older men agree with the availability of data for scientific purposes.

There are significant differences in the results of question 2, so we have also charted the differences in confidence intervals for individual groups in the form of a ray graph in Figure 9. To highlight the differences, the scale is only from 3 to 7.

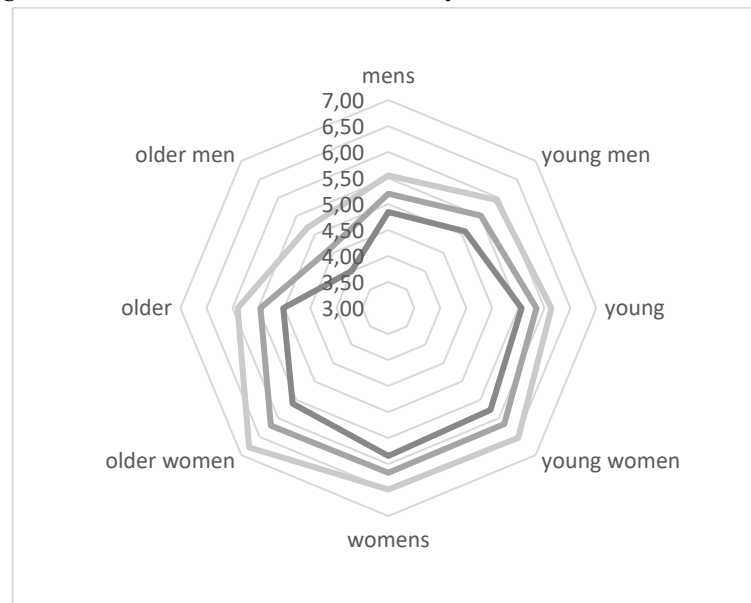


Figure 9. Differences in confidence intervals for individual groups in Q2

3.2. Differences between Men and Women, Between Younger and Older Respondents

Finally, we hypothesized whether men respond as well as women and whether young respond in the same way as older.

Table 4. T-test values for hypothesis about the same means at different types of respondents

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
men vs. women	0.93	3.99	1.02	1.47	2.46	-0.18	-2.34	-4.64	-1.09	-0.26
young vs. older	-0.05	-1.50	0.16	-0.30	-0.23	-0.01	3.06	2.08	1.95	-1.92

If we compare T-values with a critical value of the t-distribution (1.96), we can see that the differences between younger and older respondents are usually insignificant. The only difference is between questions Q7 and Q8 concerning the banning of encrypted communication and speeding monitoring by mobile phones. Both groups disagree, but the disagreement among the elders is more pronounced. Men and women also differ on these issues, with men disagreeing more.

However, men and women differ in question 2, which was discussed in more detail in the previous section, as well as in question 5 on the automatic detection of suspicious behavior at airports, and whether this detection may include race, age or gender.

4. Discussion

The paper dealt with a survey of the approach of respondents, primarily students, to monitoring/surveillance of citizens by various state institutions. The questions focused on surveillance for scientific purposes, surveillance of citizens for general undefined reasons or

for security reasons, either for protection against epidemics or surveillance of mobile phones for automatic transportation fines and for more serious criminal offenses.

The survey showed that depending on the type of question, the acceptance of the observation varies, but the answers have always been skewed towards disagreement with the statement – meaning disagreement with the surveillance. Only for questions where the whole society would directly benefit from the data (scientific purposes or prediction of traffic congestion) is this disagreement not statistically significant.

Most people do not agree with non-anonymized mobile phone tracking - both in order to find out where they actually live (the most significant disagreement) and in order to be able to fine for inappropriate behavior.

When comparing data between different groups of respondents, there is an interesting discrepancy between the availability of data for scientific purposes and a discrepancy with the distinction between age, gender, ethnic origin or religion in the automated detection of dangerous behavior. Interestingly, objection to the surveillance for this reason was more profound with women. There was also disagreement with the ban on encrypted communication and automatic fines for speeding by mobile phone. The men here predictably disagreed more.

Interestingly, young and older differed little on most issues, while men were much more pronounced than women, often in all age groups.

5. Conclusions

People in general reject surveillance and monitoring. There were some exceptions (cases where the whole society would directly benefit from the data) and we have also recorded gender differences, but in general, research has proven that people largely disagree with automated invasions of their privacy.

Acknowledgments: Paper was processed with support of grant IGA no F4/13/2021 at the Faculty of Informatics and Statistics of the Prague University of Economics and Business.

References

- Bsafe. (2021). Retrieved January 9, 2021 from <https://getbsafe.com/>
- EU H2020 TAKEDOWN Research Project. (2019). <https://www.takedownproject.eu/>
- Fabito, B. S., Balahadia, F. F., & Cabatlao, J. D. N. (2016). AppLERT: A mobile application for incident and disaster notification for Metro Manila. *2016 IEEE Region 10 Symposium (TENSYP)*, 288–292. <https://doi.org/10.1109/TENCONSpring.2016.7519420>
- Noonlight. (2021). Retrieved January 9, 2021 from <https://www.noonlight.com/>
- Sudzina, F., & Pavlicek, A. (2019). Impact of Personality Traits (BFI-2-XS) on Use of Cryptocurrencies. In P. Maresova, P. Jedlicka, & I. Soukal (Eds.), *Hradec Economic Days 2019* (pp. 363–369). <https://doi.org/10.36689/uhk/hed/2019-02-037>
- Tundis, A., Kaleem, H., & Mühlhäuser, M. (2020). Detecting and Tracking Criminals in the Real World through an IoT-Based System. *Sensors*, 20(13), 3795. <https://doi.org/10.3390/s20133795>
- Vokoun, R. (2020). Diktatura versus totalita, surveillance - a kde je svoboda? KSP20: Totalita včera, dnes a zítra. <https://www.youtube.com/watch?v=1EsHBxim4KQ>
- Watch over Me. (2020). Retrieved January 9, 2021 from <http://watchovermeapp.com/>

Impact of VUCA Environment in Practice of Rural Tourism

Eva ŠIMKOVÁ* and Martina HOFFMANNOVÁ

¹ University of Hradec Kralove, Hradec Kralove, Czech Republic; eva.simkova@uhk.cz;
martina.hoffmannova@uhk.cz

* Corresponding author: eva.simkova@uhk.cz

Abstract: Current business environment is being described as turbulent, or VUCA environment. VUCA is an acronym, which stands for Volatility, Uncertainty, Complexity and Ambiguity. The literature review shows that the approach to VUCA concept in the area of tourism and rural tourism is lagging behind other sectors. In the paper the basic principles and specifics of rural tourism are characterized. Problematic issues in rural tourism management are described in relation to VUCA environment. Using this knowledge and analysis of literature sources the VUCA Metrics of rural tourism in the Czech Republic was prepared. On the basis of VUCA Metrics the paper shows the way how to proceed with the preparation of methodological tools for the need of small companies of rural tourism. Firstly, to create the comprehensive theoretical view to this concept from the specific rural tourism point of view, and secondly to analyse the particular VUCA elements from the practical usage.

Keywords: rural tourism, business environment, VUCA concept, VUCA metrics

JEL Classification: Z3; M2; Q1

1. Introduction

Tourism is very important element of economic prosperity at the National Level. It plays very important role of regions development, mainly of rural areas and border areas (Binek et al., 2007). The rural areas development is not more connected only with agriculture support. The foreign sources show that the importance of agriculture as the main factor of development in rural areas in the West Europe and afterwards in the Middle Europe is in the last decades decreasing (Van der Ploeg, 2000). It leads to instability and unclear prospects mainly from the employment point of view for rural areas inhabitants. It is the reason of bigger support of non-agriculture activities to which belongs rural tourism.

Agriculture and most of the other businesses in rural areas are dependent on nature, and consuming natural resources. That actually raises difficulties to business-doing in those sectors. Yet, besides the above-mentioned dependence on natural resources, there are also other issues to be considered. Generally, business environment is currently very complex, turbulent, dynamic and very unpredictable (it shows the current situation affected by coronavirus pandemic). It is used with acronym VUCA, which stands for Volatility, Uncertainty, Complexity and Ambiguity. Acronym VUCA is used to describe conditions or situations in business environment, which can influence business operations. VUCA

characteristics are not isolated but rather highly interrelated. As a result, any change in the business environment could have a far-reaching impact on an organization of rural business environment. Sustainability is, however, a key element of rural tourism. It is therefore necessary to examine these impacts on rural tourism itself, i.e. turbulence levels in rural tourism, VUCA features, and business reaction ability to upcoming changes.

2. Theoretical Background

2.1. Approaches to Rural Tourism

Although the concept of rural tourism is generally accepted, operational definitions are not consistent across countries (OECD, 1994). In general, it is the tourism which takes place in rural areas. Rural tourism is a multi-aspectual activity that includes diverse activities, e.g. educational, adventure, sports-recreational, gastronomic, hiking, cycling, skiing, mountain-climbing, hunting and fishing, exploration tours, travelling in search of art and heritage and many other products provided in the countryside.

Note: Rural tourism has many forms presented as its sub products. It is subsequently divided into agro tourism (tourism in farms), eco-agro tourism (tourism in ecological farms), village tourism (tourism in village settlements), cultural tourism (tourism with cultural heritage) and ecotourism (tourism in protected areas).

Rural tourism is intended for tourists, which have a principal motivation to stay in a village in contact with nature, to escape from the urban noise and civilization. The tourists often participate in agricultural activities, learn old crafts and customs. Rural tourism is considered as a sustainable form of tourism by keeping the natural and cultural heritage – traditions, customs, handicrafts, natural attractions (e.g. Nosratabadi & Drejeris, 2016). It relates to low population densities and open space (Dinis, 2011). Šimková (2013) stated that rural tourism is directly linked to the countryside (inhabited and uninhabited landscape – with minimum human intervention), on which requirements of prevention in relation with sustainability are imposed. This means that all kinds of rural tourism should be sustainable, without negative impact on landscape and local community.

Note that it's also necessary to mention that the definition of a rural area is undoubtedly crucial for the concept of rural tourism. In order to determine rural areas, different criteria are used. From the simplest one – the population density to more complex, like economic features or combination of factors characterizing particular types of municipalities or rural regions (Maříková, 2006). In the Czech Republic, the criterion of number of inhabitants is most frequently used. According to this criterion, a municipality is considered as rural if there are less than 2,000 residents inhabiting it (MMR, 2006).

According to GNTTO (2012, p. 7) rural tourism product is very complex and its quality is dependent on typical characteristics: “natural resources quality, guest structure, village structure, and cultural wealth”. The importance of local rural resources as the most significant potential for rural tourism emphasises Lane (1994). Garrod et al. (2006) define rural resources as “rural capital”. Irshad (2010) identifies rural tourism as the “country experience” that includes many attractions and activities that are provided to visitors in the

form of entertainment or education. Jegdić et al. (2017) emphasizes sustainability of rural tourism that is defined through preservation of the countryside and natural environment, local culture and identity of local community and also creating balance between all activities in a rural area. Another specific feature of rural tourism, according to Ryglová et al. (2011), are lower requirements on infrastructure (roads, utility networks) and quite high business stability (revenues from tourism in rural areas go directly to businesses because they are provided by local subjects). According to Škrbić et al. (2015) the quality of rural tourism itself is attractiveness for tourists and therefore it is important to ensure the sustainable rural development with respecting rural areas specifics, preserving their authenticity and cultural values.

Rural tourism is believed to be a supportive element for the economic and social development of rural areas, because it is important source of income, creates new working opportunities, supports traditional hand-made manufacturing, folklore and other cultural traditions, represents rural life and heritage, protects the original landscape character, contributes to the use of rural areas' natural, cultural and historical potential, and revitalizes gastronomic traditions. Rural tourism is therefore one of the possibilities how to revive rural area and how to reduce its displacement (e.g. Ezeuduji, 2017; Figueiredo et al., 2014; McAreavey & McDonagh, 2011).

2.2. Business Environment and VUCA Concept

In general, business environment is understood as a complex of external factors (PESTLE factors) or driving forces that influence business functioning. Understanding of substance and behaviour of external business environment is necessary for the long-term functioning of business as economic subject. Business environment is often divided into external and internal (company). In the paper business environment is understood mainly as external environment.

In 1965 Emery and Trist (1965) classified four models of external business environment. Since 1953 the environment has been evaluated as turbulent that is characterized by dynamics, mutual relationships among environment components and by interaction between organisations and surroundings. To the main characteristics of environmental turbulence belong: dynamism, uncertainty, unpredictability, unexpected, expanding, fluctuating, increased complexity, etc. Volberda and van Bruggen (1997) followed up the work of Emery and Trist and characterized the three main dimensions that simultaneously affect environmental turbulence: dynamism, complexity, (un)predictability of change.

Independently on the concept of environmental turbulence the VUCA concept was created. This concept was used for the first time in the army (Richard, 1997). VUCA is an acronym, which stands for Volatility, Uncertainty, Complexity and Ambiguity. The VUCA concept is composed of the factors those were already described before (e.g. Mack et al., 2016; Kail, 2010a, 2010b, 2010c, 2011):

Volatility is a degree of instability, frequency and number of changes; high volatility implies uncertainty and ambiguity (e.g. firms experience volatility thanks to unexpected event that disturb established routine).

Uncertainty is a degree of unpredictability, or existence of multiple issues or factors, that are difficult to understand, lack of information (e.g. unpredictable competition – inability to define future competition levels, business trends and behaviour of other players; unpredictable market demand; unpredictable macro conditions etc.).

Complexity is a degree of mutual dependency, unclear causality, complexity consists of differences, which represents variability of interconnections.

Note that complexity relates to both external and internal business environment. In the both cases all relationship and mutual dependences expose. In the internal environment these are for example methodological procedure, decision-making processes, personal system, organisation and information system etc.

Ambiguity ambiguity of data and their interpretation (e.g. inability to make a decision).

In contrast to previous approaches, VUCA concept points out the necessity of understanding the mutual interaction of VUCA elements in context of concrete situations. VUCA concept broadens in the literature out that became standardized description of environment. Since 90's of the last century, the environment is referred to as VUCA environment often called as "VUCA world" (e.g. Schick et al., 2017; Wakelin-Theron et al., 2019). This term reflects rapidly changing and increasingly unstable business environment.

In the company practise in other economic sectors the VUCA concept is beginning to work into practical procedures of organizing and decision-making for different levels of management (e.g. Kambil, 2008; Lawrence, 2013; Mack et al., 2016; Sullivan, 2012).

It is important to realize that VUCA concept is not a method and does not provide the solution prepared to use but it is rather a set of measures for monitoring all four factors of environment that enables to map uncertain and complex situations influencing strategic company goals (e.g. Saleh & Watson, 2017). Hence it is more suitable to speak about VUCA environment. It is therefore necessary to check the way of information collection and analysis of all VUCA factors for the strategic planning needs and decision-making. The information from VUCA environment became evident in the operational decision-making. From the information management point of view, it is possible to describe VUCA factors by the table (a detailed overview can be found in Table 1 below).

Simultaneously with the characteristic of VUCA elements are suggested the new measures how to react to each particular VUCA factor. For example Lawrence (2013) mentioned some antidote factors that can help to mitigate negative impact of VUCA. According to the author, volatility can be reduced by having a clear vision. Uncertainty can be reduced by understanding; complexity can be mitigated by clarity and ambiguity by agility.

2.3. Application of the VUCA Environment in Rural Tourism Management

Above-mentioned VUCA concept characteristics typically describe contemporary world which is very unstable from the political, economic, technological and climatic point of view and in connection with the current coronavirus crisis. It is therefore clear that VUCA concept could not avoid the application in tourism.

Table 1. Characteristic of VUCA concept elements. Source: modified according to Bennett and Lemoine (2014); Liang et al. (2016); Mack et al. (2016)

VUCA concept elements	Driving forces	Effects
Volatility - requires the systematic monitoring of external environment	- dynamics and change character - ignorance of changes duration	- risks - market instability
Uncertainty - lies in inability to exactly describe the factors influencing the company action in environment	- many causes - uncertain result - unclear interactions	- decision-making paralysis
Complexity - increasing number of environmental factors and their mutual relationship	- information overload - a number of interconnected variables	- ambiguous consideration with the necessity to estimate the situation
Ambiguity - previous experience doesn't help to consider the current situation	- vagueness of the data with unclear relationships - wrong structured problems	- ignorance of changes reason - wrong interpretation

The literature research shows that the approach to VUCA concept in tourism and rural tourism lag behind in compare with other sectors.

In 2019 the international conference *"Tourism in the VUCA world: towards the era of (ir)responsibility"* (Vukadin & Krešić, 2020) took place in Dubrovnik. Despite the VUCA term used in the conference title, in the whole conference proceedings collection there is no analysis how to use this concept at the practical level in tourism.

How difficult it is to cope with VUCA concept for the practical needs of tourism and rural tourism is shown in the article *"Determining tourism graduate employability, knowledge, skills, and competencies in a VUCA world: Constructing a tourism employability model"*, again from 2019 (Wakelin-Theron et al., 2019). But in this article is no analysis applicability for the needs in tourism and rural tourism.

Other article called *"Conservation and sustainable development in a VUCA world: the need for a systemic and ecosystem-based approach"* (Schick et al., 2017) contains nothing what could be applicable to the managerial practice in tourism and rural tourism. Nevertheless, there is one positive. The article is interested in the particular VUCA elements at a general level and from the ecosystem point of view.

As already mentioned the literature review showed there are not many articles interested in tourism/rural tourism and VUCA concepts, the articles are more general and descriptive, and are not focused on practical usage in rural tourism management.

Rural tourism plays very important role in rural areas sustainability (economic, social, and ecological) as mentioned in the previous chapter. In context of VUCA environmental description it is important to bear in mind the interactions among economic, social and political processes and changes those influence the environment and are the base of rural

tourism. Each of these processes can contain different VUCA elements with different intensity effect. The quality of rural tourism management lies in the ability to administrate the human, financial, infrastructure and nature sources with the target to ensure the attractiveness of natural environment when respecting the specificity of rural areas. The natural sources are not often the priority of rural tourism management despite they are the pillars of rural tourism and influence the attractiveness of rural locality.

There is the question: How VUCA factors could be reflected in rural tourism business environment? It is important to realise that rural tourism businesses are the most frequently organized as small family businesses (Jegdić et al., 2017) and are often connected with the ability to react fast and effectively to the surroundings changes. The reality is often different. The small companies (which means the rural tourism businesses too) are in the contemporary turbulent environment very often vulnerable.

3. Methodology

Above-mentioned, VUCA concept globally describes increasingly unstable and rapidly changing business environment. However there is lack of information how firms or their leaders should react to some of the VUCA factors. Growing non-stability and non-predictability, however, does not necessarily carry along potential disasters. In fact, it can also mean challenges to organizations.

Because there are not many scientific articles concerning VUCA concept in rural tourism, there are three main aims of the paper:

1. to describe the basic principles of rural tourism and the problematic issues in rural tourism management,
2. to use VUCA Metrics in rural tourism,
3. to suggest that the academic community should deal with this concept more systematically so that it can be commonly used in rural tourism management.

On the example of VUCA Metrics the paper shows how to proceed with the preparation of methodological tools for needs of small rural tourism businesses. To the rural tourism environment analyse in VUCA context the Bennett and Lemoine's VUCA Metrics was used. It is about schematic interpretation of VUCA concept published in the Harvard Business Review in 2014 in contribution called *"What VUCA Really Means for You"* (Bennett & Lemoine, 2014). The particular VUCA categories are characterized according to situational knowledge ("How much do you know about the situation?"), and according to the abilities to anticipate the result of specific action ("How well can you predict the results of your actions?").

According to the authors, the VUCA is connection of four different challenges those require four different types of answers. The authors mention the instructions how to identify and react to each of four VUCA categories: approach to Volatility lies in preparedness and reserve creation; approach to Uncertainty is to invest to information – their collecting and interpretation; Complexity can solve by restructuring processes; Ambiguity solving lies in

understanding the cause and effect, creation of experiments etc. Using this knowledge and analysing other sources the VUCA Metrics of rural tourism was prepared.

4. Results

4.1. Rural Tourism Management in Turbulent Environment

It is generally accepted that management represents leadership, anticipation, organization and coordination of sources (in case of rural tourism it is primarily people, natural resources, living style, local habits) in order to achieve maximum effectiveness in the use of such sources without negative impact on the environment. Specific features of rural tourism then lays specific requirements on the management and problem solving.

In rural tourism, businesses are represented primarily by small and medium size companies, because these can better represent character of the destination (rural locality) and offer personalized rural tourism products in very specific market conditions (niche markets). However, at the same time they are exposed to:

- *limited resources (finance, know-how),*
- *lack of qualified personnel (management, financial management, marketing, etc.),*
- *specific barriers, primarily due to its business size, such as marketing costs,*
- *limitations in tourism products design.*

Rural tourism management weakness causes other factors too (Srb, 2002; Šimková, 2014):

- *deficiency in tourism management system (inefficient organisation structure of tourism),*
- *lack of coordination and cooperation in tourism,*
- *low efficiency of groups of interest,*
- *low attendance of local community,*
- *limited managerial abilities participating sides.*

Based on the characteristics and definitions (presented in chapter 2.1) it can be summarized **basic principles of rural tourism** and also its **main specifics**:

1. the primary enticement of rural tourism is *attractiveness of the nature,*
2. rural activities and services are sorted and organized by *main characteristics of rural areas,*
3. organization and economics of rural tourism is dependent especially on *effective cooperation between stakeholders,*
4. *seasonality effect of rural tourism,*
5. *labour quality requirements,*
6. *business unpredictability,*
7. *relatively risky business conditions with low profitability,*
8. *very specific infrastructure.*

Due to specific features of rural tourism in combination of the character of small and medium size businesses, there are the following risk-bearing areas in rural tourism management:

Ad₁) nature attractiveness: This is the key question of rural tourism management: How to effectively manage rural tourism while preserving nature environment as the primary

attractiveness of rural tourism, i.e. whether purely business oriented development, or with respect to sustainability development?

Ad₂) characteristics of rural areas: it relates with the concept of sustainable livelihoods that emphasizes development of needs and priorities of local people;

Ad₃) cooperation between stakeholders: involvement and coordination of stakeholders in cooperation or networking;

Ad₄) seasonality of rural tourism: seasonality problems primarily include issues such as seasonal demand for workers at one side and seasonal availability of workers on the other, negative impact of rural tourism activities on the environment coming from seasonal visit peaks (waste, damages on infrastructure, wildlife disturbance), excessive visit rate can cause increased stress on local people, waste-related problems, water supply problems;

Ad₅) labour quality requirements: specific skills and know-how requirements on rural tourism entrepreneurs, workforce seasonality;

Ad₆) business unpredictability: large sale of market segments practically involved in rural tourism activities;

Ad₇) risky business conditions - low profitability: lack of financial sources available for CAPEX investment;

Ad₈) specific infrastructure of rural tourism: development of tourism infrastructure (agriculture buildings, farms, accommodation) can lead to loss of land (for agriculture purposes) and loss of rural area characteristics.

4.2. VUCA Metrics of Rural Tourism in the Czech Republic

Based on a thorough review of the relevant literature, and determination basic principles of rural tourism and the problematic issues in rural tourism management the VUCA Metrics was created (Figure 1).

5. Discussion

Results presented in Figure 1 indicate that although all VUCA categories are presented, *uncertainty* and *complexity* are most aware of by businesses in rural tourism in the Czech Republic:

Uncertainty in connection with rural tourism's business environment in the Czech Republic lies in the lack of predictability of changes that is caused mainly by ambiguity in vision and tourism conception of the Czech Republic. These problems are deepened by the lack of specific skills and know-how requirements on rural tourism entrepreneurs (management, marketing, legislative, communication skills, risk management, knowledge about environment changes etc.). Due to inherited uncertainty from seasonality effect of rural tourism and relatively low business profitability in general is apparent mainly in agritourism with the dilemma of investments to agriculture production or agritourism services.

<div> <div>+</div> <div>How well can you predict the results of your actions?</div> <div>↑</div> <div>I</div> </div>	<div>Complexity</div> <ul style="list-style-type: none"> unclear tourism organizational structure and management of tourism unclear competences tourism management relationship between stakeholders rural activities has to be provided by main characteristics of rural areas specific infrastructure complexity of problems solved by rural tourism entrepreneurs limitation of resources 	<div>Volatility</div> <ul style="list-style-type: none"> environment volatility intensity and frequency of changes seasonality of rural tourism changes in consumer preferences climate changes
	<div>Ambiguity</div> <ul style="list-style-type: none"> ambiguity and incompleteness of policy of regional development and rural areas support ambiguity in tax legislation and tourism-related legislation business unpredictability limitations in tourism products design 	<div>Uncertainty</div> <ul style="list-style-type: none"> lack of clear tourism conception lack of environmentally friendly tourism support underestimation of tourism sustainability issues labour quality requirements relatively risky business conditions low profitability business predictability of changes
	<div> <div>→</div> <div>How much do you know about the situation?</div> <div>+</div> </div>	
	–	+

Figure 1. VUCA Metrics of rural tourism in the Czech Republic (authors' own research using Bennett and Lemoine (2014))

The biggest problem of Complexity is in the number of elements and mutual interconnections between stakeholders. It is connected mainly with non-existence of generally accepted tourism organization structure that resulted in unclear tourism organization structure and management of tourism and unclear competences of national, regional and local levels of tourism management. The involvement and coordination of stakeholders in cooperation or networking is problematic too. As a general rule the stakeholders in a local destination can manage rural tourism development. This will provide sustainability and income in rural communities. Local people are some of the most important stakeholders in rural tourism (stakeholders' roles in a destination development present e.g. Ezeuduji, 2017; Saxena, 2005). Complexity of business environment in rural tourism is connected with limitation of resources (finance, knowledge).

In general Volatility deals with instability and unexpected changes in macro and micro environment (changes in economic, social, technological, political, legislative environment), their intensity and frequency, that is in effect for rural tourism in the Czech Republic. Volatility also deals with seasonality of rural tourism that includes seasonal demand for workers, availability of workers, seasonal visit peaks causing increased stress on local people, waste-related problems, and water supply problems. There is also seasonality effect of rural tourism similar to agro tourism (haymaking, crop harvesting).

Ambiguity (same like Volatility) is no so frequent VUCA parameter; even though it belongs to the factors those make the identification of threats and opportunities difficult. In connection with rural tourism business environment in the Czech Republic the main problem is esp. ambiguity and incompleteness of regional development policy and rural areas support. Regarding business unpredictability there is a conflict between general market segmentation and providing services to individual segments. Moreover, the entrepreneurs are limited in tourism products design – businesses and must always take the environment protection, places of historic values, resources, culture and customs of rural areas into account.

6. Conclusions

In general, small companies are often considered as very flexible with the ability to effectively in time react to changes but this prerequisite does not describe to which type of changes the small companies are resistant. Paradoxically, the small companies in rural tourism are more vulnerable and fragile towards to external environment represented by VUCA concept. It was demonstrated on the research by which the VUCA parameters were identified. By summarisation and simplification, it is possible to define the key factors of “VUCA World”: clearly define strategy, team work, system communication, anticipation and risk management.

In rural tourism predominate small and medium enterprises, therefore it is important to bear in mind that the viability of these businesses depends on ability to identify the trends and opportunities in external environment. Unfortunately, the small rural tourism enterprises often do not monitor the external environment either because of lack of management skills or due to organisational and financial reasons. The VUCA concept is primary related to firm management and abilities to organize and decide. Changes in business environment often lead to resources destruction, stiffness and inflexibility. However, the VUCA concept requires a deeper understanding of how to process information and how to monitor an organization’s environment.

The literature review showed the VUCA concept is not adapted to practical use in rural tourism which could be task for academic sphere. Firstly, to create the comprehensive theoretical view to this concept from the specific tourism/rural tourism point of view, and secondly to analyse the particular VUCA elements from the practical usage.

There are as well some questions and tasks for academic sphere for the needs of future praxis:

1. *How could the VUCA factors be reflected in rural tourism business environment?*
2. *How to ensure that even small businesses in rural tourism will be able to work with VUCA concept?*

With regard to the fact that the concept of the VUCA environment is not known in practice, it is appropriate to approach the practical application mainly on the basis of well-processed theoretical data for individual actors of rural tourism, as the parameters of the VUCA environment may be perceived differently. This means using traditional

management practices such as risk management, marketing analysis of the environment, business continuity management and change management.

In conclusion it can be stated that response proposition for different situations of VUCA environment will be the subject of authors' further research.

Acknowledgments: This article is financial supported by Faculty of Education within the project to support the scientific team for tourism, project n. 11.

References

- Bennett, N., & Lemoine, G. J. (2014). What VUCA Really Means for You. *Harvard Business Review*, 92(1/2), 27.
- Binek, J. et al. (2007). *Venkovský prostor a jeho oživení*. Georgetown.
- Dinis, A. (2011). Tourism, niche strategy and networks as factor for both entrepreneurship and rural sustainability. In *IX Rural Entrepreneurship Conference: A sustainable rural?*
- Emery, F. E., & Trist, E. L. (1965). The Causal Texture of Organizational Environments. *Human Relations*, 18(1), 21-32. <https://doi.org/10.1177/001872676501800103>
- Ezeuduj, I. O. (2017). Change management for sub-Saharan Africa's rural tourism development. *Current Issues in Tourism*, 20(9), 946-959. <https://doi.org/10.1080/13683500.2014.946892>
- Figueiredo, E., Kastenholz, E., & Pinho, C. (2014). Living in a Rural Tourism Destination – Exploring the Views of Local Communities. *Revista Portuguesa de Estudos Regionais*, 36(2). 3-12. <http://www.apdr.pt/siterper/numeros/RPER36/36.1.pdf>
- Garrod, B., Wornell, R., & Youell, R. (2006). Re-conceptualising rural resources as countryside capital: The case of rural tourism. *Journal of Rural Studies*, 22(1), 117–128. <http://course.sdu.edu.cn/G2S/eWebEditor/uploadfile/20130509154805009.pdf>
- GNTO/Greek National Tourism Organisation. (2012). *How to establish a rural tourism business*. (A deliverable in the framework of the E.U. Program). Athens. http://www.eot.gr/sites/default/files/files_article/12_steps_to_establish_a_rural_tourism_business.pdf
- Irshad, H. (2010). *Rural Tourism - An Overview*. Government of Alberta, Agriculture and Rural Development. [http://www1.agric.gov.ab.ca/\\$Department/deptdocs.nsf/all/csi13476/\\$FILE/Rural-Tourism.pdf](http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/csi13476/$FILE/Rural-Tourism.pdf)
- Jegdić, V., Škrbić, I., & Milošević, S. (2017). Models of entrepreneurship development in rural tourism destinations in Vojvodina. *Economics and Agriculture*, 64(1), 221-237. <https://doi.org/10.5937/ekoPolj1701221J>
- Kail, E.G. (2010a). *Leading in a VUCA environment: V is for volatility*. Harvard Business Review. <https://hbr.org/2010/11/leading-in-a-vuca-environment>
- Kail, E.G. (2010b). *Leading in a VUCA environment: U is for uncertainty*. Harvard Business Review. <https://hbr.org/2010/11/leading-in-a-vuca-environment-1>
- Kail, E.G. (2010c). *Leading effectively in a VUCA environment: C is for complexity*. Harvard Business Review. <https://hbr.org/2010/12/leading-effectively-in-a-vuca>
- Kail, E.G. (2011). *Leading effectively in a VUCA environment: A is for ambiguity*. Harvard Business Review. <https://hbr.org/2011/01/leading-effectively-in-a-vuca-1>
- Kambil, A. (2008). Synchronization: moving beyond re-engineering. *Journal of Business Strategy*, 29(3), 51-54. <https://doi.org/10.1108/02756660810873236>
- Lane, B. (1994). What is rural tourism? *Journal of Sustainable Tourism*, 2(1-2), 7-21. <https://doi.org/10.1080/09669589409510680>
- Lawrence, K. (2013). *Developing Leaders in a VUCA Environment*. UNC Executive Development. <https://www.emergingrnleader.com/wp-content/uploads/2013/02/developing-leaders-in-a-vuca-environment.pdf>
- Liang, F. S., Lee, L., & Sang, C. N. (2016). *Risk Management in a VUCA Environment*. <https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/risk/sea-risk-management-in-vuca-environment-noexp.pdf>
- Mack, O., Khare, A., Krämer, A., & Burgartz, T. (Eds.). (2016). *Managing in a VUCA World*. Switzerland: Springer.
- Maříková, P. (2006). Where is the Countryside? (Setting the Borders of Countryside in Conditions of the Czech Republic). In Majerová, V. (Ed.), *Proceedings of the International Conference Countryside – Our World* (pp. 432-444). PEF ČZU.

- McAreevey, R., & McDonagh, J. (2011). Sustainable Rural Tourism: Lessons for Rural Development. *Sociologia Ruralis*, 51(2), 175-194.
- MMR. (2006). *Strategie regionálního rozvoje České republiky na roky 2007-2013*.
<http://www.mmr.cz/cs/Podpora-regionu-a-cestovni-ruch/Regionalni-politika/Koncepcie-Strategie/Strategie-regionálního-rozvoje-Ceske-republiky-na>.
- Nosratabadi, S., & Drejeris, R. (2016). Innovations in Rural Tourism Business Model. *International Journal of Business and Management Invention*, 5(4), 60-66.
- OECD. (1994). *Tourism policy and international tourism in OECD countries 1991-1992. Special feature: Tourism strategies and rural development*. Paris: OECD.
- Richard, J. S. (1997). *The Learning Army: Approaching the 21st Century as a Learning Organization*. Carlisle Barracks, PA: U.S. Army War College. 34 p. <https://apps.dtic.mil/dtic/tr/fulltext/u2/a327188.pdf>
- Ryglová, K., Burian, M., & Vajčnerová, I. (2011). *Cestovní ruch – podnikatelské principy a příležitosti v praxi*. Grada Publishing.
- Saleh, A., & Watson, R. (2017). Business Excellence in a volatile, uncertain, complex and ambiguous environment (BEVUCA). *The TQM Journal*, 29(5).
- Saxena, G. (2005). Relationships, networks and the learning regions: case evidence from the Peak District National Park. *Tourism Management*, 26(2), 277-289. <https://doi.org/10.1016/j.tourman.2003.11.013>
- Schick, A., Hobson, P. R., & Ibsch, P. L. (2017). Conservation and sustainable development in a VUCA world: the need for a systemic and ecosystem-based approach. *Ecosystem Health and Sustainability*, 3(4), 1-12.
<https://doi.org/10.1002/ehs2.1267>
- Srb, J. (2002). *Návrh modelu řízení cestovního ruchu v turistické destinaci Český ráj*.
www.cesky-raj.info/filemanager/files/file.php?file=1214
- Sullivan, J. (2012). *VUCA: the New Normal for Talent Management and Workforce Planning*.
<https://www.ere.net/vuca-the-new-normal-for-talent-management-and-workforce-planning/>
- Šimková, E. (2013). *Sustainability in Tourism and Rural Areas*. Gaudeamus.
- Šimková, E. (2014). Analysis of Tourism and Agro tourism Management in the Czech Republic and Austria. *Acta Univ. Agric. Silvic. Mendelianae Brun.*, 62(4), 811-824. <https://doi.org/10.11118/actaun201462040811>
- Škrbić, I., Jegdić, V., Milošević, S., & Tomka, D. (2015). Development of Sremski Karlovci wine tourism and integration in the regional tourism offer. *Economics of Agriculture*, 62(1), 229-244.
<https://doi.org/10.5937/ekoPolj1501229S>
- Van der Ploeg, D. J. (2000). Revitalizing Agriculture: Farming Economically as Starting Ground for Rural Development. *Sociologia Ruralis*, 40(4), 497-511. <https://doi.org/10.1111/1467-9523.00163>
- Volberda, H. W., & van Bruggen, G. H. (1997). Environmental Turbulence: A look into its Dimensionality. In *ERIM (Electronic) Books and Chapters* (pp. 137-145). <https://repub.eur.nl/pub/6438>
- Vukadin, I. M., & Krešić, D. (Eds.). (2020). *Tourism in the VUCA world: towards the era of (ir)responsibility*. *International Tourism Conference, Dubrovnik*.
- Wakelin-Theron, N., Ukpere, W. I., & Spowart, J. (2019). Determining tourism graduate employability, knowledge, skills, and competencies in a VUCA world: Constructing a tourism employability model. *Journal of Hospitality, Tourism and Leisure*, 8(3), 1-18.

Technology Transfer as the Third Role of Universities & National Platform in the Czech Republic

Růžena ŠTEMBERKOVÁ¹, Dagmar ŠKODOVÁ-PARMOVÁ², Petra MAREŠOVÁ^{1*} and Petr OČKO³

¹ University of Hradec Králové, Hradec Králové, Czech Republic; ruzena.stemberkova@uhk.cz; petra.maresova@uhk.cz

² University of South Bohemia, České Budějovice, Czech Republic; parmov@ef.jcu.cz

³ Silesian University in Opava, Opava, Czech Republic; petr.ockopf@slu.cz

* Corresponding author: petra.maresova@uhk.cz

Abstract: In recent years, the third role of universities has enjoyed a great support and development not only in the world, but also in the Czech Republic. The individual transfer centers and offices establish themselves within their home research institutions and expand the growth of their activities. At the same time, they are an integral part and the main service workplace within a comprehensive system of support for the protection of intellectual property and commercialization. These centers, along with other professionals in their fields in many countries, have created national knowledge transfer platforms that bring together all those who are interested in and support this field. The aim of this article is to compare the development of technology and knowledge transfer in the Czech Republic with chosen situation abroad so that possible further promising directions for this area can be determined.

Keywords: knowledge transfer; technology transfer; national association; roles of universities

JEL Classification: O30

1. Introduction

Technology transfer as the third role of universities has enjoyed a great support and development not only in the world, but also in the Czech Republic. The individual transfer centers and offices establish themselves within their home research institutions and expand the growth of their activities.

In the international context, there are different point of views on what exactly the term technology transfer refers to. Technology transfer, there can be found terms such as knowledge transfer or knowledge exploitation (Jonsson, 2008; Riege, 2007; King, in Schwartz (ed.), 2006), which try to put more stress on the role of social sciences and the humanities. Other authors (such as Benneworth and Jongbloed (2009)) also use the term valorization, which can be understood in terms of utilization, as it refers to the added value beyond purely scientific outputs, and broadly includes any social benefit, not exclusively economic. The OECD's (2007) approach to the third role of universities, which is also very close to the approach applied in the strategic documents of the European Union, emphasizes the connection between the academic and applied spheres and connects the process of knowledge transfer traditionally with its economic benefits. In this sense, university institutions serve as key elements of

regional development. The role of universities is to explore critically at the causes and consequences of the emergence of global social problems, and the knowledge generated at universities should address and alleviate social and economic disparities between developed and developing countries UNESCO (GUNI 2008). The European Commission considers the involvement of public research organizations in the protection of intellectual property and knowledge transfer to be essential for generating socioeconomic benefits and for attracting students, researchers, and further funding. Licensing and the creation of spin-off companies are regarded as the main pillars of knowledge transfer. Knowledge transfer should therefore, in accordance with the principles of responsible research and innovations, strive to fulfil its primary aim of maximizing the social impact of knowledge and technology transfer, while taking into account criteria of financial efficiency and contributing to the competitiveness of domestic industry.

2. Methodology

The aim of this article is to compare the development of technology and knowledge transfer in the Czech Republic with chosen situation abroad, try to identify factors for comparison so that possible further promising directions for this area can be determined. In terms of the choice of countries, we chose Poland for comparison, which is our neighboring country and belongs together with the Czech Republic to the V4. It is a state that historically belonged to the Eastern bloc. As a second country for comparison, we chose Italy, a representative from the former Western Europe historically belonging to the G7 bloc. The Western bloc historically supports and communicates these activities for much longer period of time. Italy, a country that has been supporting the field of knowledge transfer for a longer time than the Czech Republic and is a representative example of the Western Europe. The other selected country is Poland, which has been working with technology and knowledge transfer for a shorter period of time than the Czech Republic. However, in the past, both these countries created and developed a national platform that brings together regional and local transfer centers and offices, as well as all professionals in the field who expressed an interest in the platform membership.

For this purpose, the desk research method was used, which involves the collection and analysis of secondary data, especially in electronic form. Sources used include databases, already existing available research, reports of selected organizations, and other sources.

This research answer question: What are the national technology transfer platforms? Are their activities comparable?

3. National Technology Transfer Platform in the Czech Republic

The need for the establishment of a national platform in the Czech Republic arose primarily from European models of other countries and also from national discussions within the emerging and growing technology transfer offices at Czech public universities and academic institutions. These two factors led to the creation of a national technology transfer platform.

Transfera.cz was established on November 11, 2014 by a transformation of the Association of Knowledge Transfer Organizations and Professionals (AKTOP), which was a precursor of the present platform. From 2008, AKTOP operated as a voluntary civic association of individuals and institutions engaged in discovering, protecting, and commercializing new research findings, knowledge transfer, and the use of new knowledge for innovative entrepreneurship. The national platform Transfera.cz defends the interests of the transfer community in the Czech Republic with the aim of strengthening and developing activities in the field of technology and knowledge transfer. Through the activities of this association at the national level and all our members, relations between the academic and commercial spheres are strengthened in general; support for the development of innovations with the aim of strengthening the competitiveness of the Czech Republic at the international level; be an erudite partner of relevant public administration bodies; provide information, expert opinion and technology and knowledge transfer analysis; establish international cooperation with similar foreign associations and to facilitate the dissemination of research and development results.

In this context, it is necessary to point out that the national Transfera.cz platform has already become a consulting authority for several government departments, the Industrial Property Office, and the Technology Agency of the Czech Republic, who address the association to consult issues related to this topic. Similarly, based on the needs of its own members, a number of current working groups have emerged within this platform to address important issues and share their own practice, such as the PoC group, marketing and project group, legislative group, and last but not least a database group. Each of these groups meets approximately once a month and the subsequent results are presented to the Transfera.cz board.

3.1 Development of Members of the National Transfera.cz Platform

It should be mentioned at the outset that the representatives of the Czech national platform do not strive for the growth of their membership but seek to attract professionals who a connection to the association's main objectives, can generate significant benefits for the transfer community in the Czech Republic, and help in connecting the worlds of academia and commerce.

Table 1. Transfer community in the Czech Republic

Transfera.cz Membership	November 2014	November 2020
Universities	8	18
Science academies	1	11
Patent attorneys	0	2
Other	2	11

Note: As of November 8, 2020, Transfera.cz had 42 members, out of which 18 members were representatives of public universities. A total of 26 public universities are registered in the Czech Republic, so it is clear that the vast majority are also members of the national Transfera.cz platform. Following the universities are institutes of the Czech Academy of Sciences, out of which 11 were members as of the given date.

4. Comparison with other EU Countries –Italy and Poland

Within the countries of the European Union, we have selected for a more comprehensive comparison two national transfer associations described below, one operating in Italy under the name Netvala and the other in Poland under the name PACTT.

4.1 Italy

The Italian association is the older platform and was founded in 2002. This organization at first existed as an information network which connected its members and became an association only in 2007. “Netval’s mission is to be the organization where Technology Transfer Offices (TTOs) of Italian universities and public research organizations can meet, share experiences and learn together how to better transfer their research results to industry” (NETVAL, 2021).

Netval strives to become an important interface for ministries and local administrations, industrial associations and industries, venture capitalists, and financial bodies to strengthen the position of the third role of universities and support the connection of academia with the commercial sphere. At the same time, however, it seeks to promote the role of public research in innovation processes. The Netval association started with a bottom-up approach, primarily in order to obtain support from research and development result holders and subsequently their management, which gradually led to support for technology transfer at scientific research institutions. Netval is and intends to remain an independent association, but it has very good relations with MIUR (Ministry of Education, University, and Research), MISE (Ministry of Economic Development), CRUI (Conference of Italian University Rectors), and many other organizations in the Italian ecosystem of innovation and technology transfers.

Netval’s national and international concrete objectives are: to help its associates in improving their activities in the field of the protection and exploitation of research results from public research through education, dissemination, patenting, licensing, public-private cooperation and start up promotion; to improve the links between universities and companies in order to further enhance the production and transfer of research results; to foster the generation of new companies from public research. It is therefore a comprehensive coverage of all activities that fall into the field of commercialization.

In terms of membership, the Netval association currently includes 57 out of a total of 100 Italian universities. Furthermore, members of the Netval association include four academic scientific institutions, two foundations, one agency, and seven individual professionals.

Comparing the total number of universities in Italy and the number of university members who are part of the Netval platform, it is clear that more than half of them (57%) are members. In terms of the involvement and interconnection of researchers, Netval brings together 69% of professors from all over Italy, which testifies to the prestigious view of this association within Italy and also confirms that the original Netval network was developed with the bottom-up approach.

4.2 Poland

The other country we have chosen is Poland, where the area of knowledge transfer has a shorter history. Here, too, representatives of technology transfer offices created and built a national platform to promote the interests of knowledge transfer.

The Polish Association of Centers for Technology Transfer (PACTT.pl) is a voluntary association of representative units of Polish universities. It is therefore similar to both the Czech and Italian industry platforms. The main focus of this association is relevant to the whole area of knowledge transfer, which includes the protection, management, and commercialization of university intellectual property.

The idea of creating PACTT in Poland is not old, as it was born in 2015. The purpose of establishing the joint venture was the cooperation of similar units in the field of broadly understood commercialization of scientific research results, exchange of good practices, and experience, and, among others, the implementation of EU projects. The Polish association is very active in the mutual exchange of information and mutual cooperation with other national associations. It seeks to establish itself on both the European and international scene and to share examples of good and bad practice for further coordinated development. The core of the joint venture is the active cooperation of units and the representation of PACTT members in order to establish contacts with entrepreneurs, the creation of the university image as that of an institution open to the non-academic environment and adapted to the dynamically changing market situation and the expectations of the business environment.

The very foundation of this organization is interesting because in December 2015, representatives of six technology transfer offices (AGH University of Science and Technology, Gdańsk University of Technology, Silesian University of Technology, Wrocław University of Science and Technology, Jagiellonian University, West Pomeranian University of Technology in Szczecin) decided to enter into a partnership by establishing the Polish Association of Centers for Technology Transfer (PACTT.pl).

Nowadays, the association comprises a network of technology transfer centers of Polish universities, and approximately 65,000 scientists and 14,000 patents, and is open to new members (only TTOs). This national association is a member of Association of European Science and Technology Transfer Professionals (ASTP) and National Associations Advisory Committee (NAAC).

Currently, the joint venture consists of 73 units, mostly public but also private, and the number of participants increases from year to year (<https://pactt.pl/en/about-pactt>). The membership base is represented in the following breakdown: public universities are represented by 57 members, private universities by four members, institutes of the Polish Academy of Sciences by four members, public institutions by four members, and higher professional schools also by four members. In Poland there are in total 132 public and 306 private institutions of higher education (universities and colleges).

PACTT organizes annual nationwide conferences for its members, attended by 200–300 people. Conference programs include meetings with stakeholders (ministry, other governmental institutions, associations of university rectors, investors, etc.); expert

workshops (IP valuation, license agreements, tax law, patent law); benchmarking, and exchange of best practices.

PACTT decided to create six working groups, one each for the creation of joint technology offers of PACTT members; for the development of model technology transfer agreements (Polish "Lambert Toolkit"); for the standardization of processes and tasks of technology transfer offices; for the creation of the key competences list for technology transfer professionals; for interacting and lobbying with key stakeholders; and for international cooperation (ProgressTT and ASTP-Proton NAAC member). PACTT does not have other members than TTOs/CTTs, no attorneys etc. Current split of members between universities, academy of sciences and higher vocational schools. There is a separate organization in Poland, grouping Special Purpose Vehicles (in Polish: spółki celowe). These are LLCs owned 100% by universities, which take shares in university start-ups. This organization is called "Porozumienie Spółek Celowych" (PSC) and it groups 24 SPVs from Poland. Both organizations, PACTT and PSC work together very closely.

Table 2 Activity of platforms for the support of technology transfer

Compariosn of technology transfer platforms	Czech Republic	Poland	Italy
Established	2014	2015	2007
Number of members	42	73	71
Members "mixed" (universities, academia, another units)	X		X
Number of universities 's members	18	57	57
Organisation of national conference	X	X	X
Organisation of workshops for professionals	X	X	X
Working groups	X		X
Patents where participate academic institutions (source: database Patent Inspiration)	Year 2018 - 86 Year 2019 - 112 Year 2020 - 108	Year 2018 - 1,732 Year 2019 - 1,845 Year 2020 - 1,711	Year 2018 - 275 Year 2019 - 277 Year 2020 - 294
Patents where participate academic institutions per one hundred thousand inhabitants (source: database Patent Inspiration)	Year 2018 - 8.0 Year 2019 - 10.5 Year 2020 - 10.1	Year 2018 - 45.6 Year 2019 - 48.6 Year 2020 - 45.1	Year 2018 - 4.6 Year 2019 - 4.6 Year 2020 - 4.9

4.3 International Mutual Comparison

Considering the above, it is clear that technology transfer professionals are coming together and networking, at both national and international levels, to share information, exchange good practice, and create support for an innovative ecosystem. The area of developing the third pillar of universities is relatively new in some countries, such as in Israel or the United States. Based on the above examples, it is clear that the sharing of good practice

and the creation of working groups to support the individual activities involved in knowledge transfer are important in that they create a lobby mechanism and not only help increase the establishment of knowledge transfer between the sphere of research and development and that of business but also promote networking especially between SMEs and innovation holders and, last but not least, help increase the competitiveness of individual regions and national units. Looking at the comparison of national technology transfer support platforms, it seems that the answer to the questions of whether their activities are similar and close the answer is that mostly yes. Poland has the largest number of members, as is the most populous of the countries under comparison, but almost identical to Italy. Both in the Czech Republic and Italy, various types of entities participate in the platforms and sub-working groups are formed. If we also look at the patent activity of public institutions, which have the potential to be subsequently the subject of attention of these platforms, then Poland is clearly the leader in this regard. Italy has the least per 100,000 inhabitants.

4. Discussion and Conclusion

Public universities are traditionally focused on teaching and research. Universities have a positive influence on employment, development of industry and services through innovations, cultural potential (cultural activities, popularizing lectures), social care capacities. The ways in which universities handle their innovations and knowledge differ both in their form and their scale, where they may cooperate locally, regionally, or and globally. The cooperation of universities with employers primarily involves representatives of industry, services, and state administration, but the cooperation also includes profiling study programs, setting up science and technology parks, incubators, and start-ups, and engaging business professionals in teaching.

In order to find recommendations for the further direction of these platforms, it will be necessary to focus on other scales of facts. The findings so far point to an ambiguous relationship between platform activity and patent activity; attention in further research will focus on commercialized solutions that may be more closely linked to the activities of these platforms.

The third role of universities in the strategic documents of the Ministry of Education, Youth and Sports is included in the long-term plan of the ministry, which states: "In addition to educational and creative activities, an equally important role of universities is their direct social impact and what is known as their 'third role' in general. Universities contribute to the dissemination of knowledge and values in society in many different ways." This is explained further in strategic goal no. 4, "Relevance", which stipulates: "Universities will reflect in their activities the current social developments, the latest scientific knowledge, and the needs of their partners. Universities will be in a close and mutually open contact with partners at local, national, and international levels, with graduates, employers, scientific and academic institutions, as well as with the non-profit sector and public administration." Within the framework of various models applied in an international context, the creation of national platforms is approached, which defend their professional interests in various ways.

In some countries, such as Italy, the members of the national platform are various representatives not only from the university environment, but also from the commercial environment. In some countries, this matter is approached differently - the core and basic organizations are made up exclusively and exclusively of representatives from the university environment. The other interested parties then form another separate association, however, the two groups / platforms communicate and cooperate very well. This system largely guarantees the provision of continuous focus and targeting of the association on the set activities. In the case where the members of the platform are different interest groups from different fields, the original intentions and goals may change.

The Czech Republic joined countries that have their own professional national technology and knowledge transfer platform, which is a distinctive and constantly evolving body since its inception. Its members are professionals and representatives of institutions or companies that seek to promote the development of the third pillar, connect the academic and corporate worlds, and share good and bad practice. This professional platform always focuses on addressing current problems and trends and has become a recognized authority in the Czech Republic, helping to solve issues, provide consultations, and explain questions related to technology transfer. The same direction of development and support of technology transfer can be observed also in other European countries, such as Italy, where the history of technology transfer is longer. The current situation is no different in Poland, where, on the contrary, the history of technology transfer is shorter than in the Czech Republic.

Acknowledgement: This work was supported by the Technology Agency the Czech Republic TL02000066 “Effective knowledge transfer management “. In addition, I would like to thank prof. Ondrej Krejcar for providing data on patent activity of countries.

References

- Benneworth, P., & Jongbloed, B. W. (2010). Who matters to universities? A stakeholder perspective on humanities, arts and social sciences valorisation. *Higher Education*, 59(5), 567–588.
<https://doi.org/10.1007/s10734-009-9265-2>
- Bílá kniha terciárního vzdělávání, MŠMT ČR. (n.d.). Retrieved February 2, 2021, from <https://www.msmt.cz/reforma-terciarniho-vzdelavani/bila-kniha>
- Commercialising Intellectual Property: Joint Ventures | European IP Helpdesk. (n.d.). Retrieved February 2, 2021, from <https://www.iprhelpdesk.eu/Fact-Sheet-Commercialising-IP-Joint-Ventures>
- European Commission. Directorate-General for Research. (2008). *Commission recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations*. Publications Office. <https://data.europa.eu/doi/10.2777/13162>
- European IPR Helpdesk (CZ) | European IP Helpdesk. (n.d.). Retrieved February 2, 2021, from <https://www.iprhelpdesk.eu/services/cz>
- Higher Education in the World 3. (2015, March 24). Guni Network. <http://www.guninetwork.org/report/higher-education-world-3>
- Integrated local development at the OECD Trento Centre - OECD. (n.d.). Retrieved February 2, 2021, from <http://www.oecd.org/cfe/leed/trento-centre-integrated-local-development.htm>
- IPN EF-TRANS / Efektivní transfer znalostí a poznatků z výzkumu a vývoje do praxe a jejich následné využití, MŠMT ČR. (n.d.). Retrieved February 2, 2021, from <https://www.msmt.cz/vzdelavani/vysoke-skolstvi/ipn-ef-trans-efektivni-transfer-znalosti-a-poznatku-z>
- Jonsson, A. (2008). A transnational perspective on knowledge sharing: lessons learned from IKEA's entry into Russia, China and Japan. *The International Review of Retail, Distribution and Consumer Research*, 18(1), 17–44.
<https://doi.org/10.1080/09593960701778044>

- Krčmařová, J. (2010). Dvě cesty ke třetí roli vysokých škol. Srovnání a konceptualizace OECD a UNESCO. *Aula*, 18(4), 17–29.
- Ministry of Education. (2015). *Long-term plan Ministry of Education. 2016-2020*. Retrieved February 2, 2021, from <https://www.msmt.cz/vzdelavani/vysoke-skolstvi/dlouhodoby-zamer>
- National platform of transfer community. Transfera.cz. Retrieved February 2, 2021, from <http://www.transfera.cz/>
- NETVAL | Netval. (n.d.). Retrieved February 2, 2021, from <https://netval.it/netval-italian-network-of-technology-transfer-offices-of-universities-and-public-research-organizations/>
- OECD. (2007). *Higher Education and Regions: Globally Competitive, Locally Engaged*. OECD Publishing, Paris. <https://doi.org/10.1787/9789264034150-en>
- PACTT - Porozumienie Akademickich Centrów Transferu Technologii. (n.d.). Retrieved February 2, 2021, from <https://pactt.pl/en/about-pactt>
- Paulin, D., & Suneson, K. (2012). Knowledge Transfer, Knowledge Sharing and Knowledge Barriers – Three Blurry Terms in KM. *Electronic Journal of Knowledge Management*, 10, 82–92.
- Riege, A. (2007). Actions to overcome knowledge transfer barriers in MNCs. *Journal of Knowledge Management*, 11(1), 48–67. <https://doi.org/10.1108/13673270710728231>
- Schwartz, D. (Ed.). (2006). *Encyclopedia of Knowledge Management*. IGI Global. <https://doi.org/10.4018/978-1-59140-573-3>
- Tech transfer: Europe vs the US – a personal view. (n.d.). Science|Business. Retrieved February 2, 2021, from <https://sciencebusiness.net/news/69010/Tech-transfer%3A-Europe-vs-the-US-%E2%80%93-a-personal-view>

Why and When Paradoxical Leadership Predicts Followers' Unethical Pro-organizational Behavior: A Multilevel Model

Le TAN*, Po HAO*, Xiao YANG and Xinge YE

¹ Northwest University, Xi'an, China; tanle@nwu.edu.cn; haopo88@126.com; youngshore@163.com; 836889758@qq.com

* Corresponding authors: tanle@nwu.edu.cn; haopo88@126.com

Abstract: Unethical pro-organizational behavior (UPB) is one type of crucial organizational behaviors within work environments which aroused the academic interest of researchers recently over the past few decades. However, we still know little about how things are going under complex and uncertain environmental conditions. The present study explores the influence of paradoxical leader behaviors (PLB) on followers' unethical pro-organizational behavior (UPB) with followers perceived inclusive climate being the mediator and frequent change being the moderator based on the social information processing theory as overarching theoretical perspective. Using a multilevel and multi-source sample of 63 leaders and 218 followers in China, we found that (1) PLB negatively related to followers' UPB, (2) followers' perceived inclusive climate fully mediated the relationship between PLB and followers' UPB, and (3) frequent change moderated the relationship between PLB and followers perceived inclusive climate, specifically, when the level of frequent change is high the positive relationship will be stronger. Our findings extend the understanding of the relationship between PLB and followers' UPB, and specify how, why and when PLB can reduce followers' UPB. Theoretical contributions, practical implications, and future directions were discussed.

Keywords: paradoxical leadership; unethical pro-organizational behavior; inclusive climate; frequent change; multilevel model

JEL Classification: M19

1. Introduction

Employees' unethical pro-organizational behavior (UPB) is one form of unethical conduct in the workplace which is not beneficial to the long-term development of the organization. Previous research mostly focuses on how to predict and prevent UPB (Graham, Resick et al., 2020; Fehr et al. 2019; Chen et al., 2016). UPB refers to actions 'that are intended to promote the effective functioning of the organization or its members (e.g., leaders) and violate core social values, norms, or standards of proper conduct' (Umphress & Bingham, 2011). Empirical research of organizational behavior has focused on antecedents of UPB, and found the important roles of leadership behavior on follower UPB (Chen et al., 2016; Graham, Resick et al., 2020; Veetkazhi et al., 2020).

Prior studies have suggested that leadership behaviors such as ethical leadership (Fehr et al., 2019; Ruiz-Palomino & Linuesa-Langreo, 2018; Demirtas, 2015; Eisenbeiß & Brodbeck, 2014; Zoghbi-Manrique-de-Lara & Suarez-Acosta, 2014; Miao et al., 2013; Shao et al., 2011), transformational leadership and charismatic leadership (Effelsberg et al., 2014; Graham, Ziegert et al., 2015), transactional (Graham et al., 2015), benevolent leadership (Shaw & Liao, 2020), responsible leadership (Cheng et al., 2019), as well as abusive supervision (Greenbaum et al., 2017) and Machiavellian (Umphress & Bingham, 2011), influence UPB.

Despite these findings, our knowledge of how to prevent UPB under complex and uncertain environmental conditions, is still limited. This is a crucial theoretical question because today's organizations are facing dramatically increasing environmental uncertainty and crisis, such as COVID-19. The current pandemic wave of COVID-19 has placed organizations under significant pressure, which maybe promotes more UPB. It becomes paramount to understand which leadership behaviors help prevent UPB under uncertain environmental conditions. As one new type of leadership behavior in an uncertain environment, paradoxical leadership behavior (PLB) describes leader behaviors 'that are seemingly competing, yet interrelated, to meet competing workplace demands simultaneously and over time' (Zhang et al. 2015). Building an overarching theoretical framework based on the social information processing theory, the present study tries to empirically examine why and when PLB predicts UPB under uncertain environment, to address above gap.

Specifically, this article has three major research goals. The first purpose is to explore the relationship between the PLB and UPB. Under the uncertain environment, organizations and employees inevitably face various conflicts (Schad et al., 2016). Paradoxical leader shows employees how to accept and embrace the contradictions under complex environment, while balancing high work requirements and high autonomy (Shao et al., 2019), enabling employees to do right things. As such, PLB maybe helps reduce follower UPB under the uncertain environment.

The second purpose is to propose inclusive climate as a mediator to understand how PLB influences UPB, based on social information processing theory. Social information processing theory (Salancik & Pfeffer, 1978) indicates that individuals shape their perceptions, attitudes, and behaviors based on making sense of information cues from the social environment. As a key source of social information, leader's behaviors are very important to influence subordinates' perception and cognition of working condition, inclusive climate, which further influence their work behaviors. (Chiu et al., 2016). Accordingly, we further examine the mediating effect of inclusive climate on the relationship between PLB and UPB.

The last purpose is to explore the boundary conditions of the effect of PLB on inclusive climate, we propose and test the moderated effect of frequent change. Drawing on social information processing theory (Salancik & Pfeffer, 1978), followers rely more on information cues from workplace in uncertain ambiguous, or complex situations (Goldman, 2001; Larson & Callahan, 1990). We predict that frequent change will moderate the relationship between

PLB and inclusive climate, and also propose that relationship will be stronger under high change frequency than under low change frequency.

In conclusion, by using a multilevel and multi-source sample of 63 leaders and 218 followers in China, we empirically examine: (a) the main effect of PLB on followers' UPB; (b) the mediating effect of perceived inclusive climate in linking PLB with followers' UPB; (c) the moderated effect of frequent change on PLB and followers perceived inclusive climate. Figure 1 shows the overall theoretical model and the proposed hypotheses.

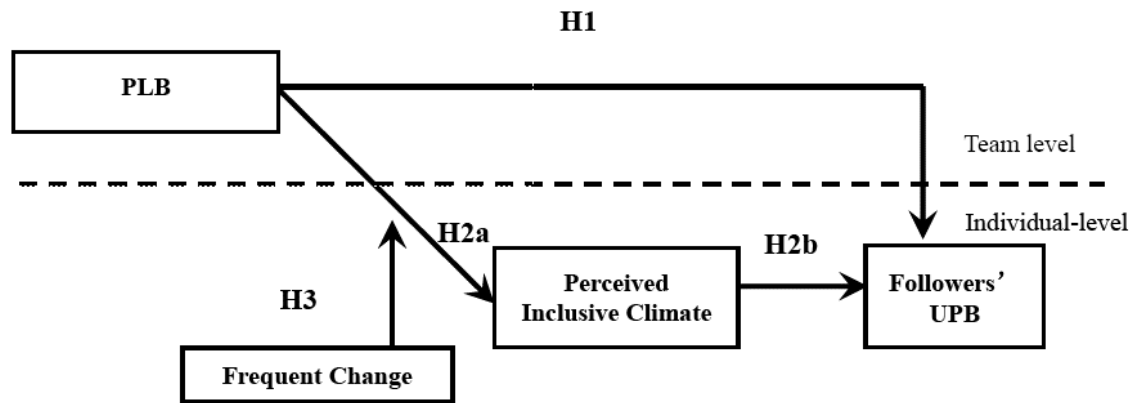


Figure 1. The overall theoretical model

1.1. PLB and UPB

The concept of paradoxical leadership stems from the application of philosophy concept 'paradox' in organizational management. Paradox is defined as 'long-term interdependent and contradictory elements' (Putnam et al., 2016). Based on paradox thinking and Eastern Yin-Yang philosophical theories, PLB is defined as leaders adopting seemingly competitive but interrelated behaviors in leadership process (Zhang et al., 2015). And Zhang et al. (2015) use 'both-and' to describe five dimensions of PLB, including (1) combining self-centeredness with other-centeredness; (2) maintaining both distance and closeness; (3) treating subordinates uniformly, while allowing individualization; (4) enforcing work requirements, while allowing flexibility; and (5) maintaining decision control, while allowing autonomy (Zhang et al., 2015).

UPB was first proposed by Umphress et al. (2010), which refers to unethical behaviors that are intended to help organizations achieve better development, but violate the core values of society, morality, or laws. UPB appears to be a paradoxical phenomenon, that is, beneficial to the organization short-term efficiency yet detrimental to customer and long-term development (Chen et al., 2016; Tang et al., 2020). According to social information processing theory (Salancik & Pfeffer, 1978), as a key source of social information, leader's behaviors influence followers' thinking, attitudes and behaviors. PLB is to simultaneously support the forces of oppositional conflicts and balance and use contradictions (Putnam et al., 2016), which shows employees how to accept and respond the contradictions under complex environment (Shao et al., 2019), enabling employees to do right things. In addition, PLB with

a long-term perspective will not encourage follower UPB because such behavior can bring short-term benefits yet harmful to long-term development.

Accordingly, we propose that PLB helps reduce follower UPB under the uncertain environment as following hypothesis:

Hypothesis1: PLB is negatively related to followers UPB.

1.2. The Mediating Role of Inclusive Climate

Inclusive climate refers to the 'shared view of employees who identify the extent of organizational involvement in making employees feel valued, creating sense of belongingness by appreciating their presence in the organizations' (Mor Barak et al., 2016). It is believed that in an inclusive climate, every follower is treated fairly and different opinions are valued (Nishii, 2013).

PLB is helpful to climate for inclusion. Paradoxical leaders not only strictly implement work rules and standards, but also allow employees to maintain flexibility; they not only maintain decision-making control, but also allow followers' autonomy, namely high standards and high standards (Zhang et al., 2015). Using 'both-and' perspective, PLB shows high flexibility and high autonomy (Shao et al., 2019), the extent to which leaders' comfort with diversity, alter rules for acceptable behaviors to ensure flexible application, integration of differences and inclusion in decision making differences, may influence the extent to which employees perceived organizational inclusion (Shore et al., 2017). Thus, we predict that PLB has a significant positive effect on followers perceived inclusive climate.

Hypothesis2a: PLB is positively related to followers perceived inclusive climate.

Perceived inclusive climate is helpful to prevent UPB. Organizational inclusive climate clearly increases fairness, respect and trust among organization members (Shore et al., 2017). Within inclusive climates, fairness trust and respect enable employees to focus more on their own work without having to cater to others, and they do not have to deliberately be immoral to impress the organization or others (Lee, Schwarz et al., 2019). Thus, we predict that perceived inclusive climate has a significant negative effect on UPB.

Hypothesis 2b: Followers perceived inclusive climate is negatively related to UPB.

On the basis of social information processing theory (Salancik & Pfeffer, 1978), employees make meaning of social cues within the workplace and socially construct their perceptions and attitudes. Research revealed that focal leaders (McKay & Avery, 2009; Kozlowski & Doherty, 1989) and climate for inclusion (Boekhorst, 2015; Rashid et al., 2020) were very important to influence followers' perceptions of job and circumstances. The information from leaders' behaviors and role models would help followers to judge how to present appropriate work behaviors (Rentsch, 1990), and perceive work climate through social interactions (Reichers & Schneider, 1990). Combing above argument, we propose the mediating hypothesis:

Hypothesis 2c: Followers perceived inclusive climate mediates the effects of PLB on followers UPB.

1.3. The Moderated Role of Frequent Change

Frequency of change refers to individual perceptions of how often change occurs in their organization (or sector) (Rafferty & Griffin, 2006). Research identified the frequent change as an important feature of change which is pertinent to employees' workplace behaviors (Babalola et al., 2016).

On the basis of social information processing theory, social information would be more important when uncertainty is high (Salancik & Pfeffer, 1978). When followers perceive frequent change, they experience high level of uncertainty (Rafferty & Griffin, 2006). Therefore, 'both-and' cognition and behaviors from paradoxical leaders would send subordinates more information about integration and tolerance for differences (Zhang & Han, 2019; Larson & Callahan, 1990). Thus, followers would perceive much more inclusive climate in work environment. Therefore, we propose:

Hypothesis 3: *Frequent change plays the moderate role in the positive relationship between PLB and followers perceived inclusive climate, that is, when the level of frequent change is higher the above positive relationship will be stronger.*

2. Methodology

2.1. Sample and Data Collection

We collected 80 questionnaires for leaders and 300 questionnaires for subordinates. In the end, 63 valid questionnaires for leaders and 218 questionnaires for subordinates were obtained, yielding a response rate of 78.75% and 72.67% respectively. We collected data from multiple sources (i.e., focal leader and their subordinates). Perceived inclusive climate and frequent change and PLB were rated by subordinates. Leaders evaluated UPB for the subordinates. Participants were assured their survey results would stay confidential and anonymous and be used for the purpose of scientific research only. The valid samples come from 12 Chinese companies. The average age of the participants was 37, 62.15% of the participants were male, and 90% had a college or higher degree. Age, education level and tenure were normally distributed.

2.2. Measures and Analysis

We used established scales to measure all variables. Respondents provided their answers on a five-point Likert scale ranging from 1 (= strongly disagree) to 5 (= strongly agree). PLB was measured with 22-item scale developed by Zhang et al. (2015) (see Appendix for the scale items), the Cronbach α for this scale was .826, and the average Rwg score for PLB was .87 (ranging from .76 to 1.00) was above the recommended cutoff of .70. UPB was measured with 6-item scale developed by Umphress et al. (2010), the Cronbach α for this scale was .789. Perceived inclusive climate was measured with 22-item scale developed by Nishii (2013), the Cronbach α for this scale was .927. Frequent Change was measured with 3-item scale developed by Rafferty and Griffin (2006), the Cronbach α for this scale was .823. Furthermore, followers age, gender, education, and organizational tenure were the control variables in this

research. We employed multilevel data to analyze the proposed model using SPSS13.0, LISREL8.80 and HLM7.0.

3. Results

3.1. Descriptive Statistics Results

We firstly conducted descriptive statistics and correlation analysis. The results were summarized in Table 1. The individual-level results showed that follower perceived inclusive climate was negatively correlated with follower UPB (-.530, $p < .01$).

Table 1. Descriptive statistics and correlations among variables.

Variables	Mean	SD	1	2	3	4	5	6	7
Individual-level variables									
1. Gender	26.88	6.18	1.000	.180	-.346**	.421**	-.268**	.449**	.095
2. Age	1.38	.66	----	1.000	-.146	.114	.119	-.171*	-.036
3. Education	3.95	.69	----	----	1.000	-.113	.138	-.200*	.074
4. Tenure	23.59	24.77	----	----	----	1.000	-.107	.217*	.083
5. UPB	2.44	.84	----	----	----	----	1.000	-.530**	.169*
6.IC	3.68	.64	----	----	----	----	----	1.000	.170*
7.FC	3.08	.71	----	----	----	----	----	----	1.000
Team-level variable									
PLB	3.90	.37	----	----	----	----	----	----	----

Note: Two-tailed test; PLB: Paradoxical leadership behaviour; IC: Perceived inclusive climate; FC: Frequent change; UPB: Unethical pro-organizational behaviour; *** $p < .001$, ** $p < .01$, * $p < .05$; N = 218 for individual-level data and N = 63 for team-level data

3.2. Hypotheses Testing Results

We conduct confirmatory factor analysis to test the discriminant validities of PLB, perceived inclusive climate, frequent change, and UPB. The result shows that the hypothesized four-factor model yielded a better fit ($\chi^2/df=1.58<3$, RMSEA=0.06<0.08, GFI=0.92>0.9, CFI=0.98>0.9, NNFI=0.96>0.9), Above results showed an acceptable level of discriminant validity of four variables in our study.

We use HLM to examine the multilevel influences on UPB. Before testing the hypotheses, we run a null model to examine the significance of systematic between-group variance. The results show that the proportion of between-group variance in UPB is 32.37%, and the chi-square test is significant ($\chi^2 (df = 62) = 104.01$, $p < 0.001$), supporting the use of HLM.

Hypothesis 1 predicts that PLB is negatively related to UPB. As shown in Table 2, PLB had a negative relationship with UPB ($\gamma=-0.645$, $p<0.01$, Model 1 in Table 2), providing support for H1. To test multilevel mediating effect of perceived inclusive climate on PLB and UPB for H2a, H2b and H2c. The results indicate that PLB is significantly related to follower

perceived inclusive climate ($\gamma = 0.745$, $p < .001$, Model 2 in Table 2) and follower perceived inclusive climate is significantly related to UPB ($\gamma = -0.658$, $p < .001$, Model 3 in Table 2). And controlling the effect of follower perceived inclusive climate, PLB is not significantly related to UPB ($\gamma = -0.194$, $p > .05$; Model 4 in Table 2), in accordance with H2a, H2b and H2c. The results further show the full mediating effect.

Regarding moderated effects H3, the interaction effect of frequent change and PLB in predicting follower perceived inclusive climate is positive ($\gamma = 0.354$, $p < .05$, Model 5 in Table 2). Furthermore, to better comprehend the moderation of frequent change, we plotted the effect in Figure 2. Figure 2 shows that the relationship of PLB with follower perceived inclusive climate strengthened more when frequency of change was high than when it was low. Thus, the results providing support for H3.

Table 2. Results of HLM.

Variables	Model1 Followers' UPB	Model2 IC	Model3 Followers' UPB	Model4 Followers' UPB	Model5 IC
Individual-Level Variables					
Gender	0.115(0.099)	-0.153**(0.060)	0.039(0.083)	0.039(0.083)	-0.151**(0.056)
Age	-0.003(0.021)	0.009(0.014)	-0.002(0.016)	-0.000(0.016)	0.004(0.013)
Education	0.121(0.120)	-0.176(0.091)	0.028(0.097)	0.042(0.096)	-0.186*(0.087)
Tenure	0.001(0.003)	-0.002(0.002)	0.001(0.003)	0.001(0.003)	-0.001(0.002)
IC			-0.658*** (0.083)	-0.612*** (0.094)	
FC					0.085(0.059)
Team-Level Variables					
PLB	-0.645** (0.213)	0.745*** (0.119)		-0.194(0.195)	0.745*** (0.120)
Interaction Variables					
PLB*FC					0.354* (0.141)
FC*IC					

¹Note: Two-tailed test; PLB: Paradoxical leadership behaviour; IC: Perceived inclusive climate; FC: Frequent change; UPB: Unethical pro-organizational behaviour; *** $p < .001$, ** $p < .01$, * $p < .05$; N = 218 for individual-level data and N = 63 for team-level data

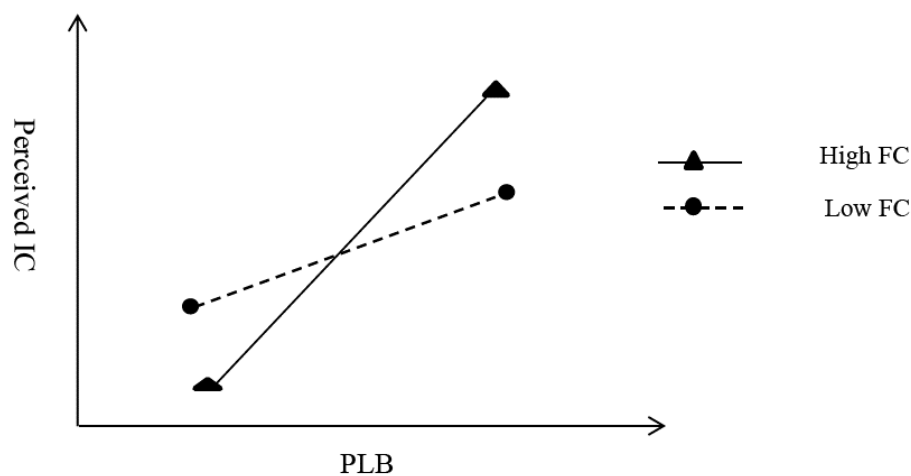


Figure 2. Interaction between PLB and frequent change on perceived inclusive climate

4. Discussion

Using a multilevel and multisource sample, from the social information processing perspective, the present study revealed three major findings: (1) PLB negatively related to followers' UPB, (2) followers perceived inclusive climate fully mediated the relationship between PLB and followers UPB, and (3) frequent change moderated the relationship between PLB and followers perceived inclusive climate.

4.1. Theoretical Implications

Our findings make some contributions as follows. Firstly, our study focused on UPB prevention under uncertain context. As one of paradoxical phenomenon in organization, UPB was beneficial to short-term efficiency of organization, yet harmful to long-term development (Umpress & Bingham, 2011). Prior studies mostly found that leadership styles such as transformational leadership (Graham et al., 2015) and benevolent leadership (Shaw & Liao, 2020) promote followers UPB. A few studies focused on preventing factors of UPB. Furthermore, even though the essential role of leadership play on the UPB has been found in the previous research, they potentially explored UPB in general context but not uncertain context. With the continuing rise in environmental complexity and dynamism, more studies should focus on how to prevent UPB under uncertain context. The present study starts from the important leadership behavior under uncertain context, PLB, conducting multilevel model on follower UPB. The result also demonstrated the important prevention effect of PLB in explaining the determinants of follower UPB, which extends previous UPB empirical research to uncertain context.

Secondly, our study enriched current research by explaining how PLB associates with UPB through followers perceived organizational climate. Using social information processing theory framework (Salancik & Pfeffer, 1978), we specified inclusive climate as a mediator, which links PLB and UPB. To date, there has been limited attention to how leaders contribute to preventing UPB under uncertain environment (Veetkazi et al., 2020). Our result findings supported that paradoxical leaders were more likely to make followers perceive climate of inclusion, which consequently resulted in fewer UPB. Past research has shown that identification related variables mediate the relationship between leadership behaviors and follower UPB (e.g., Shaw & Liao, 2020; Effelsberg et al., 2014; Miao et al., 2013). Our study supplemented the UPB literature by identifying a climate mediator —inclusive climate, and it also contributes to the social information processing perspective. And inclusive climate plays more important role in preventing follower UPB. Our results contributed to inclusive workplaces research (Shore et al., 2018) by extending previous research to change and crisis context.

Thirdly, we considered frequency of change as one of critical context variables which influences the relationship between PLB on followers perceived organizational climate, contributing to PLB literature by extending the boundary conditions of the effectiveness of PLB (Tan et al., 2020; Zhang et al., 2015). Our results found that high frequency of change

strengthened the relationship between PLB and followers perceived organizational climate. Individual differences have been the primary focus in exploring boundary conditions of PLB effectiveness, such as follower psychological safety (Yang et al., 2019) and cognitive closure needs (She & Li, 2017), workplace context, such as job stress (Shao & Liao, 2019). However, fewer study explored whether and how the uncertainty and crisis context could influence the relationship between PLB and outcomes. Our study unveils the contingent role of frequency of change in the relationship between PLB and followers perceived organizational climate, which extends previous PLB empirical research to change and crisis context.

4.2. Practical Implications

Above findings also had important practical implications. The present study indicated paradoxical leaders were effectively prevent followers UPB under change circumstances. We therefore recommend that organizations should encourage leaders to learn and adopt paradox thinking in leadership process, especially under uncertain context. Additionally, our study suggests the advantages and importance of inclusive climate both at work unit levels and individual level. Therefore, organizations should pay more attention to create or foster inclusive climate, which could further help to reduce followers' unethical work behavior.

4.3. Limitations and Directions for Future Research

Several limitations of the present study provide possible opportunities for further research. First and foremost, the current research, like all survey studies, could not allow for exploring more dynamic mechanisms. Future research may use qualitative data or experimental design to examine the dynamic or causal relationships. Secondly, it incorporates Chinese-specific sample. Future research may examine the relationships using samples from other parts of the world and further do some comparing. Thirdly, PLB is developed on Eastern Yin-Yang philosophical theories. Future research may examine the preventing role of other leadership styles.

5. Conclusions

Today's organizations are facing increasing uncertain environment and frequent crisis. This paper provides an empirical investigation of preventing effects of PLB on unethical behavior intended to benefit the organization (UPB) through inclusive climate, especially under frequent change circumstances. We suggest avenues of future research encompassing leader traits, leader behaviors, context factors to comprehensively understanding how to prevent UPB under VUCA (i.e., volatility, uncertainty, complexity, ambiguity) environments.

Acknowledgments: This work was supported by MOE Liberal arts and Social Sciences Foundation (Grant Nos 19YJA630064 and 15YJC630157) and the National Natural Science Foundation of China (Grant Nos 71401135 and 71702145).

References

Babalola, M. T., Stouten, J., & Euwema, M. (2014). Frequent change and turnover intention: The moderating role of ethical leadership. *Journal of Business Ethics*, 134(2), 311-322. <https://doi.org/10.1007/s10551-014-2433-z>

- Boekhorst, J. A. (2015). The role of authentic leadership in fostering workplace inclusion: A social information processing perspective. *Human Resource Management, 54*(2), 241-264. <https://doi.org/10.1002/hrm.21669>
- Chen, M., Chen, C. C., & Sheldon, O. J. (2016). Relaxing moral reasoning to win: How organizational identification relates to unethical pro-organizational behavior. *Journal of Applied Psychology, 101*(8), 1082-1096. <https://doi.org/10.1037/apl0000111>
- Cheng, K., Wei, F., & Lin, Y. (2019). The trickle-down effect of responsible leadership on unethical pro-organizational behavior: The moderating role of leader-follower value congruence. *Journal of Business Research, 102*, 34-43. <https://doi.org/10.1016/j.jbusres.2019.04.044>
- Chiu, C. Y. C., Owens, B. P., & Tesluk, P. E. (2016). Initiating and utilizing shared leadership in teams: The role of leader humility, team proactive personality, and team performance capability. *Journal of Applied Psychology, 101*(12), 1705-1720. <https://doi.org/10.1037/apl0000159>
- Cottrill, K., Lopez, P. D., & Hoffman, C. C. (2014). How authentic leadership and inclusion benefit organizations. *Equality, Diversity and Inclusion: An International Journal, 33*(3), 275-292. <https://doi.org/10.1108/EDI-05-2012-0041>
- Demirtas, O. (2015). Ethical leadership influence at organizations: Evidence from the field. *Journal of Business Ethics, 126*(2), 273-284. <https://doi.org/10.1007/s10551-013-1950-5>
- Effelsberg, D., Solga, M., & Gurt, J. (2014). Transformational Leadership and Follower's Unethical Behavior for the Benefit of the Company: A Two-Study Investigation. *Journal of Business Ethics, 120*(1), 81-93. <https://doi.org/10.1007/s10551-013-1644-z>
- Eisenbeiß, S. A., & Brodbeck, F. (2014). Ethical and unethical leadership: A cross-cultural and cross-sectoral analysis. *Journal of Business Ethics, 122*(2), 343-359. <https://doi.org/10.1007/s10551-013-1740-0>
- Fehr, R., Welsh, D., Yam, K. C., Baer, M., Wei, W., & Vaulont, M. (2019). The role of moral decoupling in the causes and consequences of unethical pro-organizational behavior. *Organizational Behavior and Human Decision Processes, 153*, 27-40. <https://doi.org/10.1016/j.obhdp.2019.05.007>
- Graham, K. A., Ziegert, J. C., & Capitano, J. (2015). The effect of leadership style, framing, and promotion regulatory focus on unethical pro-organizational behavior. *Journal of business ethics, 126*(3), 423-436. <https://doi.org/10.1007/s10551-013-1952-3>
- Graham, K. A., Resick, C. J., Margolis, J. A., Shao, T., & Kiker, J. D. (2020). Egoistic norms, organizational identification, and the perceived ethicality of unethical pro-organizational behavior: a moral maturation perspective. *Human Relations, 73*(9), 1249-1277. <https://doi.org/10.1177/0018726719862851>
- Greenbaum, R. L., Hill, A., Mawritz, M. B., & Quade, M. J. (2017). Employee Machiavellianism to Unethical Behavior. *Journal of Management, 43*(2), 585-609. <https://doi.org/10.1177/0149206314535434>
- Goldman, B. M. (2001). When sheep turn into wolves: an integration of organizational justice and social information processing theories in understanding employment discrimination claiming. *Academy of Management Proceedings, 2001*(1), B1-B6. <https://doi.org/10.5465/apbpbp.2001.6132972>
- Kozlowski, S. W., & Doherty, M. L. (1989). Integration of climate and leadership: Examination of a neglected issue. *Journal of Applied Psychology, 74*(4), 546-553. <https://doi.org/10.1037/0021-9010.74.4.546>
- Larson, J. R., & Callahan, C. (1990). Performance monitoring: How it affects work productivity. *Journal of Applied Psychology, 75*, 530-538. <https://doi.org/10.1037/0021-9010.75.5.530>
- Lee, M., Pitesa, M., Pillutla, M. M., & Thau, S. (2017). Male immorality: An evolutionary account of sex differences in unethical negotiation behavior. *Academy of Management Journal, 60*(5), 2014-2044. <https://doi.org/10.5465/amj.2015.0461>
- Lee, A., Schwarz, G., Newman, A., & Legood, A. (2019). Investigating when and why psychological entitlement predicts unethical pro-organizational behavior. *Journal of Business Ethics, 154*(1), 109-126. <https://doi.org/10.1007/s10551-017-3456-z>
- Miao, Q., Newman, A., Yu, J., & Xu, L. (2013). The relationship between ethical leadership and unethical pro-organizational behavior: Linear or curvilinear effects? *Journal of business ethics, 116*(3), 641-653. <https://doi.org/10.1007/s10551-012-1504-2>
- McKay, P. F., & Avery, D. R. (2015). Diversity climate in organizations: Current wisdom and domains of uncertainty. In M. R. Buckley, A. R. Wheeler, & J. R. B. Halbesleben (Eds.), *Research in personnel and human resources management* (pp. 191-233). Bingley, United Kingdom: Emerald Group.
- Mor Barak, M. E., Lizano, E. L., Kim, A., Duan, L., Rhee, M. K., Hsiao, H. Y., & Brimhall, K. C. (2016). The promise of diversity management for climate of inclusion: A state-of-the-art review and meta-analysis.

- Human Service Organizations: Management, Leadership & Governance*, 40(4), 305–333.
<https://doi.org/10.1080/23303131.2016.1138915>
- Nishii, L. H. (2013). The benefits of climate for inclusion for gender-diverse groups. *Academy of Management Journal*, 56(6), 1754–1774. <https://doi.org/10.5465/amj.2009.0823>
- Putnam, L. L., Fairhurst, G. T., & Banghart, S. (2016). Contradictions, dialectics, and paradoxes in organizations: A constitutive approach. *Academy of Management Annals*, 10(1), 65–171.
<https://doi.org/10.5465/19416520.2016.1162421>
- Rafferty, A. E., & Griffin, M. A. (2006). Perceptions of organizational change: A stress and coping perspective. *Journal of applied psychology*, 91(5), 1154–1162. <https://doi.org/10.1037/0021-9010.91.5.1154>
- Rashid, A., Nawaz, S., & Zaman, U. (in press). Examining the effect of inclusive climate on public health official's creative performance: Mediating role of innovation climate. *Journal of Public Affairs*,
<https://doi.org/10.1002/pa.2273>
- Reichers, A. E., & Schneider, B. (1990). Climate and culture: An evolution of constructs. In B. Schneider (Ed.), *Organizational climate and culture* (pp. 5–39). San Francisco: Jossey-Bass.
- Rentsch, J. R. (1990). Climate and culture: Interaction and qualitative differences in organizational meanings. *Journal of Applied Psychology*, 75(6), 668–681. <https://doi.org/10.1037/0021-9010.75.6.668>
- Ruiz-Palomino, P., & Linuesa-Langreo, J. (2018). Implications of person–situation interactions for Machiavellians' unethical tendencies: The buffering role of managerial ethical leadership. *European Management Journal*, 36(2), 243–253. <https://doi.org/10.1016/j.emj.2018.01.004>
- Salancik, G. R., & Pfeffer, J. (1978). A social information processing approach to job attitudes and task design. *Administrative science quarterly*, 224–253. <https://doi.org/10.2307/2392563>
- Schad, J., Lewis, M. W., Raisch, S., & Smith, W. K. (2016). Paradox research in management science: Looking back to move forward. *Academy of Management Annals*, 10(1), 5–64.
<https://doi.org/10.1080/19416520.2016.1162422>
- Shao, Y., Nijstad, B. A., & Täuber, S. (2019). Creativity under workload pressure and integrative complexity: The double-edged sword of paradoxical leadership. *Organizational Behavior and Human Decision Processes*, 155, 7–19. <https://doi.org/10.1016/j.obhdp.2019.01.008>
- Shaw, K. H., & Liao, H. Y. (2020). Does Benevolent Leadership Promote Follower Unethical Pro-Organizational Behavior? A Social Identity Perspective. *Journal of Leadership & Organizational Studies*, 28(1), 31–44.
<https://doi.org/10.1177/1548051820957996>
- Shore, L. M., Cleveland, J. N., & Sanchez, D. (2018). Inclusive workplaces: A review and model. *Human Resource Management Review*, 28(2), 176–189. <https://doi.org/10.1016/j.hrmr.2017.07.003>
- Tan, L., Hao, P., Yan, X. & Song, H. (2020). Paradoxical Leadership: A Literature Review and Prospects. *Foreign Economies and Management*, 42(4), 63–79. <https://doi.org/10.16538/j.cnki.fem.20200306.101>
- Tang, P. M., Yam, K. C., & Koopman, J. (2020). Feeling proud but guilty? Unpacking the paradoxical nature of unethical pro-organizational behavior. *Organizational Behavior and Human Decision Processes*, 160, 68–86.
<https://doi.org/10.1016/j.obhdp.2020.03.004>
- Umphress, E. E., & Bingham, J. B. (2011). When employees do bad things for good reasons: Examining unethical pro-organizational behaviors. *Organization Science*, 22(3), 621–640. <https://doi.org/10.1287/orsc.1100.0559>
- Umphress, E. E., Bingham, J. B., & Mitchell, M. S. (2010). Unethical behavior in the name of the company: The moderating effect of organizational identification and positive reciprocity beliefs on unethical pro-organizational behavior. *The Journal of Applied Psychology*, 95(4), 769–780. <https://doi.org/10.1037/a0019214>
- Veetkazhi, R., Kamalanabhan, T. J., Malhotra, P., Arora, R., & Mueller, A. (2020). Unethical employee behaviour: a review and typology. *The International Journal of Human Resource Management*, 1–43.
<https://doi.org/10.1080/09585192.2020.1810738>
- Yang, Y., Li, Z., Liang, L., & Zhang, X. (2019). Why and when paradoxical leader behavior impact employee creativity: Thriving at work and psychological safety. *Current Psychology*, 1–12.
<https://doi.org/10.1007/s12144-018-0095-1>
- Zoghbi-Manrique-de-Lara, P., & Suarez-Acosta, M. A. (2014). Employees' reactions to peers' unfair treatment by supervisors: The role of ethical leadership. *Journal of Business Ethics*, 122(4), 537–549.
<https://doi.org/10.1007/s10551-013-1778-z>
- Zhang, Y., Waldman, D. A., Han, Y. L., & Li, X. B. (2015). Paradoxical leader behaviors in people management: Antecedents and consequences. *Academy of Management Journal*, 58(2), 538–566.
<https://doi.org/10.5465/amj.2012.0995>

Zhang, Y., & Han, Y. L. (2019). Paradoxical leader behavior in long-term corporate development: Antecedents and consequences. *Organizational Behavior and Human Decision Processes*, 155, 42-54.
<https://doi.org/10.1016/j.obhdp.2019.03.007>

Appendix

Paradoxical leadership behavior (PLB)

My direct supervisor:

1. Uses a fair approach to treat all subordinates uniformly, but also treats them as individuals.
2. Puts all subordinates on an equal footing, but considers their individual traits or personalities.
3. Communicates with subordinates uniformly without discrimination, but varies his or her communication styles depending on their individual characteristics or needs.
4. Manages subordinates uniformly, but considers their individualized needs
5. Assigns equal workloads, but considers individual strengths and capabilities to handle different tasks.
6. Shows a desire to lead, but allows others to share the leadership role.
7. Likes to be the center of attention, but allows others to share the spotlight as well
8. Insists on getting respect, but also shows respect toward others.
9. Has a high self-opinion, but shows awareness of personal imperfection and the value of other people.
10. Is confident regarding personal ideas and beliefs, but acknowledges that he or she can learn from others.
11. Controls important work issues, but allows subordinates to handle details.
12. Makes final decisions for subordinates, but allows subordinates to control specific work processes.
13. Makes decisions about big issues, but delegates lesser issues to subordinates.
14. Maintains overall control, but gives subordinates appropriate autonomy
15. Stresses conformity in task performance, but allows for exceptions.
16. Clarifies work requirements, but does not micromanage work
17. Is highly demanding regarding work performance, but is not hypercritical.
18. Has high requirements, but allows subordinates to make mistakes
19. Recognizes the distinction between supervisors and subordinates, but does not act superior in the leadership role.
20. Keeps distance from subordinates, but does not remain aloof.
21. Maintains position differences, but upholds subordinates' dignity.
22. Maintains distance from subordinates at work, but is also amiable toward them.

B2B Sharing as Part of the Sharing Economy Model

Libena TETREVOVA* and Pavla KOLMASOVA

University of Pardubice, Pardubice, Czech Republic; libena.tetrevova@upce.cz; st49901@student.upce.cz

* Corresponding author: libena.tetrevova@upce.cz

Abstract: Business-to-business (B2B) sharing constitutes a neglected part of the model of the sharing economy. A part which does however have considerable potential as it is a source of positive economic, environmental and social impacts. The aim of the authors of the article is to identify and evaluate areas and types of B2B sharing used by industrial companies and potentially possible types. Seven possible areas of B2B sharing were identified on the basis of systematic literature review and semi-structured interviews with managers from selected industrial companies operating in the Czech Republic. This specifically concerns the area of sharing employees, vehicles, premises, other types of tangible assets, information and knowledge, financial and insurance services and non-financial services. The alternative types of these are identified in the article and discussion is presented of their benefits and possible risks from the point of view of industrial businesses. Some of these types of sharing are widely applied in practice (e.g. sharing lorries and other vehicles, sharing capacities of lorries or carsharing), others are developing (e.g. strategic employee sharing and ad hoc employee sharing) and others again offer possible potential in future (e.g. peer-to-business lending or sharing machinery and material).

Keywords: sharing economy; B2B sharing; business model; sustainable innovation

JEL Classification: L20; M14; M21

1. Introduction

The sharing economy is a phenomenon which has been experiencing an ever-increasing boom, in particular in recent years (Dec & Masiukiewicz, 2018) together with development of information and communication technologies (Lessem et al., 2016). A condition for its effective development is growth in awareness of this phenomenon (Hamari et al., 2016). The need thus arises, in particular from the point of view of companies, to uncover how the model of the sharing economy works and which challenges it poses (Gobble, 2017). Academics and practitioners are devoting an unprecedented level of attention to the topics of peer-to-peer (P2P) and business-to-customer (B2C) sharing (Cheng, 2016). The topic of business-to-business (B2B) sharing is for the time being outside of their field of interest (Antikainen et al., 2018). The sharing economy does however have remarkable potential from the point of view of B2B markets (Antikainen et al., 2018). Participating in B2B sharing allows companies to achieve higher levels of responsiveness and efficiency (Antikainen et al., 2018). It also contributes towards the social responsibility of participating companies. Contribution towards sustainability can, among others, be regarded as the original (Geissinger et al., 2019), key (Habibi, 2019) motive for sharing.

Despite the benefits associated with this phenomenon, no study exists offering comprehensive identification of the possible areas and types of B2B sharing. Several articles are available mentioning the possibility of using B2B sharing during creation of new business models for sustainable innovation – see for example Boons and Lüdeke-Freund (2013) for further details. Studies have also been created discussing selected specific types of B2B sharing (e.g. Bouncken et al., 2020; Eurofound, 2017) or studies mentioning examples of its platforms within the framework of discussion about B2C and P2P platforms (e.g. Paajanen, 2017 or Roma et al., 2019). The aim of the authors of the article is to identify and evaluate areas and types of B2B sharing used by industrial companies and potentially possible types, this using the example of selected companies operating in the Czech Republic.

The sharing economy includes activities such as traditional sharing, bartering, lending, trading, renting, gifting and swapping (Botsman & Rogers, 2011). Activities within the framework of the sharing economy are in general based on utilisation of idle capacities (Voytenko et al., 2017). According to Guyader and Piscicelli (2019, p. 1061), the sharing economy represents “an umbrella term for business and consumption practices that are based on sharing underutilized resources (e.g., goods, services, and spaces) for free or for a fee, typically enabled by online platforms and peer communities”. Sharing may be performed not only using on-line platforms, but also without them (Ertz et al., 2019). The motive for participation in sharing may be profit, compensation of costs, but also philanthropy (Ertz et al., 2019).

Businesses can share employees, tangible and intangible assets or services. Sharing of employees may be based on strategic employee sharing, in terms of which a group of employers creates a network which hires employees who regularly alternate working for the participating employers (Eurofound, 2017). One alternative is ad hoc employee sharing which is used by employers if they are temporarily unable to provide work for their employees, or if a greater need for employees is temporarily created on their part. They then share the surplus/required employees with other organisations (Eurofound, 2017). As far as sharing of assets is concerned, companies can use various types of sharing in the field of transportation, such as sharing of lorries and their capacities (Islam, 2017), ridesharing (Dillahun et al., 2017) or even carsharing. One interesting option for sharing in the field of transportation is truck platooning. A truck platoon represents a set of virtually linked trucks that drive closely behind one another using automated driving technology (Bhoopalam et al., 2018). Businesses can also share premises, e.g. manufacturing and storage premises (Molinier & Costa, 2019), co-working spaces, i.e. office space together with social areas (Bouncken et al., 2020) or accommodation capacity (Roma et al. 2019). They can also share other types of tangible assets, e.g. resources and production capacity (Antikainen et al., 2018), but also for example furniture (Trip, 2019). Another possibility is sharing of intangible assets in the form of information about future customer demand, extraordinary fluctuations in deliveries/consumption or information about the status of order processing (Patak et al., 2020). They can also share knowledge (Garcia-Perez et al., 2018). From the point of view of financial services, they can use peer-to-business lending from the position of debtor or creditor, the essence of this consisting in investors putting together funds for provision of a

loan to a client via an on-line platform (Amalian & Amalyan, 2019). They can also use equity crowdfunding, thanks to which they gain equity which investors create with their shares (Hornuf & Schwienbacher, 2018). Another option in this field is shared insurance, which differs from insurance provided by traditional insurance companies in that the funds which were not paid out as indemnity are the property of the clients, not the insurance company and if no indemnity is paid out, funds are partially refunded to them (Jinglu, 2016). Businesses can also share non-financial services of a service nature or cloud services which could include infrastructure, development and application platforms, but also software (Garg et al., 2013). They can use cooperative advertising, in terms of which the manufacturer participates together with retailers or even distributors in promotion of a specific product and they jointly share in settlement of costs (Zhang et al., 2019).

2. Methodology

Systematic literature review was the point of departure for the study. Inspired by the works of other authors (e.g. Ertz & Leblanc-Proulx, 2018 or Speldekamp et al., 2019), use was made of the Thomson Reuters Web of Science database. On the basis of defined keywords, which in the first stage were the keywords “B2B sharing” (only 2 publications) OR “sharing economy AND business model”, we identified 192 papers. Irrelevant publications were subsequently excluded and we performed in-depth analysis of 96 papers using the snowball method (Boell & Cecez-Kecmanovic, 2010) based on investigation of papers cited in relevant publications.

In the second step, semi-structured interviews were held with managers from selected businesses. A total of 13 interviews were held with representatives of 6 companies from January until April 2020. According to NACE Rev. 2 classification (Eurostat, 2008), this concerned businesses in division 20 – Manufacture of chemicals and chemical products, division 25 – Manufacture of fabricated metal products, except machinery and equipment, division 26 – Manufacture of computer, electronic and optical products and division 28 – Manufacture of machinery and equipment. According to the Commission Recommendation of 6 May 2003, this concerned both SME and also large enterprises. More detailed characteristics of these businesses is set out in Table 1. The average length of the interview was 90 minutes. Semi-structured interviews were conducted on the basis of a questioning scenario prepared in advance which was drawn up on the basis of systematic literature review. The main objective of these semi-structured interviews was to identify applied types

Table 1. Characteristics of the monitored businesses

Characteristics	Specification of characteristics	Business					
		A	B	C	D	E	F
Sector	Engineering						
	Chemical industry						
Size	SME						
	Large enterprise						
Relationship	Part of group						
Location	Industrial complex common with other						

of sharing and to evaluate their benefits and limitations as well as to map the attitude of respondents to the phenomenon of the sharing economy. The reason for application of this method of collection of primary data was the fact that this concerns a flexible method which allows for addition (Mitchell & Jolley, 2010) or explanation (Saengpakdeejit & Intaraprasert, 2014) of questions within the pre-determined framework. It was thus possible to identify other forms of B2B sharing not yet mentioned in the professional literature.

3. Results

It is evident from the study performed that within the framework of B2B sharing, industrial companies can share employees, tangible assets in the form of vehicles, premises and other types of tangible asset as well as intangible assets in the form of information and knowledge. They can also share financial and non-financial services. See Table 2 for further details.

The study also shows that sharing of employees represents a developing area of sharing. Companies are starting to utilise the potential of strategic employee sharing and ad hoc employee sharing within the framework of B2B sharing. Strategic employee sharing is above all used by the monitored businesses to ensure service activities such as IT services, accounting, the HR agenda, cleaning and security for buildings. Certain companies occasionally use ad hoc sharing of employees, again for the time being for workers performing service activities, e.g. project managers or IT experts. The above-mentioned types of employee sharing are ensured on the basis of contractual arrangements without use of on-line platforms. The monitored companies use ad hoc employee sharing not only on an intercompany level but also on an in-house level. Respondents regard the main benefit of application of these types of sharing as savings on payroll and other staffing costs. The survey performed also shows that companies are considering job sharing on an in-house level, this being when two or more employees share the workload for one job. Job sharing like this contributes towards ensuring a harmonious work-life balance for employees. Its use for example in the case of employees on parental leave seems expedient.

As far as sharing vehicles is concerned, this is a developed area of sharing. In particular companies based in large industrial complexes use lorry sharing, be this from the position of the party offering this type of sharing or the party enquiring about it, but also sharing of other vehicles such as tractors, mobile cranes or forklift trucks owned by one of the entities based in the given complex. They also share lorry capacity with these and other companies, be this the capacity of their own lorries or the vehicles of various transport companies. In the case of sharing a company's own vehicles and their capacities, certain companies use internal platforms, this being an extremely positive thing. Respondents whose companies only organise vehicle sharing on the basis of communication in person see the fundamental problem of vehicle sharing in the fact that certain vehicles are not available at the given time when they are needed. They also believe that an on-line platform would fundamentally help to resolve this problem. If companies use the services of transport companies, they use the services of platforms, e.g. the international platform TIMOCOM or the national platform ShipVio. The fact is that the scope in which companies are able to apply sharing of lorry

capacities is influenced by the sectors in which they do business. From the point of view of companies operating in the chemical industry, options for sharing lorry capacities are relatively limited, this being due to the specific requirements for transportation of raw materials and products in this sector. The monitored companies regularly use ridesharing. They apply this most often with use of company cars on business trips taken by their employees, but also by the employees of related companies. They use ridesharing mediated via platforms to a lesser extent, usually via the Uber platform, in particular during foreign business trips. Shared bicycles are also used in industrial zones. These can also be used in certain cases by employees for business trips to city centres. The monitored companies also support ridesharing of their employees to work by sharing information about supply and demand via the intranet or company notice boards. None of the monitored companies uses carsharing. Respondents see the main benefit of sharing vehicles in saving of costs relating to ownership (purchase and operation) of a lesser volume of vehicles. They also regard the positive environmental impacts associated with vehicle sharing as an important benefit. In the case of shared bicycles, another advantage is time savings.

As regards sharing of premises, companies which own large industrial complexes offer sharing of temporarily unused manufacturing and storage areas, administrative buildings and parking spaces. The scope of sharing manufacturing and storage space is again influenced by the sector. This is significantly limited by the safety regulations in the chemical industry. These obstacles do not however restrict sharing in engineering. One of the monitored companies thus shares storage space not only with partners, but also with its competitors and they even jointly manage deliveries to their customers. In the field of administrative space, it does happen in practice that the commercial management of companies is based in administrative complexes away from the industrial complexes and uses the services of coworking centres, using not only offices, but also shared meeting and conference rooms. One option for sharing in this area which none of the monitored companies currently uses but which some are considering use of in future is sharing of administrative workplaces. This type of sharing can be used both on an intercompany level and also on an in-house level. The essence of this type of sharing consists in the fact that several workers share one workplace, a work desk with office and IT equipment. The company can thus have a lesser number of workplaces than it has employees. Companies are considering this type of sharing, in particular on an in-house level, on the basis of positive experiences which they gained in relation to the need for people to work from home at the time of the COVID-19 pandemic. This type of sharing can be used not only by companies which allow their workers to work from home, but also companies which employ people part-time. Use is made in the monitored companies of sharing parking spaces and areas, in terms of which the participating companies share costs associated with the given spaces (lighting or security etc.). Companies also offer sharing of designated company parking spaces which are left vacant at the end of the working day. According to the respondents, the key benefit of sharing space is saving on costs and generation of revenue from sharing of otherwise unused space. However, certain risks also arise here, e.g. the risk relating to the activities which will be performed on the shared premises and whether internal rules will be

complied with. The risk of accidents also rises due to a greater number of people and vehicles moving around company premises.

Some companies also share capacity in employee hostels, be this as the party offering this capacity or enquiring about it. Respondents perceive this type of sharing as an expression of their social responsibility, extending the offer of employee benefits and contributing towards employee satisfaction. Companies then use sharing of short-term accommodation capacities via platforms for business trips. Respondents see the advantage in this as being the global offer, user-friendliness and availability of rating and reviews of accommodation capacities. The monitored companies most often use the services of the Booking.com and Airbnb platforms.

Sharing of other types of tangible assets can be regarded as a field of sharing which has been neglected so far. None of the monitored companies has so far used sharing of machinery, apparatus, material or equipment. However, sharing of free capacities of machinery and apparatus of engineering companies is supported using public resources. The Kooperace.cz platform was for example created with their support. This matches supply and demand for unused machinery and apparatus. Sharing of material within the framework of the circular economy also has unprecedented potential, in terms of which the waste created by one company may be a resource for another.

Another area with significant potential in future and one which is gradually developing is the field of sharing information and knowledge. Companies already regularly share information about deliveries/orders online. Within the framework of related companies, sharing of business contacts is starting together with references about suppliers and customers. Using online platforms, companies are starting to share data about the opinions of end consumers. Knowledge is regularly shared in the form of case studies for projects which have been implemented, management software, training materials and other findings and experiences. These are shared via varied communication channels, in particular company websites, external on-line platforms (e.g. the PR Club platform allows for sharing of knowledge and experience of PR workers), e-learning courses, webinars, conventional lectures and training courses, consultation or trade fairs. In the opinion of the respondents, the benefit of sharing information is quick and easy access to up-to-date information which contributes towards the quality of decision-making processes of all parties concerned. The main benefit of sharing knowledge is transfer of know-how and also establishment of new business contacts in the case of trade fairs. However, a fundamental risk posed by sharing of information and knowledge is the risk of information being leaked and misused by a third party.

As far as sharing of services is concerned, an area which has so far been completely neglected is sharing of financial and insurance services, this not being used by even one of the monitored companies. The reason for this is a lack of confidence, in particular stemming from insufficient regulation of this business segment. On the contrary, non-financial services are widely used by the monitored companies, this in particular being those companies based in industrial complexes together with other companies. They use shared building security, shared cleaning services, shared maintenance of premises or shared catering. However, they

also use types of B2B sharing such as shared fire protection, shared employee health care services or shared energy and steam supply in industrial complexes. Cloud services can also be regarded as a relatively widespread form of sharing. Cooperative advertising is not currently used by the monitored companies. However, completely new types of services are starting to find application on the B2B sharing market, these until recently having only been typical for the field of P2P sharing. One example of this is shared care for the household and family members of employees using sharing economy platforms. The main effect of sharing services is again a financial effect, i.e. saving on costs as a result of their allocation to a greater number of entities. Works catering, employee health care services and care for the household and family members of employees ensured within the framework of the sharing economy

Table 2. Areas and types of B2B sharing

Area of sharing	Type of sharing	Business					
		A	B	C	D	E	F
Sharing of employees	strategic employee sharing						
	ad hoc employee sharing						
Sharing of vehicles	sharing lorries and other vehicles						
	sharing capacities of lorries						
	ridesharing						
	carsharing						
	sharing bicycles and scooters						
Sharing of space	sharing manufacturing space						
	sharing administrative space						
	sharing administrative workplaces						
	sharing storage space						
	sharing parking spaces						
	sharing short-term accommodation capacities						
Sharing of other types of tangible assets	sharing machinery and apparatus						
	sharing material						
	sharing furniture and other equipment						
Sharing of information and knowledge	sharing information about deliveries/orders						
	sharing business contacts and references						
	sharing data about consumer opinions						
	sharing expert knowledge						
Sharing of financial services	peer-to-business lending						
	equity crowdfunding						
	shared insurance						
Sharing of non-financial services	sharing building security						
	sharing fire protection						
	sharing cleaning services						
	sharing maintenance of industrial complexes						
	sharing supply of electricity and steam in industrial complexes						
	sharing works catering						
	sharing provision of employee health care						
	cooperative advertising						
	cloud services						
	care for the household and family members of employees using sharing economy platforms						

model then, apart from the financial effect, offers the possibility of fulfilling the concept of social responsibility of companies in the field of employee care.

4. Discussion and Conclusions

It is evident from the study performed that industrial businesses can participate in the B2B sharing model in various areas and in various way (Table 2). Some of these forms of sharing are predestined for groups comprising related companies or supply chains, others can be used by companies located together in industrial complexes. Several types of sharing can however be exercised between companies which are not linked in any way, or can be used on an in-house level, e.g. between strategic business units. Employees, property and services can be shared within the framework of B2B sharing, using online platforms and also without them.

Within the framework of B2B sharing, sharing of employees comes into consideration in the form of strategic employee sharing and ad hoc employee sharing. On an in-house level, businesses can also use sharing of workplaces. Companies can share tangible assets in the form of vehicles, specifically lorries and their capacities, passenger cars (in particular in the form of ridesharing) and other vehicles, but bicycles and scooters can be shared too. Companies can also share administrative, storage, parking or accommodation space. One alternative for sharing of intercompany and in-house space is sharing of administrative workplaces. Businesses can also share machinery, apparatus, material or equipment, e.g. furniture. Sharing of information and knowledge also comes into consideration. Services represent a separate area of sharing. A relatively limited offer of financial and insurance services can be used within the framework of B2B sharing in the form of peer-to-business lending, equity crowdfunding and shared insurance, but also a wide range of non-financial services, e.g. in the form of shared building security, shared cleaning services or shared catering.

Some of these types of sharing are widely applied in practice, others are developing and others again offer possible potential in future. This is to say that it can justifiably be anticipated that the above-mentioned forms of sharing will gradually be used by businesses in a wider scope (Gobble, 2017) and at the same time, it is very likely that new forms of B2B sharing will also emerge. The reason for this is in particular the fact that B2B sharing is associated with significant economic effects, a fact which Antikainen et al. (2018) also draw attention to. The reason for this is that it leads to a reduction in costs and in some cases even generates revenue. In addition to this, these activities can in several instances be regarded as an expression of social responsibility by companies, be this with a positive impact on the environment in the form of saving on resources and reduction of emission volumes, or in the social field in the form of ensuring a harmonious work-life balance or a wider offer of employee benefits, as discussed among others by Tetreova (2018). Use of services in the sharing economy can thus be regarded as an instrument to increase the competitiveness and attractiveness of companies.

The presented study represents a preliminary study which has made it possible to identify areas and types of B2B sharing which are currently used and also potential ones. This

was accomplished using the example of selected companies in the chemical and engineering sectors operating in the Czech Republic. A limiting factor of this study is that it maps B2B sharing activities performed in two sectors of the national economy, albeit key sectors. Another limiting factor may be regarded as the fact that the study maps the situation from the point of view of a small post-communist economy. The Czech Republic does however in reality represent a relatively developed EU economy (Eurostat, 2020). The presented study creates a basis for further follow-on studies which should map applied and potential areas and types of B2B sharing in other sectors and subsequently also in other countries.

Acknowledgments: This article was supported by the project “Economic, Social and Environmental Aspects of Collaborative Economy from the Point of View of the Czech Republic”; COST Action CA16121 “From Sharing to Caring: Examining Socio-Technical Aspects of the Collaborative Economy”.

References

- Amalian, A. W., & Amalyan, N. D. (2019). Crowdfunding and the myth of disintermediation. *MIND Journal*, 7, 1–10. <https://doi.org/10.36228/MJ.7/2019.2>
- Antikainen, M., Aminoff, A., & Heikkilä, J. (2018, June 17–20). *Business model experimentations in advancing B2B sharing economy research* [Paper presentation]. ISPIM Innovation Conference – Innovation, the Name of the Game, Stockholm, Sweden.
- Bhoopalam, A. K., Agatz, N., & Zuidwijk, R. (2018). Planning of truck platoons: A literature review and directions for future research. *Transportation Research Part B: Methodological*, 107, 212–228. <https://doi.org/10.1016/j.trb.2017.10.016>
- Boell, S. K., & Cecez-Kecmanovic, D. (2010). Literature reviews and the hermeneutic circle. *Australian Academic & Research Libraries*, 41(2), 129–144. <https://doi.org/10.1080/00048623.2010.10721450>
- Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. *Journal of Cleaner Production*, 45, 9–19. <https://doi.org/10.1016/j.jclepro.2012.07.007>
- Botsman, R., & Rogers, R. (2011). *What’s mine is yours. How collaborative consumption is changing the way we live*. Collins.
- Bouncken, R., Ratzmann, M., Barwinski, R., & Kraus, S. (2020). Coworking spaces: Empowerment for entrepreneurship and innovation in the digital and sharing economy. *Journal of Business Research*, 114, 102–110. <https://doi.org/10.1016/j.jbusres.2020.03.033>
- Cheng, M. (2016). Sharing economy: A review and agenda for future research. *International Journal of Hospitality Management*, 57, 60–70. <https://doi.org/10.1016/j.ijhm.2016.06.003>
- Dec, P., & Masiukiewicz, P. (2018). Sharing economy – new phenomenon. *Business and Economic Research*, 8(2), 1–10. <https://doi.org/10.5296/ber.v8i2.12522>
- Dillahunt, T. R., Kameswaran, V., Li, L., & Rosenblat, T. (2017). *Uncovering the values and constraints of real-time ridesharing for low-resource populations*. In G. Mark, & S. Fussel (Eds.), *Proceedings of the CHI Conference on Human Factors in Computing Systems* (pp. 2757–2769). Association for Computing Machinery. <https://doi.org/10.1145/3025453.3025470>
- Ertz, M., Durif, F., & Arcand, M. (2019). A conceptual perspective on collaborative consumption. *AMS Review*, 9(1–2), 27–41. <https://doi.org/10.1007/s13162-018-0121-3>
- Ertz, M., & Leblanc-Proulx, S. (2018). Sustainability in the collaborative economy: A bibliometric analysis reveals emerging interest. *Journal of Cleaner Production*, 196, 1073–1085. <https://doi.org/10.1016/j.jclepro.2018.06.095>
- Eurofound. (2017, February 8). *Employee sharing*. <https://www.eurofound.europa.eu/observatories/eurwork/industrial-relations-dictionary/employee-sharing>
- Commission Recommendation 2003/361/EC. *Concerning the definition of micro, small and medium-sized enterprises*. European Union, The European Commission. <http://eur-lex.europa.eu/eli/reco/2003/361/oj>
- Eurostat. (2020, June 1). *GDP per capita in PPS*. <https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00114>
- Eurostat. (2008). *NACE Rev. 2: Statistical classification of economic activities in the European Community*. <http://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF>

- Garcia-Perez, A., Cegarra-Navarro, J. G., & Jahantab, M. M. (2018). Knowledge sharing as a driver of competitive advantage: Two cases from the field. In E. M. Vătămănescu, & F. Pînzaru (Eds.), *Knowledge management in the sharing economy. Knowledge management and organizational learning* (pp. 145–167). Springer Cham. https://doi.org/10.1007/978-3-319-66890-1_8
- Garg, S. K., Versteeg, S., & Buyya, R. (2013). A Framework for ranking of cloud computing services. *Future Generation Computer Systems*, 29(4), 1012–1023. <https://doi.org/10.1016/j.future.2012.06.006>
- Geissinger, A., Laurell, C., Öberg, C., & Sandström, C. (2019). How sustainable is the sharing economy? On the sustainability connotations of sharing economy platforms. *Journal of Cleaner Production*, 206, 419–429. <https://doi.org/10.1016/j.jclepro.2018.09.196>
- Gobble, M. M. (2017). Defining the sharing economy. *Research-Technology Management*, 60(2), 59–63. <https://doi.org/10.1080/08956308.2017.1276393>
- Guyader, H., & Piscicelli, L. (2019). Business model diversification in the sharing economy: The case of GoMore. *Journal of Cleaner Production*, 215, 1059–1069. <https://doi.org/10.1016/j.jclepro.2019.01.114>
- Habibi, M. R. (2019). The progression and impact of the sharing economy; A preface. *Journal of Marketing Theory and Practice*, 27(4), 349–354. <https://doi.org/10.1080/10696679.2019.1644959>
- Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The sharing economy: Why people participate in collaborative consumption. *Journal of the Association for Information Science and Technology*, 67(9), 2047–2059. <https://doi.org/10.1002/asi.23552>
- Hornuf, L., & Schwienbacher, A. (2018). Market mechanisms and funding dynamics in equity crowdfunding. *Journal of Corporate Finance*, 50, 556–574. <https://doi.org/10.2139/ssrn.2612998>
- Islam, S. (2017). Simulation of truck arrival process at a seaport: Evaluating truck-sharing benefits for empty trips reduction. *International Journal of Logistics Research and Applications*, 21(1), 94–112. <https://doi.org/10.1080/13675567.2017.1353067>
- Jinglu, J. (2016, June 27). *The challenges and opportunities of sharing economy – A new wrapping for doing* [Paper presentation]. Pacific Asia Conference on Information Systems, Chiayi, Taiwan.
- Lessem, R., Muchineripi, P. C., & Kada, S. (2016). *Integral community: Political economy to social commons*. Routledge.
- Mitchell, M. L., & Jolley, J. M. (2010). *Research design explained*. Wadsworth.
- Molinier, R., & Costa, P. D. (2019). Infrastructure sharing synergies and industrial symbiosis: Optimal capacity oversizing and pricing. *Journal of Industrial and Intelligent Information*, 7(1), 24–32. <https://doi.org/10.18178/jiii.7.1.24-32>
- Paajanen, S. (2017, November 10). *Overview of B2B sharing economy*. VTT Technical Research Centre of Finland. <https://www.slideshare.net/SallaPaajanen/overview-of-b2b-sharing-economy>
- Patak, M., Branska, L., & Pecinova, Z. (2020). Perfect order and its components: Application for deliveries of fast moving consumer goods to retail stores. *Engineering Economics*, 31(2), 233–242. <https://doi.org/10.5755/j01.ee.31.2.22480>
- Roma, P., Panniello, U., & Lo Nigro, G. (2019). Sharing economy and incumbents' pricing strategy: The impact of Airbnb on the hospitality industry. *International Journal of Production Economics*, 214, 17–29. <https://doi.org/10.1016/j.ijpe.2019.03.023>
- Saengpakdeejit, R., & Intaraprasert, C. (2014). Reading strategies in foreign language academic reading: A qualitative investigation. *Theory and Practice in Language Studies*, 4(12), 2599–2608. <https://doi.org/10.4304/tpsls.4.12.2599-2608>
- Speldekamp, D., Saka-Helmhout, A., & Knoblen, J. (2019). Reconciling perspectives on clusters: An integrative review and research agenda. *International Journal of Management Reviews*, 22(1), 75–98. <https://doi.org/10.1111/ijmr.12216>
- Tetrevova, L. (2018). Communicating CSR in high profile industries: Case study of Czech chemical industry. *Engineering Economics*, 29(4), 478–487. <https://doi.org/10.5755/j01.ee.29.4.19199>
- Trip, J. (2019, May 27). *Ikea tests subscription in age of the sharing economy*. <https://hvmns.com/blog/2019/5/27/ikea-tests-subscriptions-in-age-of-the-sharing-economy>
- Voytenko Palgan, Y., Zvoltska, L., & Mont, O. (2017). Sustainability framings of accommodation sharing. *Environmental Innovation and Societal Transitions*, 23, 70–83. <https://doi.org/10.1016/j.eist.2016.12.002>
- Zhang, T., Guo, X., Hu, J., & Wang, N. (2020). Cooperative advertising models under different channel power structure. *Annals of Operations Research*, 291, 1103–1125. <https://doi.org/10.1007/s10479-019-03257-4>

How Does the Five-year Plan Promote China's Economic Development?

Hongzhi TIAN and Hui LI*

Northwest University, Xi'an, China; nwuthz@nwu.edu.cn; nwulihui@163.com

* Corresponding author: nwulihui@163.com

Abstract: The main feature of socialist market economy with Chinese characteristics is that the development of national economy is planned. Through sorting out the development history of the 13 five-year plans, this paper finds that the planning is popular among the public, the planning context is historic inheritance, the planning objectives are logical progressiveness, and the planning implementation is practical and exploratory. The role of the five-year plan in China's economic development is reflected in the following aspects: first, the proposal of the five-year plan is targeted to China's economic reality. Second, the five-year plan can promote China's economic development. Third, the historical experience of the five-year plan has implications for China's economic future. The enlightenment is that we should respect the objective economic law as the premise, take firm and practical asymptotic development as the principle, take the pace of seek improvement in stability reform as the rhythm, take scientific and powerful policy measures as the guarantee, and take the path of building a new pattern of domestic and international double circulation.

Keywords: five-year plan; China's economic development; domestic and international double cycle

JEL Classification: O10; O11; O21

1. Introduction

Since the founding of the People's Republic of China, social progress has been made, people's living standards have been significantly improved, and China's economy has achieved great development. The five-year plan is a key to understand the miracle of China's development. It is not only an important tool for creating China's economic miracle and maintaining macro stability, but also an important tool for promoting social development and facilitating the transformation of China's development model (Hu et al., 2011). As the most characteristic national economic operation and social development management tool in China, the five-year plan can reflect the development history of China's socialist economy and has made an important contribution to China's glorious economic achievements and the overall building of a moderately prosperous society. This paper hopes to derive the successful experience of China's economy from the evolutionary logic of the five-year plan and provide lessons for the development of the world economy.

2. The Development History of the Five-year Plan of New China

After years of war, New China was faced with a shattered economy with a deformed development structure and a disrupted market. In order to repair the severely damaged productivity and make material and institutional preparations for the five-year plan in the Party Central Committee defined the period from 1949 to 1952 as a period of national economic recovery. The rural areas completed the land reform, and farmers obtained about 700 million mu of land and a large amount of production materials without compensation. The city carried out the reform of enterprise management system and property right relationship, and began to establish state-owned economy. On this basis, the 1st Five-year Plan was implemented in 1953. With the aid of the former Soviet Union, China carried out the basic construction of socialist industrialization and completed the socialist transformation of agriculture, handicraft industry and private industry and commerce at the same time, which laid the foundation of China's socialist economy.

The 2nd Five-year Plan was guided by the policy of "more speed, better savings," and although the production of iron and steel soared, due to the imbalance of resource allocation and economic structure, some light industrial products supply has problems. Due to the break-up of Sino Soviet relations and the sudden change of the international environment such as the U.S. invasion of Vietnam. During the period of the 3rd Five-year Plan and the 4th Five-year Plan, China's national defense industry has made great progress. Due to the excessive investment in the "Third Line Construction", the total demand of the society swelled and led to the disproportion of the economy. The 5th Five-year Plan has made great efforts to turn the tide, re-establish the ideological line of seeking truth from facts, and shift the focus to socialist modernization construction in time.

The 6th Five-year Plan carefully summed up the experience of the previous construction period, made an overall plan for major national construction projects and productivity distribution (Yang,2019), and put forward the guiding ideology of "all economic activities should focus on improving economic benefits" (National People's Congress,1982). During the period of the 7th Five-year Plan, planned economy and planned commodity economic system coexisted. From 1988 to 1989, the price double track system opened a new chapter in China's economic system reform and played a prelude to the transformation of economic development strategy and economic management system to a new model.

The 14th National Congress of the Communist Party of China (CPC) held during the 8th Five-year Plan period officially set the establishment of socialist market economic system as the goal of reform. The socialist market economic system has been gradually established. During the 9th Five-year Plan period, "the economic system has changed from the traditional planned economic system to the socialist market economic system,

and the mode of economic growth has changed from extensive type to intensive type" (National People's Congress, 1996).

The 10th Five-year plan put forward more targeted goals, such as strategic adjustment of economic structure, significant improvement of economic growth quality and efficiency, and the traditional "directive plan" begins to withdraw from the economic system. The average annual growth rate of GDP from 2002 to 2007 is 11.9%, which is the longest period of economic growth after the reform and opening up (Ma, 2018). As early as 2008, most of the tasks of the main indicators of the 11th Five-year Plan were completed. Two years later, China's GDP rose to the second place in the world. In the aftershocks of the international financial crisis, there are still some problems in China's economic and social development, such as imbalance, uncoordinated and unsustainable. Therefore, the 12th Five-year Plan pointed out that we should take scientific development as the theme, relying on science and technology and human capital growth to drive economic growth. As China's economic development entering the new normal, with the new development concept of "Innovation, Coordination, Green, Open and Sharing", and the main line of supply side structural reform, the 13th Five-year Plan proposed to coordinate the overall layout of "Five-in-One" and "Four Comprehensives" to ensure the realization of the goal of building a moderately prosperous society in an all-round way.

We summarize the 13 five-year plans in Table 1, based on the historical role they have played.

Table 1. The historical role of the 13 five-year plans

Five-year plan	Starting and ending years	Historical role played
the 1st Five-year Plan	1953-1957	Laying a solid foundation for socialist economy.
the 2nd Five-year Plan	1958-1962	Eager for a leap forward period.
the 3rd Five-year Plan	1966-1970	War risk preparation period.
the 4th Five-year Plan	1971-1975	War risk preparation period.
the 5th Five-year Plan	1976-1980	Guiding ideology and economic policy recovery and adjustment period.
the 6th Five-year Plan	1981-1985	The turning point of development strategy.
the 7th Five-year Plan	1986-1990	Incubation period of economic system reform.
the 8th Five-year Plan	1991-1995	The construction period of socialist market economic system.
the 9th Five-year Plan	1996-2000	Complete the three-step strategic goal, carry forward the past and start the later stage.
the 10th Five-year Plan	2001-2005	Key period for completing the third step of strategic objectives.
the 11th Five-year Plan	2006-2010	The coexistence period of strategic opportunities and contradictions.
the 12th Five-year Plan	2011-2015	Accelerating the transformation of the mode of economic development.
the 13th Five-year Plan	2016-2020	Decisive period of building a moderately prosperous society in all respects.

¹ Note: 1963-1965 was a three-year adjustment period.

3. The Basic Features of the Five-year Plan

Using development planning to guide economic and social development is an important way for China's Party to govern the country. Development planning can give full play to the decisive role of the market in the allocation of resources, but also to better play the role of the government. The basic features of the five-year plan are as follows.

3.1. *The Five-year Plan Shows the History Inheritance*

China's 13 five-year plans have realized the national overall development strategy with the longest time, the largest scale and the largest number of participants in human history. The fundamental reason for achieving the above record is that the Party Central Committee accurately grasped the process and strategic steps of China's economic and social development, and local governments at all levels earnestly implemented the five-year plans. The domestic economic and social development level has achieved unprecedented development in the past 70 years since the founding of New China, despite the great changes in the international environment. It can be seen that only when the domestic environment is stable, the development line is firm and the implementation is firm, can the five-year plan realize long-term historical inheritance.

3.2. *The Goal of the Five-year Plan Shows a Logical Progression*

As can be seen from Table 1, although the five-year plan has different construction tasks in each period, vertically, there is a logical progression between the development goals of the five-year plan. Specifically, from the 3rd Five-year Plan to solve the basic survival problems of people's "food, clothing and use", to the 9th Five-year Plan to reach the "well-off level" in advance, and then to the 13th Five-year Plan to build a well-off society in an all-round way, it reflects the logical progression of people's living standards. From the development of a planned economy in the first five plans to a planned commodity economy in the 7th Five-year Plan, and then to the fundamental role of the market economy in the 9th Five-year Plan, the change to the decisive role of the market in the 12th Five-year Plan, which reflects the logical progression of the evolution of the economic system. From the basic solution of survival problems in the 3rd Five-year Plan to the focus on the construction of material civilization in the 6th Five-year Plan, and then to strengthening the construction of spiritual civilization in the 8th Five-year Plan, it reflects the logical progressive nature of human demand level.

From the 2nd Five-year Plan, which focused only on the development of heavy industry, to the 5th Five-year Plan, which improved the disproportionate relationship between accumulation and consumption in the national economy, to the 8th Five-year Plan, which proposed a fundamental change in the mode of economic growth from a sloppy to an intensive mode, then to the 13th Five-year Plan, which proposed a green development concept of harmony between human beings and nature, showing the logical progression of economic development mode. From the "more, faster and better

province" in the 2nd Five-year Plan and the blind pursuit of high index construction policy in the 3rd Five-year plan, to the development thought of being eager for success in the 7th Five-year Plan, to the sustainable development concept in the 10th Five-year Plan, and then to the coordinated development concept in the 13th Five-year Plan, it reflects the logical progression of the concept of governing the country.

3.3. The Compilation of the Five-year Plan Reflects the Wide Range of Public Opinion

Through extensive discussions, revisions and improvements during the formulation process, the five-year plan has become increasingly scientific, democratized and standardized (Huang, 2020). In April 2014, a teleconference was held in Beijing to prepare the 13th Five-year Plan, and the National Development and Reform Commission promulgated 25 major topics to carry out preliminary work such as basic investigation, information collection, subject research and project demonstration. In February 2015, the central government set up a drafting group for the 13th Five-year Plan to conduct intensive research with the National People's Congress, the National Committee of the Chinese people's Political Consultative Conference (CPPCC) and various democratic parties, soliciting opinions extensively, and forming 117 special studies. Then, the draft of the 13th Five-year Plan outline was sent to all provinces, autonomous regions, municipalities directly under the central government and the central government departments for extensive consultation.

As we can see, the process of introducing the five-year plan actually reflects the real needs and specific suggestions of all sectors of society, and the outline of the plan reflects the greatest social consensus, expresses the development will of the whole nation, and forms the spiritual roadmap on the road of China's development.

3.4. The Five-year Planning Process Reflects the Exploratory Nature of Economic Practice

From the 1st Five-year Plan to the 5th Five-year Plan, the starting point of the Party and the government's economic work was to establish a highly centralized socialist planned economic system, with less use of market instruments to regulate the operation of the national economy at the micro level. Until the end of the 5th Five-year Plan, with the deepening understanding of the law of economic operation by the party and the government, the national economic management means gradually explored the resource allocation mode with planned economy as the main factor and market regulation as the supplement from the 6th Five-year Plan.

The 14th Party Congress during the 8th Five-year Plan proposed that "the market plays a fundamental role in the allocation of resources under the macro-control of socialist countries" (National People's Congress, 1991). At this time, the market as a basic means of resource allocation has been recognized, and the corresponding policy objectives of the five-year plan have changed from mandatory plan to guiding plan.

Furthermore, the core position of property rights was clarified during the 10th Five-year Plan period. The 11th Five-year Plan emphasized that the government

should play an increasingly important role in ecological and environmental protection, regional coordinated development, urban-rural relations, development of science, education, culture and health, social security and public services. The 12th Five-year Plan emphasized that "economic system reform is the key to comprehensively deepen the reform, and the core issue is to properly handle the relationship between the government and the market, so that the market can play a decisive role in the allocation of resources and give better play to the role of the government" (National People's Congress, 2013). So far, the relationship between the government and the market has been clearly defined, and is committed to the realization of an effective market and a responsive government.

It can be seen that the practice process of the five-year plan is also the process of the Party's continuous exploration for the laws of socialist economic development, especially the understanding of the relationship between plan and market, government and market is full of tortuous exploration.

4. China's Economic Development During the Five-year Planning Period

Since the implementation of the five-year plan, China's economy has made considerable progress. Table 2 summarizes the statistical data of China's total GDP and per capita GDP at the end of each five-year plan, as well as the proportion of China's GDP in the world.

Table 2. Changes in China's GDP and its position in the world

Five-year plan	Year at the end of the planning period	GDP (US \$100 million)	GDP per capita (USD)	Global share of GDP
the 1st Five-year Plan	1957	975.87	153.12	— —
the 2nd Five-year Plan	1962	879.31	132.07	0.70%
the 3rd Five-year Plan	1970	1,869.94	228.51	0.97%
the 4th Five-year Plan	1975	2,491.03	271.82	1.07%
the 5th Five-year Plan	1980	3,406.06	347.12	1.22%
the 6th Five-year Plan	1985	5,649.37	537.50	1.78%
the 7th Five-year Plan	1990	8,277.32	729.16	2.18%
the 8th Five-year Plan	1995	14,757.65	1,224.84	3.50%
the 9th Five-year Plan	2000	22,321.46	1,767.83	4.47%
the 10th Five-year Plan	2005	35,619.79	2,732.16	6.13%
the 11th Five-year Plan	2010	60,871.65	4,550.45	9.21%
the 12th Five-year Plan	2015	89,133.17	6,500.28	11.74%
the 13th Five-year Plan	2019	115,371.60	8,254.30	13.58%

¹ Note: The global share of China's GDP in 1957 is not available, because World Bank statistics on national GDP start from 1960. The data in the table are all calculated in constant 2010 U.S. dollars. The values at the end of the 13th Five-Year Plan period are expressed as 2019 data in this paper.

As can be seen from Table 2, China's GDP at the end of the 2nd Five-year Plan was only US\$87.931 billion, and the GDP per capita was only US\$132.07, which was less than 1% of the global GDP of the Eastern powers and ranked 20th in the world. Happily, China's GDP exceeded US\$6 trillion in 2010, the year of the 11th Five-year

Plan. Then, China's economy reached 11.74% of global GDP in 2015 and continues to grow. By 2019, China's GDP per capita had reached US\$8,254.30, and people's living standards had improved significantly. In 2020, China's total GDP has exceeded RMB 100 trillion, showing resilience in economic development even in the face of the COVID-19 epidemic.

Table 3. World ranking of GDP in five-year intervals

Rank	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
1	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA
2	UK	France	Germany	Japan	Japan	Japan	Japan	Japan	Japan	Japan	China	China
3	France	UK	Japan	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Japan	Japan
4	China	Japan	France	France	France	France	France	France	UK	UK	Germany	Germany
5	Japan	China	UK	UK	UK	UK	Italy	UK	France	China	France	UK
6	Canada	Italy	Italy	Italy	Italy	Italy	UK	Italy	China	France	UK	France
7	Italy	India	China	Canada	Canada	Canada	Canada	Brazil	Italy	Italy	Brazil	India
8	India	Canada	Canada	China	Brazil	China	Spain	China	Canada	Canada	Italy	Italy
9	Australia	Argentina	India	Brazil	Spain	India	Russia	Spain	Mexico	Spain	India	Brazil
10	Brazil	Australia	Brazil	Spain	Mexico	Brazil	Brazil	Canada	Brazil	Korea	Canada	Canada

¹ Note: Data are from the World Bank.

Table 3 shows the GDP ranking of each country according to the current price of US dollar. From this table, we can see that first, China's GDP ranking in the world basically shows a "V" shaped trend, i.e., in 1960, the total economic volume ranked fourth in the world, but with the rapid economic development of Japan, Italy and other countries, China's ranking gradually moved backward. In the 1980s and 1990s, China briefly fell out of the top ten positions in the world. Since 1995, China's ranking has gradually risen, and in 2006 it overtook the United Kingdom, in 2007 it overtook Germany, and in 2010 it overtook Japan, achieving a triple jump to second place in the world, and it has remained there ever since.

5. How Does the Five-year Plan Promote China's Economic Development?

Although the role of the government in economic development is different between the planned economy and the market economy. The socialist market economy system in China determines the dominance of the Party and the government in the formulation and implementation of the five-year plan, which inevitably brings about the promotion of the five-year plan to China's economic development. In the following, this paper provides an in-depth analysis of how the five-year plan promotes China's economic development.

Table 4. Measures for economic problems in each period of the five-year plan

Five-year plan	The current economic situation at that time	Strategic measures given in the five-year plan
the 1st Five-year Plan	Weak industrial base and weak state-owned economy.	To drive the overall construction with big projects, and to lay down and develop China's socialist industrial system with foreign aid as an auxiliary measure.
the 2nd Five-year Plan	The "Great Leap Forward" Movement.	In 1960, the policy of "adjustment, consolidation, enrichment and improvement" was introduced to correct and rectify the situation.
the 3rd Five-year Plan	Risk of external war.	Take national security as the starting point, adjust the national industrial layout and tend to the old, small and poor areas for economic construction.
the 4th Five-year Plan	Too high front-end target and too large infrastructure.	Put forward the task of accelerating the development of light industry and promoting the comprehensive balance of the national economy.
the 5th Five-year Plan	The national economy was devastated by political turmoil and the "leftist" erroneous ideology of seeking success in a hurry.	Re-establish the ideological line of "seeking truth from facts" and shift the focus of work to socialist modernization.
the 6th Five-year Plan	The level of economic development lags behind and people's living standards are not high.	Establish the policy that "all economic activities should be centered on improving economic efficiency" and the strategic goal of quadrupling the annual gross output value of industry and agriculture by the end of the 20th century.
the 7th Five-year Plan	Economic overheating, inflation.	Carried out efforts to reform the economic system and promote a linear paradigm shift in economic development strategies and economic management systems.
the 8th Five-year Plan	China's reform enters crossroads, ideological rigidity under dramatic changes in Eastern Europe.	Emancipate the mind, "be more daring in reform and opening up", and make the establishment of a socialist market economy system the goal of reform.
the 9th Five-year Plan	Low economic efficiency of enterprises, the existing economic system does not adapt to the requirements of the development of socialist market economy.	Put forward the "economic system from the traditional planned economic system to the socialist market economic system, economic growth from the sloppy to intensive transformation", giving nine important guidelines.
the 10th Five-year Plan	Backward production methods that consume a lot of energy and operate in a sloppy manner for economic development.	Propose strategies to strengthen ecological construction, environmental protection and sustainable economic and social development.
the 11th Five-year Plan	Imbalance of urban-rural and regional development, insufficient economic structure.	Put forward the coordinated development of urban and rural areas, accelerate the transformation of economic growth, improve the ability of independent innovation and other "six must" principles.
the 12th Five-year Plan	Uneven and unsustainable economic development.	Put forward the "five persistent" basic requirements.
the 13th Five-year Plan	The overlap of "growth rate shift period, structural adjustment pain period, the previous policy digestion period", effective demand and effective supply are insufficient.	Put forward the five major development concepts of "innovation, coordination, green, openness and sharing" to lead China to a moderately prosperous society.

5.1. The Proposal of the Five-year Plan is Targeted to China's Economic Reality

As can be seen from the above table, the five-year plan has a very strong realistic relevance, and dares to face the shortcomings and difficulties in each development period, not avoiding the problems, facing up to them and giving scientific and wise response guidelines and strategic planning. The realistic relevance of the five-year plan makes it a powerful guarantee for China's economic growth and promotes the rapid and healthy development of China's economy (see Table 4).

5.2. The Implementation of the Five-year Plan Tasks Has a Catalytic Effect on China's Economic Development

Generally speaking, the implementation of the 13 five-year plans has promoted China's economy in the following aspects: the first five-year plans focused on building a socialist economic system, while the latter five-year plans focused on economic system reform, resulting in the increase of China's economic volume and the improvement of economic quality.

The five-year plan improved China's economic system and gradually formed a complete industrial system and national economic system. China's industrial base was weak at the beginning of the founding of New China, but after the "4th Five-year Plan", a relatively complete industrial system and national economic system were initially established. The five-year plans promoted the reform of China's economic system and realized the transformation of China from a planned economy, a planned commodity economy, to a socialist market economy. The five-year plans propelled China's economic expansion and a sharp rise in the world ranking of GDP. As seen in Part 4, China's GDP world ranking shows a "V" shaped trend and China has become an important engine of world economic development.

5.3. The Historical Experience of the Five-year Plans Have Lessons for the Future of China's Economy

Summarizing the experience and lessons learned from the previous 13 five-year plans can provide a clear understanding of China's current historical point and stage of development, so as to provide reference for the preparation of scientific and reasonable five-year plans, and set more strategic and feasible goals to promote the sustained and positive development of China's economy and society.

First, the setting of overly aggressive development goals should be prevented. Although the five-year plan drew on a wide range of recommendations in setting its goals, its implementation was sometimes influenced by certain factors that raised the original plan's targets and brought about adventurous behavior beyond the stage of economic development. For example, the 2nd Five-year Plan was based on the idea of high speed. During the 3rd Five-year Plan, the actual implementation of the plan was adjusted to "war preparation as the center" due to the breakdown of Sino-Soviet relations and national defense considerations. During the 4th Five-year Plan, the main focus was

on the strategic rear construction of the "Great Third Front", which was characterized by high speed and high targets.

Second, the law of economic development should be respected and strong policy measures should be mastered. 1985-1988 price reform caused a sharp rise in prices and the emergence of "two prices for one product, resulting in planned products being left outside the plan, and outside the plan changing hands, with a large amount of national wealth falling into the pockets of private individuals and small groups" as predicted by Guo et al. (1985). The reasons for this are, the lack of understanding of the laws of the economic cycle, expectations were misguided at the time and inappropriate macro policy measures.

6. Conclusion

This paper compares the historical roles played by each of the five-year plans since the founding of New China. On this basis, the paper concludes that the five-year plan has shown historical inheritance, logical progression in their objectives, extensive public opinion in their preparation, and tortuous exploration in their practice. Further, the five-year plan has promoted China's economic development in the following ways. First, the five-year plan is relevant to China's economic reality. Second, the five-year plan is of great significance to China's economic development. Third, the historical experience of the five-year plan can be used for reference for the future development of China's economy. In the formulation and implementation of the next five-year plan, we should respect the objective economic laws as the premise, take the steady and steady progressive development as the principle, take the pace of reform as the rhythm, take the scientific and powerful policy measures as the guarantee, and take the construction of a new pattern of domestic and international dual circulation as the path to further improve the modern economic system proposed in the report of the 19th National Congress of the Communist Party of China.

References

- Guo, S. Q., Liu, J., & Qiu, S. (1985). Comprehensive reform needs master plan (in Chinese). *Comparison of economic and social systems*, 1, 21-26.
- Hu, A. G., Yan, Y. L., & Lv, J. (2011). An important means of China's development miracle -- Taking the transformation of the five-year plan as an example (from the sixth five year plan to the Eleventh Five Year Plan) (in Chinese). *Journal of Tsinghua University (Philosophy and Social Sciences Edition)*, 26(01), 43-52. <https://doi.org/10.13613/j.cnki.qhdz.001960>
- Huang, J. H. (2020). On the important characteristics and historical experience of the "Five Year Plan" (in Chinese). *Economic Daily*, 06-30(011). <https://doi.org/10.28425/n.cnki.njjrb.2020.006181>
- Ma, J. T. (2018). Review and Prospect of China's development strategy (in Chinese). *Managing the world*, 34(10), 2-10. <https://doi.org/10.19744/j.cnki.11-1235/f.2018.10.001>
- National People's Congress. (1982). *The sixth five-year plan for national economic and social development of the people's Republic of China* (in Chinese) (Bulletin of the Standing Committee of the National People's Congress, 1982). Standing Committee of the National People's Congress. http://www.npc.gov.cn/wxzl/gongbao/1982-11/30/content_1478459.htm

- National People's Congress. (1991). *Ten year plan for national economic and social development of the people's Republic of China and outline of the Eighth Five Year Plan* (in Chinese) (Bulletin of the Standing Committee of the National People's Congress, 1991). Standing Committee of the National People's Congress. http://www.npc.gov.cn/wxzl/gongbao/2000-12/28/content_5002538.htm
- National People's Congress. (1996). *The Ninth Five Year Plan for national economic and social development of the people's Republic of China and the outline of long term goals for 2010* (in Chinese) (Bulletin of the Standing Committee of the National People's Congress, 1996). Standing Committee of the National People's Congress. http://www.npc.gov.cn/wxzl/gongbao/2001-01/02/content_5003506.htm
- National People's Congress. (2013). *Decision of the Central Committee of the Communist Party of China on several major issues of comprehensively deepening reform* (in Chinese) (Bulletin of the Standing Committee of the National People's Congress, 2013). Standing Committee of the National People's Congress. http://www.gov.cn/jrzq/2013-11/15/content_2528179.htm
- Yang, W. M. (2019). Reform the planning system and give full play to the guiding role of planning strategy (in Chinese). *China Administration*, 8, 6-8.

The Influence of Network Economy on the High-quality Development of China's Economy

Hongzhi TIAN and Qiuli WANG*

Northwest University, Xi'an, China; nwuthz@nwu.edu.cn; wangqiuli0925@163.com

* Corresponding author: wangqiuli0925@163.com

Abstract: What impact does the Internet economy have on the high-quality development of China's economy? This paper finds that, first, the quality of economic development in most provinces and regions in China has been significantly improved in recent years, while the high-quality development level of Beijing, Shanghai and Guangdong, where the network economy is better developed, is mediocre, reflecting the need to further deepen the synergy between the network economy and high-quality development. Secondly, both the network economy and the high-quality economic development can realize their own development inertia. Third, the effect of high-quality economic development on network economy takes a long time. It is negative utility from the first year after the occurrence of high-quality pulse, and gradually turns to positive utility from the second year. Fourth, the development of the network economy significantly contributes to the high-quality development of our economy with positive effects in both the South and the North, and shows a long-term boost that lasts for four years.

Keywords: network economy; quality development; panel vector autoregressive models

JEL Classification: F49; F12

1. Introduction

With its fast information dissemination, massive information capacity and interactive information experience, the network has powerfully shortened the process of creating and accepting new knowledge and realized the rapid popularization of new technologies and new business models. To promote high-quality economic development, it is necessary to focus on meeting people's needs for a better life, while focusing on cracking the unbalanced and insufficient development contradictions and problems. The continuous growth of new dynamics of economic development and the emergence of new industries, new business models and new business models have further enhanced China's economic vitality and strongly promoted China's economic development towards high quality. Among the indexes of new dynamics of economic development, the network economy has the highest increase and the largest contribution, so it is of practical significance to study the impact of the development of the network economy on the high quality of China's economy in this context. Through this study, we examine the new dynamics of the network economy and use it to determine whether it is a new driving force for sustainable and high-quality economic development in China.

2. Literature Review

As China's economy moves from quantitative to qualitative growth, high-quality economic development approaches and goals have become an urgent development task for China today. Ren (2015) has recognized the economic consequences and social consequences of quantitative economic growth. The economic consequences include the drawbacks of dense population, urban congestion, environmental pollution, resource consumption, and declining welfare. In terms of social consequences, overemphasis on quantity-based growth leads people to fall into the loop of growth for the sake of growth. Specifically, economic high quality is innovative, coordinated, green, open and shared development, and is a high-level state of economic development approach, structure and dynamics (Jin, 2018). Shi (2018) believes that high-quality economic development should be measured in three dimensions, including the fundamental side of development, the ecological outcome side and the social outcome side. Ren (2018) pointed out that indicators of high-quality economic development should include economic development, urban infrastructure, education and retirement, ecological environment, and healthcare. Li (2019) constructs indicators of China's high-quality economic development in the new era from five dimensions: innovation, coordination, green, openness, and sharing.

Through literature combing, this paper has so far studied the development of network economy and economic high-quality development of the literature is relatively small, most of the literature only from the theoretical perspective to analyze the impact of network economy on China's economy and does not involve quantitative empirical research. In this paper, based on the existing studies, we take the panel data of 30 Chinese provinces and cities from 2013-2017 as the analysis sample, calculate China's network economy development indicators firstly through the entropy value method, then measure China's economic high-quality development indicators. And use the panel vector autoregression (PVAR) model to study the impact of network economy development on economic high-quality development, with a view to providing policy implications for China's network economy development and the PVAR model is then used to study the impact of network economy development on high-quality economic development, with a view to providing policy implications for China's network economy development and high-quality economic development.

3. Methodology

3.1. Construction of the Indicator System

3.1.1. Network Economy Development Evaluation Index System

In this paper, we refer to the study of Li (2018) and combine the actual situation in China to construct the network economy development evaluation index system from the following five aspects, which are shown in Table 1.

Table 1. Network economy development evaluation index system

Target layer	Criteria layer	Indicator layer	+/-
Network economy development level	Network economy support level	Transportation, post and telecommunications output as a proportion of GDP	+
		Research and development expenditure as a proportion of GDP	+
		Investment in education as a proportion of GDP	+
	Network Infrastructure Construction	Long distance fiber optic cable line length	+
		Cell phones per 100 people	+
	Network development and application level	Network Number	+
		Number of Domains	+
		Number of people online as a percentage of total population	+
		Total telecom services per capita	+
	Network Economy Talent Resources	Number of college students per 10,000 people	+
		Number of scientific and technical personnel per 10,000 people	+
		Proportion of total employees in transportation, post and telecommunications	+
	Network Economy Development Results	E-commerce sales	+

3.1.2. Network Economy Development Evaluation Index System

In this paper, the construction of economic quality development index system mainly focuses on the five major development concepts of "innovation, coordination, green, openness and sharing", and the evaluation index system of economic quality development is constructed by referring to the latest literature of Wu and Liang (2020), as shown in Table 2.

Table 2. Economic quality development evaluation index system

Target layer	Criteria layer	Indicator layer	+/-
Degree of high-quality economic development	Innovative Development	Scientific research, technical services and other fixed assets investment ratio	+
		Capital productivity	+
		Share of education expenditure in total fiscal expenditure	+
		Value added of tertiary industry as a share of GDP	+
	Coordinated Development	Urban-rural income ratio	-
		Consumer price index (previous year=100)	-
	Green Development	SO2 emissions per unit of regional output	-
		Emission of wastewater per unit area output	-
		Share of environmental protection expenditure in fiscal expenditure	+
		Ratio of total import and export to GDP	+
	Open Development	Ratio of total import and export to GDP	+
		Ratio of real foreign direct investment to GDP	+
		Reception of international tourists	+
	Shared Development	Per capita GDP	+
		Number of beds in medical institutions per 10,000 people	+
		Share of social security and employment expenditure in total fiscal expenditure	+

3.2. Measurements

3.2.1. Entropy Method

Based on the evaluation index system of network economic development and high-quality economic development constructed in the previous paper, this paper adopts the entropy value method to quantitatively analyze the network economic development and high-quality economic development in China. The specific calculation method is as follows.

Step 1: Standardization of the indicators. With r years, n provinces and cities, and m indicators, x_{ijt} is the value of the j th secondary indicator of province i in year t . Since different indicators have different levels and units, they need to be standardized to obtain the standardized secondary indicators r_{ijt} . For the positive indicators, the transformation formula is as follows.

$$r_{ijt} = \frac{x_{ijt} - \min(x_j)}{\max(x_j) - \min(x_j)} \quad (1)$$

For the inverse indicator, the transformation equation is as follows.

$$r_{ijt} = \frac{\max(x_j) - x_{ijt}}{\max(x_j) - \min(x_j)} \quad (2)$$

Step 2: Calculate the characteristic weight of the indicator f_{ijt} .

$$f_{ijt} = \frac{r_{ijt}}{\sum_{t=1}^r \sum_{i=1}^n r_{ijt}} \quad (3)$$

Step 3: Calculate the information entropy e_j and its redundancy d_j .

$$e_j = \frac{1}{\ln rn} \sum_{t=1}^r \sum_{i=1}^n f_{ijt} \ln(f_{ijt}) \quad (4)$$

$$d_j = 1 - e_j \quad (5)$$

Step 4: Determine the weight of the j th secondary indicator w_j .

$$w_j = \frac{d_j}{\sum_{j=1}^m d_j} \quad (6)$$

3.2.2. Panel Vector Autoregressive Model

In order to further analyze the interaction between network economy development and high-quality economic development, this paper establishes a panel vector autoregressive (PVAR) model and performs generalized moment estimation (GMM) on the parameters of the model, and then uses impulse responses to display the dynamic relationship between the two more intuitively. Among them, the specific structure of the PVAR model is as follows.

$$Y_{it} = \theta_0 + \sum_{j=1}^k \theta_j Y_{it-j} + \alpha_i + \beta_t + u_{it} \quad (7)$$

where: Y denotes the binary column vector containing the network economic development and the high-quality economic development; θ_0 denotes the vector of intercept terms; θ_j

denotes the lag j -order matrix; α_i , β_t denote individual effects and time effects, respectively; u denotes the random error vector.

4. Results

4.1. Comprehensive Evaluation of Network Economic Development and High-quality Economic Development

Based on the entropy value method, the level of network economic development and high-quality economic development of 30 provinces and cities are calculated and shown in Table 3 and Table 4 below.

Table 3. Network economic development measurement results by provinces and cities from 2013-2017

Region	2013	2014	2015	2016	2017	Average
Beijing	0.1139	0.1323	0.1953	0.1882	0.2047	0.1669
Tianjin	0.0273	0.0274	0.0434	0.0369	0.0389	0.0348
Hebei	0.0351	0.0431	0.0739	0.0507	0.0596	0.0525
Shanxi	0.0244	0.0293	0.0493	0.0276	0.0341	0.0329
Inner Mongolia	0.0162	0.0181	0.0353	0.0255	0.0270	0.0244
Liaoning	0.0360	0.0392	0.0649	0.0420	0.0497	0.0464
Jilin	0.0225	0.0196	0.0321	0.0246	0.0383	0.0274
Heilongjiang	0.0348	0.0356	0.0498	0.0338	0.0491	0.0406
Shanghai	0.0845	0.0966	0.1391	0.1138	0.1431	0.1154
Jiangsu	0.0695	0.0731	0.1395	0.0871	0.0963	0.0931
Zhejiang	0.0630	0.0657	0.1424	0.1070	0.1035	0.0963
Anhui	0.0372	0.0401	0.0686	0.0702	0.0906	0.0613
Fujian	0.0480	0.0515	0.0817	0.1062	0.1539	0.0883
Jiangxi	0.0267	0.0250	0.0503	0.0444	0.0519	0.0396
Shandong	0.1003	0.0835	0.1103	0.1114	0.1272	0.1065
Henan	0.0543	0.0504	0.0833	0.0798	0.0968	0.0729
Hubei	0.0416	0.0475	0.0718	0.0638	0.0720	0.0593
Hunan	0.0343	0.0369	0.0617	0.0600	0.0650	0.0515
Guangdong	0.1486	0.1622	0.2098	0.2083	0.2385	0.1935
Guangxi	0.0302	0.0386	0.0449	0.0444	0.0579	0.0432
Hainan	0.0987	0.0340	0.0591	0.0354	0.0608	0.0576
Chongqing	0.0329	0.0454	0.0429	0.0446	0.0442	0.0420
Sichuan	0.0515	0.0640	0.0731	0.0790	0.1671	0.0869
Guizhou	0.0381	0.0407	0.0533	0.0569	0.0487	0.0476
Yunnan	0.0491	0.0432	0.0430	0.0481	0.1269	0.0621
Shanxi	0.0331	0.0487	0.0414	0.0462	0.1030	0.0545
Gansu	0.0206	0.0310	0.0662	0.0437	0.0735	0.0470
Qinghai	0.0389	0.0230	0.0494	0.1392	0.0828	0.0667
Ningxia	0.0377	0.0354	0.0191	0.0398	0.1301	0.0524
Xinjiang	0.0308	0.0349	0.0324	0.0281	0.0550	0.0363
National average	0.0493	0.0505	0.0742	0.0696	0.0897	—

As can be seen from Table 3, the development of China's network economy has the following characteristics: first, horizontally, the higher level of network economy development in economically developed and southern provinces and regions, among which Guangdong has the highest level of network economy development and has maintained an absolute leading position, which shows that a good economic foundation can promote faster

development of the network economy. And Tianjin, Hebei, northeast three provinces, Inner Mongolia, Shanxi, Jiangxi, Hunan, Guangxi, Chongqing, Guizhou, Gansu, Xinjiang and other places of network economy development is relatively slow. Second, vertically, the provinces and regions with the fastest growing network economy level are concentrated in Zhejiang, Fujian, Hainan, Sichuan and Shanxi, showing good development momentum. Among them, Zhejiang made the fastest progress in 2015 and 2016, Fujian, Sichuan, Yunnan, Shanxi and Ningxia made the greatest progress in 2017, while Qinghai made significant progress in 2016. Thirdly, for the national average level of network economy development, the continuous development hand was maintained in 2014 and 2015, and although the development strength dropped in 2016, it immediately rebounded strongly in 2017, and the national average reached 0.0897, much higher than the level in 2015. It can be seen that the overall momentum of the development of the network economy in China is good, and the development in areas with high economic level and economic vitality is even better.

Table 4. Economic quality development measurement results by provinces and cities from 2013-2017

Region	2013	2014	2015	2016	2017	Average
Beijing	0.4566	0.4928	0.5173	0.5521	0.5177	0.5073
Tianjin	0.6818	0.6859	0.7019	0.7092	0.7419	0.7042
Hebei	0.6723	0.6526	0.6743	0.7061	0.7083	0.6827
Shanxi	0.5955	0.6519	0.5989	0.6620	0.6265	0.6270
Inner Mongolia	0.6576	0.6337	0.6201	0.6189	0.6099	0.6280
Liaoning	0.5395	0.4951	0.5376	0.5648	0.5850	0.5444
Jilin	0.7364	0.7207	0.7118	0.7338	0.7113	0.7228
Heilongjiang	0.6452	0.6480	0.6350	0.6288	0.6905	0.6495
Shanghai	0.5083	0.5014	0.5582	0.5773	0.5933	0.5477
Jiangsu	0.5813	0.5647	0.9660	0.6098	0.6054	0.6654
Zhejiang	0.6216	0.6535	0.6706	0.7083	0.7298	0.6768
Anhui	0.7180	0.6956	0.7187	0.7458	0.7803	0.7317
Fujian	0.7182	0.6769	0.7074	0.7360	0.7549	0.7187
Jiangxi	0.7466	0.7195	0.7366	0.7542	0.7716	0.7457
Shandong	0.6065	0.5850	0.5978	0.6178	0.6223	0.6059
Henan	0.6665	0.6387	0.6475	0.6865	0.7069	0.6692
Hubei	0.6778	0.6267	0.6568	0.6847	0.7109	0.6714
Hunan	0.6405	0.5880	0.6286	0.6477	0.6909	0.6392
Guangdong	0.5942	0.5992	0.6181	0.6353	0.6544	0.6203
Guangxi	0.7691	0.7260	0.7049	0.7218	0.7382	0.7320
Hainan	0.8828	0.8861	0.8731	0.9237	0.9452	0.9022
Chongqing	0.6291	0.5722	0.5817	0.6118	0.6292	0.6048
Sichuan	0.5915	0.5783	0.5989	0.6283	0.6464	0.6087
Guizhou	0.6438	0.6302	0.6539	0.6443	0.6363	0.6417
Yunnan	0.7064	0.6996	0.6912	0.7432	0.7141	0.7109
Shanxi	0.5960	0.5812	0.5917	0.5472	0.6207	0.5874
Gansu	0.6380	0.6268	0.6103	0.6257	0.6463	0.6294
Qinghai	0.7180	0.6807	0.6666	0.6800	0.6968	0.6884
Ningxia	0.6279	0.6491	0.6070	0.6361	0.6574	0.6355
Xinjiang	0.8660	0.8844	0.8965	0.9144	0.9452	0.9013
National average	0.6578	0.6448	0.6660	0.6752	0.6896	—

Table 4 reflects the basic trend of China's economic quality development: First, horizontally, provinces and regions such as Tianjin, Jilin, Jiangsu, Hainan and Xinjiang show a better level of quality development, while Beijing, Shanghai and Guangdong, where the network economy is better developed, show a mediocre level of quality development, which reflects the inconsistency of the two in some provinces and regions, and more deeply reflects that the network economy in quality development still needs Further deepen the synergy. Second, vertically, except for Inner Mongolia and Qinghai, almost all provinces have focused on the issue of high-quality development in their economic development after the 18th National Congress, and the quality of economic development in the five-year sample interval of this paper has been significantly improved. For example, Shanxi's economic quality development level increased from 0.5955 in 2013 to 0.6519 in 2014, and Jiangsu's economic quality development level increased from 0.5647 in 2014 to 0.966 in 2015. Finally, nationally, the economic quality development level showed a slight regression in 2014 except for the rest of the years, which showed a significant increase in economic quality development. The effective improvement of the level of high-quality development requires the synergistic development of all levels of the economy, and it is more difficult to obtain a significant improvement in the short term, and can only be carried out in a practical and steady manner to build a modernized economic system.

4.2. The Impact of Network Economic Development on the Quality Development of the Economy

4.2.1. PVAR Model Estimation

The GMM method is used to estimate the PVAR model needs to determine the lag order of the model first, and in this paper, the Akaike information criterion (AIC) value, Bayesian information criterion (BIC) value and Hannan-Quinn information criterion (the optimal lag order is determined to be 1 based on the minimum selection criterion (Table 5). the estimation results of the PVAR model are shown in Table 6.

Table 5. Optimal lag order results

lag	AIC	BIC	HQIC
1	-4.62349	-2.38952	-3.74966
2	-3.529	-.352951	-2.51295

Table 6. Estimation results of PVAR model

Style	h_dIE		h_dHQE	
	b_GMM	z	b_GMM	z
L.h_dIE	-0.2073611	-2.01	0.2106169	1.58
L.h_dHQE	-0.0458716	-1.91	-0.3618112	-3.28

Note: L. denotes lagged first order, h_ denotes variables after differencing treatment; b_GMM denotes regression coefficients of explanatory variables.

4.2.2. Analysis of the Dynamic Effect of Network Economy and High-quality Economic Development

In order to study the response mechanism of network economy development and high-quality economic development more visually, the impulse response diagram is obtained (Figure 1).

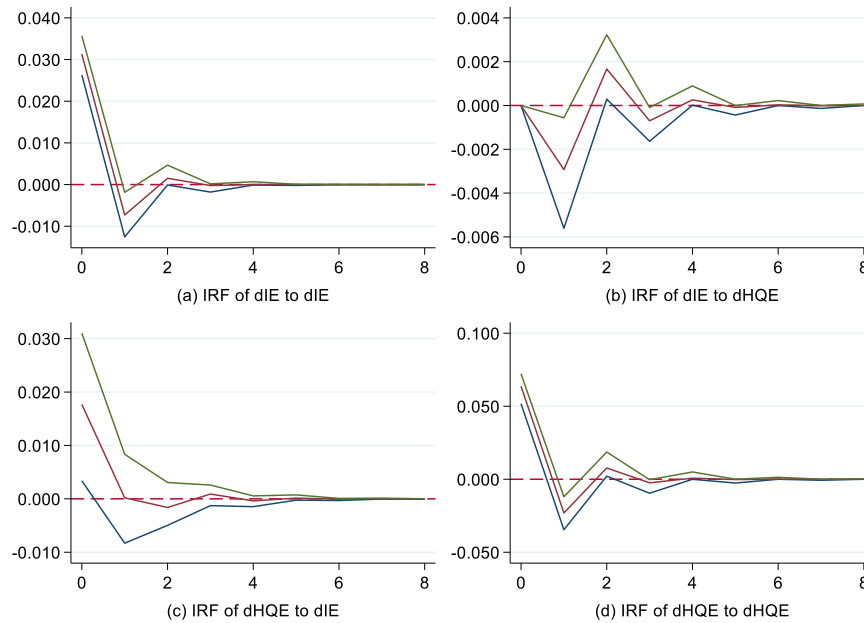


Figure 1. The dynamic relationship between the network economy and the high-quality economic development in the national region

First of all, from Figure 1(a) and Figure 1(d), it can be seen that both the network economy and the high-quality development of the economy can realize their own development inertia, that is, the good development foundation of the network economy can promote the better development of the future network economy of the country, and the positive promotion effect occurs immediately and can last for nearly four years. The high-quality development foundation of the economy can also continue to promote the high-quality development of the future economy of the country, not only the high quality the impulse can work immediately within a year and last longer than that of the network economy, with the impulse response function plotted at 5 years. As the most central measure of this paper, Figure 1(c) finds that the development of the network economy significantly contributes to the high-quality development of our economy. The figure shows that the positive pulse of the network economy is generated immediately and always positively on the high-quality development of our economy, and it shows a long-term driving effect that lasts for four years.

The results in Tables 3 and 4 show that although the overall effect of the network economy and the high-quality development of the economy is significant, there are significant regional differences. Although the previous literature focused mostly on the development differences between the eastern, central and western regions of China, the gap between the economic development of the south and north of China has been gradually expanding recently. From the GDP data of provinces and cities published in 2019, the total economic volume of the southern region occupies 65% of the country, while the total

economic volume of the north occupies only 35% of the country, and even the southwest region, which has the lowest economic level in the south, has developed very rapidly in recent years and has almost surpassed the northwest and northeast regions, strongly promoting the development of the entire southern region. On the contrary, the northeast and north China regions in the north have developed significantly slowly in recent years, obviously pulling down the development rate of the entire northern region. This phenomenon was also found by Du and Wu (2020), Wei et al. (2019) as well as Dai (2020). Therefore, this paper focuses more on the differential performance of network economy and economic quality development in the south and north of China, and also depicts Figures 2 and 3 for empirical analysis.

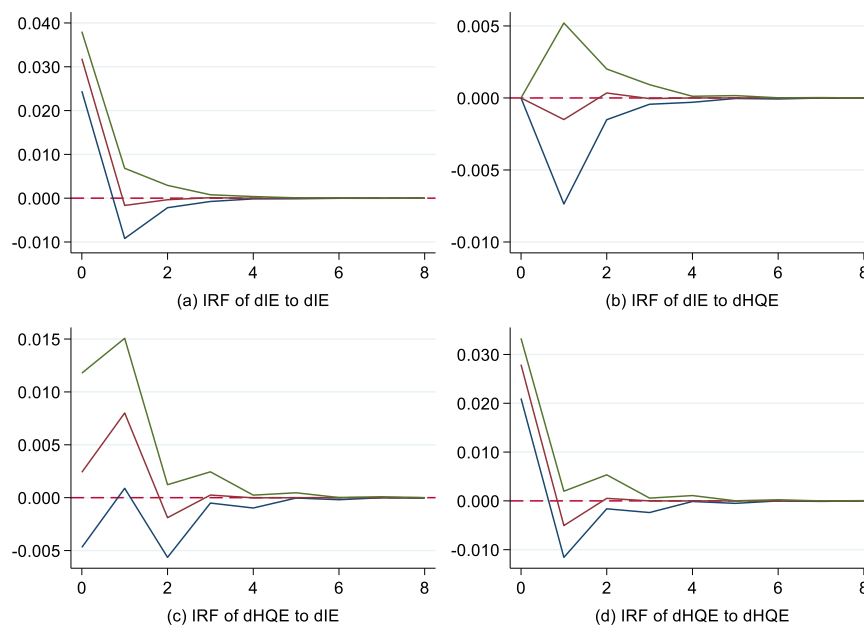


Figure 2. The dynamic relationship between the network economy and economic quality development in the northern region.

Comparing Figures 2 and 3, we can see that, first, similar to the national situation, the network economy and the quality development of the economy in both the South and the North can form a virtuous circle that promotes their respective development. There is no doubt that even though the current level of economic development in the North is lower than that in the South, both the network economy and the high-quality development of the economy are very important for both the South and the North, and both need to be developed in a focused manner. The difference is that the high-quality development of the South's economy is more significant for its own future high-quality development, with the maximum value of the impulse response function reaching 0.080, while the North's is only 0.032. It can be seen that the higher the quality development of the region, the more it contributes to its future high-quality development, which has formed a virtuous circle.

Second, the network economy has different mechanisms of action on the high-quality economic development of the northern and southern regions. Since the network economy is less developed in the northern provinces and regions than in the southern provinces and

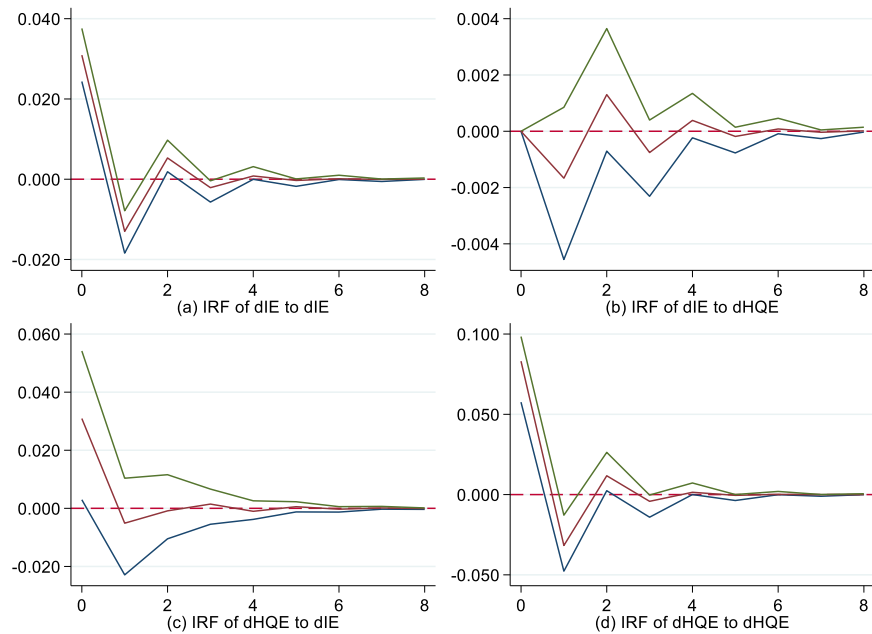


Figure 3. The dynamic relationship between network economy and economic quality development in the southern region

regions, the network economy has a slower onset and smaller effect in promoting high-quality economic development. Figure 2(c) shows that the maximum effectiveness of the network economy is reached in the second year, and it is only 0.015, while the network economy in the south has a larger and faster effect in promoting its economic quality development, within the same year when the network economy impulses occur and already has a driving effect of 0.04 on the economic quality development. Therefore, the different economic bases of the South and the North lead to the different role of the network economy in promoting the two.

Finally, at the level of high-quality economic development contributing to the development of the network economy, the South and the North show almost consistent similarity, i.e., the high-quality economic development is not very significantly affecting the development of the network economy. It can be seen that the difference in the impact on the network economy is not very significant for the time being under the condition that neither the high-quality development of the economy in the South nor the North is rapidly increasing.

5. Conclusions

Can the development of network economy effectively promote the high-quality development of China's economy? The study in this paper found that, firstly, the higher level of network economy development in economically developed and southern provinces and regions, among which Guangdong has the highest level of network economy development and has maintained the absolute leading position. Secondly, the quality of economic development in most provinces and regions in China has been significantly improved in recent years, with Tianjin, Jilin, Jiangsu, Hainan and Xinjiang showing better levels of high-

quality development, while Beijing, Shanghai and Guangdong, where the network economy is better developed, from which it is reflected that the network economy needs to further deepen the synergy with high-quality development. Third, both the network economy and high-quality economic development can achieve their own development inertia, that is the good development foundation of the network economy can promote the better development of the network economy in the future, and the positive promotion effect happens immediately and can last for nearly four years. Fourth, the effect of high-quality economic development on the network economy takes a longer time and has a negative effect in the first year, which gradually changes to a positive effect from the second year onwards, so some aspects of the network economy cannot reach the requirements of high-quality development for the time being. Fifth, the development of the network economy has significantly contributed to the high-quality development of our economy in both the South and the North. The network economy can immediately have a positive impact on the high-quality development of China's economy, and it shows a long-term promotion effect that lasts for four years.

References

- Ren, B. (2015). The path selection and reform orientation of improving the quality of China's economic growth under the new normal (in Chinese). *Tianjin Social Science*, 5, 84-90. <https://doi.org/10.16240/j.cnki.1002-3976.2015.05.013>
- Jin, B. (2018). Economic research on "High Quality Development "(in Chinese). *China's Industrial Economy*, 4, 5-18. <https://doi.org/10.19581/j.cnki.ciejournal.2018.04.001>
- Shi, B., & Ren, B. (2018). Measurement and analysis of quality development of China's inter-provincial economy (in Chinese). *Economic Issues*, 4, 1-6. <https://doi.org/10.16011/j.cnki.jjwt.2018.04.001>
- Ren, B. (2018). Target requirements and priorities of high-quality development in China (in Chinese). *Red Flag Manuscript*, 24, 21-23.
- Li, M., & Ren, B. (2018). Comprehensive evaluation of China's high-quality development in the new era and its path selection (in Chinese). *Finance and Economics*, 5, 26-40.
- Fan, Z., Li, W., & Wan, X. (2017). A preliminary study on the construction of the index system of Internet economic development level (in Chinese). *Business Economic Research*, 18, 187-189. <https://doi.org/10.3969/j.issn.1002-5863.2017.18.062>
- Wu, Z., & Liang, Q. (2020). Measurement, comparison and strategic path of China's high-quality economic development (in Chinese). *Contemporary Finance and Economics*, 4, 17-26. <https://doi.org/10.13676/j.cnki.cn36-1030/f.2020.04.003>
- Du, Y., & Wu, C. (2020). The widening economic gap between the north and the south of China: phenomenon, causes and countermeasures (in Chinese). *Journal of Anhui University (Philosophy and Social Science Edition)*, 1, 148-156. <https://doi.org/10.13796/j.cnki.1001-5019.2020.01.015>
- Wei, Y., Geng, D., & Chen, T. (2019). Analysis of the north-south gap in China based on big data of science and technology (in Chinese). *China Economic and Trade Journal*, 16, 18-20. <https://doi.org/10.3969/j.issn.1007-9777.2019.24.006>
- Dai, D. (2020). A study on the north-south economic development gap based on resource heterogeneity (in Chinese). *Research on Technology Economics and Management*, 6, 94-98. <https://doi.org/10.3969/j.issn.1004-292X.2020.01.016>

The Vital Basis of Technology Transfer Seen from the Perspective of the SECI and BA Model: Structural Insight

Josef TOMAN*, Petra MAREŠOVÁ and Blanka KLÍMOVÁ

University of Hradec Králové, Hradec Králové, Czech Republic; josef.toman@uhk.cz; petra.maresova@uhk.cz; blanka.klimova@uhk.cz

* Corresponding author: josef.toman@uhk.cz

Abstract: The portfolio of research and technology transfer (TT) activities represents a dynamic time-limited project organizational structure. The topic of the influence of a properly organized working environment of universities and the effective creation and dissemination of knowledge in research and TT projects has been identified as a research gap. Therefore, this article focuses on the following research question: "What does the operational structure of research look like and what are its characteristics?" The main method for achieving this goal is a network analysis, the procedures of which were applied to the data of the University of Hradec Králové in the field of research and TT, specifically the data from research projects. The data file contains data of 370 research activities. The scale of the network has not been confirmed and it is also a network where the presence of the small world phenomenon has not been confirmed, which in the context of relatively high average degree of centrality indicates some redundancy in the interconnection of research teams and may be an indication of limited innovation potential of researchers of UHK teams and not fully effectively developed research basis.

Keywords: technology transfer; knowledge management; social network analysis

JEL Classification: I23; O31; O32

1. Introduction: Knowledge Management and Technology Transfer

Knowledge management makes it possible to explain why knowledge cannot be well transferred or communicated during the technology transfer process. The model of the relationship between knowledge management and technology transfer (TT) includes both the technology provider organization (university) and the technology recipient organization (companies between which TT takes place) work with two basic theoretical concepts - environmental knowledge management and absorption capacity (Anderton & Watson, 2018). Knowledge management enables to clarify the reasons why there are complications in the transfer or sharing of knowledge during the technology transfer process, using the concept of absorption. This concept enabled to understand how to positively influence relations between manufacturing companies and higher education organizations in order to "facilitate the process" of technology transfer. "The key factor for successful "facilitation" appears to be the examination of both subjects simultaneously by the same optics (Leonard, 1999). The absorption capacity is one of the determining abilities of a company to accept new knowledge

and be able to benefit from it for its own innovation activities. A firm or department with a high absorption capacity has a well-developed ability to effectively transfer the knowledge it acquires from surrounding units or firms (Tsai, 2001). This is also in line with the results of related studies, which confirmed that knowledge is usually distributed unevenly within the network (Borgatti, 2003; Tsai, 2001). It is also important to emphasize that the procedural concept of absorption capacity (Lane et al., 2006) as an element indicating the above-described ability to effectively receive and transmit, i.e. to further distribute the accepted properties, is directly related to the position of the organization or company (Burt, 1976), and thus makes the position of the organization one of the primary factors of success of the transfer process (Kotler et al., 2013; Tsai, 2001). In the aviation industry, we have a proven direct impact of knowledge management on a successful TT (Rafiei et al., 2016). The results of the study say that it is appropriate for managers (in this case, in the aviation industry) to pay more attention to three topics: (1) technology transfer, (2) environment preparation to facilitate a technology flow and increase performance by allocating sufficient resources and space to these activities; and (3) building and developing relationships with support organizations, research institutes and universities, which makes it possible to transfer relevant knowledge and technology in a shorter time and at a lower cost.

In this case, the first point seems interesting, which is closely related to both the sharing of experience and the transfer of formalized know-how in the form of documentation, manuals and training, which resonates with the SECI model (Nonaka, 1994). In the case of the second point, we can also find a model for Nonaka, as it can be set into the Ba model (Nonaka, 1994). Within the same model, we can identify the third point with the following types of Ba "Origin Ba" and "Dialog Ba" see Figure 3 (Nonaka, 1994). Studies on the role of universities as "open innovators" also highlight the importance of the position that the university occupies or is able to take and also defend within specific network structures (Jonsson et al., 2015; Kim et al., 2018).

There are already traditional studies on the productivity of researchers and their co-authoring cases of co-citation networks in which these researchers work, which are studies in the full sense of the word focused on the creation and sharing of knowledge in the university environment. Usually, the abilities of universities or their research teams are analyzed, such as productivity (Racherla & Hu, 2010), openness to innovation (Powell et al., 1996; Smith et al., 2014) or the ability of companies to create new values for customers in a broader sense (Perkmann et al., 2011; Schaeffer et al., 2020; Tsai, 2001). This level, the level of creation and sharing of knowledge in the environment of universities, especially their transfer activities, is researched extensively. On the other hand, the level of creating a suitable organizational environment and learning about the processes of creating and sharing knowledge in academia is examined less often and yet according to Nonak's Ba-model, it is the level of organizational culture, which includes a key work environment for creating the so-called organizational knowledge. It turned out that the question "What does the operational structure of research look like and what are its characteristics?", i.e. what research projects are conducted and how individual knowledge from the heads of individual researchers gets into the final reports of more and more projects is not much researched, or

at least we have not found any studies at the level of "peer-review articles" in the available Scopus or WoS databases. Therefore, we consider it appropriate to pay more attention to this issue of "creating a suitable work environment for individuals in teams performing university research". A solid starting point for studying the structure and properties of the work organization of science and research is to clarify several basic concepts from the history of universities related to the topic. The university has historically occupied some "original position" (Lee, 1998), which, as mentioned above, resulted from the tradition and activities of the university, i.e. here we usually limit ourselves to two original roles (1) Teaching and (2) Research provided in Figure 1 below.

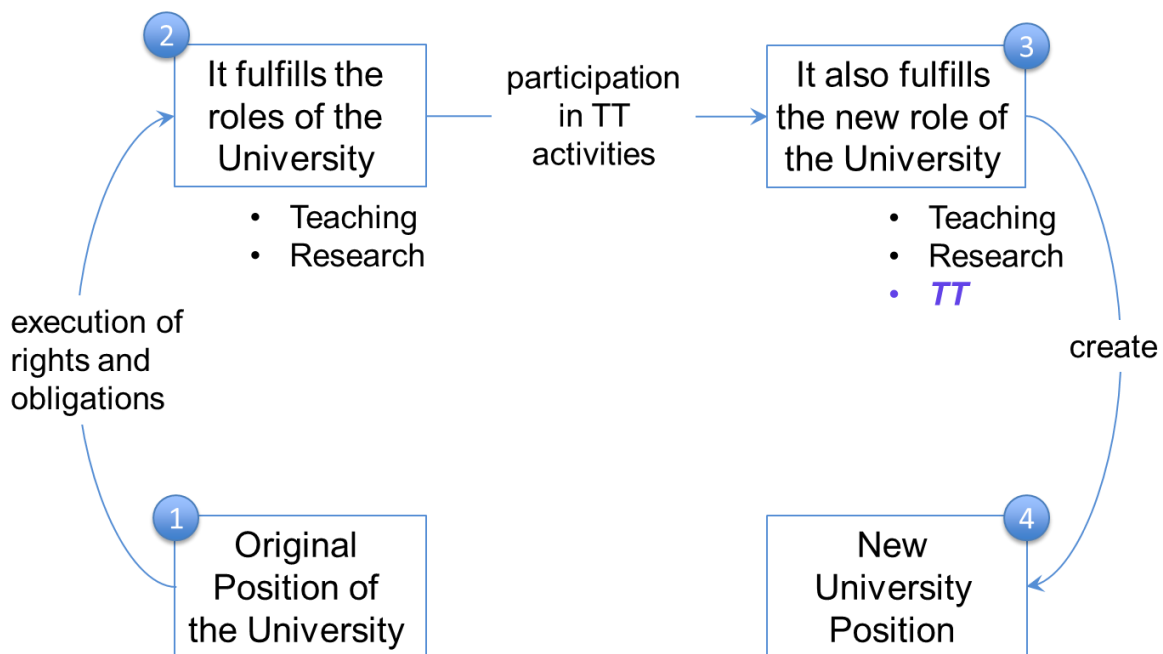


Figure 1. Conceptual scheme of the change of historical roles of the university towards TT

This defined position was then associated with "a target market" (Pritchard et al., 2016), for which the university came up with "a certain offer" (Kotler et al., 2013) that resulted from the execution of rights and obligations associated with those roles (Wasserman & Faust, 1994). In the course of time, the university has expanded its scope to include another role (3) of TT, which is naturally linked to "new target markets" and "expansion of supply" resulting from the expanded exercise of rights and obligations associated with these roles, i.e. TT and research activities (Bozeman, 2000). Now, we will specify these two roles (TT and research activities) through research projects: Research (GAČR) and (3rd role) TT (EHP, MK-NAKI, MPO, MV-PV, MZ, MŠMT, NORWAY, TACR).

The above types of projects, together with researchers moving from project to project, create a structure that may or may not help to generate and disseminate knowledge. It is a slightly modified co-author's network, which forms a manageable structure of scientific cooperation, i.e. a portfolio of projects. To understand "What does the operational structure of research look like and what are its characteristics", we have set two successive goals: (i) to describe the time evolution of the network structure of the research project portfolio and (ii)

identification of the so-called cut-point projects, i.e. the projects which, due to their position, eventually divide the network into two or more parts.

2. Methods

The main method for achieving the goal is a network analysis, the procedures of which were applied to the data of the University of Hradec Králové in the field of research and TT from the databases of UHK information systems and subsequently, their analysis, evaluation and preparation for calculations were performed. These were the data from the research projects (GAČR, TAČR). The data file contains data of 370 research activities (in the following text, the designation project may be used, but it is still the same variable, i.e. the project of R&D activities). Within the mentioned 370 projects, 806 researchers were active in the monitored period of 2014-2019. The file contains data of 80 external entities. On average, there are about two projects per researcher and the average number of researchers per project is close to five. The first key task was how the network data will be obtained from this database, i.e. how networks will be created. The procedure for all networks created in this study was identical and followed standard networking procedures (Wasserman & Faust, 1994).

3. Results

3.1. Time Evolution of the Network Structure of the Portfolio of R&D Projects

In relation to the first sub-objective, i.e. the description of the time evolution of the network structure of the research project portfolio, Table 1 provides a summary of network metrics that characterize the six networks shown in Figure 1. Specifically, network size measured by number of nodes 19 in 2014 to 370 in 2019. These are small to medium-sized networks at an advanced stage of development. Therefore, gigantic components are already recognizable in every period. The networks show a significant share of the gigantic component in the entire network, which ranges from 47 to 85.7% of the total number of peaks.

Table 1. Structural metrics of the network of research projects from the period of 2014-2019

Structural metrics	2014	2015	2016	2017	2018	2019
Number of network nodes	19	88	141	207	300	370
Number of components	4	24	25	28	33	48
The size of a gigantic component	9	61	111	175	263	317
The share of a gigantic component	0.474	0.693	0.787	0.845	0.877	0.857

The development of the network in the individual monitored periods is summarized in six graphs in Figure 2. The graph for the period of 2014 also shows the designations of individual projects as they are listed in the database. In subsequent periods, due to the legibility of the graph, we do not list these designations.

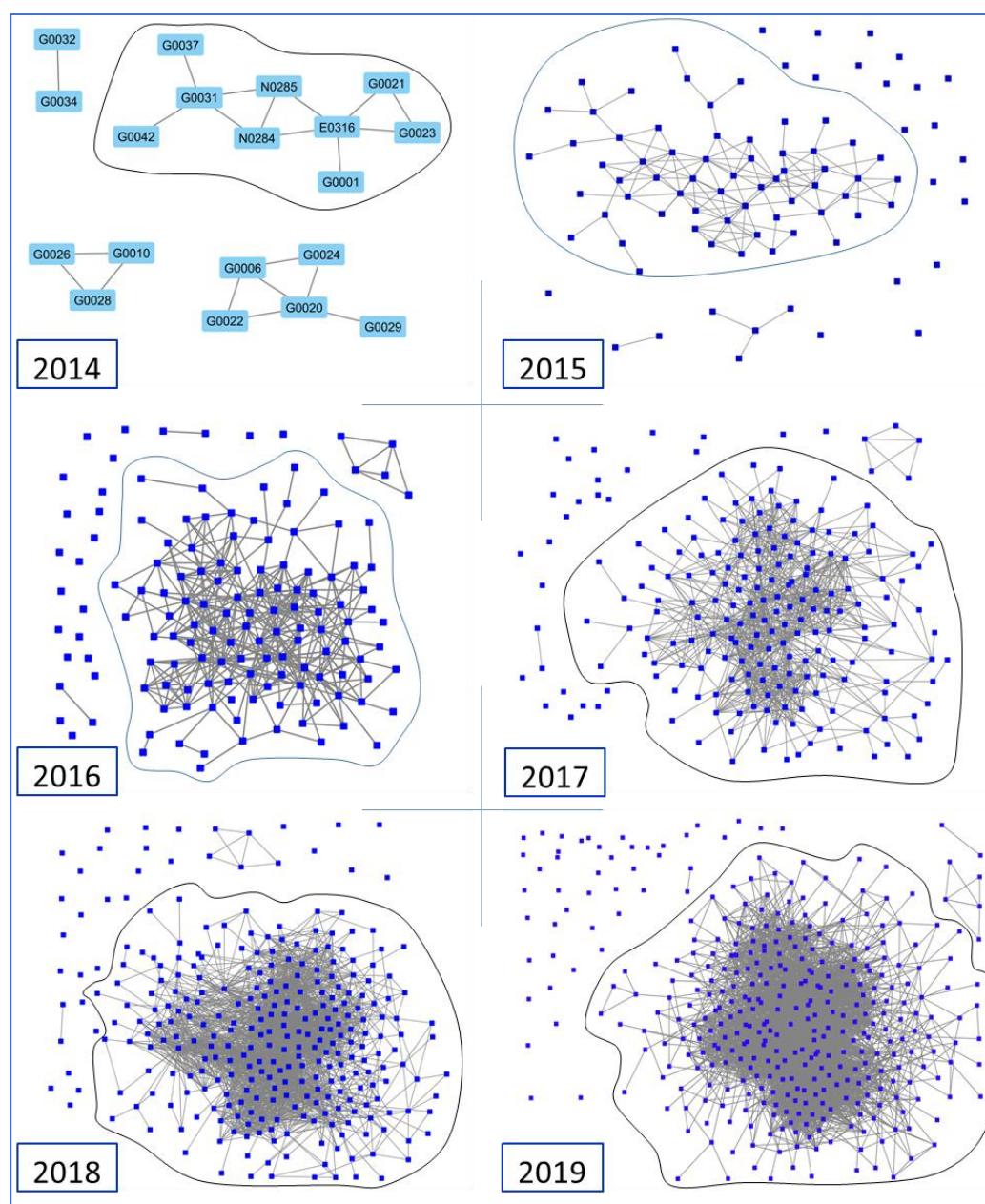


Figure 2. Time evolution of the network of research projects in the period of 2014-2019 with a marked gigantic component

For seven topological metrics see the list in the first column Table 2, the calculated values of individual topological metrics were calculated according to the relationships given in the theoretical part of this work and using routines offered by Cytoscape (Shannon, 2003) or UCINET (Borgatti, 2003). The number of researchers increased during the observed period, from 168 to 806, i.e. almost five times (4.8 times), however, the actual values of these numbers are relatively small for deciding on the presence of the phenomenon of a small world. The necessary comparisons require order differences of the compared values (Newman, 2018).

Table 2. Structural metrics of the research projects from the period of 2014-2019

Structural metrics	2014	2015	2016	2017	2018	2019
Number of network nodes	19	88	141	207	300	370
Network density	0.123	0.038	0.043	0.045	0.049	0.053
Number of isolated nodes	0	21	21	25	30	44
Number of components	4	24	25	28	33	48
Network diameter	4	9	7	7	7	6
Clustering coefficient	0.511	0.287	0.421	0.438	0.505	0.524
The average number of neighbors (degree)	2.21	3.34	5.97	9.31	14.55	19.57

The high density (0.053) of the network indicates solid conditions for cooperation similar to the average of the network (6 steps) relative to the total number of nodes (370). In addition, the average value of the degree of centrality of 19.57 is quite high compared to the number of projects, which facilitates a certain sharing of knowledge but prevents us from declaring that it is a small world type network. From the point of view of the permeability of information and knowledge, however, the value of a high degree of centrality is a positive indicator of the possibilities of the network. The number of isolated points in the network is 44 (i.e. > 11%). The comments were made for the final period, i.e. 2014-2019, for which the data are listed in the column labeled 2019.

Another typically monitored feature of the network is the so-called scale-free network, i.e. the presence of the so-called power law. Calculations performed in Excel based on the data obtained from the UCINET environment for the above-mentioned issues are summarized below, see Figure 3. The displayed graphs and results indicate that in none of the cases it is a scale-free network ($\alpha \notin (2,3)$). The axes have a logarithmic scale.

The visualization of the network is added to the numerical analyzes, which illustrates the composition in the network of research activities in individual periods according to their type. These are project-to-project networks. The visualization of individual networks is shown in Figure 4. At first glance, without further investigation, this visualization enables to see that in all monitored periods there is a clearly predominant type of research activities at UHK represented by red.

3.2. Identification of the Cut-point Projects

Within the second sub-objective, i.e. the identification of projects which, due to their position, possibly divide the network into two or more parts, 21 projects that have the role of "cut-point project" for a certain part of the network were identified. We detected the highest degree value (76) in the structure of the project portfolio. With reference to the theoretical part, we know that the examined portfolio of projects can be identified with part of the Ba space (Nonaka & Konno, 1998). A specific value of 76 means that individuals from the team that implemented the project participated in total 76 times in other projects. In other words, we can state that the bearers of knowledge who participated in the implementation of the project had a chance to spread their existing knowledge in another 76 projects.

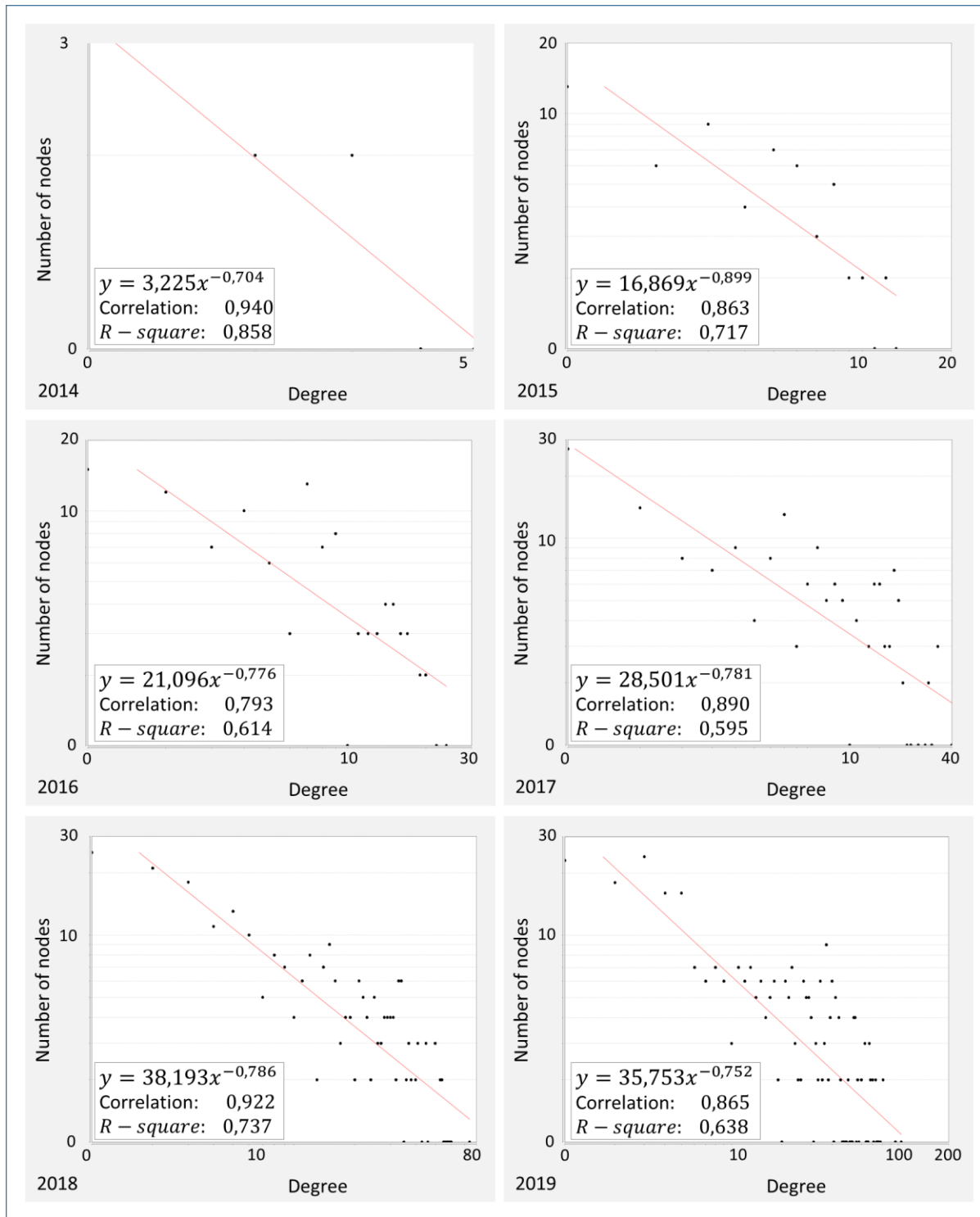


Figure 3. Probability of degree distribution for developing network between 2014 and 2019

From the point of view of developing and maintaining a network of project portfolios, the key question is how high is the risk of dividing this "path for knowledge dissemination" by the fact that for some reason a project would not occur.

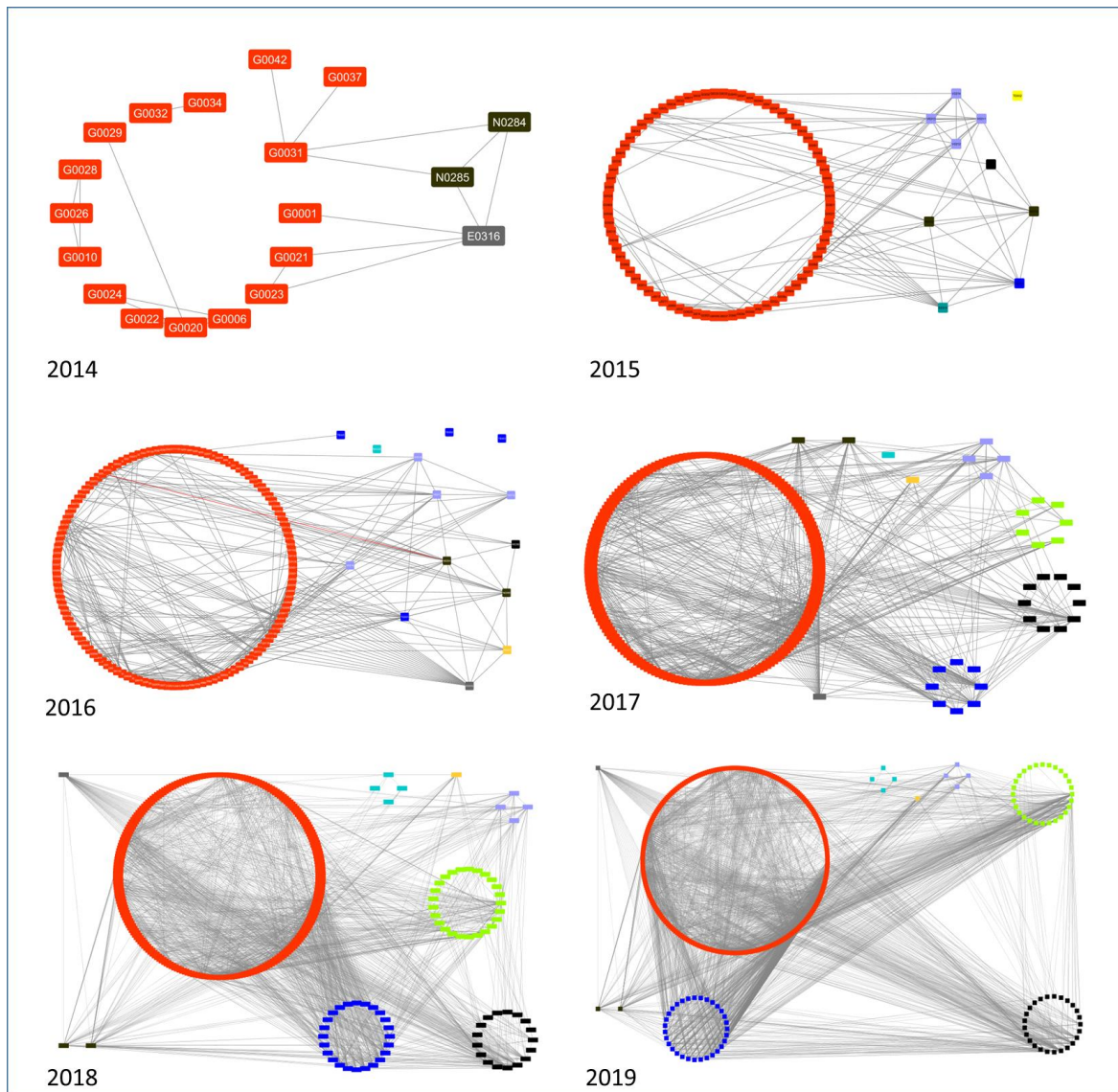


Figure 4. Development of the structure of project portfolio networks with color-coded type of projects (GAČR = red)

Figure 5 compares the situation where the four projects with the greatest cut-point potential are really removed from the network against the situation that the projects remain in the network. At the global level, this network will not be divided, as shown in Figure 5, as the remaining network of the 18 most important projects still shows multiple interconnections despite the removal of the four projects with the highest cut-point potential. However, the division of the network is already taking place at lower levels.

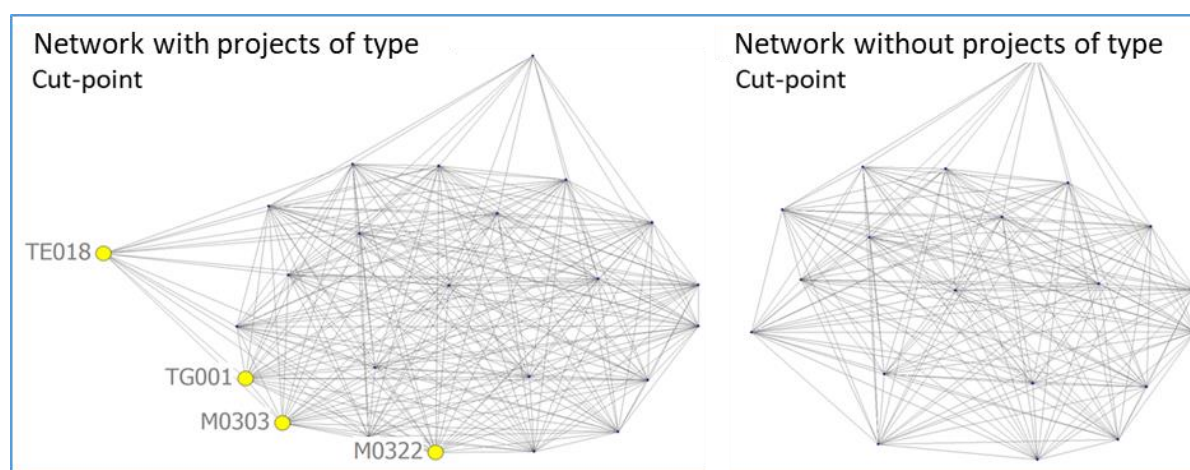


Figure 5. Results of the cut-point analysis for 2019 (filter degree > 60)

4. Discussion

The structure of the project network clearly demonstrated the dynamic development of the project portfolio from the original 19 projects to 370 projects. An interesting result of the analysis is essentially a linear increase in the number of components, i.e. according to the definition of interconnected parts of the network isolated from each other. In other words, the network is increasing, i.e. the number of internally interconnected cores (or individuals) which (who) are not interconnected with other clusters in the portfolio of research projects at UHK. In terms of the size of these clusters, the results indicate that the gigantic component, which determines the size of the largest cluster, covered about 53% of all projects in 2014, while in 2019, it was almost 85%. In view of the above, the following statement will be limited to the gigantic component. With regard to the growth in the number of unconnected clusters and in accordance with the corresponding increase in the average value of the degree of centrality, the analysis indicates a growing increase in the number of projects in which an individual researcher is involved, from the original approx. 3 ($2.21 + 1$) projects in 2014 to 20 ($19.57 + 1$) in 2019. From the performed analyzes it is not possible to confirm either the presence of the network property of small world, neither the scale-free network. From the point of view of the permeability of the network for knowledge (measured by the degree of centrality metrics), this is the axis of the network, which has increased its permeability more than nine times during the six years of its development. The results of the analysis of significant projects and cut-point projects with regard to the impersonal nature of the "project" are summarized only at the level of cut-point projects. A total of 21 projects were identified with the potential to divide the network into two or more parts. Despite the relatively high values of the centrality of these projects in the analysis, we did not identify the space for the division of the network elsewhere than at the local level, which from a university perspective with the above network heterogeneity will not be a fundamental change.

From the point of view of the intention to work with interaction with the environment and the university, the development of the number of projects and the number of projects according to the type of research activity appears to be key, i.e. GAČR, EHP, MK-NAKI,

MPO, MV-PV, MZ. The ratio between GAČR-type projects and other projects has shifted from the original values of approx. 5:1 in favor of GAČR to 3:1 in favor of GAČR. This shift in a possible change in the perception of the university, i.e. a possible change in the position of the university, is also an important result.

5. Conclusions

The question of what the structure of research at UHK looks like in terms of network structure can be answered with reference to Figure 4 and Figure 5. Specific properties can be summarized as follows: (i) the fact that the scale of the network has not been confirmed indicates that the network still changes significantly with the growing number of implemented projects, (ii) it is a network where the presence of the small world phenomenon has not been confirmed, which in the context of relatively high average degree of centrality indicates some redundancy in the interconnection of research teams and may be an indication of limited innovation potential of UHK research teams and not fully effectively developed basic structure for the implementation of research projects. This might be affected by limited availability in obtaining research projects.

Acknowledgments: This work was supported by the Technology Agency the Czech Republic TL02000066 "Effective knowledge transfer management "and internal specific research "Investments under the Industry 4.0 concept. "

References

- Anderton, A., & Watson, K. (2018). Knowledge Management: A Technology Transfer Perspective. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3241729>
- Borgatti, S. (2003). The Network Paradigm in Organizational Research: A Review and Typology. *Journal of Management*, 29(6), 991–1013. [https://doi.org/10.1016/S0149-2063\(03\)00087-4](https://doi.org/10.1016/S0149-2063(03)00087-4)
- Bozeman, B. (2000). Technology transfer and public policy: a review of research and theory. *Research Policy*, 29(4–5), 627–655. [https://doi.org/10.1016/S0048-7333\(99\)00093-1](https://doi.org/10.1016/S0048-7333(99)00093-1)
- Burt, R. S. (1976). Positions in Networks. *Social Forces*, 55(1), 93. <https://doi.org/10.2307/2577097>
- Jonsson, L., Baraldi, E., Larsson, L.-E., Forsberg, P., & Severinsson, K. (2015). Targeting Academic Engagement in Open Innovation: Tools, Effects and Challenges for University Management. *Journal of the Knowledge Economy*, 6(3), 522–550. <https://doi.org/10.1007/s13132-015-0254-7>
- Kim, T., Park, K., & Kim, E. (2018). Complementary or contradictory? The effects of structural holes and status on innovation. *Innovation*, 20(4), 393–406. <https://doi.org/10.1080/14479338.2018.1478733>
- Kotler, P., Keller, K. L., Juppa, T., & Machek, M. (2013). *Marketing management*. Grada.
- Lane, P. J., Koka, B. R., & Pathak, S. (2006). The Reification of Absorptive Capacity: A Critical Review and Rejuvenation of the Construct. *Academy of Management Review*, 31(4), 833–863. <https://doi.org/10.5465/amr.2006.22527456>
- Lee, Y. S. (1998). University-Industry Collaboration on Technology Transfer: Views from the Ivory Tower. *Policy Studies Journal*, 26(1), 69–84. <https://doi.org/10.1111/j.1541-0072.1998.tb01925.x>
- Leonard, D. (1999). *Wellsprings of knowledge: building and sustaining the sources of innovation* 3. Harvard Business School Press.
- Newman, M. E. J. (2018). *Networks* Second edition. Oxford University Press.
- Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, 5(1), 14–37. <https://doi.org/10.1287/orsc.5.1.14>
- Nonaka, I., & Konno, N. (1998). The Concept of "Ba": Building a Foundation for Knowledge Creation. *California Management Review*, 40(3), 40–54. <https://doi.org/10.2307/41165942>
- Perkmann, M., King, Z., & Pavelin, S. (2011). Engaging excellence? Effects of faculty quality on university engagement with industry. *Research Policy*, 40(4), 539–552. <https://doi.org/10.1016/j.respol.2011.01.007>

- Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly*, 41(1), 116. <https://doi.org/10.2307/2393988>
- Pritchard, R. M. O., Pausits, A., & Williams, J. (2016). *Positioning Higher Education Institutions From Here to There*. SensePublishers : Imprint : SensePublishers. <https://doi.org/10.1007/978-94-6300-660-6>
- Racherla, P., & Hu, C. (2010). A social network perspective of tourism research collaborations. *Annals of Tourism Research*, 37(4), 1012–1034. <https://doi.org/10.1016/j.annals.2010.03.008>
- Rafiei, A., Akhavan, P., & Hayati, S. (2016). Knowledge management in successful technology transfer (Case study: Iranian aerospace industries and knowledge-based centers). *Aircraft Engineering and Aerospace Technology*, 88(1), 178–188. <https://doi.org/10.1108/AEAT-11-2013-0220>
- Schaeffer, V., Öcalan-Özel, S., & Pénin, J. (2020). The complementarities between formal and informal channels of university–industry knowledge transfer: a longitudinal approach. *The Journal of Technology Transfer*, 45(1), 31–55. <https://doi.org/10.1007/s10961-018-9674-4>
- Shannon, P. (2003). Cytoscape: A Software Environment for Integrated Models of Biomolecular Interaction Networks. *Genome Research*, 13(11), 2498–2504. <https://doi.org/10.1101/gr.1239303>
- Smith, H. L., Chapman, D., Wood, P., Barnes, T., & Romeo, S. (2014). Entrepreneurial Academics and Regional Innovation Systems: The Case of Spin-Offs from London’s Universities. *Environment and Planning C: Government and Policy*, 32(2), 341–359. <https://doi.org/10.1068/c11159b>
- Tsai, W. (2001). Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance. *Academy of Management Journal*, 44(5), 996–1004. <https://doi.org/10.5465/3069443>
- Wasserman, S., & Faust, K. (1994). *Social network analysis: methods and applications*. Cambridge University Press.

The Economic and Social Importance of Farm Diversification towards Nonagricultural Activities in EU

Gabriela TRNKOVÁ

University of Hradec Kralove, Hradec Kralove, Czech Republic, gabriela.trnkova@uhk.cz

Abstract: The paper deals with the economic and social importance of farm diversification towards non-agricultural activities in the EU, and examination whether the level of employment in agricultural enterprises differs with regard to the economic importance of these diversified activities in total production. The analysis covers 135 European regions in 28 EU countries in the year 2018 based on the FADN database. In order to find out how employment differs with regard to the economic importance of other gainful activities (OGA), the data set was divided into four groups according to OGA's share of total output and the differences between these groups were analyzed and tested by the ANOVA analysis. The results show that the social and economic importance of other gainful activities is much higher in the countries of Central and Northern Europe than in the countries of Southern and South-Eastern Europe. Furthermore, statistically significant differences in the level of employment between groups were found according to the economic importance of OGA. The group with the highest economic importance of OGA has on average 3.5 times more paid AWU compared to the group with the lowest economic importance of OGA.

Keywords: farm diversification; other gainful activities; FADN; economic importance; social importance; ANOVA analysis

JEL Classification: Q12; Q18; R12

1. Introduction

There are important synergies between agricultural and rural economies. Agriculture and its value chain was historically an important contributor to rural employment in many rural regions. However, the role of agriculture as a provider of jobs in rural areas has weakened significantly since the 1960s, when the Common Agricultural Policy (CAP) was introduced. Up until the 1950s and 1960s, the majority of farms in Europe were mixed farms, combining animal and plant production and exploiting the agronomic advantages of this combination. With the introduction of the CAP, there has been constant pressure for specialization and growth in labor productivity and as a result, there was a decrease in agricultural workers. Roest et al. (2018) mention, that for decades agricultural development has been led by a modernization paradigm based on specialization, intensification, and scale enlargement. This model of development has been supported using price support policies and, often, strong central marketing agencies, which had a stabilizing effect on prices and significantly reduced market risks for an array of commodities. The increased market

orientation of the CAP launched by the document Agenda 2000 was reflected in the reduction of market measures and the consequent problems of price volatility and economic vulnerability of specialized farms. This fact has led many farmers to rethink their farm development strategies. According to Salvioni et al. (2013), the second pillar of the CAP became in this time pivotal in widening the realms of the intervention of multifunctional agriculture with the production of externalities and public goods and also stimulating other economic activities with indirect social and environmental effects in rural areas. Nowadays employs agriculture only a fraction of the working population of rural areas, nevertheless, it plays an irreplaceable role in rural areas, as food and feed producers and landscape managers, as well as in the area of forestry, crafts, rural tourism, or the sustainable use of farm and forest resources to produce renewable energy, etc., so in the production of non-agricultural activities.

Ilbery (1991) and other authors as Boncinelli et al. (2018) define similarly on-farm non-agricultural diversification - as a business strategy in which a farmer produces non-agricultural goods and services employing farm resources to sell them in the market. The criterion of using the farm production factors and the economic impact of these activities on the farm is also included in the definition according to the European Commission (see Commission Regulation (EC) No. 1200/2009). On-farm diversification is defined as the creation of any gainful activities on the farm. These include all activities other than farm work – so-called other gainful activities (OGA), directly related to the holding or having an economic impact on the holding. Such activities include e.g., agri-tourism, handicraft, processing of farm products, renewable energy production, wood processing, contractual work, or other activities.

According to European Parliament (2016a), many rural areas face a series of challenges such as low income, negative population growth, a lack of jobs and high rate of unemployment, slow development in the tertiary sector, a lack of processing capacity for food products, low skills, and limited capital. The implementation of other gainful activities can bring benefits for the farm itself, from reducing income variability to the optimal use of production factors, but it can also be beneficial for the development of rural areas. Diversification of agricultural business generates new jobs in rural areas. Di Iacovo (2014) in Boncinelli et al. (2018) adds that diversification has a pivotal impact at a local level because it helps to maintain employment levels in areas with development concerns and where opportunities provided by other economic sectors are limited. The contribution to the local economy is also obvious, as farmers provide a wider range of services to the local rural economy, which can create spillover effects on employment in rural areas.

Salvioni et al. (2020) mention that in many cases, additional revenues coming from non-agricultural activities may be strategic to keep family farms in business, with benefits that go well beyond the farm gates, both to the local communities and to society (increase in revenue of local budgets, etc.). Diversification towards non-agricultural activities can be also beneficial from the point of view of the environment or infrastructure.

CAP instruments to support non-agricultural diversification in the RDPs are also seen as a means of maintaining rural employment and creating new jobs. According to the European

Parliament (2016b), in the programming period (2014–2020) EU regions have allocated 7.4% on average of total public expenditure from the rural development fund (EAFRD) to the measure dedicated to farm and business development (Measure 6), which include instruments to support non-agricultural diversification. Specific conditions of these instruments commit the beneficiary to create new jobs.

Many authors deal with the characteristics of farms or farmers and the adoption of diversification activities or with the main forces for diversification (Salvioni et al., 2013; Bartolini et al., 2014; Meraner et al., 2015; Boncinelli et al., 2018). However, there are not many authors who deal with the relationship between diversification and on-farm employment and existing studies usually have a local or regional focus. Based on a questionnaire survey in the Czech Republic, Poland, and Hungary, Chaplin et al. (2004) state that other gainful activities of agricultural enterprises in these countries are of course not the main source of new jobs in rural areas, but their implementation contributes in some way to regional employment. Also Salvioni et al. (2013) deals with differences in employment in Italy with regard to the adoption of a diversification and differentiation strategy in comparison to conventional farms.

According to the official statistics, the income from non-agricultural production represents a still small but growing share of total farm income. Therefore, it is also important to address the impact of diversification on employment. The main objective of this paper is to:

- measure and compare the economic importance of OGA,
- measure and compare the social importance of OGA,
- determine whether there are differences in employment (paid and unpaid labor force) between groups of regions divided according to the economic importance of the OGA.

The paper is structured as follows: in the introduction was carried out a literature review and were introduced basic research goals, in section 2 are introduced the data used in the analysis and their advantages and disadvantages and the methodology. In the next step are presented results, which are discussed in section 5. Section 5 draws some conclusions as well.

2. Methodology

The analysis is performed using the data from the Farm Accountancy Data Network (FADN) database, which monitors farms' income and business activities across all EU regions and is the only source of microeconomic data based on harmonized bookkeeping principles. From this database, although is mainly focused on monitoring the production dimension of agriculture, it is possible to obtain some information on the socio-economic importance of non-agricultural activities. FADN is continuously evolving and since 2017 includes more information about non-agricultural production and other non-productivist aspects of the farm's activities. This analysis seeks to respond to these changes. For this reason, the analysis used data from the FADN database for the year 2018. The definitions of variables used in FADN standard results is given in RI/CC 1750 (European Commission, 2020). The other possible source of statistical information on the farm diversification towards non-agricultural activities is the Farm Structure Survey (available in the Eurostat database) which is collected

by all Member States, Iceland, Norway, and Switzerland, and sent to Eurostat. Within this survey, it is only monitored whether non-agricultural activities are carried out within the farm or not. However, the economic or social dimension of these activities for the farm is not monitored. Therefore, this source is not suitable for this analysis.

The data set consists of 135 observations per the year 2018 of FADN regions (NUTS I) in 28 EU states. Although this regional data represents the lowest level of aggregation freely available within the FADN database, it introduces several limitations to the analysis, see Madau et al. (2017). However, as mentioned above, it is the only source for analyzing the socio-economic dimension of diversification at the EU level.

First, the economic importance of farm diversification across 135 European regions is evaluated using the indicator share of total OGA output (FADN code: SE700) on total output (SE131). The results are presented at the country level. Also, the importance of individual other gainful activities and differences between countries are monitored. Total OGA output is coming from other gainful activities directly related to the holding such as processing of farm products both, animal's and crop's, receipts from contract work, agritourism, production of renewable energy, forestry, and other OGA (see Commission Regulation (EC) No 1200/2009). However, only forestry and wood processing (SE715), contractual work (SE720), and agritourism (SE725) are monitored separately within FADN. The other OGA are calculated as the difference between total OGA output (SE700) and these mentioned categories (SE715, SE720, SE725). The share of AWU (The full-time equivalent employment, i.e. the total hours worked divided by the average annual hours worked in full-time jobs in the country (see Commission Regulation (EC) 1200/2009) for other gainful activities in total labor (in %) (SE022) is then the indicator of the social dimension of farm diversification. This indicator is monitored and calculated by the FADN database.

Subsequently, the data set is divided according to the economic importance of other gainful activities in the total output into four groups – group I with low economic importance (the share of OGA in the total output is 0–2.5%), group II (OGA's share of total output is 2.5–5%), group III (OGA's share of total output is 5–10%) and group IV with the greatest economic importance (OGA's share of total output is 10% and more). The differences in employment characteristics (total, paid, and unpaid labor force) between these groups are tested through one way ANOVA analysis. The null hypothesis that among the above-mentioned groups, there is no difference in the average value of the given indicator is tested actually. If the P-value is less than 5% alpha, the null hypothesis is rejected. That means there is a significant difference in the average value of the indicators between groups according to the economic importance of OGA. Assumptions of normal distribution and homogeneity of the variances were checked using the Shapiro-Wilk and Levene's tests respectively. The null hypothesis formed in Levene's test is that the groups have equal variance. However, the result of Levene's test rejects the null hypothesis. Therefore, robust tests of equality of variances (Welch test, Brown-Forsythe test) were used. Statistical analyses were carried out using the SPSS software package.

3. Results and Discussion

The economic and social importance of other gainful activities varies significantly between EU countries. The results for 135 European regions are aggregated according to individual EU countries and are presented in Table 1.

Table 1. The economic and social importance of other gainful activities in EU countries in the year 2018.
Own calculation according to FADN

	Share of OGA work /AWU (%)	Share OGA/Total output (%)
Belgium	2.55	5.23
Bulgaria	0.58	2.30
Cyprus	1.41	5.23
Czech Republic	8.64	10.64
Denmark	17.98	13.86
Germany	7.13	7.18
Greece	1.19	1.95
Spain	0.56	1.25
Estonia	8.28	14.88
France	2.52	3.01
Croatia	0.75	4.99
Hungary	4.24	15.76
Ireland	0.40	0.70
Italy	5.95	6.42
Lithuania	1.71	2.68
Luxembourg	0.00	8.97
Latvia	7.25	9.62
Malta	1.91	5.98
Netherlands	4.86	4.64
Austria	3.96	18.02
Poland	0.67	1.22
Portugal	0.26	2.92
Romania	0.98	2.00
Finland	7.85	9.74
Sweden	12.03	13.01
Slovakia	7.22	14.76
Slovenia	7.98	19.49
United Kingdom	11.32	5.79

Based on the FADN database the social importance is measured as the share of AWU for other gainful activities in total labor (in %) and the economic importance as the share of OGA output on total output.

Most annual work units are engaged in other gainful activities in Denmark (17.98%), Sweden (12.03%), and the United Kingdom (11.32%). Diversification towards non-agricultural activities also has a tradition in the Czech Republic, Estonia, Slovenia, and Slovakia. Especially in these post-communist countries, the implementation of other gainful activities in agricultural enterprises in the form of associated production has a relatively long tradition. Less than 2% AWU for OGA in total labor is in the Southern European countries (Portugal, Spain, Malta,

Cyprus), in the South-Eastern countries (Croatia, Greece, Bulgaria, and Romania), and some countries of Central and Eastern Europe (Poland, Lithuania), and in Ireland as well.

With regard to the economic importance, it can be stated that other gainful activities account for the largest share of total output in the Central European countries – Slovenia (19.49%), Austria (18.02%), Hungary (15.76%), Slovakia (14.76%) and the Czech Republic (10.64%). Further in Estonia (14.88%), and Denmark (13.86%), and Sweden (13.01%) as well. Especially in these countries, it is clear that the farm, apart from food and feed production, is a producer of various products and services in the rural sector as well. As in the case of social importance, economic importance is lower in the Southern and South-Eastern European countries.

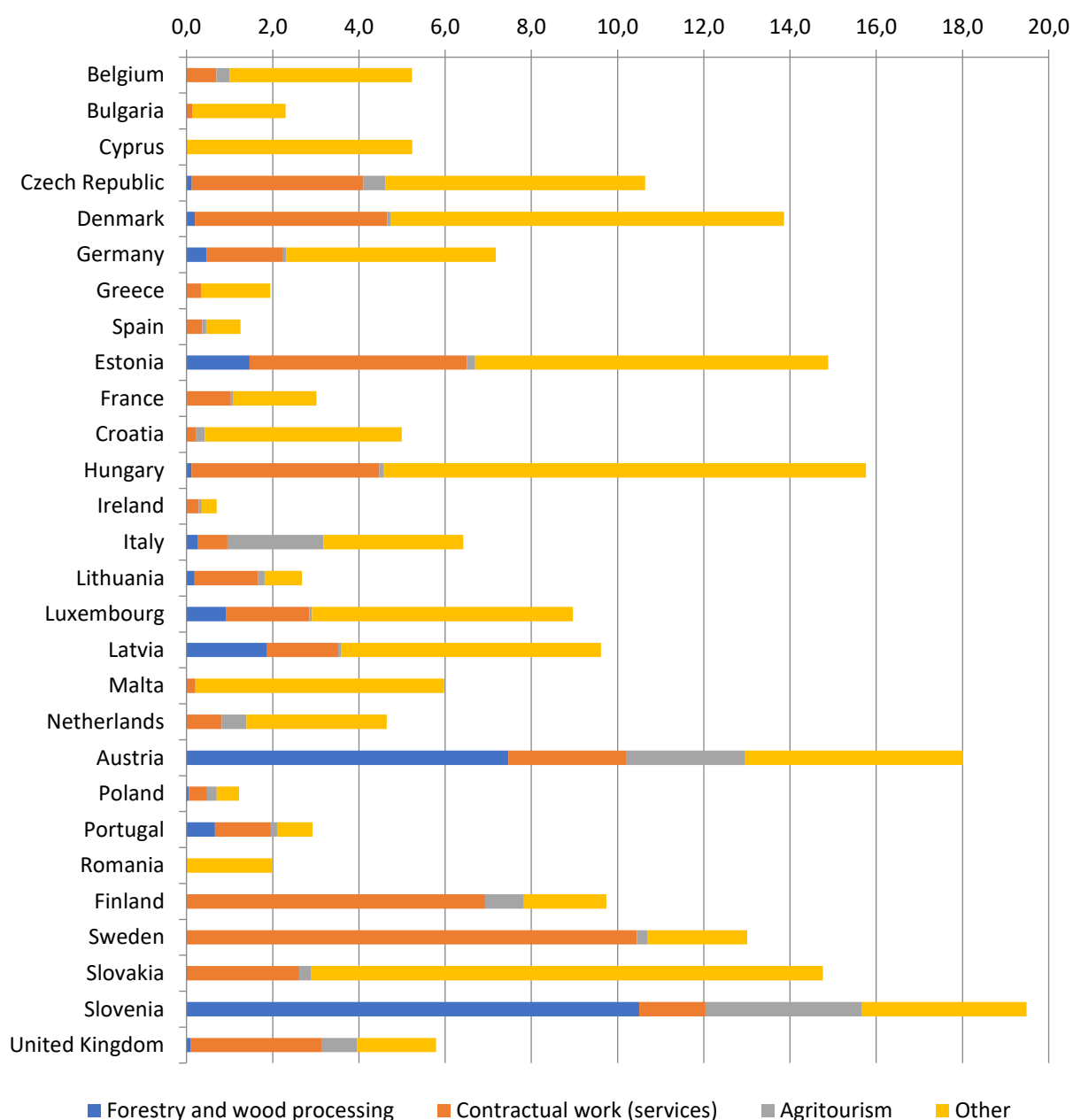


Figure 1. Share of individual OGA on total output (in %)

The economic importance of individual gainful activities in total output is presented in Figure 1. The economic importance of particular gainful activities reflects the natural and

historical conditions of a given country. Moreover, the implementation of particular OGA's and thus their social and economic importance is also influenced by the farm size, its specialization, soil quality or location, management, and in the case of the sole holder the education, age, and the number of family members living on the farm as well (see for example Bartolini et al. (2014), Boncinelli et al. (2018)).

Forestry and wood processing as other gainful activity covers sales of felled and standing timber, of forestry products other than timber, and processed wood (see EC RI/CC 1750). A higher share of forestry and wood processing in the total output of agricultural enterprises is obvious in Slovenia, Austria, and is also typical for the Baltic countries as Latvia and Estonia.

Contractual work includes hiring out of equipment or agricultural contract work carried out by the labor force of the holding (see EC RI/CC 1750). These activities are economically significant, especially in Sweden, Finland, Estonia, Denmark, and the Czech Republic. In these countries, agricultural production is carried out in conditions of high concentration of production resources (measured by utilized agricultural area/farm and AWU/farm). It is therefore clear that diversification into this activity represents a strategy for more efficient use of production factors, which, for example, for reasons of seasonality, but also other reasons, are not used.

Agritourism includes various tourist activities, such as accommodation (bed and breakfast, rural lodgings, farm campsite), catering, leisure activities (pedagogical farms, sports, horse-riding, farm visits), etc. Agritourism contributes the most to the total production of agricultural enterprises in the Alpine countries like Slovenia and Austria and also in Italy. In contrast, agritourism is very underdeveloped in the Balkan countries – such as Greece, Bulgaria, and Romania.

Other gainful activities that are not subject to the previous categories include activities directly related to the holding such as processing of farm products both, animal's and crop's, production of renewable energy, handicraft, and other. The FADN database does not allow its more detailed monitoring. These activities are particularly important in Slovakia and Hungary, where they could continue the tradition of associated productions from the communist period, and in Denmark.

In order to find out how employment differs with regard to the economic importance of OGA, the data set was divided into four groups according to OGA's share of total output. The differences between these groups were analyzed and tested by the ANOVA analysis. The assumptions for the analysis were tested using the Shapiro-Wilk test and robust tests equality of variances (Welch test, Brown-Forsythe test).

Focus on total labor input (measured in time worked in hours and in AWU) and paid labor input (measured in time worked in hours and AWU), the ANOVA reveals the statistically significant differences between the groups according to the economic importance of OGA at the 5% significance level (see Table 2). In group IV, with the greatest economic importance of OGA (OGA's share of total output is 10% and more), works on average 2.84 total AWU, while in group I, with the small economic importance of OGA (OGA's share of total output is less than 2.5%), works on average 1.66 total AWU. An even more significant

difference is in the case of paid labor input. The value of the indicator in AWU is for group IV 3.5 times higher than for group I.

Only the difference in the unpaid labor input is not statistically significant based on the ANOVA test at 5% significance level. This is due to the limited possibility of expanding the family workforce in the case of the implementation of these diversified activities.

Table 2. The comparison of labor characteristics according to the economic importance of OGA

	Groups according to the economic importance of OGA			
	I. (N = 43)	II. (N = 38)	III. (N = 31)	IV. (N = 23)
Total labor input	3,276.39	3,714.07	4,201.84	5,796.93
Total labor input (AWU)	1.66	1.86	2.01	2.84
Unpaid labor input	2,296.42	2,511.11	2,579.38	2,354.32
Unpaid labor input (FWU)	1.15	1.23	1.20	1.08
Paid labor input	979.97	1,202.96	1,622.46	3,442.60
Paid labor input (AWU)	0.51	0.63	0.81	1.76

Based on this analysis, it cannot be stated that other gainful activities create new jobs and thus directly contribute to higher employment. However, it can be stated that diversification towards non-agricultural activities is linked with a higher concentration of paid labor and thus total labor as well. The other gainful activities help to maintain employment in agricultural enterprises by more efficient use of production factors. These activities can make the farm more resilient and stable in the event of an agricultural crisis and create new income sources.

4. Discussion and Conclusions

The main aim of this paper was to analyze the social and economic importance of on-farm diversification towards non-agricultural activities. It was also examined whether the level of employment in agricultural enterprises differs with regard to the economic importance of these diversified activities in total production. The analysis includes 135 European regions in 28 EU countries in the year 2018 based on the FADN database.

The results show that the most workers are engaged in other gainful activities in Denmark, Sweden, and the United Kingdom, as well as in Central European countries such as the Czech Republic, Slovenia and Slovakia, and Estonia. Economically, other gainful activities are the most important especially in Central European countries such as Slovenia, Austria, Hungary, Slovakia, and the Czech Republic, as well as in Estonia, Denmark, and Sweden. Based on the analysis, it can be stated that the social and economic importance of other gainful activities is much higher in the countries of Central and Northern Europe than in the countries of Southern and South-Eastern Europe.

Statistically significant differences in the level of employment were found between the groups according to the economic importance of other gainful activities in total production, except unpaid work of family workers. Group IV with the highest economic importance of OGA employs 3.5 times more AWU compared to group I with the lowest economic importance. This conclusion is in line with Salvioni et al. (2013), who compared conventional

farms in Italy with diversified farms and also found that farms engaged in some other gainful activity employed more workers than conventional farms. Also the results of McNamara and Weiss for Austria (2005) and Boncinelli et al. (2018) for the Italian region Tuscany indicate that the larger farms (measured by workforce or land) are more diversified or have more farm resources allocated to non-agricultural activities.

Other gainful activities thus help maintain employment through a more efficient allocation of production resources or the creation of new sources of income. Because the viability of rural areas is closely linked to the products and services provided by agricultural holdings and to their ability to generate a sufficient level of income to prevent further reductions in the number of workers.

Acknowledgments: The work was supported by the internal project “SPEV – Economic Impacts under the Industry 4.0 / Society 5.0 Concept”, 2021, University of Hradec Králové, Faculty of Informatics and Management, Czech Republic.

References

- Bartolini, F., Andreoli, M., & Brunori, G. (2014) Explaining determinants of the on-farm diversification: Empirical evidence from Tuscany region. *Bio-based and Applied Economics*, 3(2), 137–157. <https://doi.org/10.13128/bae-12994>
- Boncinelli, F., Bartolini, F., & Casini, L. (2018). Structural factors of labour allocation for farm diversification activities. *Land Use Policy*, 71, 204–212. <https://doi.org/10.1016/j.landusepol.2017.11.058>
- Chaplin, H., Davidova, S., & Gorton, M. (2004). Agricultural adjustment and the diversification of farm households and corporate farms in Central Europe. *Journal of Rural Studies*, 20(1), 61–77. [https://doi.org/10.1016/S0743-0167\(03\)00043-3](https://doi.org/10.1016/S0743-0167(03)00043-3)
- Commission Regulation (EC) No 1200/2009. *On agricultural production methods, as regards livestock unit coefficients and definitions of the characteristics*. European Commission. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R1200&from=en>
- European Commission. (2020). *RI/CC 1750. Definitions of Variables used in FADN standard results*. European Commission Directorate – General for Agriculture and Rural Development. [https://circabc.europa.eu/sd/a/17a3cb1f-8199-4df2-b857-161fefc4c857/RICC%201750%20Standard%20Results%20v%20May%202019\(0\).pdf](https://circabc.europa.eu/sd/a/17a3cb1f-8199-4df2-b857-161fefc4c857/RICC%201750%20Standard%20Results%20v%20May%202019(0).pdf)
- European Parliament. (2016a). *Report on how the CAP can improve job creation in rural areas*. European Parliament, Committee on Agriculture and Rural Development. https://www.europarl.europa.eu/doceo/document/A-8-2016-0285_EN.pdf
- European Parliament. (2016b). *Farm Diversification in the EU - Briefing*. European Union. [https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/581978/EPRS_BRI\(2016\)581978_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/581978/EPRS_BRI(2016)581978_EN.pdf)
- Ilbery, B. W. (1991) Farm diversification as an adjustment strategy on the urban fringe of the West Midlands. *Journal of Rural Studies*, 7(3), 207–218. [https://doi.org/10.1016/0743-0167\(91\)90085-7](https://doi.org/10.1016/0743-0167(91)90085-7)
- Madau, F. A., Furesi, R., & Pulina, P. (2017). Technical efficiency and total factor productivity changes in European dairy farm sectors. *Agricultural and Food Economics*, 5(1). <https://doi.org/10.1186/s40100-017-0085-x>
- McNamara, K. T., & Weiss, C. (2005). Farm household income and on-and off-farm diversification. *Journal of Agricultural and Applied Economics*, 37(1), 37–48. <https://doi.org/10.1017/S1074070800007082>
- Meraner, M., Heijman, W., Kuhlman, T., & Finger, R. (2015). Determinants of farm diversification in the Netherlands. *Land Use Policy*, 42, 767–780. <https://doi.org/10.1016/j.landusepol.2014.10.013>
- Roest, K. D., Ferrari, P., & Knickel, K. (2018). Specialisation and economies of scale or diversification and economies of scope? Assessing different agricultural development pathways. *Journal of Rural Studies*, 59, 222–231. <https://doi.org/10.1016/j.jrurstud.2017.04.013>
- Salvioni, C., Ascione, E., & Henke, R. (2013). Structural and economic dynamics in diversified Italian farms. *Bio-based and Applied Economics*, 2(3), 257–275. <https://doi.org/10.13128/BAE-13094>
- Salvioni, C., Henke, R., & Vanni, F. (2020). The Impact of Non-Agricultural Diversification on Financial Performance: Evidence from Family Farms in Italy. *Sustainability*, 12(2), 486. <https://doi.org/10.3390/su12020486>

Job Satisfaction and Intention to Leave According to the Size of the Organization

Ladislav UHLÍŘ* and Petr ŘEHOŘ

¹ University of South Bohemia, České Budějovice, Czech Republic; uhlir103@ef.jcu.cz; rehor@ef.jcu.cz

* Corresponding author: uhlir103@ef.jcu.cz

Abstract: The issue of job satisfaction has been discussed by the researchers and managers of organizations for several decades. There are many different approaches to the issue. Currently, it is possible to find the research dealing with psychological aspects determining the level of job satisfaction, the research analyzing the role of satisfaction and work motivation and the research focused on the consequences of job satisfaction and dissatisfaction. This paper describes the differences in general job satisfaction depending on the size of the organization and the relationship between job satisfaction and the intention to leave current job. It was found that job satisfaction is significantly higher for employees of small organizations. The correlation between job satisfaction and the intention to leave was confirmed. Finally, it was found that in small organizations there is a significantly higher correlation between job satisfaction and the intention to leave than in large organizations. The data for the research are based on a questionnaire survey, attended by 4,728 respondents from the Czech Republic working in various industries and in the enterprises of various sizes.

Keywords: job satisfaction; intention to leave; size of the organization; employees

JEL Classification: J28; J63

1. Introduction

The issue of job satisfaction has been discussed by the researchers and managers of organizations for several decades. There are many different approaches to the issue. In relation to job satisfaction, the areas such as employee motivation, turnover, personal characteristics of employees, identification of the most important factors influencing job satisfaction, etc. are analyzed. It is also important to define the term correctly. Locke (1976) found a generally accepted definition, describing job satisfaction as a pleasant and positive emotional state of a person resulting from the evaluation of work and working experience.

At first glance, however, interchangeable terms may in fact describe different phenomena. As an example, Kollárik (1986) distinguishes the terms “job satisfaction” and “satisfaction with a job”. The satisfaction with a job is related to specific work activities performed, its requirements and requirements for the employee; on the other hand the job satisfaction is satisfaction in a broader sense and it includes the factors such as the work environment and personality characteristics of the employee.

Nakonečný (2005) distinguishes the concepts of job satisfaction and satisfaction at work. The job satisfaction indicates satisfaction with work activities and performance, the

satisfaction at work does not require any performance, as even person who has done nothing can be satisfied at work.

Satisfaction at the workplace can be also defined as the overall response of the employee to the organization and company, in terms of the individual's emotional status and behavior. Job satisfaction also measures to which extent there is a good individual-organization fit (Chou et al., 2019).

The issue of job satisfaction in relation to the formation of employee motivation is included in classical motivational theories. As an example, Maslow (1943) describes a person's motivation to act as an unsatisfied need, the needs being different and their type arrangement representing a well-known hierarchy of needs. If the needs of a person are not met at a given level, dissatisfaction occurs. Herzberg (1959) then identified two types of factors - hygienic factors and motivators. If the hygienic factors are not sufficiently fulfilled, the employee is dissatisfied. On the contrary, the presence of the second group of factors, the known as the motivators, leads to employee satisfaction with a positive effect on motivation.

Possible consequences of job dissatisfaction are summarized by Clegg and Bailey (2008) in such a way that the dissatisfied employees are more prone to absences, turnover, late arrivals, long breaks, theft, aggression, using work for their personal use, intent to look for new jobs and drug use at the workplace. An unsatisfied employee has the tendency to evaluate the cost of quitting and searching for alternative jobs and it increases turnover intention (Mobley, 1982).

Turnover intention is defined as the subjective probability that an individual will change his or her job within a certain period of time (Henneberger & Souza-Poza, 2004). Intention to leave current job has been studied by researches because of its important effect on productivity. Over the years, many studies have been done to identify significant predictors of turnover intention, such as job satisfaction, organizational commitment, administrative leadership or co-workers' job embedding (Park & Johnson, 2019; Robson & Robson, 2016). There is evidence from many countries and professions that overall job satisfaction has a significant negative association with turnover intention. For example teachers in USA (Ingersoll, 2001), teachers in Norway (Skaalvik & Skaalvik, 2011), CTE health science teachers in USA (Park & Johnson, 2019), nurses in USA (Derby-Davis, 2014), (Applebaum et al., 2010), social workers in England (Hussein et al., 2014), lecturers in Pakistan (Ali, 2007), prison staff in Turkey (Güres & Sökmen, 2015), manufacturing workers in Malaysia (Tnay, Othman, Siong & Lim, 2013), midwives in Jordan (Alnuaimi, Ali, & Al-Younis, 2020) or workers of shipping industry in China (Yao & Huang, 2018).

There are external and internal factors influencing job satisfaction. The external factors are independent of the individual, connected with the overall work environment. These include, for example, salary, working conditions, co-workers. The internal factors are linked to the personality of the employee and their relationship to the work activity itself (Štikar et al., 2003). Sokolová, Mohelská and Zubr (2016) describe significant differences in job satisfaction based on determinants such as gender, age, years of experience or size of the organization.

Research focused on the relationship between the organization size and job satisfaction suggest that employees of small businesses are the most satisfied and that job satisfaction

decreases as the number of employees increases. With these results came for example Lang and Johnson (1994), Clark (1996), Tansel and Gazioglu (2013), or Sokolová, Mohelská, and Zubr (2016). Higher rate of job satisfaction in smaller organizations reports also Artz (2008), who examined the effect of performance rewards in organizations of various sizes.

Job satisfaction was also analyzed in the Czech Republic in the past, but there are only a few studies focused on this topic. The first empirical data on job satisfaction in the Czech Republic are available, since 1997 from the International Social Survey Programme (Franěk et al., 2014). Franěk and Večeřa (2008) or Sokolová, Mohelská, and Zubr (2016) focused their research on description of differences in job satisfaction between different group of employees, determined by gender, education level or age. In terms of international comparison, mention may be made, for example, of the research by Eskildsen, Kristensen, and Antvor (2010). The study compared data on job satisfaction from 22 European countries, with job satisfaction in the Czech Republic being the second lowest. The conclusions of this research thus confirmed the traditionally low value of job satisfaction in the Czech Republic, which results from previous research. E.g. Medgyesi and Róbert (2003) concluded that the Czech Republic belongs to the group of eight countries with the lowest level of job satisfaction in Europe. Similar results are reported by Večerník (2003). Borooah (2009) also recorded significantly lower job satisfaction in the countries of Central and Eastern Europe. These results are consistent with one of the latest research made by Sokolová and Mohelská (2019) who concluded, that overall job satisfaction in Czech Republic is relatively low.

2. Methodology

The data were obtained by a questionnaire survey, carried out in the first half of 2019. The questionnaire was created in the Google Forms interface and respondents were addressed through geographically local groups on social networks. These local groups are usually made up of people who live, work or study in the place. The groups for inserting the questionnaire were selected so that each district of the Czech Republic was represented. In total, up to 500,000 potential respondents in 120 groups were addressed; 4,728 questionnaires were completely completed, so the return rate is approximately 1%.

There are a total of 48 questions in the questionnaire, of which 31 questions are focused on the issue of job satisfaction. These are the closed questions; with the respondents assessing their satisfaction with selected aspects of their working lives on a scale from 0 to 10, where 0 means absolute dissatisfaction and 10 means absolute satisfaction with the factor. The remaining 17 questions are of an identifying nature and made it possible to create several segments of the respondents, such as the income, branch and size of the enterprise, size of municipality, marital status, etc. For the purposes of the paper, three questions of the questionnaire are used – assessing general job satisfaction, assessing intention to leave current employment and size of the organization where respondents work.

The data are analyzed in two ways. The contingency tables in MS Excel are used to describe the sample, and determine the absolute and relative frequencies of the answers. Statistical testing of hypotheses is performed in the software of R and software

STATISTICA 13. The characteristics of the sample in terms of classification into the monitored groups of the respondents for the purposes of the paper are reported in Table 1.

Table 1. The sample.

	Category	Frequency in the sample	Percentage
Gender	Male	1,221	26%
	Female	3,507	74%
Age	Under 30 years	1,514	32%
	30–44 years	2,190	46%
	45–59 years	938	20%
	60 years and older	86	2%
Education	Primary	115	2%
	Secondary technical school	772	16%
	Secondary with a leaving examination	2,008	42%
	Higher professional school	317	7%
	Bachelor	511	11%
	Master	930	20%
	PhD.	75	2%
Employer size (number of employees)	Under 10	742	16%
	10–49	1,148	24%
	50–249	1,186	25%
	250 and more	1,652	35%
Marital status	No partnership and dependent child	792	17%
	No partnership with a dependent child	245	5%
	In a partnership without a dependent child	1,776	38%
	In a partnership with a dependent child	1,870	40%
	Marital status not determined	45	1%

Based on literature review, the following three hypotheses have been chosen to test in this study:

H1: Employees of organizations with up to 49 employees rate their level of job satisfaction better, than employees of organizations with 50 employees and more.

H2: Employees of organizations with up to 49 employees have a lower level of intent to leave their current job, than employees of organizations with 50 employees and more.

H3: In organizations with up to 49 employees is the relationship between job satisfaction and intent to leave more significant, than in organizations with 50 employees and more.

The hypotheses H1 and H2 were tested using the Welch's T-test of the agreement of the means for unequal variances. This method of hypothesis testing is a modification of the Student's t-test, which is suitable for use in comparing two sets of different sizes with unequal variances. The value of the test criterion is based on the following formula (Welch, 1947):

$$t = \frac{\mu_1 - \mu_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}} \quad 1)$$

For determining the existence of dependency between job satisfaction and intention to leave current job we used Pearson's Correlation Coefficient:

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}} \quad 2)$$

3. Results

3.1. Hypothesis 1

The first hypothesis assumes that employees of smaller organizations (fewer than 50 employees) rate their job satisfaction better, than employees of bigger organizations. In the questionnaire, respondents selected the size of their employer from four options according to the number of employees in accordance with the definition of SMEs. These options were: 1. Fewer than 10 employees, 2. 10-49 employees, 3. 50-249 employees, 4. 250 employees and more. The results of job satisfaction for each category are shown in Table 2.

Table 2. Job satisfaction according to the size of the organization.

Employees	Mean	Standard deviation	N
Fewer than 10	7.2075	2.6769	742
10-49	6.9138	2.5153	1,148
50-249	6.6020	2.4929	1,186
250 and more	6.5992	2.5606	1,652

A look at Table 2 indicates that there might be a negative correlation between average level of job satisfaction and the size of the organization. The highest average satisfaction is shown by employees in the smallest companies. On the contrary, we recorded the lowest level of job satisfaction among employees of the largest organizations.

To test hypothesis H1, two groups of respondents were created from the data. Group A contains all the respondents who selected first two options for the size of organization they are working at (Fewer than 10 employees and between 10 and 49 employees). The respondents who selected remaining 2 options are included in group B. There are 1,890 respondents in group A and 2,838 in group B.

In accordance with the above H1, the following null and alternative hypotheses are formulated:

$$H_0: \mu_A = \mu_B$$

$$H_A: \mu_A > \mu_B$$

Table 3. H1 testing.

Mean A	Mean B	t	p-value
7.0291	6.6004	5.6338	9.424e ⁻⁹

Conclusion: Based on the data as reported by Table 3, at the level of significance of $\alpha = 0.05$, the null hypothesis is rejected in favor of the alternative hypothesis. The data of the

research group show that employees of smaller organizations rate their job satisfaction significantly better than employees of bigger organizations.

3.2. Hypothesis 2

The second hypothesis assumes that employees of bigger organizations (with 50 and more employees) generally plan to change their current job more than employees of smaller organizations. The results of the question related to the intention to leave the current job are summarized in Table 4.

Table 4. Intention to leave the current job according to the size of the organization.

Employees	Mean	Standard deviation	N
Fewer than 10	3.8059	3.7319	742
10 - 49	4.2134	3.6038	1,148
50 - 249	4.3642	3.5900	1,186
250 and more	4.2772	3.5970	1,652

Looking at the Table 4 above, it is clear that employees in the smallest organizations have the lowest intention to leave their current job. The mean value of this intention is approximately 3.8 on a scale from 0 to 10, where 0 means no intention to leave current job and 10 means maximum intention. Mean values of this intention in organizations with 10 and more employees are above 4.2. On the other hand, we can see the biggest value of standard deviation by the smallest organization. It indicates that in these organizations the intention to leave varies the most among their employees.

To test the hypothesis H2, we again use groups of respondents A and B, as in testing hypothesis H1 earlier (fewer than 50 employees = group A; 50 employees and more = group B).

In accordance with the above H2, the following null and alternative hypotheses are formulated:

$$H_0: \mu_A = \mu_B$$

$$H_A: \mu_A < \mu_B$$

Table 5. H2 testing.

Mean A	Mean B	t	p-value
4.0534	4.3136	2.4119	0.007956

Conclusion: Based on the data as reported by Table 5, at the level of significance of $\alpha = 0.05$, the null hypothesis is rejected in favor of the alternative hypothesis. The data of the research group show that employees of smaller organizations have lower level of intention to leave their job than employees of bigger organizations.

3.3. Hypothesis 3

Results of first two hypotheses, as well as the researches presented in the literature review indicate that there is a correlation between the level of job satisfaction and the intention to leave the organization. In this section, we would like to answer the question of

whether there is a significant difference in the correlations of satisfaction and the intention to leave the current job between organizations of different sizes.

Pearson's correlation coefficient was used to verify the relation between job satisfaction and the intention to change current job. We confirmed a negative correlation between these two variables for organizations of all sizes. An overview of the coefficients thus obtained is in Table 6.

Table 6. Correlation between job satisfaction and intention to leave.

Employees	r	N
Fewer than 10	-0.7153	742
10 - 49	-0.6877	1,148
50 - 249	-0.6932	1,186
250 and more	-0.6282	1,652

Looking at the Table 6 we can see that the strongest correlation between job satisfaction and the intention to leave employment was found in companies with less than 10 employees. In small (10-49 employees) and middle organizations (50-249 employees) is the correlation coefficient approximately -0.69. The smallest correlation was found for the largest organizations with 250 employees and more. But with value -0.6282 it is still medium strength correlation.

To test the hypothesis H3, we again use groups of respondents A and B, as in testing previous hypotheses H1 and H2 (fewer than 50 employees = group A; 50 employees and more = group B).

In accordance with the above H3, the following null and alternative hypotheses are formulated:

H0: $r_A = r_B$

H_A: $r_A > r_B$

Table 7. H3 testing.

Pearson r - A	Pearson r - B	p-value
-0.7016	-0.6543	0.0016

Conclusion: Based on the data as reported by Table 7, at the level of significance of $\alpha = 0.05$, the null hypothesis is rejected in favor of the alternative hypothesis. It means, that generally in organizations with up to 49 employees is a stronger correlation between job satisfaction and intention to leave than in enterprises with 50 employees and more.

However, this conclusion is the result of a statistical operation rather than a reflection of reality. If we look back at Table 6, we find that the difference in correlations between small (10-49 employees) and medium-sized organizations (50-249 employees) is very small and even slightly larger in medium-sized enterprises. The difference in correlation coefficients between group A and B is therefore caused only by a significantly lower value of correlation in the largest organizations.

4. Discussion and Conclusions

In this paper, we tried find out whether there are differences in employee job satisfaction and the intention to leave the current job depending on the size of the organization in the Czech Republic. Based on the results of our questionnaire survey, we can state that significant differences were found in this area.

First of all, we found that people rate their job satisfaction best when they work in micro-enterprises that employ a maximum of 9 employees. With the growing number of employees, the average reported job satisfaction decreases. Based on data from our research group, we have shown that in organizations with up to 49 employees, employees have significantly higher job satisfaction than in organizations with 50 on more employees. This result is consistent with research by Sokolová, Mohelská and Zubr (2016). Their research carried out in 2013 and repeated in 2015 shows that the most satisfied are employees of companies with a maximum of 50 employees.

The second finding is that the intention to leave the current job is significantly higher for employees working in organizations with 50 and more employees. In connection with the first finding, we thus obtain the assumption of negative correlation between job satisfaction and the intention to leave employment.

This assumption was also confirmed. The average correlation regardless of the size of the organization has a value of -0.674 that is a relatively strong dependence. A closer look at the correlations in organizations of different sizes revealed significant differences. The correlation between job satisfaction and the intention to leave the organization is highest in micro, small and medium-sized enterprises with maximum of 249 employees. In contrast, for companies with more than 250 employees, the correlation is significantly lower. This means that employees in large organization do not reflect their level of job satisfaction in their plans to stay in the company or leave it as elastically as employees in smaller organizations.

These results can be practically beneficial for small and medium-sized enterprises and their management. If they want to keep existing employees, it is relatively more important for them to take care of their job satisfaction, because these employees react more elastically than with a similar level of satisfaction in large organizations. It is therefore not advisable to underestimate job satisfaction.

In terms of further research in this area, it may be interesting to focus similarly of different segments of employees (e.g. gender, age, marital status). Finding out that some groups of employees respond to job dissatisfaction in different ways can be beneficial for management. Data were collected before the Covid-19 pandemic. It would by therefore also interesting to find out whether this pandemic has in any way been reflected in the issue of job satisfaction and the intention to leave.

At this point, we would also like to mention the limits we see in this study. It is mainly the composition of the sample, which is described in more detail in Table 1. At first glance in the table, it is clear that it is not a representative sample and the general results (for example overall average job satisfaction of the whole sample) should not be generalized to the whole

population. The problem is, for example, that over 70% of respondents are women, the sample is relatively more educated than the population and it is mainly represented by the younger generation. The reason is the fact that the criterion for completion the questionnaire was only minimal age of 18 years and continuing gainful activity. Furthermore, it was only at the discretion of the social media group user whether to complete the questionnaire or not. The representation of more educated and young people probably stems from the fact that the completion of the questionnaire presupposes access to the internet and its use during leisure time. To increase representativeness, it would therefore be possible to supplement the data with and offline paper-pencil questionnaire survey. Nevertheless, we believe that partial conclusions can be formed from the data.

Acknowledgments: The realization of this paper was supported by the project GAJU 047/2019/S

References

- Ali, N. (2007). Factors affecting overall job satisfaction and turnover intention. *Journal of Managerial Science*, 2(2), 240-252.
- Alnuaimi, K., Ali, R., & Al-Younis, N. (2020). Job satisfaction, work environment and intent to stay of Jordanian midwives. *International Nursing Review*, 67(3), 403-410. <https://doi.org/10.1111/inr.12605>
- Applebaum, D., Fowler, S., Fiedler, N., Osinubi, O., & Robson, M. (2010). The impact of environmental factors on nursing stress, job satisfaction and turnover intention. *The Journal of Nursing Administration*, 40(7), 323-238. <https://doi.org/10.1097/NNA.0b013e3181e9393b>
- Artz, B. (2008). The role of firm size and performance pay in determining employee job satisfaction brief: Firm size, performance pay, and job satisfaction. *Review of Labour Economics and Industrial Relations*, 22(2), 315-343. <https://doi.org/10.1111/j.1467-9914.2007.00398.x>
- Borooah, V. K. (2009). Comparing levels of job satisfaction in the countries of Western and Eastern Europe. *International Journal of Manpower*, 30(4), 304-325. <https://doi.org/10.1108/01437720910973025>
- Clark, A. E. (1996). Job Satisfaction in Britain. *British Journal of Industrial Relations*, 34(2), 189-217. <https://doi.org/10.1111/j.1467-8543.1996.tb00648.x>
- Clegg, S. R., & Bailey, J. R. (2008). *International Encyclopedia of Organizational Studies*. London: SAGE Publications.
- Derby-Davis, M. J. (2014). Predictors of nursing faculty's job satisfaction and intent to stay in academe. *Journal of Professional Nursing*, 30(1), 19-25. <https://doi.org/10.1016/j.profnurs.2013.04.001>
- Eskildsen, J. K., Kristensen, K., Antvor, H. G. (2010). The relationship between job satisfaction and national culture. *The TQM Journal*, 22(4), 369-378. <https://doi.org/10.1108/17542731011053299>
- Franěk, M., Mohelská, H., Zubr, V., Bachmann, P., & Sokolová, M. (2014). Organizational and Sociodemographic Determinants of Job Satisfaction in the Czech Republic. *SAGE Open Journal*, 4(3), 1-12. <https://doi.org/10.1177/2158244014552426>
- Franěk, M., & Večeřa, J. (2008). Personal characteristics and job satisfaction. *E&M Ekonomie a Management*, 11(4), 63-76.
- Güres, C. G., & Sökmen, A. (2015). Effects of the leadership styles on the organizational commitment, job satisfaction, and intention to leave: A research on Turkish prisons and detention house. *Journal of Business Research*, 7(3), 59-74. <https://doi.org/10.20491/isader.2015315713>
- Herzberg, F. (1959). *The Motivation to Work*. New York: Wiley.
- Hussein, S., Moriarty, J., Stevens, M., Sharpe, E., & Manthorpe, J. (2014). Organisational factors, job satisfaction and intention to leave among newly qualified social workers in England. *Social Work Education*, 33(3), 381-396. <https://doi.org/10.1080/02615479.2013.806467>
- Chou, H. H., Fang, S. C., & Yeh, T. K. (2019). The effects of facades of conformity on employee voice and job satisfaction. *Management Decision*, 58(3), 495-509. <https://doi.org/10.1108/MD-04-2019-0492>
- Ingersoll, R. M. (2001). Teacher turnover and teacher shortages: An organizational analysis. *American Educational Research Journal*, 38(3), 499-543. <https://doi.org/10.3102/00028312038003499>
- Kollárik, T. (1986). *Spokojnosť v práci*. Bratislava: Práca.

- Lang, J. R., & Johnson, N. B. (1994). Job satisfaction and firm size: An interactionist perspective. *The Journal of Socio-Economics*, 23(4), 405-423. [https://doi.org/10.1016/1053-5357\(94\)90011-6](https://doi.org/10.1016/1053-5357(94)90011-6)
- Locke, E. A. (1976) The Nature and Causes of Job Satisfaction. In Dunnette, M. D. (Ed.), *Handbook of Industrial and Organizational Psychology*. Chicago: Rand McNally.
- Maslow, A. (1943). A Theory of human motivation. *Psychological Review*, 50(4), 370-396. <https://doi.org/10.1037/h0054346>
- Medgyesi, M., & Róbert, P. (2003). Satisfaction with work in a European perspective: Center and periphery, „old“ and „new“ market economies compared. *Review of Sociology*, 9(1), 43-68. <https://doi.org/10.1556/revsoc.9.2003.1.3>
- Mobley, W. H. (1982). Some unanswered questions in turnover and withdrawal research. *The Academy of Management Review*, 7(1), 111-116. <https://doi.org/10.2307/257255>
- Možný, I. (1999). *Proč tak snadno?* Praha: Slon.
- Nakonečný, M. (2005). *Sociální psychologie organizace*. Praha: Grada.
- Park, K. A., & Johnson, K. R. (2019). Job satisfaction, work engagement, and turnover intention of CTE health science teachers. *International Journal for Research in Vocational Education and Training*, 6(3), 224-242. <https://doi.org/10.13152/IJRVET.6.3.2>
- Robson, A., & Robson, F. (2016). Investigation of nurses intention to leave: a study of a sample of UK nurses. *Journal of Health Organization and Management*, 30(1), 154-173. <https://doi.org/10.1108/JHOM-05-2013-0100>
- Skaalvik, E., & Skaalvik, S. (2011). Teacher job satisfaction and motivation to leave the teaching profession: Relations with school context, feeling of belonging, and emotional exhaustion. *Teaching and Teacher Education*, 27(6), 1029-1038. <https://doi.org/10.1016/j.tate.2011.04.001>
- Sokolová, M., & Mohelská, H. (2019). Job satisfaction as an innovative approach to the management – Case study Czech Republic 2013-2017. In *17th International Scientific Conference on Hradec Economic Days*. Hradec Králové, University of Hradec Králové. <https://doi.org/10.36689/uhk/hed/2019-02-034>
- Sokolová, M., Mohelská, H., & Zubr, V. (2016). Pay and offer of benefits as significant determinants of job satisfaction – a case study in the Czech Republic. *E&M Ekonomie a Management*, 19(1), 108-120. <https://doi.org/10.15240/tul/001/2016-1-008>
- Sousa-Poza, A., & Henneberger, F. (2004). Analyzing job mobility with job turnover intentions: An international comparative study. *Journal of Economic Issues*, 38(1), 113-137. <https://doi.org/10.1080/00213624.2004.11506667>
- Štikar, J., Rymeš, M., Riegel, K., & Hoskovec, J. (2003). *Psychologie ve světě práce*. Praha: Karolinum.
- Tansel, A., & Gazioglu, S. (2013). Management-Employee Relations, Firm Size and Job Satisfaction. *International Journal of Manpower*, 35(8), 1260-1275. <https://doi.org/10.1108/IJM-09-2014-0179>
- Tnay, E., Othman, A. E., Siong, H. C., & Lim, S. (2013). The Influences of Job Satisfaction and Organizational Commitment on Turnover Intention. *Procedia – Social and Behavioral Sciences*, 97, 201-208. <https://doi.org/10.1016/j.sbspro.2013.10.223>
- Večerník, J. (2003). Skating on thin ice: A comparison of work values and job satisfaction in CEE and EU countries. *International Journal of Comparative Sociology*, 44(5), 444-471. <https://doi.org/10.1177/002071520304400502>
- Welch, B. L. (1947). The Generalization of Student's Problem when Several Different Population Variances are Involved. *Biometrika*, 34(1-2), 28-35. <https://doi.org/10.1093/biomet/34.1-2.28>
- Yao, C., & Huang, P. (2018). Effects of leadership style on job satisfaction and intention to stay in shipping industry. *Journal of Coastal Research*, 83(1), 796–801. <https://doi.org/10.2112/SI83-130.1>

Corporate Social Responsibility and Internationalization of Czech Transport Enterprises

Emil VELINOV^{1,2*} and Simona CINCALOVA³

¹ SKODA AUTO University, Mlada Boleslav, Czech Republic; emil.velinov@savs.cz

² RISEBA University of Applied Sciences, Riga, Latvia; emil.velinov@riseba.lv

³ College of Polytechnics Jihlava, Czech Republic; simona.cincalova@vspj.cz

* Corresponding author: emil.velinov@savs.cz

Abstract: The paper aims at investigating the conditions for development and application of Corporate Social Responsibility best practices in selected Czech transport small and medium-sized enterprises. Furthermore, the study sheds a light on the internationalization process, which is taking place in seventy Czech transport companies by exploring the importance of corporate social responsibility pillars in three regions in Bohemia. Furthermore, the paper is focusing on the applicability and transferability of such of corporate social responsibility and internationalization measures, which will support the Czech transport companies to become more competitive entities by adopting or improving such practices. Paper's results show that the firms, which tend to internationalize more than their counterparts, tend to implement more corporate social responsibility activities. The study suggests that the selected firms from the transport sector are acting proactively by adopting best practices on corporate social responsibility in order to attract more investor and to foster their process of internationalization.

Keywords: corporate social responsibility; internationalization; transport

JEL Classification: M14; O18

1. Introduction

The global business highly is acknowledged with the fact that international trade has a big impact on society. Wide variety of stakeholders across businesses suggests that customers are getting more and more demanding. Furthermore, there are challenges and risks connected with the businesses, which appear without any signals from the global market. Moreover, there are many political wars, which have affected international business such as the US-China trade was. Therefore, many medium-sized enterprises (SMEs) have introduced into their business activities so called corporate social responsibility (CSR) practices, which would help the enterprises to leverage their business activities by taking into account the inside and outside shareholders such as workers, clients, creditors, business allies, trade unions, local governance, non-profit organizations (NGOs) and governments. Big body of research suggests that SMEs are losing the competition with the multinational firms in the acquiring of CSR policies and practices (cf. Brammer et al., 2012; Cassells & Lewis, 2011; Revell et al., 2010). Similarly, a report from the European Union explicitly underlines this gap between SMEs and bigger firms. Based on the above statements SMEs are significant factor for the economic growth across the majority of European states, that are engaged with sustainable growth (Klewitz & Hansen, 2014; Revell

et al., 2010). Moreover, it is of crucial weight to realize that SMEs' aspects of implementing a converging pattern to business. Other studies on corporate social sustainability suggest CSR steers to better corporate image, emerging sales and higher clients credibility, and higher efficiency and quality (Mishra & Suar, 2010). CSR in the frame of big multinational enterprises leads to the company's setting of social accountability and social responsiveness, practices, and initiatives, which could boost its bonding with the local communities (Luo, 2006). Considering the economic prominence of SMEs and their increasing level of internationalization (for example, in the neighboring Austria more than 80% of the enterprises are SMEs and their level of internationalization is very high), this study intends to focus on the process of internationalization across selected Czech SMEs, their extent of CSR program adoption, organizational structure and models of management. We start with the notion that local communities impose particular demands on appropriate business policies and attitudes. Apart from business acumen for generating profit and higher margins, the paper argues the satisfaction of community's expectations is significantly critical for SMEs. CSR is more than a strategy, but at the same time outlines a firm assignment, which SMEs supposes to comply with the moral, social, ecological, and economic requirements from the local business partners in all markets where they are present. This positive image and broad stakeholder support can be a valuable extension of SMEs' resource bases that can be used to compete against larger firms that are less resource-constraint and ultimately influence SMEs performance (Fiala & Hedija, 2019).

Evidently, the most influential aspect on SME endeavors is nested in the competences of the top management to make strategic decisions (Sommer, Durst, & Haug, 2007, pp. 256). The senior management plays significant role in the process of internationalization, which have been research in previous studies on sustainability and top management teams (Velinov et al., 2020). European Union has investigated in the previously stated document that the most common issues in the process of SME internationalization are absence of envisaged strategy, lack of know-how on internationalization patterns, information asymmetries during searching corresponding allies and wrong forecasts on the market prospectus (Observatory of European SMEs 2003, pp. 35 et seqq.). In the context of internationalization, the resource scarcity of SMEs may impact on their ability to enter foreign markets and can also limit a smaller firm's ability to reach more advanced stages of internationalization (Westhead et al., 2001 and 2002). Other aspects are the experiences of managers regarding internationalization. Different studies mentioned the relevance of the managers' attitudes (CEDEFOP, 2002; Ajzen & Fishbein, 1980; Ajzen & Madden, 1986; Allport, 1935; Rosenberg & Hovland, 1960).

There are numerous entities that maintain a "critical eye" on CSR. These relationships are critical for the firms to realize its mission in producing goods or services are often referred to as primary stakeholders and include: clients, inside managers and workers, governmental bodies, suppliers, and creditors. Secondary stakeholders are consisting of social and political participants functioning as supporters of the mission by assuring their tacit approval of the SME's activities, thereby making them acceptable and giving the business credibility. Such non-priority stakeholders might be competitors, media, local communities, and non-governmental organizations (NGOs) (Maon et al., 2009). Based on the literature review, the paper aims to

investigate the link between CSR practices and the level of internationalization, and the influence of independent stakeholders on SMEs foreign-market activities.

There are the following hypotheses in the paper:

Hypothesis 1: *SMEs with CSR practices tend to have higher level of internationalization.*

Hypothesis 2: *Managers and employees play an important role in influencing CSR practices of SMEs in foreign markets.*

Hypothesis 3: *CSR practices of SMEs in foreign markets will have a positive impact on SMEs' performance.*

2. Methodology and Data Collection

The study investigates more than 70 Czech SMEs from the transport and logistics sectors classified according to the EU classifications on SMEs. The data collection will be carried out from secondary information sources as SMEs annual reports, Eurostat, database Albertina, Bisnode and Thomson Reuters. Additionally, data on sustainability and FDIs will be collected directly from several of the SMEs because of the fact that specific information is required on their international business activities and corporate strategy. The paper aims at identifying the stakeholders and the specifics of small and medium business in Czechia, identifying the share of SMEs that have social responsibility practices in regard to environment, employees and society, systematizing the factors that impede the formation of corporate social responsibility of SMEs. Furthermore, the paper is assessing the level of corporate responsibility of SMEs in Czechia, analyzing the influence of employees of enterprises on the formation of corporate social responsibility, conducting a survey of employees of SMEs to determine the functioning elements of business social responsibility, studying Global practices in the implementation of corporate social responsibility. Moreover, the paper is developing a model of adaptation of individual elements of foreign corporate social responsibility for Czech small business, proposing a mechanism allowing SMEs to increase the efficiency of their activities through the implementation of corporate social responsibility practices, testing the results of research in the international scientific space (Velinov et al., 2020).

In order to establish the level of social responsibility in practice, empirical research was carried out in the form of a questionnaire survey. Nuts 2 Northeast Cohesion Region has been elected. It consists of Pardubice, Hradec Kralove and Liberec region. Medium-sized and large enterprises have been selected for research, given that the smaller the company, the more difficult it is to implement CSR both organizationally and staffed. The selected sector was Transport. This section covers passenger and freight transport activities, regular or irregular, on rails, by pipeline, by road, water or air, and related activities such as terminals, parking and storage facilities, terminals, etc. This section includes the rental of transport equipment with a driver or operator, as well as postal and courier activities.

Using the Magnus web and Albertina enterprise database (2017), it was found that there is a basic statistical set of 70 medium and large enterprises (with 50 or more employees), that are doing business in the Transport sector. The questionnaire was intended for a top management employee of a company who is expected to have comprehensive knowledge of

about the enterprise. First and foremost, it was necessary to ensure representativeness. The representativeness of the sample for research can be statistically determined by the formula (1) (Kozel, 2006):

$$n > \frac{t_{\alpha}^2 * p * (1 - p)}{d^2} \quad (1)$$

where: n the minimum selection range is required, α is reliability, t_{α} indicates the coefficient of reliability for a given α , p is an estimate of the relative frequency of the character examined in the population, d determines the required permissible error in the research. If the required reliability is selected $\alpha = 0.1$, the coefficient of the confidence interval is 90% $t_{\alpha} = 1.65$, with a permissible error $d = 10\%$ with an estimate of the relative frequency $p = 0.9$, then according to the above, the minimum number of elements in the sample should reach at least 24 enterprises.

At the beginning of 2018, data collection took place and the return was 40%, or 28 enterprises. No questionnaire was excluded from this file. This ensured the calculated representativeness. The evaluation of the questionnaire was carried out in IBM SPSS Statistics and MS Excel. The data are drawn from the original research of the co-author (Činčalová, 2018). Table 1 shows the basic statistics of this representative sample of the enterprises in transport sector, namely the variables number of employees in 2017 and turnover revenues for 2017.

Table 1: Descriptive statistics on the selected firms. Source: own elaboration

		Number of employees in 2017	Firm Turnover Revenue in 2017
N	Valid	28	28
	Missing	0	0
Mean		172.75	361,995,235.86
Median		103.00	288,785,000.00
Std. Deviation		136.685	305,256,398.562
Variance		18,682.861	93,181,468,862,993,200.000
Skewness		0.812	1.494
Std. Error of Skewness		0.441	0.441
Kurtosis		-0.693	2.413
Std. Error of Kurtosis		0.858	0.858
Range		452	1,276,267,000
Minimum		30	51,818,000
Maximum		482	1,328,085,000
Percentiles	25	59.50	117,658,250.00
	50	103.00	288,785,000.00
	75	285.00	489,922,250.00

3. Results

The questionnaire was completed by representatives of companies with an average of 173 employees and a turnover of almost 362 million CZK, the median is 103 employees and CZK 289 million. Smallest business in the research sample had 30 employees and a turnover

of CZK 51.8 million, on the contrary, the largest company employs 482 employees and has a turnover of CZK 1.33 billion.

4. Discussion

The questionnaire contained 9 questions of semi-open and closed questions concerning the use of CSR, the degree of interconnection of social responsibility with the corporate strategy, the activities carried out by enterprises under the 4 pillars, subsequent CSR measurement, CSR certification, as well as other areas.

The introductory question found that 21 of the companies examined (75% of those surveyed) use the CSR concept, 4 companies do not use it, but are considering introducing it from this year or next.

Another question examined the importance of different motives for introducing social responsibility. Table 2 shows the basic characteristics (mean, standard deviation and error, confidence interval for average, minimum and maximum value) for all subquestions that have been rated by the Likert scale from 1 to 5 according to the importance of the theme (1 - most important, 5 - unimportant).

Table 2: Descriptive statistics on motives for introducing CSR activities. Source: own elaboration.

Subquestion	Mean	St.Dev.	St.Error of Skewness	95% Confidence interval		Minimum	Maximum
				Low confidence	High confidence		
1 – convinced firms. that it is correct	1.750	0.4410	0.0833	1.579	1.921	1.0	2.0
2 – effort on gaining competitive advantage	2.393	0.9165	0.1732	2.037	2.748	1.0	5.0
3 – profit increase. costs decrease	2.000	0.8165	0.1543	1.683	2.317	1.0	5.0
4 – increase of loyalty among customers	1.393	0.6853	0.1295	1.127	1.659	1.0	4.0
5 – firm image improvement	1.286	0.4600	0.0869	1.107	1.464	1.0	2.0
6 – public relations	1.250	0.4410	0.0833	1.079	1.421	1.0	2.0
7 – external forces pressure	3.500	1.1055	0.2089	3.071	3.929	2.0	5.0
8 – engagement and retention of skilled employees	2.000	1.2172	0.2300	1.528	2.472	1.0	4.0
9 – good looking in the eyes of potential investors	1.679	1.0905	0.2061	1.256	2.101	1.0	5.0
Total	1.917	1.0660	0.0672	1.784	2.049	1.0	5.0

5. Conclusions

The following questions concerned the use of CSR activities within the pillars, their importance and measurement. It was found that all the undertakings examined reported at

least one activity from each area and also measured them in these pillars, except for 6 enterprises that do not target to a philanthropic area. The social pillar is the most important of the 10 (see Table 3). It is clear from Table 3 that 18 undertakings see differences between the pillars. The other 10 companies indicated that all pillars are equally important and it is not possible to say which or less.

Table 3: Importance of the CSR pillars. Source: own elaboration.

Pillar/importance	The most important	The least important
Economical	5	5
Social	10	0
Environmental	3	8
Philanthropic	0	5
Total	18	18

There are a large number of transport companies and it is difficult for them to increase their market share. They often enter into short-term contracts, also because they offer similar services and compete mainly with price. Potential new comers have easy access to distribution channels, and with more and more opportunities and no need for high initial capital, there are almost no barriers to entry.

Suppliers' bargaining power depends on fuel price, policy, taxes, land price and others. Input prices have a big share of how profitable the business is. The bargaining power of customers is related to the number of current competitors in the sector – there is a large selection of them, customers can easily compare the prices of the services provided and in some cases vertical integration with producers takes place. The availability of substitutes is high (e.g. rail, air transport), but it depends on the nature of the goods transported (the difference in whether bricks or perishable goods are transported).

References

- Bashtovaya, V. (2014). CSR reporting in the United States and Russia. *Social Responsibility Journal*, 10(1), 68-84. <https://doi.org/10.1108/SRJ-11-2012-0150>
- Belyaeva, Z. (2018). Business Environment Challenges and Trends for Contemporary SMEs in Europe. In *The Sustainable Marketing Concept in European SMEs: Insights from the Food & Drink Industry* (pp. 13-28). Emerald Publishing Limited.
- Brammer, S., Jackson, G., & Matten, D. (2012). Corporate social responsibility and institutional theory: New perspectives on private governance. *Socio-Economic Review*, 10(1), 3-28. <https://doi.org/10.1093/ser/mwr030>
- Činčalová, S. (2018). Evaluation of the Current Position of CSR in the Logistics Sector. In *Innovation Management, Entrepreneurship and Sustainability (IMES 2018)* (pp. 154-165). Vysoká škola ekonomická v Praze.
- Fiala, R. & Hedija, V. (2019). Testing the validity of Gibrat's law in the context of profitability performance. *Economic Research-Ekonomska Istraživanja*, 32(1), 28502863. <https://doi.org/10.1080/1331677X.2019.1655656>
- Hassid, J. (2002). *Internationalisation and Changing Skills Needs in European Small Firms: Synthesis Report*. CEDEFOP Reference Series. Bernan Associates, 4611-F Assembly Drive, Lanham, MD 20706-4391
- Klewitz, J., & Hansen, E. G. (2014). Sustainability-oriented innovation of SMEs: a systematic review. *Journal of Cleaner Production*, 65, 57-75. <https://doi.org/10.1016/j.jclepro.2013.07.017>
- Luo, Y. (2006). Political behavior, social responsibility, and perceived corruption: A structuration perspective. *Journal of International Business Studies*, 37, 747-766. <https://doi.org/10.1057/palgrave.jibs.8400224>

- Maon, F., Lindgreen, A., & Swaen, V. (2009). Designing and implementing corporate social responsibility: An integrative framework grounded in theory and practice, *Journal of Business Ethics*, 87, 71–89. <https://doi.org/10.1007/s10551-008-9804-2>
- Mishra, S., & Suar, D. (2010). Does corporate social responsibility influence firm performance of Indian companies? *Journal of Business Ethics*, 95, 571–601. <https://doi.org/10.1007/s10551-010-0441-1>
- Przytuła, S., Formánková, S., Ubrežiová, I., & Dunay, A. (2019). Corporate Social Responsibility in Visegrad Countries (Poland, Czech Republic, Slovakia, Hungary) Overall Landscape. In *Corporate Social Responsibility in Poland* (pp. 325-353). Springer, Cham.
- Sommer, L., Durst, S., & Haug, M. (2007). The role of the international Owner-Manager Identity in the Internationalization Process of SME. *The Business Review*, 9(1), 256-265.
- Uzhegova, M., Torkkeli, L., & Ivanova-Gongne, M. (2019). The Role of Culture in Responsible Business Practice: An Exploration of Finnish and Russian SMEs. In *The Changing Strategies of International Business* (pp. 177-197). Palgrave Macmillan, Cham.
- Velinov, E., Maly, M., Petrenko, Y., Denisov, I., & Vassilev, V. (2020). The Role of Top Management Team Digitalization and Firm Internationalization for Sustainable Business. *Sustainability*, 12(22), 9502. <https://doi.org/10.3390/su12229502>
- Velinov, E., Vassilev, V., & Denisov, I. (2018). Holacracy and Obliquity: contingency management approaches in organizing companies. *Problems and Perspectives in Management*, 16(1), 330-335. [https://doi.org/10.21511/ppm.16\(1\).2018.32](https://doi.org/10.21511/ppm.16(1).2018.32)
- Westhead, P., Binks, M., Ucbasaran, D., & Wright, M. (2002). Internationalization of SMEs: A research note. *Journal of Small Business and Enterprise Development*, 9(1), 38-48. <https://doi.org/10.1108/14626000210419473>

Examination of Relationship Between Goal Orientation, Work Engagement and Self-Efficacy

Marek VICH

University of Economics, Prague, Czech Republic, marek.vich@vse.cz

Abstract: Our society is facing a growing amount of crises and the nature of co-operation and business is changing. Organizations need to be more adaptive and employees are required to be more engaged and self-efficient. This paper argues that organizations willing to support employees in terms of self-efficacy and engagement should give more focus on learning rather than performance. The study conducted on a sample of 155 working adults examines the relationships between performance & learning goal orientation, self-efficacy and aspects of work engagement (vigor, dedication, absorption). Analyses of linear regressions showed highly significant positive effects of learning goal orientation on self-efficacy, work engagement and all its sub-aspects vigor, dedication and absorption. On the contrary, the effects of performance goal orientation on any of the examined variables were not significant. Implications of the results as well as recommendations for organizations willing to support orientation for learning are further presented in discussion.

Keywords: work engagement; self-efficacy; learning goal orientation; performance goal orientation

JEL Classification: M14; M53; O35

1. Introduction

Our society witnesses great changes driven by increasing technological progress, ongoing globalization and the more recent Covid-19 crisis. All those factors force contemporary organizations to continue operating in increasingly complex and uncertain conditions (Baard et al., 2014; Shaw et al., 2020). New conditions in turn exert significant psychological pressure on employees and force them to be more engaged and self-efficient at work (Merdiaty & Aldrin, 2020). Both work engagement and self-efficacy are highly demanded in contemporary organizations, but their development and well as an understanding of their motivation antecedents continues to be an undergoing challenge (Carleton et al., 2018; Coe & Salanova, 2018; Knight et al., 2019).

Motivations factors that drive organizational actions are described by goal orientation theory that distinguishes performance and learning goal orientation (Dweck & Leggett, 1988). Performance goal orientation is characterized by a belief that ability is the most important determinant of performance, while the learning goal orientation gives main emphasis on effort (Vandewalle et al., 2019). In practice, the learning goal orientation represents the willingness of individuals to learn through both pleasant and unpleasant experiences, embrace new aspects of work and perceive failures as valuable feedback (Button et al., 1996). The performance goal orientation represents a rather narrow-minded focus on the attainment

of goals that makes individuals concerned about gaining favorable judgment of their competence or avoiding negative judgments of their incompetence (Dweck & Leggett, 1988). The mainstream of business today still places the strongest emphasis on performance (Hamel, 2020). However, previous studies on goal orientation indicate that hiring employees that are mainly oriented on performance can hamper organizational progress, while the learning goal orientation is associated with numerous positive effects on quality of feedback, well-being and resilience (Gong et al., 2014; Vandewalle et al., 2019). This paper examines, whether this difference exists also in the case of self-efficacy and work engagement.

Self-efficacy is characterized by an individual's stable belief in his/her capacity to achieve across a wide range of challenges, tasks and situations (Bandura, 1977; Chen et al., 2000). This capacity is linked with numerous workplace-related benefits, such as better team leadership (Paglis, 2010), higher job satisfaction (Judge & Bono, 2001) and increased performance (Judge & Bono, 2001; Tims et al., 2014). There is also strong evidence which indicates that high self-efficacy is the result of high past performance (Sitzmann & Yeo, 2013). Notwithstanding the fact of strong relationships between self-efficacy and performance, I assume that self-efficacy is rather predetermined by one's willingness to learn, rather than his/her need to perform. It was already suggested that individuals with high learning goal orientation are more opened to new experiences, including failures (Button et al., 1996). Such an attitude seems to provide a good position for the development of confidence that is based on skill of handling the present experience as best as possible and learning from it. On the contrary, the performance goal orientation is linked with more tension, because the main focus of individual that oriented in this way is to finish the task and to prove his/her ability (Vandewalle, 1997). Therefore, I suggest that learning goal orientation is positively related to self-efficacy, while the performance goal orientation is negatively related to self-efficacy. Those hypotheses have been already examined by previous studies, but most of them were conducted on students (Al-Harthy & Was, 2013; Dull et al., 2015; Fan et al., 2008; Ford et al., 1998) or job applicants (Donovan & Hafsteinsson, 2006) and so their findings cannot be generalized for work-place settings. Furthermore, two studies that were conducted on working adults (Chen et al., 2000; Heidemeier & Staudinger, 2015) did not use validated scales of self-efficacy and so the validity of their findings is problematic. Hence the reason for the examination of the effects on self-efficacy in this study with the following hypotheses:

Hypothesis 1. Learning goal orientation is positively related to self-efficacy.

Hypothesis 2. Performance goal orientation is negatively related to self-efficacy.

This study also examines the impact of learning and performance goal orientation on work engagement. Work engagement represents a positive work-related state of fulfilment that is characterized by vigor, dedication, and absorption (Schaufeli et al., 2006). Work engagement is considered as one of the key indicators of the healthy organization as it is related to many benefits, such as higher well-being (Malinowski & Lim, 2015), job satisfaction (Rayton & Yalabik, 2014), job performance (Rich et al., 2010) and organizational commitment (Bakker & Schaufeli, 2008). Although the work engagement is related to increased performance (Rich et al., 2010), closer observation of its three aspects indicates that its driving

force is rather learning. In more detail, “vigor is characterized by high levels of energy and mental resilience while working and by the willingness and ability to invest effort in one’s work. Dedication is characterized by a sense of significance, enthusiasm, inspiration, pride, and challenge. The final dimension of engagement, absorption, is characterized by being fully concentrated and happily engrossed in one’s work, whereby time passes quickly and one feels carried away by one’s job” (Schaufeli et al., 2002, p. 465).

All three sub-concepts of work-engagement are related to the pleasure of doing work and facing its challenges that are typical for learning goal orientation rather than the tendency to prove one’s ability that is typical for performance goal orientation (Button et al., 1996). In fact, it seems likely that individuals who are so much driven by the need to perform might lose the contact with the simple pleasure of doing an activity (Pink, 2011). Few previous studies showed pioneering findings on the positive impact of learning goal orientation on work engagement (Adriaenssens et al., 2015; Bakker et al., 2020; Matsuo, 2019; Zhang et al., 2017) and two of them also showed the negative impact of performance goal orientation on work engagement (Adriaenssens et al., 2015; Bakker et al., 2020). However, all those studies with exception of Zhang et al. (2017) did not provide a deeper examination of work engagement, because they examined the total construct only, but did not examine the effect on three sub-components of vigor, dedication and absorption. Therefore, I examine the impact of performance and learning goal orientation on vigor, dedication and absorption based on the following hypotheses:

Hypothesis 3a. Learning goal orientation is positively related to vigor.

Hypothesis 3b. Learning goal orientation is positively related to dedication.

Hypothesis 3c. Learning goal orientation is positively related to absorption

Hypothesis 4a. Performance goal orientation is positively related to vigor.

Hypothesis 4b. Performance goal orientation is positively related to dedication.

Hypothesis 4c. Performance goal orientation is positively related to absorption

2. Methodology

Participants

The sample of this study included 155 working adults located in the Czech Republic. Participants were recruited via e-mail and the survey was conducted through the google forms platform. Initially, 192 participants filled the survey. To be included in our study, the participants had to 1) correctly fill all items of the questionnaire, 2) be full-time or part-time employees, 3) have minimal age of 18 and maximum age of 65, 4) have Czech or Slovak nationalities (both neighbor nationalities have almost identical language and culture) and 5) work in at least one of the 8 service or industry sectors (IT services, Advisory & Financial Services, Retail & Logistics, Hospitality & Food production, Automobile Industry, Research & Laboratory Works, Social Care & Education, Construction Industry & Materials). Based on these criteria, 37 participants were excluded from the initial sample. More specifically, 22 participants were excluded because of the missing data, 6 participants were excluded because they filled items incorrectly, 5 participants were excluded because they were not full-time or

part-time employees and 4 participants were excluded because their affiliation did not match with 8 industry and service sectors stated above. Participants (M age = 28.98, SD = 10.54) were 66.5 % female, 42.3 % reported having previous managerial or entrepreneurial experience and 29.7 had previous experience with mindfulness meditation or psychotherapy.

Measures

All questionnaires used in this study were translated from the original English version to the Czech language and translated back to English by an independent translator to access high-quality translation. Final versions of questionnaires were then created with help of one independent researcher and one translator.

Learning goal orientation and performance goal orientation. Learning and performance goal orientation were examined by the 8-item Goal orientation measure-learning (GOM-L) and 8-item Goal orientation measure-performance (GOM-P) developed by Button et al. (1996). Participants indicated how much they agree with the presented statements by choosing on the 1-5 Likert scale (from 1[strongly disagree] to 5[strongly agree]). The GOM-L contains items like: "The opportunity to do challenging work is important to me." The example of the item of GOM-P is "I'm happiest at work when I perform tasks on which I know that I won't make errors."

Work engagement. The level of work engagement and its subscales vigor (UWES-V), dedication (UWES-D) and absorption (UWES-A) was measured by a 9-item version Utrecht Work and Well-Being Survey (UWES; Schaufeli et al. 2006). The participants indicated how often they experience feelings and situations described in the scale by choosing on 7-item Likert scale, ranging from 1 [Never] to 7 [Always / Every day]. The examples of the particular subscales are "At my work, I feel bursting with energy." (UWES-V), "My job inspires me." (UWES-D), "I am immersed in my work." (UWES-A).

Self-efficacy. Self-efficacy was examined by the 10-item General Self-Efficacy Scale (GSE; Schwarzer & Jerusalem, 1995). Participants indicated how much they agree with the presented statements by choosing on the 1-4 Likert scale (from 1[not at all true] to 5[exactly true]). The item example of the GSE is: "Thanks to my resourcefulness, I know how to handle unforeseen situations."

All measures proved to be reliable with Cronbach alphas ranging from .77 for the GOM-P to .93 for the UWES (see Table 1 for scale reliabilities and correlations). Apart from hypothesized relationships, the correlation analysis showed that there was no significant effect between performance goal orientation and any of the other examined variables. Therefore, performance goal orientation was not included in the main analysis.

3. Results

Data were analyzed using RStudio (version 1.2.5033). Series of linear regressions were used to examine the effect of learning goal orientation on self-efficacy and work engagement, including its sub-qualities vigor, dedication and absorption. Results showed highly significant relationship between learning goal orientation and self-efficacy ($\beta = .51$, $p < .001$),

work engagement ($\beta = .21, p < .001$), vigor ($\beta = .21, p < .001$), dedication ($\beta = .16, p < .001$) and absorption ($\beta = .18, p < .001$). For more detailed data see Table 2.

Table 1. Means, Standard Deviation, Bivariate Correlations and Scale Reliabilities (N = 155)

Scale ¹	M	SD	1	2	3	4	5	6	7
GSE	3.03	.49	(.87)						
GOM-L	3.97	.58	.43**	(.85)					
GOM-P	4.18	.52	.01	.21**	(.77)				
UWES	4.86	1.18	.28**	.43	.02	(.93)			
UWES-A	4.84	1.27	.22**	.45**	.04	.91**	(.78)		
UWES-D	4.97	1.38	.23**	.37**	.28	.95**	.82**	(.89)	
UWES-V	4.76	1.19	.33**	.38**	-.00	.89**	.72**	.79**	(.80)

Note. GSE = General Self-Efficacy Scale; GOM-L = Goal orientation measure-Learning; GOM-P = Goal orientation measure-Performance; UWES = Work and Well-Being Survey; UWES-A = Work and Well-Being Survey-Absorption; UWES-D = Work and Well-Being Survey-Dedication; UWES-V = Work and Well-Being Survey-Vigor; * $p < 0.05$. ** $p < 0.01$.

Table 2. Standardized Regression Coefficients per relationship between Learning Goal orientation and Self-efficacy and Work engagement qualities (N = 155)

	GOM-L	
	β	R ²
GSE	.51***	.19***
UWES	.21***	.19***
UWES-A	.21***	.21***
UWES-D	.16***	.14***
UWES-V	.18***	.14***

Note. GSE = General Self-Efficacy Scale; GOM-L = Goal orientation measure-Learning; UWES = Work and Well-Being Survey; UWES-A = Work and Well-Being Survey-Absorption; UWES-D = Work and Well-Being Survey-Dedication; UWES-V = Work and Well-Being Survey-Vigor; * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$

4. Discussion and Conclusions

Interpretation of the results

This study was conducted to examine the effect of performance and learning goal orientation on self-efficacy and three domains of work engagement: vigor, dedication and absorption. The study hypothesized that learning goal orientation is positively related to self-efficacy (Hypothesis 1), vigor (Hypothesis 3a), dedication (Hypothesis 3b) and absorption (Hypothesis 3c). It was also expected that performance goal orientation is negatively related to self-efficacy (Hypothesis 2), vigor (Hypothesis 4a), dedication (Hypothesis 4b) and absorption (Hypothesis 4c). Results showed highly significant support for all effects related to learning goal orientation and did not support the effects related to performance goal orientation.

Firstly, the significant relationship between learning goal orientation and self-efficacy supports the suggestion that learning orientation fosters one's confidence in his/her abilities.

Learning goal orientation is characterized by the ability to face failures and mistakes and use them for one's growth and learning (Button et al. 1996). Results indicate that individuals which are oriented in this way gain their confidence from "living through experiences" - no matter whether they are marked with success or with failure (Hajloo, 2014). On the contrary, results did not show support for the negative relationship between performance goal orientation and self-efficacy. Previous studies showed that performance goal orientation is less beneficial and, in some cases, even detrimental to individual well-being and performance (Gong et al., 2014; Vandewalle et al., 2019). Yet, my results indicate that performance goal orientation is not harmful in terms of self-efficacy, but also not beneficial. Those findings are similar to the findings of previous studies (Al-Harthi & Was, 2013; Chen et al., 2000; Donovan & Hafsteinsson, 2006; Dull et al., 2015; Fan et al., 2008; Ford et al., 1998; Heidemeier & Staudinger, 2015). Those studies confirmed the positive significant effect of learning goal orientation on self-efficacy as well, but their support of negative effects of performance goal orientation was weaker. Contrary to those studies, this study was both conducted on working adults and used validated self-efficacy measure and thus extends the current state of the art.

Secondly, there was a significant relationship between learning goal orientation and vigor, dedication and absorption. This result extends current evidence of learning goal orientation and work engagement (Adriaenssens et al., 2015; Bakker et al., 2020; Matsuo, 2019; Zhang et al., 2017) because it confirmed (with exception of Zhang et al., 2017) highly significant effects on all three aspects - the vigor, dedication and absorption. Significant effect on vigor indicates that individuals oriented on learning tend to feel more vitality and excitement at work. Effect on dedication implies that individuals oriented on learning have can keep focus and determination on tasks. The significant effect on absorption indicates that learning goal orientation helps individuals enjoy their tasks and to be more frequently in the state of flow while working (Csikszentmihalyi, 2008). Effects for the performance goal orientation were not significant. Similarly to self-efficacy, these results suggest that performance goal orientation is not beneficial but also not harmful for domains of work engagement. Those results are not consistent with the results of Adriaenssens et al. (2015) and Bakker et al. (2020) that showed the negative impact of performance goal orientation on total work engagement. Therefore, more studies on the relationship between performance goal orientation and domains of work-engagement are needed to further clarify this point.

Limitations of the study and Recommendations for Future Studies

This study has three limitations. Firstly, the sample of this study was limited to 155 participants. Although other correlation studies cited in this paper had an even smaller samples (Al-Harthi & Was, 2013; Bakker et al., 2020; Donovan & Hafsteinsson, 2006; Ford et al., 1998), I recommend future studies to include a higher sample. Study with higher samples may benefit from a comparison between particular business sectors. For example, it can compare results between the IT sector and hospitality. This measure would be particularly fruitful in the face of the current Covid-19 crisis, which seems to deepen differences between business sectors even more than it was before.

Secondly, this study was exclusively based on self-report measures that are limited for organizational research, especially in terms of possible self-report biases (Podsakoff & Organ 1986). I recommend future studies to include other methods as well, such as peer-report measures or qualitative analyses (Medhurst et al., 2016).

Thirdly, I observe another limitation in the fact that the study was based on data that was obtained at one time. This fact is limiting because it does not allow to observe any kind of development in time (Bakker et al., 2020). Therefore, I recommend future studies to either obtain data two or three times.

Implications for Organizational Practice

Results of this study indicate that individuals oriented to learning are more engaged and self-efficient at work. Therefore, my suggestion for organizations is to take learning seriously. Learning is not only about the increased ability of workers to absorb new knowledge and increase cognitive flexibility. It is also a capacity that helps organizations to have more self-sustainable and self-organized members. This is possible because it allows workers to experience new things and mistakes more often as well as share what they have learned openly, with dignity and without fear (Laloux, 2014). There are companies, such as Google when even million-dollar mistakes are welcomed and cherished because they bring important lessons learned (Birkinshaw, 2012).

The first step to encourage learning is to give members more freedom from delivering results (Pink, 2011). Sometimes it is even beneficial for the whole organization as a whole to give itself more freedom. One of the benefits of this measure is expressed by the principle of indirect attainment of goals called obliquity. Many companies that do not directly strive to achieve financial or other performance results are highly profitable and performing (Birkinshaw, 2012). The second step is represented by supporting workers in the development of their orientation on learning. Learning might require a lot of courage because experiencing mistakes tends to be painful. Therefore, the establishment of group sessions where members can share their experiences, appreciate and support each other can be very empowering (Vich & Kim, 2016). Some portion of those circles can be also included in the regular meetings, because it actually makes them more vivid and interesting (Laloux, 2014). Organizations should also help members to further develop their socio-emotional skills, though learning mindfulness and compassion (Good et al. 2016; Vich & Lukeš, 2020).

References

- Adriaenssens, J., De Gucht, V., & Maes, S. (2015). Association of goal orientation with work engagement and burnout in emergency nurses. *Journal of Occupational Health*, 57(2), 151-160. <https://doi.org/10.1539/joh.14-0069-OA>
- Al-Harthi, I., & Was, C. A. (2013). Knowledge monitoring, goal orientations, self-efficacy, and academic performance: A path analysis. *Journal of College Teaching and Learning*, 10(4), 263.
- Baard, S. K., Rench, T. A., & Kozlowski, S. W. J. (2014). Performance adaptation: A theoretical integration and review. *Journal of Management*, 40(1), 48–99. <https://doi.org/10.1177/0149206313488210>
- Bakker, A. B., Petrou, P., Emma M Op den, K., & Tims, M. (2020). Proactive vitality management, work engagement, and creativity: The role of goal orientation. *Applied Psychology*, 69(2), 351–378. <https://doi.org/10.1111/apps.12173>

- Bakker, A. B., & Schaufeli, W. B. (2008). Positive organizational behavior: Engaged employees in flourishing organizations. *Journal of Organizational Behavior*, 29, 147–154. <https://doi.org/10.1002/job.515>
- Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191–215. [https://doi.org/10.1016/0146-6402\(78\)90002-4](https://doi.org/10.1016/0146-6402(78)90002-4)
- Birkinshaw, J. (2012). *Reinventing Management: Smarter Choices for Getting Work Done, Revised and Updated Edition*. Jossey-Bass.
- Button, S. B., Mathieu, J. E., & Zajac, D. M. (1996). Goal orientation in organizational research: A conceptual and empirical foundation. *Organizational Behavior and Human Decision Processes*, 67(1), 26–48. <https://doi.org/10.1006/obhd.1996.0063>
- Carleton, E. L., Barling, J., & Trivisonno, M. (2018). Leaders' trait mindfulness and transformational leadership: The mediating roles of leaders' positive affect and leadership self-efficacy. *Canadian Journal of Behavioural Science*, 50(3), 185–194. <https://doi.org/10.1037/cbs0000103>
- Chen, G., Gully, S. M., Whiteman, J. A., & Kilcullen, R. N. (2000). Examination of the relationships among trait-like individual differences, state-like individual differences, and learning performance. *Journal of Applied Psychology*, 85, 835–847. <https://doi.org/10.1037/0021-9010.85.6.835>
- Coo, C., & Salanova, M. (2018). Mindfulness can make you happy-and- productive: A mindfulness controlled trial and its effects on happiness, work engagement and performance. *Journal of Happiness Studies*, 19(6), 1691–1711. <https://doi.org/10.1007/s10902-017-9892-8>
- Csikszentmihalyi, M. (2008). *Flow: The Psychology of Optimal Experience*. Harper Perennial Modern Classics.
- Donovan, J. J., & Hafsteinsson, L. G. (2006). The impact of goal- performance discrepancies, self-efficacy, and goal orientation on upward goal revision1. *Journal of Applied Social Psychology*, 36(4), 1046–1069. <https://doi.org/10.1111/j.0021-9029.2006.00054.x>
- Dull, R. B., Schleifer, L. L. F., & McMillan, J. J. (2015). Achievement goal theory: The relationship of accounting students' goal orientations with self-efficacy, anxiety, and achievement. *Accounting Education*, 24(2), 152. <https://doi.org/10.1080/09639284.2015.1036892>
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, 95(2), 256–273. <https://doi.org/10.1037/0033-295X.95.2.256>
- Fan, J., Meng, H., Billings, R. S., Litchfield, R. C., & Kaplan, I. (2008). On the role of goal orientation traits and self-efficacy in the goal-setting process: Distinctions that make a difference. *Human Performance*, 21(4), 354. <https://doi.org/10.1080/08959280802347122>
- Ford, J. K., Smith, E. M., Weissbein, D. A., Gully, S. M., & Salas, E. (1998). Relationships of goal orientation, metacognitive activity, and practice strategies with learning outcomes and transfer. *Journal of Applied Psychology*, 83(2), 218–233. <https://doi.org/10.1037/0021-9010.83.2.218>
- Gong, Y., Wang, M., Huang, J. C., & Cheung, S. Y. (2014). Toward a goal orientation- based feedback-seeking typology: implications for employee performance outcomes. *Journal of Management*, 39, 1924–1951. <https://doi.org/10.1177/0149206314551797>
- Good, D. J., Lyddy, C. J., Glomb, T. M., Bono, J. E., Brown, K. W., Duffy, M. K., Baer, R. A., Brewer, J. A., & Lazar, S. W. (2016). Contemplating mindfulness at work: An integrative review. *Journal of Management*, 42(1), 114–142. <https://doi.org/10.1177/0149206315617003>
- Hajloo, N. (2014). Relationships between self-efficacy, self-esteem and procrastination in undergraduate psychology students. *Iranian Journal of Psychiatry Behavioral Sciences*, 8(3), 42–49.
- Hamel, G. (2020). *Humanocracy: Creating Organizations as Amazing as the People Inside Them*. Harvard Business Review Press.
- Heidemeier, H., & Staudinger, U. M. (2015). Age differences in achievement goals and motivational characteristics of work in an ageing workforce. *Ageing and Society*, 35(4), 809–836. <https://doi.org/10.1017/S0144686X13001098>
- Judge, T. A., & Bono, J. E. (2001). Relationship of core self-evaluations traits— self-esteem, generalized self-efficacy, locus of control, and emotional stability—with job satisfaction and job performance: A meta-analysis. *Journal of Applied Psychology*, 86(1), 80–92. <https://doi.org/10.1037/0021-9010.86.1.80>
- Knight, C., Patterson, M., & Dawson, J. (2019). Work engagement interventions can be effective: a systematic review. *European Journal of Work and Organizational Psychology*, 28(3), 348–372. <https://doi.org/10.1080/1359432X.2019.1588887>
- Laloux, F. (2014). *Reinventing Organizations: A Guide to Creating Organizations Inspired by the Next Stage of Human Consciousness*. Nelson Parker.

- Malinowski, P., & Lim, H. J. (2015). Mindfulness at work: Positive affect, hope, and optimism mediate the relationship between dispositional mindfulness, work engagement, and well-being. *Mindfulness*, 6, 1250–1262. <https://doi.org/10.1007/s12671-015-0388-5>
- Matsuo, M. (2019). Effect of learning goal orientation on work engagement through job crafting. *Personnel Review*, 48(1), 220–233. <https://doi.org/10.1108/PR-11-2017-0346>
- Medhurst, A. R., & Albrecht, S. L. (2016). Salesperson work engagement and flow: A qualitative exploration of their antecedents and relationship. *Qualitative Research in Organizations and Management*, 11(1), 22–45. <https://doi.org/10.1108/QROM-04-2015-1281>
- Merdiaty, N., & Aldrin, N. (2020). Analyzing the effect of resilience on burnout with mindfulness as a mediator. *International Journal of Research in Business and Social Science*, 9(5), 109–115. <https://doi.org/10.20525/ijrbs.v9i5.820>
- Paglis, L. L. (2010). Leadership self-efficacy: research findings and practical applications. *Journal of Management Development*, 29(9), 771–782. <https://doi.org/10.1108/02621711011072487>
- Pink, D. H. (2011). *Drive: The Surprising Truth About What Motivates Us*. Riverhead Books.
- Rayton, B. A., & Yalabik, Z. Y. (2014). Work engagement, psychological contract breach and job satisfaction. *The International Journal of Human Resource Management*, 25(17), 1–19. <https://doi.org/10.1080/09585192.2013.876440>
- Rich, B. L., Lepine, J. A., & Crawford, E. (2010). Job engagement: Antecedents and effects on job performance. *The Academy of Management Journal*, 53(3), 617–635. <https://doi.org/10.5465/AMJ.2010.51468988>
- Schaufeli, W. B., Bakker, A. B., & Salanova, M. (2006). The measurement of work engagement with a short questionnaire: A cross-national study. *Educational and Psychological Measurement*, 66(4), 701–716. <https://doi.org/10.1177/0013164405282471>
- Schaufeli, W. B., Salanova, M., González-Romá, V., & Bakker, A. B. (2002). The measurement of engagement and burnout: A two sample confirmatory factor analytic approach. *Journal of Happiness Studies*, 3(1), 71–92. <https://doi.org/10.1023/A:1015630930326>
- Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston (Eds.), *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp. 35–37). Nfer-Nelson.
- Shaw, W. S., Main, C. J., Findley, P. A., Collie, A., Kristman, V. L., & Gross, D. P. (2020). Opening the workplace after covid-19: What lessons can be learned from return-to-work research? *Journal of Occupational Rehabilitation*, 30(3), 299–302. <https://doi.org/10.1007/s10926-020-09908-9>
- Sitzmann, T., & Yeo, G. (2013). A meta-analytic investigation of the within- person self-efficacy domain: Is self-efficacy a product of past performance or a driver of future performance? *Personnel Psychology*, 66(3), 531. <https://doi.org/10.1111/peps.12035>
- Tims, M., Bakker, A. B., & Derks, D. (2014). Daily job crafting and the self-efficacy – performance relationship. *Journal of Managerial Psychology*, 29(5), 490–507. <https://doi.org/10.1108/JMP-05-2012-0148>
- Vandewalle, D. (1997). Development and validation of a work domain goal orientation instrument. *Educational and Psychological Measurement*, 57(6), 995–1015. <https://doi.org/10.1177/0013164497057006009>
- Vandewalle, D., Nerstad, C. G. L., & Dysvik, A. (2019). Goal Orientation: A Review of the Miles Traveled and the Miles to Go. *Annual Review of Organizational Psychology and Organizational Behavior*, 6(1), 115–144. <https://doi.org/10.1146/annurev-orgpsych-041015-062547>
- Vich, M., & Kim, M. (2016). Construction and application of radical candor: Efficiency of criticism at work. *Central European Business Review*, 5(4). <https://doi.org/10.18267/j.cebr.161>
- Vich, M., Lukeš, M., & Burian, J. (2020). Out of sight, out of mind? Exploring the long-term effects of relational mindfulness training (RMT). *Journal of Contextual Behavioral Science*, 16, 162–171. <https://doi.org/10.1016/j.jcbs.2020.04.001>
- Zhang, W., Jex, S. M., Peng, Y., & Wang, D. (2017). Exploring the effects of job autonomy on engagement and creativity: The moderating role of performance pressure and learning goal orientation. *Journal of Business and Psychology*, 32(3), 235–251. <https://doi.org/10.1007/s10869-016-9453-x>

Strategy of Servitization as a Tool for Achievement of Sustainable Development

Vladimira VLCKOVA^{1*}, David VLCEK¹ and Lucie KANOVSKÁ²

¹ University of Pardubice, Pardubice, Czech Republic; vladimira.vlckova@upce.cz; david.vlcek.upce.cz

² Brno University of Technology, Brno, Czech Republic; kanovska@fbm.vutbr.cz

* Correspondence: vladimira.vlckova@upce.cz

Abstract: The reasons leading companies to the servitization strategy have recently been supplemented with society-wide global trend of striving for sustainable development. To be successful on the current markets, companies invest into services to increase the added value for the customer, diversification, and new income; to ensure the lock-in effect; to use the opportunity to grow and environmental burden reduction. These targets can be achieved by implementation of a strategic approach to servitization. In this paper, a research hypothesis that the manufacturers' strategic approach to servitization has a significant potential to affect achievement of sustainable development in a positive way has been constructed and discussed. The paper outcomes were drawn up based on the analysis, comparison, and synthesis of the information obtained (i) from a targeted professional literature review (ii) from an outcomes of the conducted electronic questionnaire survey. The questionnaire identified the level of the currently provided services related to their products and their expectations concerning an increased interest in services by their management, their customers, and their competitors. The outcomes should then help to direct companies in the Czech Republic to more extensive application of the servitization business model as a strategy supporting sustainable development.

Keywords: servitization; services; manufacturing companies; sustainable development

JEL Classification: O14, L10; Q01

1. Introduction

In the era of globalization, companies are facing a lot of changes in the market environment. These mainly include the growing competitiveness of developing countries leading, besides other things, to margin compression and market saturation, rapid development of new technologies connected with acceleration of the product innovation cycle, growing demands of the customers and the relating commoditization, shortening of the product life cycle, and changes in the customer demand. At the same time, manufacturing companies face new challenges of a global character with society-wide impacts, particularly on the environment, such as the sharing economy, circular economy, corporate social responsibility, and sustainable development. Elkington (1997) and Maxwell et al. (2006) identified three criteria, namely environment, social and economic, to translate sustainable development into business context.

To be successful in this highly competitive environment and, at the same time, to satisfy the society-wide demands placed on the business, companies are seeking and considering new business strategies, which would bring a higher customer value, compared to the competitors. One of the options for manufacturers is implementation of the developing business strategies, largely known as servitization. It is the innovation of an organizations capabilities and processes to better create mutual value through a shift from selling product to selling product service system (PSS) (Baines et al., 2009). Since the term servitization was first used by Vandermerwe and Rada (1988), different approaches to services provided by manufacturers have been developed. Differences between them are given partly by the growing demands placed by the customers on the scope and level of the provided services, partly by different motivation and geographical origin of the manufacturers, and partly also by the branch of industry. A successfully implemented PSS should then become a source of income and profits, lead to new opportunities and advantages on the market, to differentiation, and to customer satisfaction. As a result, successful servitization supports not only the manufacturing company itself, but also the entire supply chain or network. Moreover, implementation of a servitization business model itself may also have a significant positive impact on sustainable development. For example, we have recently been coming across the terms of a sustainable service business model (Liu et al., 2014), sustainable PSS (Vezzoli et al., 2015), IPSS (The integrated product service system) which is in compliance with conforming to triple bottom lines of sustainability, and Scandinavian concept PSS which is closely coupled to the debates on sustainability and the reduction of environmental impact (Baines et al., 2009).

However, the outcomes of the website analyses and structured interviews conducted with selected chemical companies in the Czech Republic in 2018 and 2019 imply that although the companies provided a wide portfolio of services, these were mostly rather complementary services connected with a product in an effort to extend their portfolio to increase the product sales. The manufacturing companies only sporadically offered advanced services closely related to a product in cooperation with other supply-chain entities (Vlckova & Podskubkova, 2020). Manufacturing companies in the Czech Republic use servitization as a tool fulfilling their marketing targets, rather than as a way of redirecting their strategic orientation towards PSS. In fact, the main target of the marketing approach to servitization is differentiation of the offer to the customers, where products and services can be separated and sold separately (Pistoni & Songini, 2018). On the other hand, the modern strategic approach represents innovation of corporate abilities and processes to achieve a shift from the sale of products (product-dominant logic) to the sale of a product-service system (service-dominant logic), which better creates both the customer and the supplier value (Kryvinská et al., 2014). The manufacturer's and the customer's sources are being integrated and information is being shared mutually to make it possible for the manufacturer to help the customer reach their targets, which should, on top of that, also respect the society-wide requirement concerning permanently sustainable development. This requirement is also a part of the strategic document ČR 2030. It specifies the direction of our country in the next decade. It defines long-term priorities of the development of the Czech Republic, whose

fulfilment will help to increase the quality of life in all the regions and will direct the Czech Republic to development that is sustainable in social, economic, and environmental aspects. (Úřad vlády ČR, 2017)

Therefore, we formulated a research hypothesis: the manufacturers' strategic approach to servitization has a significant potential to affect achievement of sustainable development in a positive way. To verify this hypothesis, we set the following targets: to conduct a targeted professional literature review, focusing on the manufacturers' strategic approach to servitization, particularly on the reasons and circumstances leading the companies to this business model. Then, to conduct a survey among companies in the Czech Republic, which should bring more detailed information about the provided services from the point of view of their scope and relation to the offered products. Then, based on these outcomes, to identify the influence and possibilities of servitization with respect to achievement of sustainable development. The outcomes should then help to direct companies in the Czech Republic to more extensive application of the servitization business model as a strategy supporting sustainable development.

2. Methodology

The formulated hypothesis was verified using primary and secondary sources. The used secondary sources mainly included foreign professional articles, professional studies, and company websites.

The primary sources refer to the outcomes of the electronic questionnaire survey we conducted with the companies belonging, based on their main business activity, to Sections 20 (Manufacture of chemicals and chemical products), 24 (Manufacture of basic metals), 26 (Manufacture of computer, electronic and optical products) and 27 (Manufacture of electrical equipment) under the CZ-NACE classification of economic activities.

The companies were addressed in September 2020 through their email addresses acquired from the Amadeus database (database of comparable financial information for public and private companies across Europe), where they were sent a link to an online questionnaire created in the tool Lime Survey. In total questionnaires were sent 820 companies. The questionnaire contained 23 questions, structured in accordance with the branch of industry where they classified themselves. The questionnaire identified the level of the currently provided services related to their products and their expectations concerning an increased interest in services by their management, their customers, and their competitors. The paper outcomes were processed based on the analysis, comparison, and synthesis of the obtained information.

3. Results

3.1. The Reasons for Servitization

The reasons leading industrial companies to introduction of the concept of servitization can be different. They mainly include commoditization, market saturation (Pistoni & Songini, 2018; Vandermerwe & Rada, 1988), acceleration of the product innovation cycle (Benedettini

et al., 2015), competitive pressure, globalization, new technologies (Vandermars & Rada, 1988), and recently also environmental circumstances (Ahamed et al., 2013) pushing the society-wide global trend towards sustainable development.

The company's external environment and internal conditions, and thus also different reasons for servitization, are affected by the branch of business the company belongs to (Turunen & Finne, 2014)). Kryvinská et al. (2014) divides these reasons into three groups, i.e. general trends in management (external reasons), financial factors and strategic reasons (internal reasons). General trends leading companies to introduction of servitization include: a companies' shift from product orientation to solution orientation, which should complete them ; shift from outputs to outcomes, transactions to relationships (e.g. making contracts with customers, guaranteeing a volume of sales); shift from suppliers to network partners; a shift from orientation to separate elements to complex ecosystems.(Neely et al., 2011)

The internal reasons for servitization relate to managerial decision-making (Pistoni & Songini, 2018). The financial reasons relate to the customers' pressure on the profit margins, which results in the suppliers' problems with achievement of higher income through the sale of products, particularly commodities. Therefore, they are starting to invest into services as a source of diversification (Pistoni & Songini, 2018) and new income (Ahamed et al., 2013). Moreover, a significant effect is origination of a so-called lock-in effect, as it is the manufacturer who can develop, sell, and deliver services best of all. The strategic reasons then relate to the suppliers' efforts to acquire competitive advantage (Ahamed et al., 2013) by providing a range of services that is as specific and intensive as possible (Kryvinská et al., 2014).

Therefore, companies can see servitization as an opportunity: how to differentiate themselves from competitive offers through extension of their own offerings by services and to increase the product sales and customer loyalty this way (Pistoni & Songini, 2018); how to compete with mass production of large companies without a significant long-term increase in the costs (Neely, 2008); how to get more opportunities for growth as the area of services is more profitable than the area of products (Ahamed et al., 2013; Pistoni & Songini, 2018). However, it is necessary to note that introduction of servitization is not necessarily always of benefit to the company, e.g. in the case of a high role and function of products in operations, or in an unstable operational product environment at the customers' premises (e.g. it did not prove successful in the case of construction machines used outside companies). Then we speak about undervalued services, which do not bring an increased customer value (Jovanovic et al., 2016).

3.2. The Integration of Products and Services - Opportunity for Sustainable Development

Servitization obviously includes both innovation of offerings, and innovation of the manufacturing process and operation. Servitization can be represented by three steps, characterized by different levels of offering complexity and by integration of different products and services, which naturally affects the entire process of satisfying customer requirements. In the first step of servitization, a product offering is supported by a few

product services focused on improvements of its functionality; in the second step, some product services aiming to improve the processes and some customer services improving the relationships with customers are added. In the last step, products and services combine into a new and unique offering in the form of a product-service system - PSS (Pistoni & Songini, 2018).

Integration of products and services itself can then take place in various ways. Park et al. (2012) divides them into two groups. The first group is based on the marketing approach, and it contains different forms of integration of product services aiming to observe the marketing targets, i.e. differentiation of the company's offering and increasing sales. However, there is a relatively small space left for further improvements in the Environment and ecology, which is more or less on the part of the manufacturer. It can refer e.g. to improvements in a technological process, modernization of technologies, etc. However, this usually requires considerable investments. In the period of the pressure on price reduction resulting from severe competition, companies usually stay in this area on the level of the parameters of their products, technologies, etc., given by the statutory limits. Only few customers are, for the time being, willing to pay more for a more environmentally friendly product.

The second group of the ways of integration is then based on the strategic approach, and it refers to a change in the corporate strategic orientation. Most of these approaches to product-service integration did not develop until after 2000, and they include Solutions (Miller et al., 2002), Integrated solutions, Product-service system (Manzini & Vezzoli, 2003), Functional sales (Aurich et al., 2006), Function product (Alonso-Rasgado et al., 2004), Integrated product and service engineering (Pistoni & Songini, 2018).

However, to verify our hypothesis, the last three ways are most important. Functional sales represent a comprehensive solution consisting of a combination of products and services satisfying the identified customer need, taking account of the entire product or service lifetime, from its design to manufacturing. (Aurich et al., 2006). In the case of integration into a function product, the customer purchases a function provided by a function product, e.g. space cleaning instead of a cleaning detergent (Alonso-Rasgado et al., 2004). The highest form of servitization is then Integrated product and service engineering. This concept incorporates the properties of a function product in the way to aim at the functions delivered to the customer and at the complete integration of various components into corporate offerings to better satisfy the customer needs (Pistoni & Songini, 2018). All these three ways of integration of servitization create huge opportunities just for sustainable development. As an example from personal practice, we can mention a company manufacturing, and earlier only selling, catalysts, which has agreed with one of their customers on delivery of solutions in the form of ensuring proper functioning of the catalyst. It means that the catalyst manufacturer monitors the effectiveness of the catalyst in the customer's operations and ensures its partial regeneration and replacement. Differently from the previous way, where the catalyst was only replaced and disposed, but not regenerated. As the customer pays for the function, but not for the quantity of the catalyst and the supplier is a catalyst expert, this results not only in a significant decrease in the consumption of the catalyst and all the sources

necessary for its replacement and disposal, but also in an increase in its effectiveness in the customer. This leads both to a decrease in the cost of the catalyst, and mainly to further reduction of the environmental burden. Another example can be reduction of carbon footprint using advanced services to monitor machine performance.

However, implementation of the strategic approach to servitization is much more demanding than in the case of the marketing approach. It is related to creation of a new form of corporate organization, its integration/change in the position in the supply chain, a change in its structure, culture, and management control systems. It requires investments, a change in the corporate attitude, and strong confidence.

Servitization mainly refers to services provided on the B2B market, where they are offered together with a product for the purpose of increasing its added value. They are often divided into services supporting a product (e.g. warehousing, transport, installation, training of workers, maintenance, and guarantee period services) and 'pure' services (e.g. marketing surveys, financial services, consultancy in the areas of management, finance, and law) (Ellis, 2011). They can also be divided in accordance with their relation to the product itself and the possibility of their growth on the industrial market (Raddats & Easingwood, 2010).

Our questionnaire was based on classification of services according to their orientation to outcome, i.e.: basic services (their outcome is focused on provision of products, facilities, ensuring spare parts, guarantee, etc.), intermediation services (they are focused on maintaining the product condition, e.g. status monitoring, on-site services, scheduled maintenance, technical assistance services, repairs, direct-to-site delivery, installation, training of operators), and advanced services (whose outcome is oriented to the abilities delivered together through the product performance, e.g. takeover of product performance control by the service provider, contractual provision of customer support and related contract on risks a reward sharing, revenue-through-use contract and rental agreement). (Baines & Lightfoot, 2013,) We added category Smart services (they use new smart technologies to collect data from the operation of a facility or equipment at the customer site and to analyze them). These services then aim to increase productivity decrease the failure rate, increase the operating cost efficiency and the operations safety (Kaňovská, 2018). As a result, they can significantly contribute to sustainable development, e.g. through the above carbon footprint reduction.

3.3. Services Provided by Manufacturing Companies in the Czech Republic (Survey Outcomes)

Individual types of services obviously differ in accordance with the branch of business the service provider operates in, and in accordance with their prevailing customers from the point of view of their share in profit creation, i.e. according to the fact, whether the customers are manufacturer (B2B), end consumers (B2C), or intermediaries (distributors). Therefore, we chose two groups of industries for our research.

- Group CZ-NACE 20 (Manufacture of chemicals and chemical products) and 24 (Manufacture of basic metals),

- Group CZ-NACE 26 (Manufacture of computer, electronic and optical products) and 27 (Manufacture of electrical equipment).

The rule was that members of one group operate in very similar branches of business, while the groups differ from each other significantly in terms of their products, type of production, applied technologies, and so also in terms of the possibilities of services suitable for servitization. On the other hand, we dare to declare that we know these branches of business from our previous scientific activity at the given faculties.

That is why the questionnaire was structured in the way to first divide the respondents into the above groups by industry. Assignment of questions to individual groups relating to the respective types of services is specified in Table 1.

Table 1. Questions on individual types of services provided

Questions: Do you provide your customers with:	Examples of provided services	
	1st Group	2nd Group
Basic accompanying services	<ul style="list-style-type: none"> - necessary product information (incl. necessary documentation, samples; tests, etc.); - professional consultancy for the serviced type of customer to the technology and product usage, - training, helpdesk 	<ul style="list-style-type: none"> - necessary product information (incl. necessary documentation, - services related to product delivery and invoicing
Advanced accompanying services	<ul style="list-style-type: none"> - environmental programs: - assistance with waste reduction, recycling, and waste disposal, - logistic services: supplying, warehousing, transport, professional consultancy for finetuning processes; -process optimization; - safety programs; - product quality control 	<ul style="list-style-type: none"> - ensuring spare parts, service/inspections, first training, preventive service maintenance, service-level agreements
Complete and comprehensive solutions, i.e. products in the form of services (complex services)	<ul style="list-style-type: none"> - protection, cleaning, or disinfection of materials, equipment, production halls at the customer site; - pest control, - coating, painting, another treatment of facilities/ materials; - ensuring operation and service on the equipment at the customer site (effectiveness monitoring, catalyst regeneration and replacement, oil lubrication, including regular inspections), -provision of tests, service, and guarantees for overall flawless operation of the equipment 	<ul style="list-style-type: none"> - product design, where the end customer does not have to solve technical details of the product, and the supplier is the one who solely ensures the entire product operation and service, including regular inspections, service, repairs, and guarantees overall flawless operation of the product
Accompanying services using smart technologies, so called smart services	<ul style="list-style-type: none"> - remote monitoring, - remote diagnostics, - remote repairs, - predictive maintenance, etc. 	<ul style="list-style-type: none"> - remote monitoring, - remote diagnostics, - remote repairs, - predictive maintenance, etc.

The questionnaire was filled in by 88 companies in total, 33 of them in Group 1 and 55 in Group 2. Most of them supplied B2B market, and most companies had up to 50 employees. If we are to suppose that the questionnaire was mainly filled in by companies interested in

servitization, this result was expected in view of the facts that small companies are usually more flexible and that the questions were mainly aimed at services complementing a product.

For the outcomes of the questioning conducted with the companies concerning the respective types of provided services structured by group of branches of business, prevailing customers and company size, see Tables 2 and 3.

Table 2. The proportions of companies from Group 1 divided according types of provided services as structured by prevailing customers and company size

Type of provided services		Number of companies	Basic	Advanced	Complex	Smart
Prevailing customers	B2B	21	100%	71%	24%	5%
	B2C	5	100%	60%	20%	20%
	Intermediaries	7	100%	43%	29%	0%
	Total	33	100%	64%	24%	6%
The size of the company according to the number of employees	Not Answered	7	100%	29%	14%	0%
	Small (do 50)	12	100%	67%	17%	8%
	Medium (51 - 250)	10	100%	70%	30%	0%
	Large (250 and more)	4	100%	100%	50%	25%
	Total	33	100%	64%	24%	6%

All 33 companies from Group 1 who filled in the questionnaire completely provide basis services regardless of the customer type or their size see Table 2. Together with the growing complexity of the provided services, the number of companies providing them gradually significantly decreases. Intermediaries and medium-sized companies don't even provide any smart services. The other companies do, but sporadically only. From two to three times more companies (ca. 70% small and medium companies, and at B2B) then declared provision of an advanced service than it was with provision of a comprehensive solution for customers (between 20% and 30% companies).

Table 3. The proportions of companies from Group 2 divided according types of provided services as structured by prevailing customers and company size.

Type of provided services		Number of companies	Basic	Advanced	Complex	Smart
Prevailing customers	B2B	30	87%	70%	33%	33%
	B2C	12	100%	83%	50%	42%
	Intermediaries	13	100%	92%	31%	54%
	Total	55	93%	78%	36%	40%
The size of the company according to the number of employees	Not Answered	11	91%	82%	36%	36%
	Small (do 50)	22	95%	82%	36%	32%
	Medium (51 - 250)	12	83%	50%	17%	42%
	Large (250 and more)	10	100%	100%	60%	60%
	Total	55	93%	78%	36%	40%

Almost 100% of the companies from Group 2, see Table 3, also provide basic services. Similarly, growing (with exception of smart services) complexity of services results in a decreasing number of their providers, as it is among Group 1 companies. However, the decrease is not as dramatic, and, except for medium-sized companies, more than 70% of the companies provide advanced services, and more than one third of them provide comprehensive services. As for large companies and B2C offerings, it is even more than 50% companies. The biggest difference in the expectations between the selected groups is in smart services. While in the first group, there were in total 6% of providers of these services, in the second group there were 40% of them.

3.4. Expectations Concerning Increased Interests of Services Provided by Manufacturing Companies in the Czech Republic (Survey Outcomes)

The questionnaire also asked whether the manufacturing companies expect an increased interest of their customers, their management, and their competitors in individual types of services. The questions relating to their expectations concerning customers were answered by 77 companies, concerning management by 74 companies, and concerning competitors by 70 companies. Result are shown in Tables 4 and 5.

Table 4. The proportions of companies divided according to their expectations concerning increased interests on the part of their selected stakeholders in types of services

Type of service		Basic			Advanced			Complex			Smart		
Expectations of:	No. of Co.	Yes	Don't know	No	Yes	Don't know	No	Yes	Don't know	No	Yes	Don't know	No
Customers	77	32%	26%	42%	29%	29%	43%	31%	29%	40%	31%	32%	36%
Management	74	42%	19%	39%	30%	26%	45%	35%	20%	45%	39%	27%	34%
Competitors	70	39%	27%	34%	34%	30%	36%	34%	33%	33%	31%	36%	33%

Table 5. The proportions of companies divided according to their expectations concerning increased interests on the part of their selected stakeholders in types of services as structured by industry.

CZ-NACE	Type of service		Basic			Advanced			Complex			Smart		
	Expectations of:	No. of Co.	Yes	Don't know	No	Yes	Don't know	No	Yes	Don't know	No	Yes	Don't know	No
20 & 24	Customers	28	46%	29%	25%	39%	32%	29%	43%	29%	29%	29%	46%	25%
	Management	26	62%	15%	23%	42%	27%	31%	42%	19%	38%	38%	35%	27%
	Competitors	26	58%	27%	15%	42%	31%	27%	42%	31%	27%	31%	38%	31%
26 & 27	Customers	49	24%	24%	51%	22%	27%	51%	33%	29%	39%	33%	24%	43%
	Management	48	31%	21%	48%	23%	25%	52%	31%	21%	48%	40%	23%	38%
	Competitors	44	27%	27%	45%	30%	30%	41%	30%	34%	36%	32%	34%	34%

Table 4 outcomes show that about one third of companies expect an increased interest in each type of service from their customers, and a little more from their management. 19-33% of the companies do not know what they can expect from in the area of development of services from their customers, their management, or their competitors. As many as 45% of the companies do not expect any growing interest in certain services. If we look at these

outcomes more closely, see Table 5, we can see that the expectations of companies from different branches of business differ.

As for industries in Group 1, see Table 5, higher or the same percentage of companies always expect a growing interest in a type of services (29-62%), compared to the companies expecting no increase in the given service (15-38%). As for Group 2, with one exception (management's interest in smart services), it is in the opposite way. The percentage of companies expecting no increase in the interest in a type of service is always higher (34-52%), than that of companies expecting a growing interest in the given service (22-33%). The biggest difference in the expectations among the chosen groups is in basic services, where more than 46% of Group 1 companies expect a growing interest in these services on the part of their management, their competitors, and their customers. On the other hand, less than 31% of Group 2 companies expect a growing interest in basic services. The smallest differences are in the expectations of a growing interest in smart services.

4. Discussion and Conclusions

The reasons leading industrial companies to the servitization strategy have recently been supplemented with society-wide global trends: solving environmental issues, worsening environment, and striving for sustainable development. The reasons for which companies approach different forms of product-service integration (servitization) are affected by the company's external environment and the internal conditions that are also related to the industry the company belongs to. To be successful on the current markets, companies invest into services to increase the added value for the customer, diversification, and new income; to ensure the lock-in effect; to use the opportunity to grow and environmental burden reduction. The above targets can be achieved through services by implementation of a strategic approach to servitization. That means mainly by implementation of comprehensive solutions (complex services) and smart services. However, implementation of servitization does not necessarily always have to be of benefit. It is necessary to keep an eye on services undervalued by the customers.

The questioning outcomes imply that practically all of 88 companies filling in the questionnaire provide basic services, regardless of the branch of their business. For companies from CZ-NACE 20 and 24 (see Table 2) is fact that the number of companies providing services is gradually significantly decreasing together with growing complexity of these services. Advanced services are provided by 64% of the companies, complex services by 24% of the companies, and smart services by a negligible number only (6%).

As for Group 2 companies (see Table 3) there we can also see the trend of a decreasing number of providers together growing complexity of provided services (except smart services), but the decline is not so sharp. Advanced services are provided by 78% of the companies, complex services by 36% of the companies. For large companies and offers on B2C, it is even over 50% of companies. However, the biggest difference between the groups is in provision of smart services, which are provided by significantly more companies from Group 2, i.e. 40%. This difference is, in view of the close relations among the branches of

business of production of computers, electronic and optical apparatuses and devices, and production of electrical facilities and the contents of smart services (see Table 1) is explicable.

If we come out of the fact that they are just advanced services, and particularly entire comprehensive solutions and smart services being applied in the strategic approach to servitization (see the research outcomes) can most contribute to sustainable development, then it is possible, in view of still unused potential of these services, particularly in Group 1 companies, to make a conclusion about acceptance of the formulated hypothesis, i.e. that a strategic approach of manufacturing companies to servitization has a significant potential to affect achievement of sustainable development in a positive way.

As for the other research outcomes, see Table 4, it is possible to see a positive fact that, in each type of service, almost one third of the companies expect an increased interest on the part of their customers, and also the fact that a similar number of companies expect an increased interest in these services on the part of their management. What is a little surprising, in view of the growing trend of transition to servitization, is the finding that as many as 45% of the companies do not expect a growing interest in certain services, and 19-33% of the companies do not even know what they can expect in the area of service development from their customers, their management, or their competitors. These companies probably still have not duly appreciated the importance of servitization.

A more detailed analysis (see Table 5) affirmed our assumption that expectations of companies differ in different branches of business. As for Group 1 companies, a higher or the same percentage of companies always expect an increased interest in a type of service, compared to the number of companies expecting no increase in the interest in the given service. As for Group 2, except for management expectations concerning a smart service, it is in the opposite way. It can also be given by the fact that more Group 2 companies are already using higher forms of servitization (see Table 2). The biggest difference in the expectations between the selected groups is in basic services. A growing interest in these services is expected by more companies in Group 1. The reason can be found in the fact that companies belonging to NACE 20 and 24 still perceive implementation of services rather on the level of the marketing approach to servitization aiming to increase the sales of their products, but also higher demands concerning implementation of the strategic approach to servitization. However, it is possible to expect, taking account of the society-wide global trend to sustainable development, that these companies will gradually seek, under the pressure of the competition and customers, ways where and how to implement the strategic approach to servitization.

Acknowledgments: This study was supported by a grant from the Fund for Bilateral Relations within the framework of the EEA and Norway Grants 2014-2021 (EHP-BFNU-OVNKM-3-134-01-2020).

References

- Ahamed, Z., Kamoshida, A., & Inohara, T. (2013). Organizational Factors to the Effectiveness of Implementing Servitization Strategy. *Journal of Service Science and Management*, 6, 177-185, <https://doi.org/10.4236/jssm.2013.62018>
- Alonso-Rasgado, T., Thompson, G., & Elfström, B. O. (2004). The design of functional (total care) products. *Journal of Engineering Design*, 15(6), 515-540. <https://doi.org/10.1080/09544820412331271176>

- Aurich, J. C., Fuchs, C., & Wagenknecht, C. (2006). Life cycle-oriented design of technical Product-Service Systems. *Journal of Cleaner Production*, 14(17), 1480-1494. <https://doi.org/10.1016/j.jclepro.2006.01.019>
- Baines, T., & Lightfoot, H. (2013). *Made to serve: how manufacturers can compete through servitization and product service systems*. John Wiley & Sons.
- Baines, T. S., Lightfoot, H. W., Benedettini, O., & Kay, J. M. (2009). The servitization of manufacturing: A review of literature and reflection on future challenges, *Journal of Manufacturing Technology Management*, 20(5), 547-567. <https://doi.org/10.1108/17410380910960984>
- Benedettini, O., Neely, A., & Swink, M. (2015). Why do servitized firms fail? A risk-based explanation. *International Journal of Operations & Production Management*, 35(6), 946-979. <https://doi.org/10.1108/IJOPM-02-2014-0052>
- Elkington, J. (1997). *Cannibals with Forks, The Triple Bottom Line of 21st Century Business*. Calstone Publishing Limited.
- Ellis, N. (2011). *Business-to-business marketing: relationships, networks and strategies* (2nd ed.). Oxford University Press.
- Jovanovic, M., Engwall, M., & Jerbrant, A. (2016). Matching Service Offerings and Product Operations: A Key to Servitization Success. *Research Technology Management*, 59(3), 29-36. <https://doi.org/10.1080/08956308.2016.1161403>
- Kaňovská, L. (2018). *Využití smart technologií ve službách průmyslových podniků*. Akademické nakladatelství CERM.
- Kryvinská, N., Kaczor, S., Strauss, C., & Greguš, M. (2014). Servitization Strategies and Product-Service-Systems, 2014 IEEE World Congress on Services (pp. 254-260). IEEE. <https://doi.org/10.1109/SERVICES.2014.52>
- Liu, C. H., Chen, M.-C., Tu, Y.-H., & Wang, C.-C. (2014). Constructing a sustainable service business model: An S-D logic-based integrated product service system (IPSS). *International Journal of Physical Distribution & Logistics Management*, 44(1-2), 80-97. <https://doi.org/10.1108/IJPDLM-02-2013-0039>
- Manzini, E., & Vezzoli, C. (2003). A strategic design approach to develop sustainable product service systems: Examples taken from the 'environmentally friendly innovation' Italian prize. *Journal of cleaner production*, 11(8), 851-857. [https://doi.org/10.1016/S0959-6526\(02\)00153-1](https://doi.org/10.1016/S0959-6526(02)00153-1)
- Maxwell, D., Sheate, W., & van der Vorst, R. (2006). Functional and systems aspects of the sustainable product and service development approach for industry. *Journal of Cleaner Production*, 14(17), 1466-1479. <https://doi.org/10.1016/j.jclepro.2006.01.028>
- Miller, D., Hope, Q., Eisenstat, R., Foote, N., & Galbraith, J. (2002). The problem of solutions: Balancing clients and capabilities. *Business Horizons*, 45(2), 3-12. [https://doi.org/10.1016/S0007-6813\(02\)00181-7](https://doi.org/10.1016/S0007-6813(02)00181-7)
- Neely, A. (2008). Exploring the financial consequences of the servitization of manufacturing. *Operations Management Research*, 1, 103-118. <https://doi.org/10.1007/s12063-009-0015-5>
- Neely, A., Benedettini, O., & Visnjic, I. (2011). The Servitization of Manufacturing – Further Evidence. In *Proc. 18th European Operations Management Association Conference*. University of Cambridge. https://www.researchgate.net/publication/265006912_The_Servitization_of_Manufacturing_Further_Evidence
- Park, Y., Geum, Y., & Lee, H. (2012). Toward integration of products and services: Taxonomy and typology. *Journal of Engineering and Technology Management* 29(4), 528-545. <https://doi.org/10.1016/j.jengtecman.2012.08.002>
- Pistoni, A., & Songini, L. (2018). *Servitization strategy and managerial control*. Emerald Publishing.
- Raddats, C., & Easingwood, C. (2010). Services growth options for B2B product-centric businesses. *Industrial Marketing Management* 39(8), 1334-1345. <https://doi.org/10.1016/j.indmarman.2010.03.002>
- Turunen, T., & Finne, M., (2014). The organisational environment's impact on the servitization of manufacturers. *European Management Journal*, 32(4), 603-615. <https://doi.org/10.1016/j.emj.2013.11.002>
- Úřad vlády ČR. (2017). *Strategický rámec Česká republika 2030*. <https://www.cr2030.cz/strategie/dokumenty-ke-stazeni/>
- Vandermerwe, S., & Rada, J. (1988). Servitization of business: adding value by adding services. *European Management Journal*, 6(4), 314-324. [https://doi.org/10.1016/0263-2373\(88\)90033-3](https://doi.org/10.1016/0263-2373(88)90033-3)
- Vezzoli, C., Ceschin, F., Diehl, J. C., & Kohtala, C. (2015). New Design Challenges to Widely Implement 'Sustainable Product-Service Systems'. *Journal of Cleaner Production*, 97, 1-12. <https://doi.org/10.1016/j.jclepro.2015.02.061>
- Vlckova, V., & Podskubkova, L. (2020). The Approach to Servitization in the Czech Manufacturing Companies. In P. Jedlička, P. Marešová, K. Firlej, & I. Soukal (Eds.), *Proceedings of the international scientific conference Hradec Economic Days 2020* (pp. 861-870). University of Hradec Králové. <https://doi.org/10.36689/uhk/hed/2020-01-097>

The Approach of Czech Business Entities to the Promotion and Application of the Corporate Social Responsibility

Pavla VRABCOVÁ^{1*} and Hana URBANCOVÁ²

¹ Czech University of Life Sciences Prague, Prague, Czech Republic; vrabcovapavla@gmail.com

² University of Economics and Management, Prague, Czech Republic; hana.urbancova@vsem.cz

* Corresponding author: vrabcovapavla@gmail.com

Abstract: The importance of responsible business lies in the reflection of the basic values of the company. Responsible business is important for large or small businesses, which can improve their economic, environmental, and social characteristics in the short and long term through innovative products and services, new skills, and stakeholder involvement. It includes the commitment of the organization to develop its economic activities effectively and responsibly towards society and the environment, taking into account the interests of all stakeholders. The aim of the article is to identify the approaches of Czech business entities to the promotion of the concept of social responsibility in selected organizations ($n = 179$). Data were obtained through questionnaire data collection during June to December 2020. Chi-square tests were applied to determine the dependencies. The results showed that most of the addressed organizations focus on the assessment of processes and projects regarding their economic, environmental, and social aspects and impacts (41.3%), while the approach of business entities to promoting the concept of social responsibility is not influenced by the sector, size, type or ownership share of the organization.

Keywords: competitiveness; corporate social responsibility; the Czech Republic; sustainable development

JEL Classification: M10; M14

1. Introduction

The primary theme of sustainable development in the 19th century was the relationship between man and nature and human settlement and the landscape. The beginnings of the idea of corporate social responsibility (CSR) have been appearing in society since the 1930s, and the experience of a deteriorating environment (Cancino et al., 2018), catastrophes (Yadlapalli et al., 2020) and the global energy crisis. Some authors (Kolk & Van Tulder, 2010) consider CSR to be a key contribution of society to sustainable development. CSR initiatives are often closely linked to business sustainability initiatives (Ahi & Searcy, 2013), and some authors consider these terms to be synonymous (Van Marrewijk, 2003).

Social responsibility represents the entrepreneur's obligation to carry out such procedures and make such decisions that are desirable from the point of view of the company's values. It is the voluntary integration of social and environmental aspects into everyday corporate operations and interactions with corporate stakeholders (EU, 2001). It is also possible to state,

that social responsibility is further applied in management fields such as sustainable revenue management, etc. (Petříček et al., 2020). According to the European Commission, CSR is described as *“to create favorable conditions for sustainable growth, responsible business behavior and durable employment generation in the medium and long term”* (EC, 2011). A characteristic feature of the above definitions is universality (Charitoudi et al., 2011).

In 2011, the Commission adopted a renewed strategy for CSR. The strategy combines horizontal approaches to promote CSR with specific approaches. Commission published document called Corporate Social Responsibility, Responsible Business Conduct, and Business & Human Rights: Overview of Progress which gives an overview of the progress progress implementing CSR. CSR is not regulated in the Czech Republic; it is a voluntary instrument managed by the Ministry of Industry and Trade. The support of the concept of social responsibility in the Czech Republic is not solved centrally by the state; there is no formal support for the concept of corporate social responsibility.

A number of analyzes of CSR definitions have been published (e.g. Dahlsrud (2008) who shows that most definitions are largely identical). However, most definitions focus on addressing the needs of key stakeholders in the long term. Key characteristics include (Ahi & Searcy, 2013; Cancino et al., 2018; Ciccullo et al., 2018; Fortunati et al., 2020): economic pillar, social pillar, and environmental pillar. In addition to these three characteristics, the authors Sarkar and Searcy (2016) add stakeholder focus, volunteer focus, longevity, and resilience focus. However, for example, Bansal et al. (2015) state that CSR can be accepted as a short-term – tactical orientation of the company, or as a long-term – strategic orientation.

In the context of a large number of definitions, CSR has been described as a chameleon concept (Gond & Moon, 2011; Sarkar & Searcy, 2016). Authors Sarkar and Searcy (2016) agree that the fact that so many definitions of CSR have been proposed makes it even difficult to develop a theoretical concept, which hinders the development and implementation of tactics and strategies to promote CSR goals. In their research, they concluded that the peer-reviewed journals, books, and nonacademic publications examined yielded a total of 110 definitions of the term CSR. Or, e.g., Dahlsrud (2008) focused on the analysis of 37 definitions. The analysis of the definitions according to Sarkar and Searcy (2016) shows following definition: *“CSR implies that firms must foremost assume their core economic responsibility and voluntarily go beyond legal minimums so that they are ethical in all of their activities and that they take into account the impact of their actions on stakeholders in society, while simultaneously contributing to global sustainability.”*

The authors (e.g. Burke et al., 1996; Gallardo-Vázquez & Turyakira et al., 2014) mention the benefits of implementing CSR: increased profits through reduced costs and increased productivity, better availability of capital (Schiebel & Pöchtrager, 2003), improved image (Jorge et al., 2015), achieving higher customer loyalty (Ali et al., 2010; Camacho & Fernandez, 2018), better opportunities in recruiting and retaining quality employees (Mandl & Door, 2007; Jenkins, 2009), mitigation legal measures, risk reduction and risk management costs, increased performance (Bernal-Conesa et al., 2017; Hung et al., 2019), maintaining competitiveness (Porter & Kramer, 2006; Marín et al., 2012; Boulouta & Pitelis, 2014; Gallardo-Vázquez & Sanchez-Hernandez, 2014; Jorge et al., 2015) and improving the learning and innovation cycle (Vilanova et al., 2009). CSR activities can be one of several criteria on the basis of which the

customer chooses the company from which to purchase services or products. In contrast, Marin et al. (2017) did not show in their research the direct impact of CSR on competitiveness, but it turned out that innovation and investment affect the impact of CSR on competitiveness indirectly but significantly (their results show the overall intermediary effect of innovation and investment on the impact of CSR on competitiveness).

Based on the above, it can be concluded that setting the concept of social responsibility and sustainable development in organizations is a current and discussed topic, not least because past and present developments, which are based primarily on economic growth, irreversibly affect the form and functioning of landscapes and entire planets. Therefore, it is necessary to deal with the possibilities of eliminating or mitigating the negative manifestations of the current way of development of human society, whether for individuals or organizations themselves and to apply this in the concept of CSR.

Most natural resources are finite and it is necessary to control their over-exploitation in some way. The word sustainability should become a priority for every organization, and each of its employees should be made aware of this direction and identified with it. It is necessary to realize that for the continued existence it is not possible to take into account not only economic growth but also social values and natural resources sustainability tends to do so. Each organization and its employees should address the quality of life and meet the needs of the present generation without compromising the needs of future generations and other people. The social, environmental, and economic pillars of society are closely linked, and that one of them cannot be given priority over the others.

The article aims to identify the approaches of Czech business entities to the promotion of the concept of social responsibility in selected organizations ($n = 179$). The article contains six logically connected parts. The first part describes the topicality, importance, and theoretical background of the article, followed by the research methodology and an analytical part with annotated results of advanced statistical analyzes, followed by a discussion and conclusion with a summary of key survey results.

2. Methodology

The research is focused on identifying the approaches of organizations to sustainable development in selected organizations. The quantitative data was obtained by a questionnaire survey in Czech organizations (quota-based selection). A total of $n = 179$ organizations participated in the survey. The survey occurred from 06/2020 to 12/2020. The results can only be generalized for the research sample. The sample was based on the ALBERTINA database of organizations (which contains important data of more than 2,700,000 organizations registered in the Czech Republic). The questionnaire was distributed to companies by e-mail, 850 companies were contacted twice (with a reminder), the rate of return of the questionnaire is 21%. The basic identifying features of the questionnaire survey include: size of the organization, sector of operation of the organization (primary, secondary, tertiary), type of organization (for-profit, non-profit), and majority ownership.

The questionnaire was completed by mid-tier or higher management of the organization, in case of smaller organizations by the owner itself (thus the responses reflected the point view of their heads/owner/manager).

Dependencies between selected qualitative features were tested. To test the hypothesis of homogeneity and independence, chi-square tests with $(r - 1)(s - 1)$ degrees of freedom were applied:

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^s \frac{(n_{ij} - m_{ij})^2}{m_{ij}}, \quad (1)$$

where:

n_{ij} – observed frequency,

m_{ij} – expected frequency.

The results were analyzed using statistical tools – the dependence test (χ^2) and the power of dependence test (Cramer's V). The chi-square tests are used to test the hypothesis of homogeneity and independence, rejecting / rejecting the null hypothesis of dependence or homogeneity at a given level of significance $\alpha = 0.05$. Good approximation requirements were always met in the computations, if theoretical frequencies were larger than or equal to 5 in 80% of instances, and never dropped below 2 even in the remaining 20%. The dependence strength was calculated using the Cramer's V measure, that is within $0 \leq V \leq 1$.

The questionnaire was designed to comply with ethical rules and with the requirement for anonymity, and contained 60 questions. Within this article, 3 questions and 4 identification questions were evaluated with multiple answer options.

The questions were close-ended (allowing only provided response options) and with more response options. The structure of the organizations, participating in the research ($n = 179$), was as follows (see Table 1).

Table 1. Organizations that participated in the research – basic data

Characteristics	Categories		
Sector	Primary	Secondary	Tertiary
	4.5%	40.2%	55.3%
Type of organization	Private	Public	Non-profit
	86.0%	11.2%	2.8%
Turnover	<10 mil. EUR	11–50 mil. EUR	>50 mil EUR
	38.5%	38.0%	23.5%
Type of organization in terms of majority ownership	Domestic	Foreign	
	45.3%	54.7%	
The size of the organization (number of employees and %)	<50	51–249	>250
	26.8%	27.9%	45.3%
Organization focus	Business activity	Provision of services	Production
	18.4%	40.8%	40.8%

Table 1 shows that the research focused mainly on private organizations, 11.2% represents the share of public organizations, and only less than 3% of non-profit organizations. Most organizations have a foreign shareholding (54.7%) and employ more

than 250 employees (45.3%). In terms of the focus of organizations, it can be stated that 40.8% are services, the same part of production and business activities from the examined sample of respondents occupies 18.4%. The IBM SPSS Statistics 24 statistical software was used to evaluate the results (Bryman et al., 2011; Verma, 2012; Gunarto, 2019).

3. Results

Based on the evaluation of the results, it can be stated that the addressed organizations focus mainly on their economic, environmental, and social aspects and impacts in all processes and projects within their business activities (see Table 2).

Table 2. The organization's focus on CSR and sustainability

Organization's focus	Absolute frequency	Relative frequency (%)
A. Organization's focus – economic and environmental Within business activities, the main emphasis is placed on economic and environmental goals. In the social field, compliance with relevant laws is achieved	16	8.9
B. Organization's focus – economic and social Within business activities, the main emphasis is placed on economic and social goals. The company's approach to the environment is in accordance with environmental protection laws	48	26.8
C. Organization's focus – economic Within business activities, the main emphasis is placed on economic goals (i.e. long-term profit making). In the social area and in the area of access to the environment, compliance with applicable laws is achieved	41	22.9
D. Organization's focus – economic, environmental, and social Within business activities, all processes and projects are assessed with regard to their economic, environmental and social aspects and impacts	74	41.3
Total	179	100.0

The results are positive, as most of the examined organizations emphasize not only the economic side of individual goals but also the social and environmental area. The social, environmental, and economic pillars of society are closely linked and it is not possible for the organization to prioritize any of them at the expense of others. Respondents were also able to rate the specific characteristics of the organization in the field of CSR and sustainability (see Table 3) on a scale of 1 (strongly agree) to 4 (strongly disagree).

Most organizations stated that they have only partially incorporated sustainable development into their corporate strategy (level 2) at 49.2%. Only 1.3% of the addressed organizations do not include this area in the strategy. At level 2 out of 4, most respondents were in all answers, i.e. within the use of voluntary tools beyond the law (41.3%), attention to social entrepreneurship and health and safety (45.8%) and CSR profiling (35.8%) or compliance with laws in this area (38%). However, regarding the characteristics of the organization in the CSR approach leading to competitive advantage, the respondents were in favor of the fact that these characteristics do not have a direct impact on the

Table 3. Characteristics of the organization in the approach to CSR

Characteristics of the organization	Minimum	Maximum	Mean	Std. Deviation
Sustainable development is incorporated into the company's strategy	1	4	1.85	0.735
Voluntary tools and approaches (beyond the law) aimed at environmental protection and pollution prevention are used	1	4	2.21	0.893
We pay great attention to the social aspects of business (beyond the law), especially the issue of safety and health at work and relations with the company's environment and other important stakeholders	1	4	1.82	0.760
We profile ourselves as a socially responsible company; we implement projects focused on environmental protection, projects beneficial to employees, the local location, or other relevant stakeholders	1	4	2.12	0.922
The concept of sustainable development is a matter for the state	1	4	2.40	0.884

Table 4. Characteristics of the organization in the approach to CSR lead to a competitive advantage.

Characteristics of the organization	Minimum	Maximum	Mean	Std. Deviation
Involvement in the supply chain	1	4	3.04	0.905
Innovation activities	1	4	3.40	0.691
Productivity (valuation of inputs, use of production factors)	1	4	3.47	0.698
Differentiation from the competition	1	4	3.49	0.752
Reputation (good name), brand	1	4	3.69	0.664
Attractiveness of the company as an employer	1	4	3.41	0.755
Market share	1	4	3.20	0.828
Company communication (internal and external)	1	4	3.46	0.751
Creating value for the customer	1	4	3.50	0.730
The willingness of the customer to pay for the high perceived value of the products	1	4	3.14	0.740
Payment morale of the company	1	4	3.29	0.838
Ability to generate profits (long term)	1	4	3.49	0.737
Impact of government measures	1	4	2.99	0.768
Human resources competence	1	4	3.19	0.733

achievement of competitive advantage. However, they are heavily influenced by government measures (see Table 4).

Furthermore, the dependencies between selected qualitative features were tested, hypotheses were tested:

- H₀₁: The focus of the organization in terms of a three-pillar CSR system does not depend on the business sector.

- H₀₂: The focus of the organization in terms of a three-pillar CSR system does not depend on the size of the organization.
- H₀₃: The focus of the organization in terms of a three-pillar CSR system does not depend on the majority ownership of the organization.
- H₀₄: The focus of the organization in terms of a three-pillar CSR system does not depend on the type of the organization.

Table 5. Pivot table of organizations focusing on CSR by sector.

Organization's focus	Sector			Total
	Primary (agriculture, forestry and fishing)	Secondary (manufacturing)	Tertiary (services)	
A. Organization's focus: economic, and environmental	0	6	10	16
B. Organization's focus: economic, and social	4	18	26	48
C. Organization's focus: economic	0	13	28	41
D. Organization's focus: economic, environmental, and social	4	35	35	74
Total	8	72	99	179

Table 6. Pivot table of organizations focusing on CSR according to the size of the organization.

Organization's focus	Size of the organization (number of employees)			Total
	>250	51–249	<50	
A. Organization's focus: economic, and environmental	7	5	4	16
B. Organization's focus: economic, and social	19	18	11	48
C. Organization's focus: economic	17	7	17	41
D. Organization's focus: economic, environmental, and social	38	20	16	74
Total	81	50	48	179

Table 7. Contingency table of organizations focusing on CSR according to majority ownership and type of organization.

Organization's focus	Majority ownership		Type of organization			Total
	Domestic	Foreign	Non-profit	Private	Public	
A. Organization's focus: economic, and environmental	10	6	2	11	3	16
B. Organization's focus: economic, and social	20	28	1	43	4	48
C. Organization's focus: economic	19	22	0	36	5	41
D. Organization's focus: economic, environmental, and social	32	42	2	64	8	74
Total	81	98	5	154	20	179

The dependencies of the PivotTables are listed in Tables 5–7. Table 5 shows that the largest share of organizations that deal with CSR and the environmental aspect, including economical aspect, are companies in the primary sector (agriculture, forestry, and food). Furthermore, in the secondary sector and subsequently in the tertiary sector. According to size, these are primarily larger companies with a set CSR strategy and sustainability (see Table 6).

Furthermore, these are organizations with a foreign majority share in the private sector (see Table 7).

Based on the performed testing, it can be summarized that the null hypotheses were confirmed:

- H₀₁: The focus of the organization in terms of a three-pillar CSR system does not depend on the business sector (p -value = 0.214).
- H₀₂: The focus of the organization in terms of a three-pillar CSR system does not depend on the size of the organization (p -value = 0.186).
- H₀₃: The focus of the organization in terms of a three-pillar CSR system does not depend on the majority ownership of the organization (p -value = 0.511).
- H₀₄: The focus of the organization in terms of a three-pillar CSR system does not depend on the type of the organization (p -value = 0.204).

The approach of business entities to the promotion of the concept of social responsibility does not affect the sector, size, type or ownership share of the organization.

The concept of CSR must be applied in organizations at the highest level, i.e. strategic management, and must be supported by top management. CSR leads organizations to responsible and sustainable business and is currently indispensable against the classic focus on short-term or long-term profit or prosperity and risk-free operations with a close link to the company's economic goals. Now, organizations are increasingly exposed to greater oversight by all interest groups that affect or are affected by the organization's operations. Therefore, it is necessary to focus all more on environmental and social local and global CSR challenges such as transparency, ethics, anti-corruption strategies, human rights, climate change, supply chain responsibility, or tax transparency in all types of organizations, regardless of sector, size, focus or majority share.

4. Discussion

Responsible business is becoming an increasingly important topic in the debate on globalization, competitiveness, and sustainable development (Kolk & Van Tulder, 2010; Bansal et al., 2015; Fortunati et al., 2020). Responsible business is important for people working in companies and for companies that can help them create a work environment. At the same time, it is important for those who buy from businesses for consumers, who are paying increasingly attention to the social or environmental nature of the products and services they buy (Sarkar & Searcy, 2016). It is important for local communities (Newell, 2005) to know that they live among organizations that share their values and concerns. It is also important for investors (Verbeeten et al., 2016) who feel the need to promote responsible

corporate behavior, but also for people from other parts of the world who expect European companies to behave in accordance with European and international values and principles. At present, by opening up the market, customers / citizens (Martínez & Del Bosque, 2013) perceive the market more complex and are interested in products and services from companies whose goals are not only economic, but also social and environmental. This is a challenge for small and medium-sized organizations.

5. Conclusions

Responsible business is a concept in which companies voluntarily incorporate social and environmental aspects into their business operations and stakeholder relationships. It is therefore the overall relationship of the organization with all stakeholders – customers, owners-investors, employees, public authorities, suppliers, competitors, communities, etc. It includes the organization's commitment to develop its economic activities effectively and responsibly to society and the environment, taking into account the interests of all stakeholders' entities. Each stakeholder in a way affects the competitiveness of the organization. Owners and shareholders are interested in the growth and prosperity of the organization, employees evaluate working conditions, customers are interested in the quality of products and services, the government is interested in reducing unemployment and creating suitable business conditions, and citizens are interested in the behavior of organizations in their place of operation. The results showed that the surveyed organizations are more concerned with the concept of CSR and sustainability, although they do not see a direct impact on the competitiveness of the organization. However, they consider this area to be important and impossible to ignore in the future.

References

- Ahi, P., & Searcy, C. (2013). A comparative literature analysis of definitions for green and sustainable supply chain management. *Journal of cleaner production*, 52, 329–341. <https://doi.org/10.1016/j.jclepro.2013.02.018>
- Ali, I., Rehman, K. U., Yilmaz, A. K., Nazir, S., & Ali, J. F. (2010). Effects of corporate social responsibility on consumer retention in the cellular industry of Pakistan. *African Journal of Business Management*, 4(4), 475–485.
- Bansal, P., Jiang, G. F., & Jung, J. C. (2015). Managing responsibly in tough economic times: strategic and tactical CSR during the 2008–2009 global recession. *Long Range Planning*, 48(2), 69–79. <https://doi.org/10.1016/j.lrp.2014.07.002>
- Bernal-Conesa, J. A., de Nieves Nieto, C., & Briones-Peñalver, A. J. (2017). CSR strategy in technology companies: Its influence on performance, competitiveness and sustainability. *Corporate social responsibility and environmental management*, 24(2), 96–107. <https://doi.org/10.1002/csr.1393>
- Boulouta, I., & Pitelis, C. N. (2014). Who needs CSR? The impact of corporate social responsibility on national competitiveness. *Journal of business ethics*, 119(3), 349–364. <https://doi.org/10.1007/s10551-013-1633-2>
- Bryman, A., & Cramer, D. (2011). *Quantitative data analysis with IBM SPSS 17, 18 and 19*. Routledge, New York.
- Burke, L., & Logsdon, J. M. (1996). How corporate social responsibility pays off. *Long range planning*, 29(4), 495–502. [https://doi.org/10.1016/0024-6301\(96\)00041-6](https://doi.org/10.1016/0024-6301(96)00041-6)
- Camacho, J., & Fernandez, J. L. (2018). Competitiveness and CSR in SME: Results from a Study in the Madrid Region. *Management Dynamics in the Knowledge Economy*, 6(1), 105–116. <https://doi.org/10.25019/mdke/6.1.06>
- Cancino, C. A., La Paz, A. I., Ramaprasad, A., & Syn, T. (2018). Technological innovation for sustainable growth: An ontological perspective. *Journal of Cleaner Production*, 179, 31–41. <https://doi.org/10.1016/j.jclepro.2018.01.059>

- Charitoudi, G., Sariannidis, N., & Giannarakis, G. (2011). The development guide for corporate social responsibility programming. *European Journal of Scientific Research*, 65(1), 20–27.
- Ciccullo, F., Pero, M., Caridi, M., Gosling, J., & Purvis, L. (2018). Integrating the environmental and social sustainability pillars into the lean and agile supply chain management paradigms: A literature review and future research directions. *Journal of Cleaner Production*, 172, 2336–2350.
<https://doi.org/10.1016/j.jclepro.2017.11.176>
- Dahlsrud, A. (2008). How corporate social responsibility is defined: an analysis of 37 definitions. *Corporate social responsibility and environmental management*, 15(1), 1–13. <https://doi.org/10.1002/csr.132>
- EU. (2001). Promoting a European framework for corporate social responsibility. Retrieved December 19, 2020, from https://www.jussempier.org/Resources/Corporate%20Activity/Resources/greenpaper_en.pdf
- European Commission. (2011). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Youth Opportunities Initiative.
- Fortunati, S., Morea, D., & Mosconi, E. M. (2020). Circular economy and corporate social responsibility in the agricultural system: Cases study of the Italian agri-food industry. *Agricultural Economics*, 66, 489–498.
<https://doi.org/10.17221/343/2020-AGRICECON>
- Gallardo-Vázquez, D., & Sanchez-Hernandez, M. I. (2014). Measuring Corporate Social Responsibility for competitive success at a regional level. *Journal of Cleaner Production*, 72, 14–22.
<https://doi.org/10.1016/j.jclepro.2014.02.051>
- Gond, J. P., & Moon, J. (2011). Corporate social responsibility in retrospect and prospect: Exploring the life-cycle of an essentially contested concept. *ICCSR Research Paper Series*, 59, 1–40.
- Gunarto, H. (2019). *Parametric and Nonparametric Data Analysis for Social Research: IBM SPSS*. LAP LAMBERT Academic Publishing, Beau-Bassin, Mauritius.
- Hung, S., Li, C., & Lee, J. (2019). Firm growth, business risk, and corporate social responsibility in Taiwan's food industry. *Agricultural Economics*, 65, 366–374. <https://doi.org/10.17221/339/2018-AGRICECON>
- Jenkins, H. (2009). A business opportunity model of corporate social responsibility for small and medium-sized enterprises. *Business Ethics: A European Review*, 18(1), 21–36. <https://doi.org/10.1111/j.1467-8608.2009.01546.x>
- Jorge, M. L., Madueño, J. H., Martinez-Martinez, D., & Sancho, M. P. L. (2015). Competitiveness and environmental performance in Spanish small and medium enterprises: is there a direct link? *Journal of cleaner production*, 101, 26–37. <https://doi.org/10.1016/j.jclepro.2015.04.016>
- Kolk, A., & Van Tulder, R. (2010). International business, corporate social responsibility and sustainable development. *International business review*, 19(2), 119–125. <https://doi.org/10.1016/j.ibusrev.2009.12.003>
- Mandl, I., & Dorr, A. (2007). CSR and competitiveness–European SMEs' good practice. *Consolidated European Report*, Vienna: Austrian Institute for SME Research.
- Marín, L., Martín, P. J., & Rubio, A. (2017). Doing good and different! The mediation effect of innovation and investment on the influence of CSR on competitiveness. *Corporate social responsibility and environmental management*, 24(2), 159–171. <https://doi.org/10.1002/csr.1412>
- Marín, L., Rubio, A., & de Maya, S. R. (2012). Competitiveness as a strategic outcome of corporate social responsibility. *Corporate social responsibility and environmental management*, 19(6), 364–376.
<https://doi.org/10.1002/csr.1288>
- Martínez, P., & Del Bosque, I. R. (2013). CSR and customer loyalty: The roles of trust, customer identification with the company and satisfaction. *International Journal of Hospitality Management*, 35, 89–99.
<https://doi.org/10.1016/j.ijhm.2013.05.009>
- Newell, P. (2005). Citizenship, accountability and community: the limits of the CSR agenda. *International affairs*, 81(3), 541–557. <https://doi.org/10.1111/j.1468-2346.2005.00468.x>
- Petříček, M., Chalupa, S., & Chadt, K. (2020). Identification of Consumer Behavior Based on Price Elasticity: A Case Study of the Prague Market of Accommodation Services. *Sustainability*, 22(12), 1–14.
<https://doi.org/10.3390/su12229452>
- Porter, M. E., & Kramer, M. (2006). Strategy and society: The link between competitive advantage and corporate social responsibility. *Harvard Business Review*, 84(12), 78–92. <https://doi.org/10.1108/sd.2007.05623ead.006>
- Sarkar, S., & Searcy, C. (2016). Zeitgeist or chameleon? A quantitative analysis of CSR definitions. *Journal of Cleaner Production*, 135, 1423–1435. <https://doi.org/10.1016/j.jclepro.2016.06.157>
- Schiebel, W., & Pöchtrager, D. (2003). Corporate ethics as a factor for success - the measurement instrument of the University of Agricultural Sciences (BOKU), Vienna. *Supply Chain Management*, 8(2), 116–121.
<https://doi.org/10.1108/13598540310468715>

- Turyakira, P., Venter, E., & Smith, E. (2014). The impact of corporate social responsibility factors on the competitiveness of small and medium-sized enterprises. *South African Journal of Economic and Management Sciences*, 17(2), 157–172. <https://doi.org/10.4102/sajems.v17i2.443>
- Van Marrewijk, M. (2003). Concepts and definitions of CSR and corporate sustainability: Between agency and communion. *Journal of business ethics*, 44(2–3), 95–105. <https://doi.org/10.1023/A:1023331212247>
- Verbeeten, F. H., Gamerschlag, R., & Möller, K. (2016). Are CSR disclosures relevant for investors? Empirical evidence from Germany. *Management Decision*. <https://doi.org/10.1108/MD-08-2015-0345>
- Verma, J. P. (2012). *Data analysis in management with SPSS software*. Springer Science & Business Media.
- Vilanova, M., Lozano, J. M., & Arenas, D. (2009). Exploring the nature of the relationship between CSR and competitiveness. *Journal of business Ethics*, 87(1), 57–69. <https://doi.org/10.1007/s10551-008-9812-2>
- Yadlapalli, A., Rahman, S., & Gunasekaran, A. (2020). Corporate social responsibility definitions in supply chain research: An ontological analysis. *Journal of Cleaner Production*, 277, 123265. <https://doi.org/10.1016/j.jclepro.2020.123265>

Effects of High-Speed Rail on Regional Economic Growth and Employment in China

Li WANG¹, Lu SHEN¹ and Fei XUE^{2*}

1 Northwest University, Xi'an, China; wlily218@126.com; 936627973@qq.com

2 University of Chinese Academy of Social Sciences, Beijing, China; 201620145@stumail.nwu.edu.cn

* Corresponding author: 201620145@stumail.nwu.edu.cn

Abstract: High-Speed Rail (HSR) has an important impact on the economic growth and employment of cities along the line. Based on the data of 284 prefecture-level cities in China from 2007 to 2015, this paper analyzes the impact of HSR construction on the economy and employment in cities along the line at the national and sub-regional levels using the difference-in-differences model. The research results show that China's high-speed rail construction has failed to promote economic growth in the sample cities taken as a whole, but significantly improved the short-term employment levels in cities along the line. Moreover, there is obvious heterogeneity in the impact of HSR. The economic inhibitory effect of HSR is mainly reflected in the eastern region, while the employment promotion effect is mainly reflected in the central region. Finally, the effect of HSR on economic growth is a result of the change in the investment and degree of openness.

Keywords: high-speed railway; difference-in-differences; economic effect; employment effect; heterogeneous effects

JEL Classification: O18; R11

1. Introduction

China's High-Speed Rail (HSR) construction is a landmark event in the recent history of transportation infrastructure not only in China, but the world over. The "space-time compression" effect brought about by HSR is becoming an important factor in transforming the layout of the national economy and rebuilding the spatial pattern of cities along the line (Chen, 2012; Deng et al., 2017; Dong & Zhu, 2016). The rapid spread of China's HSR passenger transport network has improved accessibility between regions and cities and reduced travel costs. This has, in turn, induced a rapid flow and frequent interchange of population as well as logistics, information, and capital among regions. It has a comprehensive and profound impact on the employment and economic development in the areas along the line and also those within the cities.

Compared with the HSR networks abroad, which have been in operation for more than half a century, the construction of China's HSR started relatively late. In 2003, the Qinhuangdao-Shenyang Passenger Dedicated Line, the first HSR in China, was completed and opened to traffic. Implementation of the "Medium and Long-Term Railway Network Plan", promulgated in 2004, inaugurated a new era of HSR construction. The Beijing-Tianjin Inter-city HSR, which opened to traffic in 2008, marked China's official entry into the "High-

speed Rail era." Since then, a new batch of HSR lines has been operationalized every year. In order to meet the rapidly growing passenger demand and optimize the development space for regional development, the "Medium and Long-Term Railway Network Plan," promulgated by the State Council in July 2016, proposed the construction of "eight vertical and eight horizontal" HSR and planned to build a 38,000 km HSR network by 2025. At the end of 2016, HSR operation mileage in China exceeded 22,000 km, accounting for 60% of the total HSR operation mileage in the world. The White Paper "Development of Transport in China" issued by the Information Office of the State Council proposes that the HSR network will cover more than 80% of the major cities by 2020. Under the dual constraints of the demographic dividend decline and the depletion of resources and the environment, HSR is regarded as the driver of development along the line, leading to a "scramble" for HSR tracks and stations. At present, large-scale HSR construction provides the Chinese government with a chance to achieve major changes in the economic sphere. What kind of role does HSR play in regional economic growth and employment? What is the mechanism behind this impact? We focus on these issues not only to assess the effectiveness the large-scale HSR investment but also to provide a quantitative interface for the implementation of an optimum transport infrastructure policy with the strategic objective of narrowing regional disparities and achieving coordinated regional development.

Studies on HSR cover the promotion of regional economic integration (Zhang & Nie, 2010) and population migration (Li et al., 2014) to achieve accessibility (Donaldson & Hornbeck, 2016; Liu, 2013), leading to urban development and urban spatial evolution (Duranton & Turner, 2012; Wang & Nian, 2014). With the opening of more HSR lines, people are beginning to consider whether the HSR established in their area will bring them the expected payoff. Sasaki et al. (1997) analyzed the urban regional economic system along the Shinkansen in Japan and found that the ability of the regional central cities to achieve economic agglomeration was strengthened as the degree of networking of the Shinkansen. Tan and Zhong (2014) found, by analyzing data from 177 cities along the line in China, that HSR benefited economic agglomerations by improving the accessibility of cities along the line. Li et al. (2016a) studied 226 cities at the prefecture level or above and found a significant spatial gradient gap in the impact of HSR on economic agglomerations.

According to the research report of the National Railway Bureau in 2017, HSR cities have 72% more GDP and 55% more sustainable development than those with no railway. However, there is disagreement on whether HSR plays a significant role in promoting the economic growth of cities and the regions around them. Researchers hold that HSR plays an important role in the economic growth of a region through the spillover effect of the space economy (Zhang, 2012; Wang & Ni, 2016). HSR also drives regional economic growth by influencing the supply of effective labor or wage levels (Dong & Zhu, 2016). However, the high travel costs associated with HSR tend to cause an economic slowdown. As a result, the construction of HSR has no significant effect on the economic growth in the areas along the line in the short term (Li et al., 2016b; Wang & Nian, 2014). Although HSR will enhance the advantages of regional central cities, it will also have a "tunnel effect" on small and medium-sized cities along the line, and thus, will thus inhibit the economic and employment

development of small cities (Hall, 2009; Ortega et al, 2012; Yu, 2017). Some scholars have also proposed that the launch of HSR would have the “siphon effect” of reducing the economic growth of non-regional central cities along the line (Zhang & Tao, 2016).

Based on the relevant literature both at home and abroad, this paper focus on the following aspects. First, we assess the impact of HSR on economic growth and employment from the perspective of cities of the prefecture level and above, this makes the results more reliable. Second, considering the large-scale HSR construction in China as a quasi-natural experiment, we use the DID method, which is commonly used in policy evaluation, to estimate HSR effects, this helps us to recognize more clearly the causal effect between HSR and the growth of the economy and employment. We also conduct a series of robustness tests to ensure the accuracy of the regression results. Third, selecting the period before 2007 as the sample may lead to estimation bias caused by the six speed increments in train speed between 1997 to 2007, and thus we select the sample period from 2007 to 2015.

This paper is structured as follows: Section 2 presents the data and describes the econometric methodology. Section 3 provides the results of the empirical analysis, while Section 4 conducts a series of robustness tests. Section 5 analyzes the mechanism through which the HSR economic impact occurs. Section 6 presents our conclusions and policy recommendations.

2. Data and Methodology

To assess the economic and employment effects of HSR, we collect data on the HSR opening time, the economic growth and employment level of each city, and other city-level characteristics. This section mainly presents the data and describes the econometric methodology.

2.1. Data

Because HSR stations are often built in the suburbs, we select city data for research. Taking into account the adjustment for administrative districts and missing data, we leave out cities such as Lhasa, Haidong, Chaohu, Sansha, Tongren, Bijie and Puer. In addition, to avoid the estimation bias caused by the six increments in train speed between 1997 and 2007, we selected panel data on 284 Chinese cities at the prefecture level or above for the 2007-2015 period. The main data are obtained from the China Entrepreneur Investment Club (CEIC) and China Stock Market & Accounting Research (CSMAR) databases; the City Statistical Yearbook series is also used to obtain data. To eliminate potential heteroskedasticity, we log-transformed all variables.

We use real GDP per capita and employment density as the measures of the regional economy and employment level, respectively. The GDP deflator for each city with 2007 as the base year is calculated with the GDP price index provided in the CEIC database. The employment density of city s in year t is defined as $ED_{st} = \text{Employment}_{st} / \text{Area}_{st}$.

To set the HSR dummy variable (HSR_city) for each city, we collect data on the year of commencement of HSR operations according to the Medium and Long-term Railway Plan and the actual state of HSR operations in all prefecture level cities. The HSR dummy variable

for the current year equals one if the date of commencement of HSR operations is in the first half of the year (by June 30). However, if the date falls in the second half of the year, the HSR dummy variable for the next year is set as one.

Five control variables of interest are included in our research. First, regional fixed investment is a primary driver of economic growth. We measure fixed investment (Invest) using the ratio of regional fixed investment to GDP. Second, the government plays an indispensable role in China's economic growth. We measure government's role in economic development (Gov) using the ratio of local government expenditure to GDP. Third, trade openness (Open) directly affects regional economic growth. We use the ratio of total regional imports and exports to GDP as a proxy. Finally, other infrastructure measures are included, which are defined as the logarithm of the number of public transportation vehicles per 10,000 population (Log_Bus) and the logarithm of the per capita area of paved roads in city (Log_Road).

2.2. Econometric Methodology

Generally, the economic growth and employment levels of a city are affected by not only the HSR policy, but also by the date on which HSR operations commenced in the city. The change in the economic environment over time will play an important role. The main purpose of our paper is to examine the policy effect of HSR operations. Thus, the key issue is the manner of eliminating the time and other policy effects from the total effect. The DID method, as one of the most common estimation methods of treatment effects, can help us to observe the changes resulting from policy implementation, assuming that the time trends of the treated and untreated groups are common. Therefore, we choose this methodology as a measure of the economic and employment effects of HSR.

However, the traditional DID model requires that the execution time of the policy should be the same, but the date of commencement of HSR operations varies in our sample, this prevents us from setting a policy time dummy variable. Following Beck et al. (2010) and Hoynes et al. (2016), we focus on the sign and significance of interaction terms between the treated group dummy and the policy time dummy. Furthermore, controlling for the city-level fixed effect and year fixed effect, we can take care of any city-specific yearly shocks on the local economic and employment conditions. The benchmark model is of the following form:

$$Y_{st} = \alpha + \beta HSR_city_{st} + \delta X_{st} + v_t + \mu_s + \varepsilon_{st} \quad (1)$$

In this equation, Y_{st} , as an explained variable, represents the economic or employment situation in city s in year t . μ_s and v_t are the vectors for city dummy variable and year dummy variable, respectively, which measure city and year fixed-effects. The control variable X_{st} measures the degree of trade openness, investment, government spending, and other city-level characteristics. ε_{st} is the error term. The variable of interest is the interaction term HSR_city_{st} , which is equal to one for the years after the year in which HSR operation commences in city s and zero otherwise. The coefficient β indicates the impact of HSR on economic growth and employment. A positive and significant β suggests that HSR exerts a

positive effect on the economy or employment in cities along the line, while a negative and significant β indicates that it is not conducive to economic growth and employment.

The DID model can help us effectively identify the effect of HSR. However, the primary challenge in using this identification strategy is the endogenous selection of infrastructure. In other words, the non-random construction of infrastructure, such as HSR, adds to the difficulty of estimating the causal effect (Datta, 2012). This means that there are systematic differences between the cities that open HSR and those that do not. However, Chandra and Thompson (2000) proposed that many large-scale transportation infrastructure projects can be viewed as an exogenous shock to the area through which they pass because their purpose is to connect two places. Furthermore, according to Medium and Long-term Railway Plan (adjusted in 2008), one of the purposes of HSR construction is to connect capital cities, as well as large and medium-sized cities. Therefore, following Chandra and Thompson (2000) and Datta (2012), we leave out the node cities (including capital cities, vice provincial cities, and municipalities) to eliminate the endogeneity problem. The final sample includes 253 cities.

3. Estimation Results

3.1 Preliminary Results

Table 1 shows the results of the benchmark regression, which assesses the impact of the opening of HSR on economic growth and employment. In columns 1 and 6, the regressions simply control for city and year fixed effects. In the other columns, we also control for gross fixed investment as percentage of GDP, fiscal expenditure as percentage of GDP, total import and export as percentage of GDP, the logarithm of the number of public transportation vehicles per 10,000 population, and the logarithm of the per capita area of paved roads in city.

Table 1 show that the HSR dummy variable enters negatively and significantly at the 10% level in columns 1 and 2, but positively and significantly at the 5% level in columns 6 and 7, indicating that the commencement of HSR operation substantially inhibits economic growth but improves the level of employment. Specifically, the results in column 2 suggest that HSR induced a 1.5% reduction in per capita GDP, whereas those in column 7 show a 4.8% growth in employment owing to HSR. The reason behind this phenomenon may be the “space-time compression” effect brought about by HSR. It accelerates the flow of economic resources from the periphery to the middle cities, improving the competitiveness and market access of this region. Further, there would be a negative impact on the economic growth of small and medium-sized cities along the HSR; this is called the “siphon effect.” Further, labor demand, the anticipated effect on the labor force, and the polarization effect brought about by the HSR would induce the transfer of the non-HSR labor force to cities with advantageous locations.

Table 1. The impact of HSR on regional economic growth and employment: basic results

Variables	All cities	All cities	Eastern Cities	Middle Cities	Western Cities
Economic Effects: Log_GDPP					
	(1)	(2)	(3)	(4)	(5)
HSR_city	-0.018*	-0.015*	-0.024**	0.029**	0.008
	-0.009	-0.009	-0.011	-0.014	-0.019
Observations	2250	2242	768	828	646
R2	0.96	0.961	0.976	0.952	0.973
Employment Effect: Log_ED					
	(6)	(7)	(8)	(9)	(10)
HSR_city	0.063**	0.048**	0.021	0.061**	-0.03
	-0.026	-0.022	-0.04	-0.027	-0.032
Observations	2250	2242	768	828	646
R2	0.426	0.443	0.489	0.426	0.548
Controls	NO	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES
City fixed effect	YES	YES	YES	YES	YES

Notes: Standard errors, which appear within parentheses, are heteroskedasticity robust and clustered at the city level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 1 also shows the impact of HSR on different regions. The negative and significant coefficients for the eastern cities in columns 3 and 7 indicate that HSR not only failed to promote economic growth and employment, but also had an inhibitory effect on their economy. Columns 4 and 8 show that HSR significantly promoted economic growth and employment in the middle cities. Furthermore, columns 5 and 10 show that the economic and employment effects in the western cities are not significant. HSR has had heterogeneous economic and employment effects in the regions. This may be mainly related to the spatial economic agglomeration ability of middle cities in different regions. The central agglomerations in the eastern coastal areas are much more concentrated than those in other regions. Therefore, HSR created a “siphon effect” in the eastern region and failed to promote economic growth and employment there. Benefiting from HSR, cities in the middle region consistently leveraged their transport advantages to attract labor and promote economic growth. Moreover, because of the late start of HSR in the western region, most of the cities there had no HSR during the sample period, and therefore, did not experience the HSR effect.

3.2 Measuring Annual Treatment Effects

In addition to the average effect, we also estimate the dynamic impact of HSR on economic growth and employment. Generally, the impact of the HSR on economic growth and employment would continue to accumulate with the speeding up of HSR construction and improvement of the network. We examine this assumption by introducing interaction terms between the year dummy variables and the HSR dummy variables:

$$\text{Log}(Y_{st}) = \alpha + \sum_{j=1}^8 \beta_j D_{st}^j + \delta X_{st} + v_t + \mu_s + \varepsilon_{st} \quad (2)$$

where D_j represents the year dummy variable in the j th year after HSR's opening. For example, D_j is equal one for cities in the j th year after the opening of HSR, otherwise, zero. β_j measures the impact on economic growth and employment after the j th year. In addition, the model includes a series of control variables, and we use a two-way fixed effect model to regress at the national and sub-regional levels. The results are shown in Table 2.

Table 2. The impact of HSR on regional economic growth and employment levels: dynamic effect

Variables	Economic Effects: Log_GDPP				Employment Effect: Log_ED			
	All Cites	Eastern Cities	Middle Cities	Western Cities	All Cites	Eastern Cities	Middle Cities	Western Cities
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D^1	-0.011 (0.007)	-0.011 (0.008)	0.013 (0.011)	-0.001 (0.016)	0.039** (0.018)	0.034 (0.034)	0.060** (0.026)	-0.024 (0.029)
D^2	-0.007 (0.009)	-0.014 (0.010)	0.039** (0.015)	0.010 (0.026)	0.064*** (0.023)	0.041 (0.038)	0.071** (0.030)	-0.011 (0.037)
D^3	-0.018 (0.012)	-0.031** (0.014)	0.051** (0.021)	0.045** (0.019)	0.063** (0.030)	0.016 (0.051)	0.074** (0.035)	-0.091* (0.046)
D^4	-0.031** (0.014)	-0.037** (0.017)	0.035* (0.021)	0.046** (0.019)	0.044 (0.034)	0.004 (0.055)	0.029 (0.033)	-0.136** (0.058)
D^5	-0.029* (0.016)	-0.035* (0.020)	0.048* (0.026)	0.059*** (0.019)	0.022 (0.034)	-0.018 (0.058)	0.005 (0.039)	-0.104** (0.046)
D^6	-0.027 (0.020)	-0.023 (0.024)	0.040 (0.036)	0.090** (0.035)	-0.005 (0.039)	-0.044 (0.065)	0.000 (0.063)	-0.148*** (0.052)
D^7	-0.031 (0.033)	-0.034* (0.019)	0.072 (0.073)		-0.046 (0.051)	-0.143** (0.069)	-0.000 (0.095)	
D^8	-0.064** (0.025)	-0.060** (0.025)			-0.068 (0.043)	-0.147** (0.064)		
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
City fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2242	768	828	646	2242	768	828	646
R^2	0.962	0.976	0.952	0.974	0.446	0.494	0.429	0.550

Notes: Standard errors, which appear within parentheses, are heteroskedasticity robust and clustered at the city level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

As shown in column 1, annual coefficients indicate that the economic effects of HSR took several years to emerge in the cities considered. The coefficients become statistically significant from the 4th year onward, and the effects increase over time. In column 5, the coefficients of the first three years are significant, indicating that the HSR has a short-term effect on employment.

From columns 2 and 6, the economic and employment effects in the eastern cities show trends similar to those for the cities taken as a whole. The effects on economic growth appear with a time lag and those on employment are insignificant. The economic effects of HSR in the cities of the middle and western regions, shown in columns 3 and 4, are mainly positive, indicating that HSR has more of a promotional effect, than a negative effect. The employment effect in the middle cities, indicated in column 7, is similar to that for the cities taken as a whole, which shows short-term effects. However, the employment effect of HSR on the western region shows a negative effect. Figures 1 and 2 provide a more direct representation

of the economic and employment effects of HSR, using dynamic graphs, and the cap lines represents 95% confidence intervals.

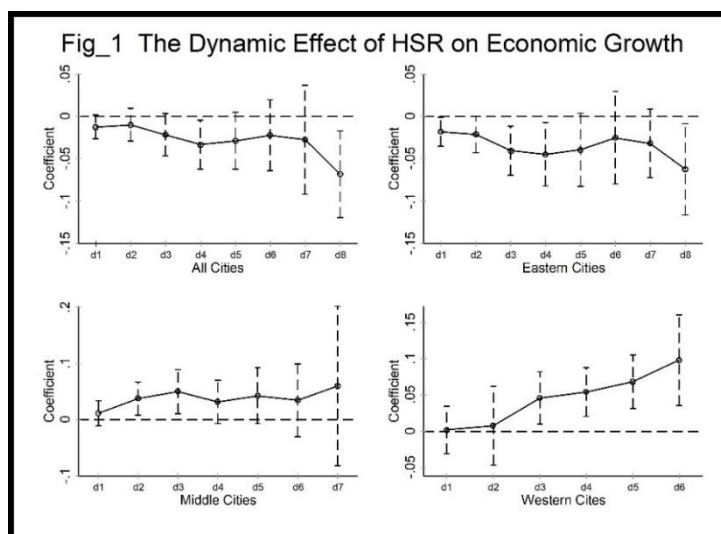


Figure 1. The dynamic effect of HSR on economic growth

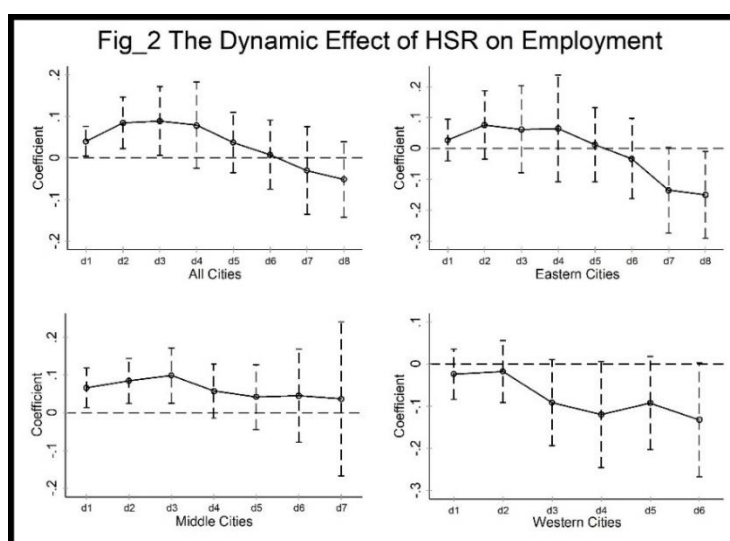


Figure 2. The dynamic effect of HSR on employment

4. Mechanism of the HSR Effect on Economic Growth

Interestingly, according to the series of regression and test results presented above, HSR has not promoted economic growth in all the cities and in eastern cities. What countervailing factors override the economic effect of HSR? To answer this question and identify the mechanism of the economic effect, we next examine HSR's impact on various economic growth factors.

Having found that HSR affects economic growth through the flow of investment and economic resources, market size, and other economic growth factors, we now explore three potential channels that explain the HSR impact: (1) HSR can affect the transportation infrastructure and associated infrastructure investments have a direct effect on the regional economy. (2) HSR is conducive for the rapid agglomeration of economic resources from the

surrounding cities to the central city. (3) It also affects the city's market size, degree of openness and industrial structure. Therefore, we use total import and export as percentage of GDP, gross fixed investment as percentage of GDP, fiscal expenditure as percentage of GDP, and the tertiary industry share as the explanatory variables, to estimate a two-way fixed effects model. The results are shown in Table 3.

The results in Table 3 indicate that degree of openness and investment are the core factors that affect economic growth. As shown in Panels A and B of Table 3, the reduction in economic growth for all cities taken together and in the eastern cities is mainly accounted for by the decline in the degree of openness. From Panel C of Table 3, the increase in middle cities is explained by the increase in degree of openness and investment. In addition, Panel D indicates that HSR has only a weak influence on fiscal expenditure.

Table 3. The impact of HSR on regional economic growth: mechanism test

Variables	Import & Export	Investment	Fiscal Expenditure	Industrial Structure
Panel A: All Cities				
HSR_city	-0.023* (0.014)	-0.011 (0.018)	-0.008*** (0.003)	0.004 (0.004)
Observations	2,250	2,250	2,250	2,250
R ²	0.061	0.482	0.399	0.316
Panel B: Eastern Cities				
HSR_city	-0.059*** (0.021)	-0.001 (0.023)	-0.001 (0.003)	-0.002 (0.005)
Observations	774	774	774	774
R ²	0.154	0.395	0.664	0.510
Panel C: Middle Cities				
HSR_city	0.026* (0.015)	0.044* (0.024)	-0.009** (0.004)	-0.001 (0.005)
Observations	828	828	828	828
R ²	0.050	0.634	0.641	0.400
Panel D: Western Cities				
HSR_city	0.001 (0.020)	-0.036 (0.055)	-0.015* (0.008)	-0.005 (0.011)
Observations	648	648	648	648
R ²	0.013	0.483	0.286	0.277
Year fixed effect	YES	YES	YES	YES
City fixed effect	YES	YES	YES	YES

Notes: Standard errors, which appear within parentheses, are heteroskedasticity robust and clustered at the city level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

5. Conclusion and Policy Implications

This paper model the impact of HSR on the cities along the line from the perspective of economic growth and employment based on the concepts of new economic geography and traffic economics. Using a sample of 284 Chinese cities that are at the prefecture-level or above, it evaluates, through empirical tests based on DID analysis, whether HSR has an impact on the regional economy and employment. The results are as follows: (1) HSR scales down the economic development of cities along the line and, from a national perspective,

decreases GDP per capita by 1.5%; however, it has a significant positive impact on the employment scale of cities along the line, with a regression coefficient of 4.8%. (2) The economic and employment effects of HSR vary across regions. HSR construction has an inhibitory effect on economic growth, but has no significant effect on employment in the eastern cities. In the middle cities, the commencement of HSR operation significantly improves the economic growth and employment level in cities along the line. (3) Regarding the impact mechanism, the economic effects occur through the degree of trade openness and investment.

Based on the findings of this study and after considering the current status of China's high-speed rail construction, we offer the following policy recommendations:

(1) Establishment of suburban and inter-city railways should be speeded up along with the construction the HSR trunk road network (the "eight horizontal and eight vertical" lines). Due to the high cost of HSR construction, the gap between planning and construction is relatively large, and the economic spillover effects are not fully achieved in the establishment of hub cities and the rapid development of the surrounding areas and cities, especially the core cities and their satellites. Therefore, while building HSR networks, we must place greater importance on the construction of suburban and inter-city railways.

(2) Various types of cities should seize the opportunity provided by HSR and promote their all-round social and economic development. The core cities should actively develop the hub economy, wherein all modern modes of transport are used in an integrated manner, to accelerate the outward transfer of low-end industries, vigorously develop the modern service industry, and transform and upgrade the three new economies which include new industries, new formats and new business models. They should take full advantage of the status of hub cities, actively attract high-end talent, and encourage capital accumulation, thereby providing a new impetus for rapid development. Small- and medium-sized cities along the line should seize the opportunity offered by HSR and show the initiative to undertake and extend the industrial chain of the core cities. They should do so as per their development positioning and advantages so as to integrate with the urbanized economy. Non-HSR lines should be connected to the HSR network to avoid large-scale loss of the labor force in regions without HSR.

(3) We propose that HSR construction should be taken up in an orderly manner in the western part of the country in the 13th Five-Year Plan for Western Development. In response to the new round of HSR construction plans, all cities should calmly assess the costs and benefits of HSR construction. Instead of blindly setting up stations for HSR, they should launch a series of "road-racing" rounds (Zhang, 2017).

Due to the limitation of data availability, although this paper has a lot of discussion on the economic and employment effects of HSR, it fails to discuss the impact of HSR on enterprises from a micro-level. Also, there are the following aspects that can be expanded: first, the construction of HSR has increased the degree of economic connection between regions, so we will further investigate the spatial spillover effect of HSR from the perspective of spatial measurement; second, we plan to examine the overall impact of HSR on resource allocation efficiency in each region in the future, i.e. the impact on total factor productivity.

References

- Beck, T., Levine R., & Levkov, A. (2010). Big bad banks? the winners and losers from bank deregulation in the United States. *Journal of Finance*, 65(5), 1637-1667. <https://doi.org/10.1111/j.1540-6261.2010.01589.x>
- Chandra, A., & Thompson, E. (2000). Does public infrastructure affect economic activity? evidence from the rural interstate highway system. *Regional Science & Urban Economics*, 30(04), 457-490
- Deng, T. T., Wang, S. Y., & Cheng, S. Y. (2017). The impact of high speed railway on urban service industry agglomeration. *Journal of Finance and Economics*, 43(07), 119-132
- Donaldson, D., (2018). Railroads of the raj: Estimating the impact of transportation infrastructure. *American Economic Review* 108, 899-934
- Dong, Y. M., & Zhu, Y. M. (2016a). Can High-Speed Rail construction reshape the layout of China's economic space—Based on the perspective of regional heterogeneity of employment, wage and economic growth. *China Industrial Economics*, 10, 92-108
- Dong, Y. M., & Zhu, Y. M. (2016b). Study on the employment effect of the construction of High Speed Railway—Evidence from 285 cities of China based on PSM-DID method. *Business Management Journal*, 38(11), 26-44.
- Duranton G., & Turner M. A. (2012). Urban growth and transportation. *The Review of Economic Studies*. 79(4), 1407-1440
- Faber, B. (2014). Trade integration, market size and industrialization: Evidence from China's national trunk highway system. *The Review of Economic Studies*, 81(3), 1046-1070
- Hall, P. (2009). Magic carpets and seamless webs: opportunities and constraints for high-speed trains in Europe. *Built Environment*, 35(1), 59-69
- Hoyne H., Schanzenbach, D. W., & Almond, D. (2016). Long-run impacts of childhood access to the safety net. *The American Economic Review*, 106(4), 903-34
- Li, H., Shen, Y. M., Meng, D., & Xue, J. (2013). The city network centrality and spatial structure in the Beijing-Tianjin-Hebei metropolitan region. *Economic Geography*, 33(08), 37-45
- Li, H. C., Tjia, L., & Hu, C. X. (2016a). Agglomeration and equalization effect of high speed railway on cities in China. *The Journal of Quantitative & Technical Economics*, 11(33), 127-143
- Li, H. C., Tjia, L., & Hu, C. X. (2016b). Causality relationship between high speed railway and economic growth. *Journal of Chang'an University (Social Science Edition)*, 18(4), 31-43
- Li, X. M., Liu, Y. Z., & Cao, L. P. (2014). Research about the influence of population space of flow under the high-speed railway construction. *China Population, Resources and Environment*, 24(6), 140-147
- Long, F. (2017). High-speed railway and venture capital investment. *Economic Research Journal*, 52(04), 192-208
- Ortega, E., López, E., & Monzón, A. (2012). Territorial cohesion impacts of high-speed rail at different planning levels. *Journal of Transport Geography*, 24(4), 130-141
- Moser, P., & Voena, A. (2012). Compulsory licensing: evidence from the trading with the enemy act. *The American Economic Review*, 102(1), 396-427
- Shaw, S. L., Fang, Z., Lu, S., & Tao, R. (2014). Impacts of high speed rail on railroad network accessibility in China. *Journal of Transport Geography*, 40, 112-122
- Datta, S. (2012) The impact of improved highways on Indian firms. *Journal of Development Economics*, 99(01), 46-57
- Tan, C. L., & Yang, Q. Q. (2016). Development of high-speed railway and producer services agglomeration. *Economic Survey*, 33(03), 1-6
- Tan, C. L., & Yang, Q. Q. (2017). The effect of HSR on the spatial pattern dynamics of producer service. *Economic Geography*, 37(02), 90-97
- Wang, M., & Nian, Y. (2013). Did High-Speed Trains Promote the Development of Regional Economy? *Shanghai Journal of Economics*, 2, 82-91
- Wang, Y. F., & Ni, P. F. (2016). Economic Growth Spillover and Spatial Optimization of High-speed Railway. *China Industrial Economics*, 02, 21-36
- Zhang, J. (2017). High-speed rail construction and county economic development: the research of satellite light data. *China Economic Quarterly*, 16(4). 1533-1562
- Zhang, X. L., & Nie, H. K. (2010). High-speed rail construction and the regional economic integration in China. *Modern Urban Research*, 25(6), 7-10
- Zhang, X. L. (2012). Has transport infrastructure promoted regional economic growth? —With an Analysis of the spatial spillover effects of transport infrastructure. *Social Sciences in China*, 34(2), 24-47

Infrastructure, Agglomeration and Regional Economic Growth in China: A Panel VAR Analysis

Li WANG^{1,*}, Ningning JIA¹ and Fei XUE^{2*}

¹ Northwest University, Xi'an, China; wlily218@126.com; 1135038662@qq.com

² University of Chinese Academy of Social Sciences, Beijing, China; 201620145@stumail.nwu.edu.cn

* Corresponding author: 201620145@stumail.nwu.edu.cn

Abstract: Infrastructure is considered as an important social advance capital. Infrastructure construction is a crucial tool in China for stabling employment, expanding domestic demand, adjusting the economic structure, and promoting economic growth and development. Based on a panel vector autoregressive model, this paper uses China's provincial panel data from 1993 to 2015, to examine the relationship among infrastructure, agglomeration, and regional economic growth. We find statistically significant long-term positive effect on infrastructure to regional economic growth and economic agglomeration, for increasing level of infrastructure capital stock density. According to the results of the prediction error variance decomposition, the contribution of infrastructure construction to regional economic growth is between 1.56% and 18.53%, and the contribution of infrastructure construction to agglomeration is between 0.14% and 12.67%. Obviously, it can be seen that there is a certain degree of difference in the contribution of infrastructure construction to the positive effect of regional economic growth and aggregation.

Keywords: infrastructure; agglomeration; regional economic growth; A Panel VAR Analysis

JEL Classification: R11

1. Introduction

Considered as an important social advance capital in China, infrastructure construction is a basic tool to promote regional economic development and urbanization. Over the last half of the century, the relationship between infrastructure and economic growth has been a hot topic of the economic policy debate. A vast literature has examined the empirical evidence on the role in promoting economy. In an influence article, Aschauer (1989) used the US public landfall data from 1949 to 1985 and found that the US core infrastructure capital had a significant positive effect on US economic growth. Cook and Munnell (1990) studied the public infrastructure of American expressways and drainage systems and found that infrastructure investment has a positive effect on economic growth. In addition, Canning (1999), Haque and Kim (2003), Straub et al. (2008), Calderón et al. (2014), and others have conducted thorough studies of the economic growth effects of infrastructure around the world.

Researches on the economic effect of infrastructure in China began in the 21st century. Fan et al. (2004a, b) investigated the relationship between China's infrastructure investment and economic growth based on the model constructed by Barro (1990). Based on a detailed

estimate of the capital stock of China's infrastructure, Ge (2012, 2016) found that the elasticity of economic infrastructure capital output is between 0.12-0.13, and social infrastructure capital-output elasticity is between 0.10-0.12. Zhang (2013) examined the spillover effects of transport infrastructure to regional economic growth.

The above-mentioned literature promotes the research of infrastructure in China. Due to the different understandings of the specific scope of the infrastructure, the differences in research methods, especially the diversity and differences in the choice of variable indicators, the mechanism and impact effects of infrastructure investment reflect different conclusions. Most studies used the flow data of infrastructure from the perspective of physical stock or investment in infrastructure. Few articles studied the impact of infrastructure capital stock. Besides, most of the literature will focus on the economic growth effects of infrastructure but ignoring the infrastructure of the economic growth of the transmission mechanism of the study. As an attempt to estimate the long-term and dynamic effect, a panel vector autoregressive model is used to describe the dynamic effect between infrastructure, agglomeration, and regional economic growth, by using China's provincial panel data from 1993 to 2015.

2. Data and Methodology

In order to comprehensively assess the mutual effect of infrastructure, agglomeration, and regional economic development, and to explain the mechanism of interaction between the three, we choose the three variables, which are capital stock density, economic agglomeration index, and GDP per capita to construct the model to estimate the parameters. This section describes the data and the econometric methods.

2.1 Infrastructure Capital Stock

We use the ratio of infrastructure capital stock to the administrative area of each province to represent the density of infrastructure capital stock. We obtain data on infrastructure capital stock from Ge (2012) and the time series of the data is extended to 2015. To eliminate the impact of price factors, we use the fixed asset investment price index to reduce the stock data, converting to 1993 as the base of the constant price.

2.2 Economic Agglomeration Index

A vast literature showed that infrastructure plays an important role in economic agglomeration, and the tertiary industry is most sensitive to changes in infrastructure among all industries. Therefore, we select the tertiary industry location entropy as an indicator to describe the regional tertiary industry agglomeration situation. The formula of the location entropy of the tertiary industry is as follows:

$$LQ_{it} = (L_{3it} / L_{it}) / (L_{3t} / L_t) \quad (1)$$

In equation(1), LQ_{st} is the tertiary industry location entropy in province s in year t . L_{3st} and L_{st} are represented the number of employed persons in the tertiary industry and the total

employed persons in province s , respectively; L_{3t} and L_t are the tertiary industry employed persons and the total employed persons in China.

2.3 The Level of Economic Development

To measure the economic development of the region, according to the general practice in the literature, we use the real GDP per capita of the region as a substitute variable. Considering the comparability of the data, we convert data to constant price GDP and the base year is 1993. Besides, the data of GDP per capita of the region is calculated by dividing the "real GDP of the region by the resident population at the end of the year".

2.4 Data Sources and Descriptive Statistics

This paper uses the panel data of 31 provinces and autonomous regions in China from 1993 to 2015. To maintain the comparability, the data of Chongqing and Sichuan are combined since Chongqing was separated from Sichuan as a municipality in 1997. In the three variables above, the basic data of the infrastructure is derived from the research results of Ge (2012) and defer the data to 2015 according to the method provided. Other raw data are derived from the "China Statistical Yearbook" and "New China 60 years of statistical information". Besides, to eliminate the possible heteroscedasticity, we make the logarithmic processing of the infrastructure capital stock and the GDP per capita in each region. As the third industry location entropy is not carried out logarithmic processing, due to the ratio form.

2.5 Methodology

To describe the interaction between infrastructure, agglomeration and economic growth better, we use a panel vector autoregressive (PVAR) model in further study. The panel autoregressive model is proposed by Holtz-Eakin et al. (1988) for the first time and has been continuously extended and perfected by Arellano and Bover (1995), McCoskey and Kao (1998), Hsiao (2014), Andrews and Lu (2001), Love and Zicchino (2006). Becoming a mature model with both time series analysis and panel data analysis. The panel vector autoregressive model not only inherits the advantages of the vector autoregressive model but also overcomes the limitations of the traditional time series vector autoregressive model on the amount of data and the heterogeneity of the spatial individual. We construct the following model to examine the impact of infrastructure on economic growth and economic agglomeration: We construct the following model:

$$y_{st} = \beta_0 + \sum_{j=1}^n \beta_{nj} y_{st-j} + \mu_s + \eta_t + \varepsilon_{st} \quad (2)$$

In which $y_{st} = (\Delta \ln kd, \Delta LQ, \Delta \ln pgdp)'$; β_{nj} is a 3×3 coefficient matrix; β_0 is a 3×1 vector of intercept terms; μ_s and η_t are 3×1 vectors of the province and year dummy variables for province and year fixed effects. ε_{st} is a 3×1 residual term. s and t denote province and year, respectively.

2.6 Estimation Issues

Before estimating the equation, there are still some issues to be solved. The first issue is the existence of fixed effects. Since the regressors are predetermined rather than strictly exogenous, mean-difference which is traditionally used to eliminate the fixed effect would create biased estimates (Love & Zicchino, 2006). Therefore, we use the Helmert transformation (Arellano & Bover, 1995), which uses forward mean-differencing to preserve orthogonality between transformed errors and untransformed original variables.

To prevent pseudo-regression, it is necessary to test the stationary of variables. We select Levin-Lin-Chu Test (LLC) and Im-Pesaran-Shin Test (IPS), which is more effective than Augmented Dickey Test (ADF). These two ways are non-stationary for the original data of the panel, if both test results are significantly rejected the original hypothesis, then the description of the stationary data, otherwise the panel data is non-stationary. As results are shown in Table 1, both stationary tests suggest that the first differences of the variables are stationary and integrated of order 1.

Table 1. Unit root test

Variables	Levin-Lin-Chu Test		Im-Pesaran-Shin Test	
	Individual Intercept First Difference	Individual Intercept & Trend First Difference	Individual Intercept First Difference	Individual Intercept & Trend First Difference
Ln_KD	-5.3458***	-3.6429***	-4.2599***	-4.9619***
Ln_PGDP	-7.5992***	-5.7743***	-7.6251***	-7.8177***
LQ	-10.5967***	-8.0752***	-12.6913***	-13.5152***

Indicates the *significance at 10%, **significance at 5% and ***significance at 1%.

The choice of lag order is also a crucial aspect based on a panel vector autoregressive (PVAR) model. We use the PVAR2 package and consider the Akaike information criterion (AIC), Schwartz information criterion (BIC) and Hannan-Quinn information criterion (HQIC) to choose optimal lag order for our model. As shown in Table 2, we set the optimal hysteresis of the model to 1 according to AIC and HQIC.

Table 2. Optimal order-selection

lag	AIC	BIC	HQIC
1	-11.2856	-10.5601	-11.0031
2	-11.2582	-10.4348	-10.9369
3	-11.2202	-10.2904	-10.8566
4	-11.2759	-10.2298	-10.8658
5	-11.3814	-10.2075	-10.9199

3. Results

In order to comprehensively assess the mutual relationship of agglomeration, infrastructure, and regional economic in China, and to explain the mechanism of interaction between them, more comprehensively, we examine the internal logic through three dimensions: Generalized Method of Moment Estimation, Impulse Response Graph and Variance Decomposition.

3.1. GMM Estimation

Table 3 is a comparative table in which each equation can be analyzed and analyzed as an independent function. The primary interest is column (2). An analysis of the results shows that infrastructure in China has positively contributed to the development of the regional economy. This result is similar to Ge (2012), show that infrastructure capital stock has a significant positive effect on regional economic growth. There are other interesting results, from column (1) and column (3). It is noted that an increase in infrastructure or economic growth in China can lead to agglomeration. On the other hand, regional economic growth can lead to agglomeration. Moreover, column (3) shows that GDP per capita and agglomeration have no statistically significant impact on infrastructure capital stock density.

Table 3. The result from PVAR

	h_LQ	h_LnPGDP	h_Lnkd
	(1)	(2)	(3)
L.h_LQ	0.0627 (0.056)	-0.0220 (0.025)	-0.0371 (0.049)
L.h_LnPGDP	0.5346*** (0.179)	0.6999*** (0.099)	0.1414 (0.150)
L.h_LnKD	0.2207** (0.093)	0.1002** (0.040)	0.6653*** (0.093)
Observations	600	600	600

Indicates the *significance at 10%, **significance at 5% and ***significance at 1%

3.2. Impulse Response

Figure 1 visualize the impulse-response functions derived from the estimated equation (2). The results show the estimated impulse functions using the standard deviation of change in each variable. The dotted line in the following figures denotes the 95% confidence interval which is generated by Monte-Carlo with 1,000 bootstrap simulations. The standard errors are calculated using the bootstrap method.

Figure 1(2) and Figure 1(8) show the impact on regional economic growth and economic agglomeration after a standard deviation of infrastructure capital stock density, which is of our main interest. As shown in Figure 1(2), for the impact on a standard deviation of infrastructure capital stock density, the response of the changes of GDP per capita of the region is obvious in phase 1, reaching the highest value in phase 2 and 3 and then gradually decay. Figure 1(8) depicts the impact on agglomeration for ten years after a standard deviation of infrastructure capital stock density. The results show that the change response of agglomeration last longer and reach the highest value at the beginning. Though the response gradually decays after phase 2, it keeps the positive response all the time.

Moreover, the change response of regional economic growth after a shock to agglomeration is also our interesting results. A positive shock to agglomeration does however hurt GDP per capita shown in Figure 1(3), reaching the lowest in phase 2. Though the response increases gradually after phase 2, it always keeps a negative response in ten years.

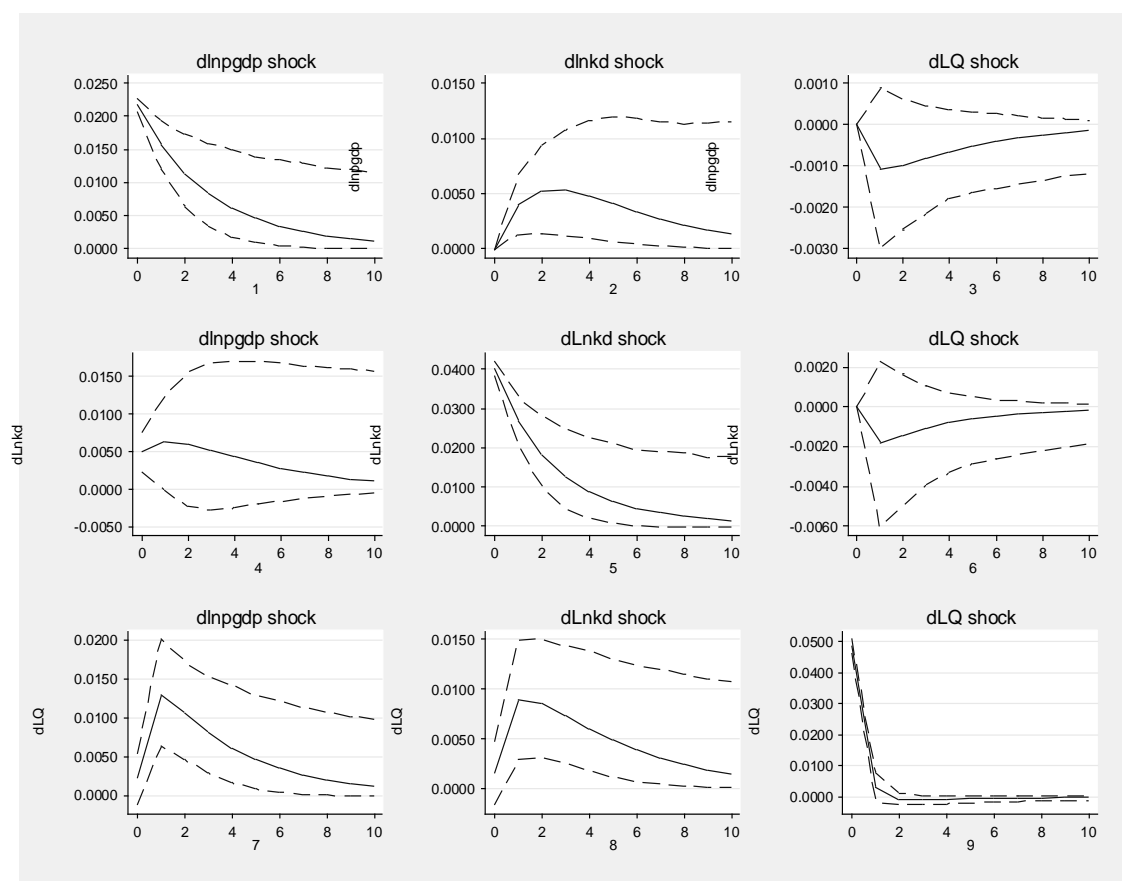


Figure 1. Impulse Response Graph

3.3. Forecast-Error Variance Decomposition

Finally, we use forecast-error variance decomposition to help us analyze the contribution of variables between each other more clearly. Table 4 shows the result of variance decomposition with 1,000 Monte Carlo simulations. The results show that the contribution of infrastructure construction to regional economic growth is between 1.56%~18.53%, the contribution of infrastructure construction to agglomeration is between 0.14%~12.67%. The results show that the infrastructure construction can explain the contribution to regional economic growth is between 1.56%~18.53%, the contribution of infrastructure construction to agglomeration is between 0.14%~12.67%.

Table 4. Variance decomposition

	s	dLnkd	dLQ	dLnPGDP
dLnkd	1	1	0	0
dLQ	1	0.00140654	0.99859346	0
dLnPGDP	1	0.01546156	0.00173496	0.98280348
dLnkd	5	0.98269557	0.00193032	0.01537411
dLQ	5	0.10779599	0.79252236	0.09968165
dLnPGDP	5	0.14916848	0.00168066	0.84915085
dLnkd	10	0.97709252	0.00202274	0.02088474
dLQ	10	0.12666002	0.7657049	0.10763508
dLnPGDP	10	0.18531971	0.00183378	0.812846

4. Discussion

We select the PVAR model to examine the long-term effects among infrastructure, agglomeration, and regional economic growth, in which the variables are endogenous. Although this method is useful to estimate the long-run effect, it is not very informative about the estimation of short-run effects. Moreover, this approach fails to find the spatial correlation and spillover effect among infrastructure and agglomeration. Therefore, what can be further expanded is introducing more control variables in the economic model and examining the spatial spillover effect.

5. Conclusions

According to the estimation result of the PVAR model, there is a significant positive relationship between infrastructure and regional economic growth in China. In the long run, it is found that increasing the density of infrastructure capital stock can still have a positive impact on regional economic growth and economy agglomeration. Specifically, GDP per capita growth has a positive effect on the tertiary industry location entropy, but the tertiary industry location entropy has an opposite effect on the GDP per capita growth. This means that economic agglomeration is negatively correlated with regional economic growth, which needs to be further studied. We also find that the growth of the tertiary industry location entropy and GDP per capita have not statistically significant long-run effect on infrastructure capital stock density.

References

- Abrigo, M. R., & Love, I. (2016). Estimation of panel vector autoregression in Stata. *The Stata Journal*, 16(3), 778-804. <https://doi.org/10.1177/1536867X1601600314>
- Andrews, D. W., & Lu, B. (2001). Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models. *Journal of econometrics*, 101(1), 123-164. [https://doi.org/10.1016/S0304-4076\(00\)00077-4](https://doi.org/10.1016/S0304-4076(00)00077-4)
- Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, 68(1), 29-51. [https://doi.org/10.1016/0304-4076\(94\)01642-D](https://doi.org/10.1016/0304-4076(94)01642-D)
- Aschauer, D. A. (1989). Is public expenditure productive? *Journal of monetary economics*, 23(2), 177-200. [https://doi.org/10.1016/0304-3932\(89\)90047-0](https://doi.org/10.1016/0304-3932(89)90047-0)
- Barro, R. J. (1990). Government spending in a simple model of endogeneous growth. *Journal of political economy*, 98(5, Part 2), S103-S125. <https://doi.org/10.1086/261726>
- Canning, D. (1999). *Infrastructure's Contribution to Aggregate Output*. (World Bank Policy Research Working Paper 2246). The World Bank.
- Canova, F., & Ciccarelli, M. (2013). *Panel Vector Autoregressive Models: A Survey*. Emerald Group Publishing Limited.
- Calderón, C., Moral-Benito, E., & Servén, L. (2015). Is infrastructure capital productive? A dynamic heterogeneous approach. *Journal of Applied Econometrics*, 30(2), 177-198. <https://doi.org/10.1002/jae.2373>
- Cook, L. M., & Munnell, A. H. (1990). How does public infrastructure affect regional economic performance? *New England economic review*, (Sep), 11-33.
- Holtz-Eakin, D., Newey, W., & Rosen, H. S. (1988). Estimating vector autoregressions with panel data. *Econometrica: Journal of the econometric society*, 56(6), 1371-1395. <https://doi.org/10.2307/1913103>
- Fan, J. L., Bai, B. L., & Pan, Q. (2004a). Progress made by the study on the contribution of infrastructure capital to economic growth—A summary of the method of production function. *Modern Economic Science*, 26(2), 87-96.
- Fan, J. L., Bai, B. L., & Pan, Q. (2004b). A Study on the Different Influence of Infrastructure on Regional Economic Growth in China. *Human Geography*, 19(2), 35-38.
- Ge, J. (2012). The Estimation of China's Infrastructure Capital Stock. *Economic Research Journal*, 4, 4-8.

- Ge, J. (2016). Infrastructure and non-infrastructure capital stocks in china and their productivity: A new estimate. *Economic Research Journal*, 5, 41-56.
- Haque, M. E., & Kim, D. H. (2003). *Public investment in transportation and communication and growth: a dynamic panel approach*. University of Manchester, School of Economic Studies.
- Hsiao, C. (2014). *Analysis of panel data* (No. 54). Cambridge university press.
- Love, I., & Zicchino, L. (2006). Financial development and dynamic investment behavior: Evidence from panel VAR. *The Quarterly Review of Economics and Finance*, 46(2), 190-210. <https://doi.org/10.1016/j.qref.2005.11.007>
- McCoskey, S., & Kao, C. (1998). A residual-based test of the null of cointegration in panel data. *Econometric reviews*, 17(1), 57-84. <https://doi.org/10.1080/07474939808800403>
- Straub, S. (2008). *Infrastructure and economic growth in East Asia* (Vol. 4589). World Bank Publications.
- World Bank. (1994). *Infrastructure for Development*. Oxford University Press.
- Zhang, X. L. (2013). Has transport infrastructure promoted regional economic growth? - With an analysis of the spatial spillover effects of transport infrastructure. *Social Sciences in China*, 34(2), 24-47. <https://doi.org/10.1080/02529203.2013.787222>

The Influence of Digital Economy on Employment in China's Labor Market: Mechanism, Characteristics and Strategies

Chenzi WU

Northwest University, Xi'an, China; chenziwu90@hotmail.com

Abstract: Chinese economy is transforming from an industrial economy to a digital economy and accelerating the changes of China's labor market. Firstly, this paper explores the influence mechanism of digital economy on employment from the perspective of digital economy and proposes that digital economy has an influence on employment through the triple effects of substitution, creation, and matching. Secondly, it analyzes the characteristics of new forms of employment in China's labor market. The digital economy has become an important driving force for China's employment growth, and it is also facing the challenges from the changes in total volume, structure, and required vocational skills of employment. Finally, it puts forward the strategies on how to optimize the employment of Chinese labor force in the era of digital economy, including digital skills training, social support policies, and support for independent entrepreneurship to respond to the challenges of employment and Facilitate the coordinated development of digital economy and employment effectively.

Keywords: digital economy; China's labor market; new forms of employment

JEL Classification: O15; J21; J40

1. Introduction

With the rapid development of Chinese economy, the digital economy has become a critical driving force for Chinese economic and social development. According to a report released by the China Academy of Information and Communications Technology (CAICT) (2020), China's digital economy was valued at 35.8 trillion yuan (\$5.5 trillion) in 2019, which was second only to the United States worldwide, accounting for 36.2 percent of China's GDP and contributing 67.7 percent to its GDP growth. China's digital transformation now is expanding from the demand side to the supply side, from marketing to the upstream of the industrial chain, such as logistics, manufacturing and research and development. According to Okun's Law, an increase in GDP of 2% reduces the unemployment rate by 1%. The development of China's digital economy will greatly promote the development of employment. The development of digital economy has made significant contributions to the social development, such as the lower production costs and higher-quality goods and services, etc. However, it is also facing the challenges brought about by the changes in total volume and structure of employment, such as imbalance in the supply and demand of digital skilled talents and structural contradictions in employment. Therefore, the study of the influence of digital economy on employment in China's labor market under the new

situations has a theoretical and practical significance for promoting the coordinated development of digital economy and employment effectively.

Since the beginning of the new century, the researches on digital economy and employment have been continuously increased and enriched. As of the end of December 2020, a total of 23,466 related articles were found by searching the database of Web of Science and China National Knowledge Infrastructure (CNKI) with the subject of "digital economy" : 9,449 from the Web of Science and 14,017 from the CNKI. After 2015, the research on digital economy showed a blowout growth, which has a great research value. In addition, an advanced search was conducted on the subject of digital economy and employment, and 420 and 78 valid articles were obtained in the Web of Science database and the CNKI database respectively. The related research has gradually increased during the past four years.

According to the existing literature, the research on digital economy, digital transformation, artificial intelligence, labor market and employment has attracted increasing attention from researchers. And the research on employment is mainly reflected in such key words as technical unemployment, employment structure, organizational forms, labor ability, digital talent, top-level design and promotion of employment. It can be found that the requirements for vocational skills and skill transition have become a current research hot spot in the era of digital economy, however the research on the influence of digital economy on employment in labor market is insufficient. Therefore, this paper focuses on the employment in China's labor market from the following aspects: First, from the perspective of digital economy, the influence mechanism of the development of digital technology on employment in China is discussed. Second, it analyzes the characteristics of new employment forms in China's labor market under the background of digital economy, and finally puts forward the strategies on how to optimize the employment of Chinese labor force in the era of digital economy.

2. The Influence Mechanism of Digital Economy on Employment in China

The influence of the digital economy on employment in China can be shown in Figure 1. As a new economic form, the digital economy is manifested not only in the progress of Internet technology, but also in new production factors such as digital knowledge and information. Under these two manifestations, digital technologies and the real economy are deeply integrated to form a new economy. The new economy refers to fostering new drivers of growth and encouraging China's economic transformation, which includes three levels: new industries, new business forms and new business models. The development of the new economy creates a large number of new vocations and new jobs, changes the traditional ways of hiring and working, increases the number of jobs, and demands the higher requirements for worker's vocational skills, etc. Specifically, the digital economy affects future employment in the labor market through three mechanisms: substitution effect, creation effect and matching effect.

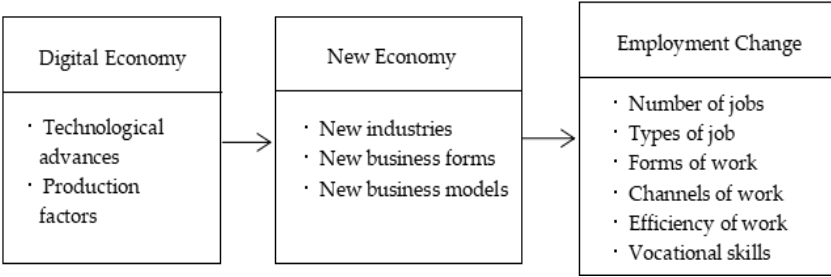


Figure 1. The influence of digital economy on employment in China

2.1. *Employment Substitution Effect*

The development of China’s digital economy is mainly based on big data, cloud computing, artificial intelligence, the internet of things and 5G, and is reflected in the digitization of industries, such as the development of intelligent agriculture, intelligent manufacturing, digital services, digital logistics and other fields. China’s supply-side structural reform strategy emphasizes eliminating superfluous industrial capacity, cutting business costs, and speeding up the development of emerging industries and enterprises, etc. This strategy has accelerated the effective integration of technology in major industries and forced traditional labor-intensive enterprises to transform. Therefore, the low-skilled workers who work in this type of work will be out of the labor market, it was replaced with the intelligent equipment and digital skilled talents.

Employment substitution mainly occurs in the front-line workers of traditional manufacturing, loading and unloading in logistics, traditional agriculture, and other low-skilled workers. For example, Cainiao Network Technology, the logistics affiliate of Alibaba Group implements the IoT strategy of logistics, i.e., the internet of things technology applied to logistics, realizes the digital connection of parcels, and replaces a large number of logistics warehouse keepers, operation center porters, and end sorting personnel (Guo, 2020). In Shentong Express, a Chinese logistics company, its intelligent robot sorting system to improve the sorting efficiency of goods can save more than 70% of the labor cost (Zhao, 2019). In "the black lamp" factory of Foxconn Industrial Internet Company, 18 working scenes were digitally upgraded, saving labor costs by 88% and increasing production efficiency by 2.5 times (Li, 2020). Thus, digitization greatly reduces labor costs, creates more profits for enterprises, and at the same time squeezes out a large number of labor.

2.2. *Employment Creation Effect*

With the development of digital economy, the employment substitution effect of digital economy on the labor market will reduce the employment of low-skilled personnel to some extent in the short term. In the long term, as a new factor of production, digital information accelerates the emergence of new enterprises at a lower cost and creates the new opportunity for employment. As the labor market gradually adjusts to economic development trends and laborers adapt to the needs of emerging jobs, the employment creation effect formed by the digital economy may exceed the employment substitution effect.

At present, China's digital economy is leading the emergence of new businesses such as information consumption, new retail and streaming media, including the latest 5G and artificial intelligence. Relevant data show that in 2018, there were 191 million jobs in the field of digital economy in China, accounting for 24.6% of the total number of jobs in that year, with a year-on-year growth of 11.5%, significantly higher than the growth rate of the total employment scale in the same period of the country. The newly prosperous e-commerce sector has created 10 million jobs through online shops and related services, creating 1.3% of China's total employment. In April 2019, Chinese Ministry of Human Resources and Social Security released information on 13 new jobs, mainly focusing on new jobs derived from the digital economy and artificial intelligence technology. According to the Employment Report of Digital Culture Industry (2020) released by the Employment Research Institute of Renmin University of China in November 2020, the total number of full-time and part-time employees in the four digital cultural industries, including games, e-sports, live broadcasting and literature, reached about 30 million (Ding, 2020), and digital jobs became an important part of jobs in the cultural industry. The employment creation effect of the digital economy strongly offsets its employment substitution effect.

2.3. Employment Matching Effect

The most basic characteristic of the Internet is the openness, transparency and real-time of the information platform, which avoids the disadvantages of the mismatch and asymmetry of supply and demand information in the traditional labor market. With the help of big data information and Internet platform, digital economy will constantly share information, dynamically match the information of supply and demand, and create various forms of job opportunities in a more flexible way of employment (Ji, 2017).

In China, digital industrialization and industrial digital transformation in various regions are mutually promoting each other. The employment ecology built by digital technology and digital economy has improved the matching efficiency of workforce from the following three aspects: First, the digital infrastructure. As a country with the fastest development of Internet and supporting infrastructure, China has ensured the possibility of improving the efficiency of market-oriented allocation of labor resources from the perspective of development environment and alleviated the problem of information asymmetry in the traditional labor market to the greatest extent. Second, the applications of digital equipment. Under the general trend that 5G network will be fully applied, the penetration rate of mobile phones in China is very high. In 2020, the number of mobile phone users in China is 1.594 billion, with a penetration rate of 113.9 units per 100 people, and smart phones enhanced the mobility of workers' cross-province and cross-industry employment through the instant dissemination of information and various software applications (Cong & Yu, 2020). Third, the innovation of the government administrative mode. At present, the development of digital technology has promoted the efficiency and quality of social security systems such as "smart + medical" and "smart + education" and basic public services, so improving the matching efficiency of supply and demand of workforce and promoting the gradual deepening of the market.

3. The Characteristics of New Forms of Employment in China's Labor Market

3.1. The Employment Growth Driven by Digital Economic Growth

It is still a controversial issue for economists to give conclusion whether the digital economy is positive to employment growth. The general views consider the combination of computerization and artificial intelligence will replace the workers confined to routine tasks involving explicit rule-based activities, even worse, some simple service jobs (Frey & Osborne, 2017). However the economic statistics from China as described in Figure 2, both economic scale and corresponding employment maintain a remarkable increase even the general GDP and employment growth decelerated in recent years. According to statistics from the China Communications Industry Institute, in 2007, China's digital economy accounted for 14.7% of its GDP and created 44.11 million jobs. Over the past decade, the digital economy continues to maintain a rapid expansion of scale. In 2018, the scale of the digital economy reached 31.3 trillion yuan, with a nominal growth of 20.9% on a comparable basis, accounting for 34.8% of GDP. The number of jobs in the digital economy was 191 million, accounting for 24.6% of the total employment in the same year, with a year-on-year growth of 11.5% (CAICT, 2019), significantly higher than the growth of the total employment in the same period. Quite a number of Chinese researchers believe that the digitization in China's industrial upgrade process undoubtedly replace the low-skilled workforce continuously, however the disappeared jobs of low-end manufacturing will shift towards millions of new jobs in service sectors and total number maintains increasing (Zhang & Chen 2019).

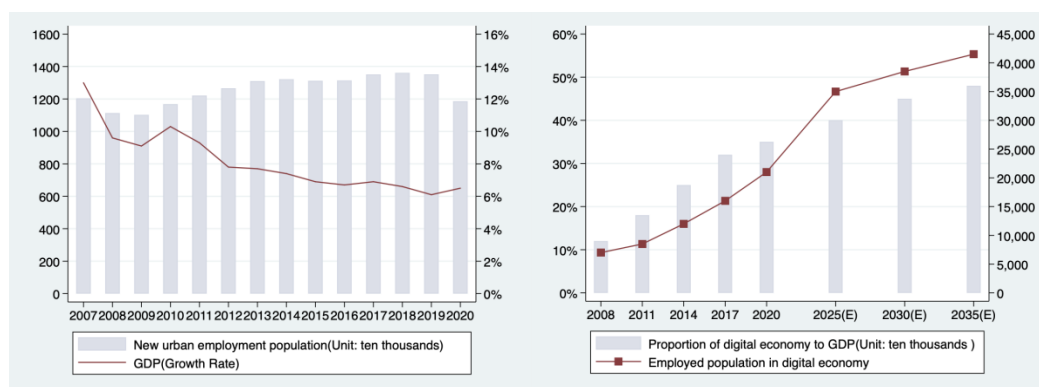


Figure 2. The relationship between economic growth and employment in China. Data Source: China's Statistical Report on National Economy and Social Development, China's White Paper on Digital Economy Development and Employment on 2019, China's White Paper on digital economy development on 2020 & Study Report from Boston Consulting Group

3.2. The "3-1-2" Employment Structure Characterized by Digital Economy

Digital economy has a huge impact on the employment structure. From the perspective of employment structure of industries, the employment proportion of the tertiary industry will continue to rise, the primary industry will further improve the scale, intensive and intelligent level, and more agricultural labor force will be released by agricultural automation. Employment in the secondary industry (traditional manufacturing) will continue to decline. In 2018, there were 19.28 million jobs related to the digital transformation of the primary

industry, accounting for 9.6 percent of the total number of jobs in the primary industry, an increase of about 2 percent. The number of digital transformation jobs in the secondary industry was 52.21 million, accounting for 23.7 percent of the total number of jobs in the secondary industry, an increase of about 1.4 percent. There are about 134.26 million jobs in the digital transformation of the tertiary industry, accounting for 37.2% of the total number of jobs in the tertiary industry, accounting for an increase of about 4% (CCIRI, 2019). It can be seen that the proportion of digital transformation jobs in the tertiary industry has increased the fastest, and the proportion of the secondary industry has increased the slowest. The employment absorption of the digital economy presents a "3-1-2" structural feature, because the digital transformation of the labor force in the tertiary industry is the least difficult. Digital transformation of the labor force in the secondary industry is the most difficult.

3.3. The Flexible and Diversified Forms Employment

Crowdsourcing and "Gig Economy" are new forms of digitally mediated employment that involves the performance of tasks online for a fee by distributed independent workers. They not only created many jobs in platform companies but also create numerous jobs for those part-time employees. On top of crowdsourcing, the rapid development of new business forms with digital economy, such as platform economy, sharing economy, and crowd innovation, has led to profound changes in employment. The typical characteristic of this new economy is that practitioners will never be required fixed working time and places. This kind of flexible and diversified employment forms caused by digital technology development leads to a prosperity in labor market. According to the statistics from Chinese authorities, the compound growth trend of "flexible employment" in China has increased from 2.7% to 9.1% during 2013 to 2017, showing an obvious and well growth trend (Zhang, 2017). Chinese Internet giants like Tencent and Alibaba both have dabbled in the crowdsourcing businesses and obtain considerable profits. However, negative effects like high probable unemployment and vulnerable social insurance are unignorable problems to be solved (Gol et al., 2019).

3.4. The Higher-Level Education Proportion in Digital Practitioners

The educational level of workforce correlates strongly with the degree of employment in digital sectors. In digital developed countries, the jobs require analytic skills and computing skills have a strong demand which implies the higher education is indispensable for digital economy (Lovaglio et al., 2018). From the perspective of the educational structure of the new employment groups, in China's urban labor market, the educational level of the new labor force has changed from junior high school graduates to higher education graduates. For example, from 13.8% and 17.1% of the first batch of college students entering the labor market (2002 and 2003) after the expansion of higher education enrollment increased to 67.8% in 2019. In 2016, 55.1% of the full-time drivers on China's network platforms had high school education, and 20.7% had higher education. Among the part-time drivers, 43% have high school education and 44.8% have higher education, which is also much higher than the corresponding proportion of the national employed population (Ji, 2020). According to the

annual report on the employment quality of graduates in 2019 released by Peking University (2019), the proportion of flexible employment of graduates with master's or doctoral degrees is increasing, among which the proportion of flexible employment of graduates with master's degree in 2019 reached 42.44%, 4.01% higher than that of 2018. The proportion of PhD graduates in flexible employment is 25.67%, an increase of 3.11% compared with 2018.

3.5. The Severe Shortage of Digital Talents

In the context of accelerating industrial automation and intelligent technological transformation in various regions, China's employment problem has increasingly caused a structural contradiction related to the required labor skills (Cai, 2017). At present, there is a larger supply gap of new digital skilled workers in China. The digital talents can be divided into three categories: general digital talents, professional digital talents and supplementary digital talents. In China, the supply and demand of general digital talents is relatively balanced. The supply of professional digital talents cannot meet market demand, for the training of digital skills is still insufficient. For supplementary digital talents, they mainly include high-skilled talents with rich practical experience such as digital transformation leaders and strategic leaders, which have a severe shortage in China (Chen & Ma, 2018). Also, a survey showed nearly 40 million digital talents among all LinkedIn's users in 31 cities worldwide, and found that the proportion of digital talents in the ICT sector in China is higher than that in Europe and the US, while the percentage of digital talent in traditional industries in Western countries is higher than that in China. In addition, most China's digital talents only have digital skills, while their counterparts in the West also have industry and business skills and experience. These findings show that compared with developed countries, China still lags behind in digitalizing traditional industries (Chen, 2021). China needs to nurture or find interdisciplinary talent with digital literacy and management skills in industries and other fields of the value chain to facilitate its digital transformation.

4. The Strategies to Optimize Employment of Chinese Labor Force

4.1. Improving a New, Flexible and Personalized Employment Service System

The employment service system is the basis for regulating the labor market to achieve full employment. At present, the construction of China's public employment service system is not perfect. For example, the scope, content and procedure of employment services are difficult to adapt to the new employment forms. Therefore, a new, flexible and personalized employment service system is urgently needed. First, building a diversified employment service system. It focuses on public employment services at the five levels of provinces, cities, districts, townships, and villages. It is composed of various types of employment service agencies, enterprises, universities, NGO, and NPO in the society to enrich the content of employment services and improve the service process. Second, the government and non-profit organizations work together to effectively use Internet technology to build a digital platform for employment and entrepreneurship services, use big data resources to dig into the employment and entrepreneurship dynamic information in labor market, improve

traditional employment service methods, and provide timely and personalized employment services for the labor market. Third, making full use of the flexible features of the Internet to develop online employment services in the human resource service industry and improve the professional level of employment services. Fourth, formulating a labor market employment and entrepreneurship service standard system that adapts to flexible employment, and form a unified service procedure, management method and business process to improve the quality of employment services.

4.2. Improving the Basic Support Policies for New Forms of Employment

The digital economy drives the vigorous promotion of new forms of employment, using digital technology to innovate employment and entrepreneurship support platform, social security, household registration system and other services. First, ensuring the policies to be implemented at all range. And the improvement of employment and entrepreneurship policies that adapt to new forms of employment, focus on the formulation of employment policies for special groups such as college students and the disabled, and solve the difficulties in the process of employment or reemployment of workers due to insufficient digital economic skills. Second, government should take measures to eliminate the digital divide existed in the traditional workforce in order to avoid the crowd-out effects. Establishment of the digital talent training mechanism is the responsibilities of companies, but relevant government departments should play a leading role, supporting the workforce by clear employment policies, vocational training subsidies and other insurance policies. Third, eliminating barriers to the population flow between the urban area and urban area. Due to the reduction of development between the urban and rural area in digital age, it is necessary to release the potential power of employment market in rural area. Only by eliminating the barriers to household registration can we better attract digital talents and promote the sustainable development of the digital economy.

4.3. Strengthening Laborer's Digital Vocational Skills Training

As talent is the most important resource, digital talent is the foundation underpinning the future of the digital economy. To better tap the digital talent dividend and make up for its talent shortage, China needs to drive supply-side reforms of its labor market and education with digital skills and education that is tailored to industry needs and scientific breakthroughs. Therefore, first, improving the government support system to facilitate school-enterprise cooperation, and strengthening the construction of digital related professional disciplines and the training of digital talents. Colleges and universities should optimize the construction of disciplines and specialty structures and introduce the construction of digital and information practice bases to increase the supply of digital skills talents needed to adapt to the digital economy. With an emphasis on the integration of digital technologies with other scientific and engineering fields, China should nurture more cutting-edge digital talent with disruptive digital skills to expedite its digital transformation. Second, increasing social vocational skills training. Government departments should play a leading role, support enterprises to build professional vocational skills training departments, and

vigorously carry out enterprise digital skills upgrading and transfer professional training; outsource vocational skills training for the unemployed, disabled persons and other special employment groups to professional institutions to increase the supply of vocational skills training. Third, increasing subsidies for vocational training. On the one hand, subsidies can effectively stimulate the training initiative of vocational training providers; on the other hand, free training or corresponding subsidies can attract rural surplus labor, reemployed groups, and vocational skilled personnel to actively participate in vocational skills or transfer training.

4.4. Increasing Support for Digital Innovation and Entrepreneurship

The advancement of Internet technology has activated market innovation and entrepreneurship. Only by effectively marketing digital innovation projects can the quality of entrepreneurship projects be improved. Therefore, it is necessary to increase support for innovation and entrepreneurship in the era of digital economy. First, actively introducing entrepreneurial support policies to encourage independent entrepreneurship. Relevant government departments should support digital entrepreneurship, the construction of digital entrepreneurship and incubation bases, expand financing channels for digital platform entrepreneurship, solve the source of mass entrepreneurship, and provide housing security policies for special groups of entrepreneurs to encourage active start a business. Second, increasing innovation and entrepreneurship training and improving the quality of innovation and entrepreneurship services. Colleges and universities should strengthen the popularization of innovation and entrepreneurship courses, guide college students' innovation and entrepreneurship projects, and cultivate their innovative thinking and entrepreneurial abilities. At the same time, the government should organize social organizations to provide professional entrepreneurial skills training for groups interested in starting a business, so as to increase the employment capacity of the labor market. Third, building a digital entrepreneurial service platform to provide continuous entrepreneurial support services. All provinces, districts, and cities should set up entrepreneurship counseling service centers to provide entrepreneurs with entrepreneurial services in a timely manner to help workers in the entrepreneurial stage solve problems.

5. Conclusions

The digital economy is a new economic form that has emerged with the development of human society. It has become a critical driving force for global economic and social development. In the process of the transformation from the industrial economy to the digital economy, the digital economy influences on the employment in China's labor market through the triple effect of substitution, creation, and matching, which has brought about many new characteristics of China's employment. Entering the era of digital economy, Chinese labor market is trending towards platform economy, sharing economy, crowd-sourcing, crowd-creation and other new employment forms. The ways of employment are becoming more and more flexible and diversified. Employment opportunities have undergone tremendous changes, and digital skills have become laborer's basic employment

skills. However, It is also facing some problems, such as imbalance in the supply and demand of digital skilled talents and structural contradictions in employment. Therefore, In the era of the digital economy, strengthening laborer's digital skills training, improving social support policies and employment service systems, increasing support for independent entrepreneurship are the strategies for optimizing employment of labor force in the labor market, which will effectively solve the employment problems to promote the coordinated development of digital economy and employment and China's digital transformation.

References

- China Academy of Information and Communications Technology (CAICT). (2020). *White Paper on China's Digital Economy Development on 2020*. <http://m.caict.ac.cn/yjcg/202007/P020200703318256637020.pdf>
- Guo, G. E. (2020). Analysis of the Development Status and Trends of China's E-commerce Express Industry. *Business Economics Research*, 16, 118-121.
- Zhao, K. F. (2019). Operation Performance Evaluation of Shentong Express. *Logistics Engineering and Management*, 5, 60-63. <https://10.3969/j.issn.16744993.2019.05.023>
- Li, H. L. (2020). Industrial Fulian turned around. *21st Century Business Review*, (4), 44-47.
- Ding, R. (2020, November 6). *The Employment Report of Digital Culture Industry (2020)*. School of Labor and Human Resources, Renmin University of China. <https://news.ruc.edu.cn/archives/296180>
- Ji, W. W. (2017). Digital Economy and the Future of Work. *Journal of China Institute of Industrial Relations*, 6, 37-47.
- Cong, Y., & Yu, B. Y. (2020). The Influence of Digital Economy on the Efficiency of Chinese Labor Force Resource Allocation. *The Theory and Practice of Finance and Economics*, 42(2), 108-114. <https://10.16339/j.cnki.hdxbcjb.20200403.001>
- Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological forecasting and social change*, 114, 254-280. <https://doi.org/10.1016/j.techfore.2016.08.019>
- China Academy of Information and Communications Technology (CAICT). (2019). *White Paper on China's Digital Economy Development and Employment (2019)*. <https://wenku.baidu.com/view/a1a7c0d469ec0975f46527d3240c844768eaa076.html>
- Zhang, M. L., & Chen, M. S. (2019). China's digital economy: Opportunities and risks. *International Monetary Fund Working Papers*. <https://www.sipotra.it/wp-content/uploads/2019/03/Chinas-Digital-Economy-Opportunities-and-Risks.pdf>
- China Commercial Industry Research Institute (CCIRI). (2019, April 25). *In 2018, there were 191 million jobs in my country's digital economy, accounting for 24.6% of total employment*. <https://www.askci.com/news/chanye/20190425/1737271145399.shtml>
- Zhang, C. W. (2017). *Green Book of Population and Labor: Reports on China's Population and Labor (No. 18)*. Beijing: Social Science Literature Press.
- Gol, E. S., Stein, M. K., & Avital, M. (2019). Crowdswork Platform Governance toward Organizational Value Creation. *The Journal of Strategic Information Systems*, 28(2), 175-195. <https://doi.org/10.1016/j.jsis.2019.01.001>
- Lovaglio, P. G., Cesarini, M., Mercorio, F., & Mezzanzanica, M. (2018). Skills in demand for ICT and statistical occupations: Evidence from web-based job vacancies. *Statistical Analysis and Data Mining: The ASA Data Science Journal*, 11(2), 78-91. <https://doi.org/10.1002/sam.11372>
- Ji, W. W. (2020). The main characteristics and development trends of China's new employment patterns. *New Economic Guide*, 3, 17-28.
- Peking University. (2019). *Annual Report on the Employment Quality of Peking University Graduates*. Peking University Admissions Office. http://cdn1.kybimg.com/ohr/2020/01/06/135743_5e12cc57a9c25.pdf
- Cai, F. (2017). Analysis of the Effects of China's Economic Reform: A Perspective of Labor Force Reconfiguration Angle. *Economic Research*, 7, 4-17.
- Chen, Y., & Ma, Y. F. (2018). Digital talent: the core driving force of the digital transformation of the Chinese economy. *Tsinghua Management Review*, (Z1), 30-40.
- Chen, Y. B. (2021, January 28). *Future of China's digital economy*. China Daily Global. <https://www.chinadaily.com.cn/a/202101/28/WS6011fe41a31024ad0baa5911.html>

The Impact of Transportation Infrastructure on Export Trade: Evidence from 31 Provinces in China

Lei WU* and Rong KANG*

Northwest University, Xi'an, China; 18904603020@163.com; kangrong@nwu.edu.cn

* Corresponding author: 18904603020@163.com; kangrong@nwu.edu.cn

Abstract: This paper uses data from 31 provinces in China to test the impact of transportation infrastructure level on China's regional export trade. The regression results show that: the improvement of transportation infrastructure level has a positive impact on regional export trade; through the heterogeneity analysis of transportation infrastructure improvement on regional export trade, it is found that compared with the southern region, the improvement of transportation infrastructure level has a more obvious impact on the export trade of the northern region; compared with the western region, the improvement of transportation infrastructure has a more obvious impact on the export trade of the eastern and central regions; after China's accession to the World Trade Organization, the improvement of transportation infrastructure has a more obvious impact on regional export trade. Further discussion found that the improvement of transportation infrastructure is conducive to improving regional transportation efficiency, thus promoting the development of regional export trade. On the basis of the research conclusion, this paper puts forward the corresponding policy suggestions to better play the role of transportation infrastructure in regional export trade, so as to further promote the development of China's foreign export trade.

Keywords: transport infrastructure; highway; railway; export

JEL Classification: C51; F14; O18

1. Introduction

The improvement of transportation infrastructure is conducive to reducing transportation costs, to promoting regional trade and economic growth. Since the 1990s, China has carried out large-scale transportation infrastructure construction. From 1978 to 2019, China's railway mileage increased from 51,700 km to 139,900 km, and China's highway mileage increased from 890,200 km to 5,012,500 km. As shown in the figure below, Figure 1 shows the growth trend of railway mileage, and figure 2 shows the growth trend of highway mileage.

At the same time, China's export trade is also growing at a high speed. From 1978 to 2019, China's exports increased from US \$9,475 million to US \$2,499,482 million. In 2015, China's exports of goods accounted for 20.49% of GDP. As shown in Figure 3, since the reform and opening up, especially after China's accession to the World Trade Organization, China's export trade as a whole has been in a state of rapid growth. Export trade has always been an important force in promoting China's economic development. Does the improvement of transportation infrastructure promote regional export trade? Theoretically, the answer is yes. The

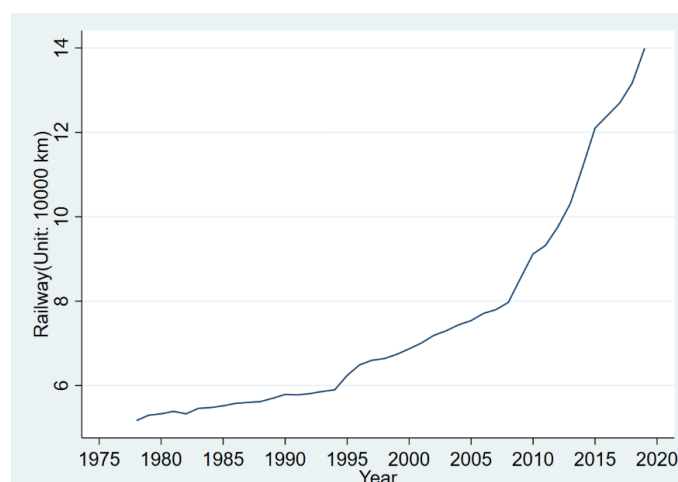


Figure 1. Growth trend of Railway mileage since reform and opening up

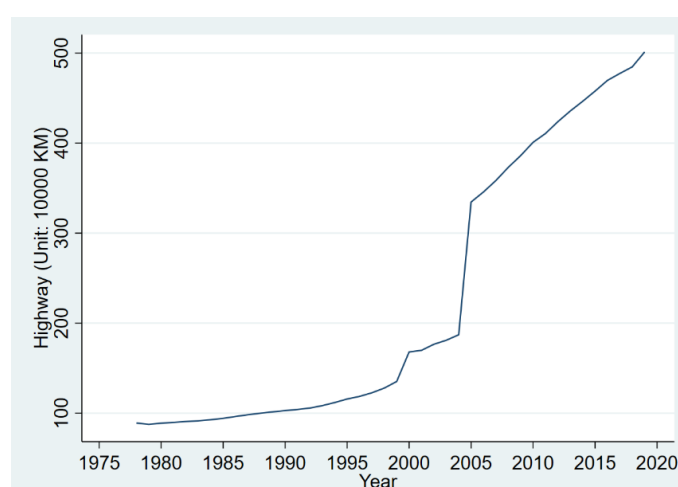


Figure 2. Growth trend of Highway mileage since reform and opening up

improvement of transportation infrastructure will reduce the transportation cost from inland areas to border and port, promote the trade between regions, and enhance the competitiveness of domestic products in the international market. Based on the relevant data of 31 provinces in China, this paper researches the impact of the improvement of transportation infrastructure on China's export trade, and distinguishes the importance of transportation infrastructure on the export trade of different regions by analyzing the heterogeneity of the impact of the improvement of transportation infrastructure on China's regional export trade. On this basis, this paper provides effective policy recommendations on how to improve the level of regional export trade, balance regional export differences and promote regional economic development by improving the transportation infrastructure in the new era.

2. Literature Review

Transportation infrastructure is the necessary public goods in the process of economic development, and it is the leading factor to achieve economic growth. Many scholars have done a lot of research on export trade and economic growth around the improvement of transportation infrastructure.

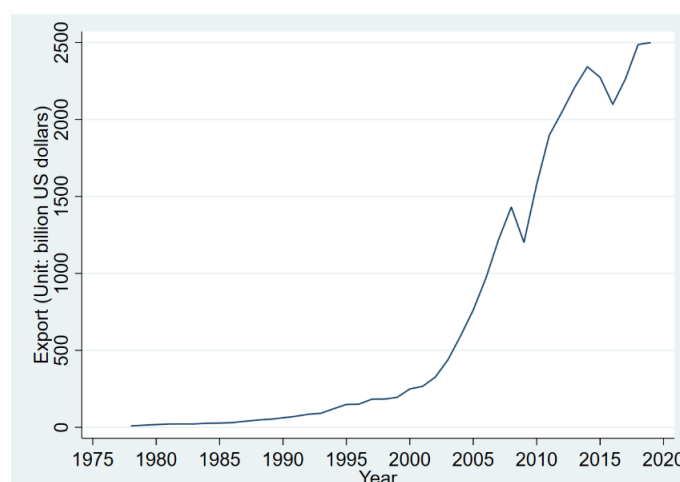


Figure 3. Growth trend of China's export trade since the reform and opening up

Trade cost is one of the important factors affecting bilateral trade. High transportation cost will significantly reduce the trade advantage brought by geographical location (Raballand et al., 2005). Transportation infrastructure is the key to determine the transportation cost (Limão & Venables, 2001). The improvement of transportation infrastructure quality in both importing and exporting countries plays an important role in the development of international trade. Shi et al. (2018) believe that transportation infrastructure can reduce negotiation cost, time cost and logistics cost, and strengthen the connection of global economic activities. Glaeser and Kohlhase (2003) found that the railway reduced the land transportation cost through the US data inspection. The improvement of transportation infrastructure can make the originally separated regions and markets connected, thus stimulating the generation and growth of trade (Martínez & Suárez, 2005). Persson (2011) found that the export of heterogeneous products and homogeneous products will increase by 0.7% and 0.4% respectively when the transaction cost of export decreases by 1%.

The improvement of transportation infrastructure can also improve transportation efficiency, promote regional export trade and economic growth. Zhou and Zheng (2012) found that China's railway speed increase increases the per capita GDP growth rate by about 3.7%. Gong and Yin (2016) found that the shortening of railway transportation time and distance can effectively improve the export trade efficiency of China's provinces and cities.

In China's macro level, At the macro level, Liu and Hu (2010) found that transportation infrastructure plays a significant role in promoting China's economic growth; Xu et al. (2016) as well as Zhang (2018) found one belt, one road transport infrastructure has positive effects on the improvement of the import and export trade and the regional structure of the relevant countries. The improvement of transportation infrastructure can reduce logistics costs and shorten transportation distance, thus reducing trade costs and promoting trade and economic growth (Liu & Liu, 2011; Martincus, 2017; Bai & Ji, 2018). Wang and Huang (2017) investigated the impact of transportation infrastructure on export trade from the perspective of time sensitivity based on the data of China industrial enterprise database from 1998 to 2007, and found that the time sensitivity of different export industries is very different, and the time sensitivity of high-tech industry is the highest. Xu et al. (2012) found that road transportation

cost and port efficiency are the main factors affecting China's trade expansion. Liu and Shao (2018) found that the improvement of transportation infrastructure inhibited the export trade of enterprises, but promoted the development of domestic trade. There are also many papers studying on the impact of logistics performance (Wang et al., 2018) and port development (Deng, 2016; Wei & Li, 2017) on export trade.

Through the above research, it is found that the improvement of transport infrastructure can reduce trade costs and improve transport efficiency, thus promoting regional trade growth and regional economic growth. Most of the existing studies focus on the impact of transport infrastructure improvement on the overall trade growth and economic growth, while a few focuses on the temporal and spatial differences of the impact of transport infrastructure improvement on export trade. Based on the analysis of the impact of the improvement of transportation infrastructure on China's export trade, this paper studies the differences of the impact of the improvement of transportation infrastructure on China's export trade between the north and the south, the East, the middle and the west, and before and after China's accession to the World Trade Organization, and analyzes whether the improvement of transportation infrastructure improves the transportation efficiency, so as to promote the development of export trade development.

3. Methodology

3.1 Model Building

In view of the vital role of transportation infrastructure in promoting local economic development and trade, this paper examines the impact of transportation infrastructure level on China's export trade. This paper selects the provincial panel data of 31 provinces, autonomous regions and municipalities in China from 1997 to 2017 to evaluate the impact of transportation infrastructure level on China's export trade from two aspects: the total regional export volume and the proportion of regional total export in the regional unit output value. The model is set as follows:

$$Y_{it} = \alpha_0 + \alpha_1 Lnmileage_{it} + \sum Control_{it} + \mu_i + \sigma_t + \varepsilon_{it} \quad (1)$$

In the above formula, Y_{it} represents the export trade level of each region. This paper uses the total export trade volume of each region and the export trade volume per unit GDP to measure the regional export trade level. $Lnmileage_{it}$ represents the core explanatory variables, that is the sum of highway mileage and railway mileage; $Control_{it}$ represents a series of control variables that affect the export trade of provinces; μ_i and σ_t represent the fixed effect of province and year respectively; ε_{it} is a random disturbance term.

3.2. Data Resources

This paper uses the relevant data of 31 provinces, autonomous regions and municipalities in China from 1997 to 2017, all of which are from *China's Province Statistical Yearbook* and the official website of the National Bureau of Statistics. Because of the disunity of units in the indexes, this paper adjusts them by calculation.

3.3 Index Selection

The explanatory variable of this paper is the level of regional export trade, which is measured by two indicators: regional total export trade (Lnexport) and export volume per unit of GDP (Gdpexport). The core explanatory variable of this paper is the level of regional transportation infrastructure, which is measured by the sum of regional highway and railway mileage (Lnmileage). In addition, this paper selects other factors that may affect the level of regional export trade as control variables, including GDP (Lngdp), per capita GDP (Lnpergdp), education funds (Lnedufee), social fixed asset investment (Lnfixed), and the number of industrial enterprises (Lnindustry).

3.4 Model Hypothesis

This paper puts forward two hypotheses: (1) The improvement of transportation infrastructure level can promote the growth of regional export trade, and the impact of transportation infrastructure level on regional export trade may have time and space differences. (2) The improvement of transportation infrastructure may promote the development of regional export trade by improving transportation efficiency.

4. Results

4.1. Descriptive Statistics

First of all, this paper makes descriptive statistical analysis on the selected variables, and proves the scientificity of variable selection through variable calculation method and statistical display. As shown in Table 1, the standard deviation of the selected variables is small, reflecting the characteristics of relatively stable data, which can be used for regression analysis.

Table 1. Descriptive statistical analysis of variables

Variables	Computing Method	Obs	Mean	Std.Dev
Lnexport	$\ln(\text{export}+1)$	651	15.810	1.913
Gdpexport	export/GDP	651	0.208	0.241
Lnmileage	$\ln(\text{highway mileage} + \text{railway mileage} + 1)$	651	2.166	0.746
Lngdp	$\ln(\text{gdp}+1)$	651	8.678	1.293
Lnpergdp	$\ln(\text{gdp}/\text{population}+1)$	651	1.138	0.577
Lnedufee	$\ln(\text{education expenditure}+1)$	651	14.82	1.200
Lnfixed	$\ln(\text{fixed assets investment}+1)$	651	8.031	1.451
Lnindustry	$\ln(\text{number of enterprises}+1)$	651	8.530	1.319
Lntransport	$\ln(\text{the volume of freight transport}+1)$	651	10.853	1.253
Lnturnover	$\ln(\text{turnover}+1)$	651	7.342	1.310

4.2. The Impact of Transportation Infrastructure Level on Export Trade

In order to evaluate the impact of transportation infrastructure level on export trade, based on formula (1), this paper obtains the benchmark regression results shown in Table 2.

It can be seen that no matter whether the control variable is added or not, the regression results will not change essentially. Under the significant level of 1%, the increase of highway and railway mileage promotes the growth of regional total export trade and regional unit GDP export trade. This shows that the improvement of transportation infrastructure level can promote the development of regional export trade. The improvement of transportation infrastructure level reduces the barriers of interregional trade and transportation, reduces the cost of trade and transportation, and improves the possibility of interregional trade, thus promoting the development of regional export trade.

Table 2. The impact of transportation infrastructure level on export trade

	(1)	(2)	(3)	(4)
Variables	Lnexport	Lnexport	Gdpexport	Gdpexport
Lnmileage	0.775*** (0.081)	0.579*** (0.088)	0.077*** (0.020)	0.077*** (0.020)
Constant	13.175*** (0.138)	3.834** (1.675)	0.043 (0.033)	-0.494 (0.383)
Control variable	NO	YES	NO	YES
Province fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Observations	651	651	651	651
R-squared	0.911	0.918	0.257	0.379

¹ Standard errors in parentheses; ²*, **, *** are significant at the level of 10%, 5% and 1% respectively.

4.3. Heterogeneity Analysis of Transportation Infrastructure Level on Regional Export Trade

4.3.1. Regional Differences in the Impact of Transportation Infrastructure Level on Regional Export Trade

In order to further investigate the difference of the impact of transportation infrastructure level on export trade in different regions, this paper uses the method of sub sample regression to investigate the difference of the impact of transportation infrastructure level on export trade between the South and the North of China and the difference of the impact of transportation infrastructure level on export trade between Eastern, Central and Western China.

This paper divides the north and south of China into 15 and 16 provinces according to China's physical and geographical boundaries, and investigates the differences in the impact of transportation infrastructure on export trade between the South and the North of China. The regression results are shown in Table 3. In Table 3, columns (1) and (3) are the regression results of the impact of transportation infrastructure level on the export trade of the northern region, and columns (2) and (4) are the regression results of the impact of transportation infrastructure level on the export trade of the southern region. It can be found that the improvement of transportation infrastructure level promotes the growth of the total export trade volume of the northern and southern regions at a significant level of 1%, and promotes the growth of the export trade volume per unit GDP of the northern region at a significant level of 1%, but it has no significant impact on the export trade volume per unit GDP of the southern region. The impact of transportation infrastructure level on the export trade of northern and southern regions is different. Through the regression coefficient of the core

explanatory variables, we can find that the impact of transportation infrastructure level on the export trade of the northern region is more obvious than that of the southern region.

Table 3. The impact of transportation infrastructure level on export trade in North and South China

	(1)	(2)	(3)	(4)
Variables	Lnexport-north	Lnexport-south	gdlexport-north	gdlexport-south
Lnmileage	0.630*** (0.133)	0.507*** (0.120)	0.090*** (0.022)	0.014 (0.032)
Constant	6.876*** (2.185)	-0.301 (2.603)	-0.148 (0.358)	-2.435*** (0.689)
Control variable	YES	YES	YES	YES
Province fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Observations	315	336	315	336
R-squared	0.923	0.939	0.457	0.521
Number of provinces	15	16	15	16

¹ Standard errors in parentheses; ² *, **, *** are significant at the level of 10%, 5% and 1% respectively.

According to the eastern, central and western regions of China divided by the national development and Reform Commission, 31 provinces in China are divided into 12 eastern provinces, 9 central provinces and 10 western provinces for sub sample regression. The regression results are shown in Table 4. In Table 4, columns (1) and (4) are the regression results of the impact of transportation infrastructure level on the export trade of eastern region, columns (2) and (5) are the regression results of the impact of transportation infrastructure level on the export trade of central region, and columns (3) and (6) are the regression results of the impact of transportation infrastructure level on the export trade of western region. The results show that the improvement of transportation infrastructure level has significantly increased the regional total export trade volume and regional unit GDP export trade volume of the eastern and central regions, but has no significant impact on the western region. Moreover, the impact of the improvement of transportation infrastructure level on the total export trade volume of the central region is higher than that of the eastern region, while the impact of the improvement of transportation infrastructure level on the export trade volume per unit GDP of the two regions is on the contrary, and the impact of the eastern region is higher than that of the western region. Although the improvement of transportation infrastructure level has no significant impact on the western region, from the sign of regression coefficient, the improvement of transportation infrastructure level can promote the development of export trade in the western region. The differences between the three regions affected by the level of transportation infrastructure may be related to the geographical differences and location differences between the eastern, central and western regions of China, as well as the policy influence since China's reform and opening up. Compared with the western region, the eastern and central regions have natural geographical advantages and location advantages. Since China's reform and opening up, the eastern region is often the first region of China's economic policy. These factors lead to the improvement of transportation infrastructure level in the eastern and central regions of China, which is easier to promote the economic development and export trade level of the region.

Table 4. The impact of transportation infrastructure level on export trade in eastern, central and Western China.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Lnexport-e	Lnexport-m	Lnexport-w	gdpxport-e	gdpxport-m	gdpxport-w
Lnmileage	0.433*** (0.103)	0.929*** (0.271)	0.221 (0.186)	0.093** (0.047)	0.044* (0.023)	0.033 (0.027)
Constant	0.708 (2.699)	-6.474* (3.849)	25.909*** (3.989)	-0.569 (1.223)	-1.188*** (0.325)	2.664*** (0.578)
Control variable	YES	YES	YES	YES	YES	YES
Province fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
Observations	252	189	210	252	189	210
R-squared	0.963	0.932	0.914	0.581	0.484	0.437
Number of Provinces	12	9	10	12	9	10

¹Standard errors in parentheses; ²*, **, *** are significant at the level of 10%, 5% and 1% respectively.

4.3.2. The Impact of Transportation Infrastructure Level on Regional Export Trade before and after China's Accession to the World Trade Organization

After China's accession to the World Trade Organization in 2001, China's foreign trade development level has been greatly improved, and China's international influence has gradually improved. Taking 2001 as the boundary, this paper analyzes the impact of transportation infrastructure level on regional export trade before and after China's accession to the World Trade Organization. The regression results are shown in Table 5. In Table 5, columns (1) and (3) are the regression results of the impact of transportation infrastructure level on regional export trade after China's accession to the World Trade Organization, and columns (2) and (4) are the regression results of the impact of transportation infrastructure level on regional export trade before China's accession to the World Trade Organization. It can be seen that after China's accession to the World Trade Organization, the improvement of the level of transportation infrastructure has significantly promoted the growth of regional export trade, while before China's accession to the World Trade Organization, the level of transportation infrastructure has no significant impact on regional export trade. This shows that after China's accession to the World Trade Organization in 2001, China's export trade has developed rapidly, so the improvement of transportation infrastructure can significantly promote the development of regional export trade, and release the potential of China's export trade development.

5. Discussion

By analyzing the impact of transportation infrastructure level on regional export trade, this paper has a comprehensive understanding of the importance of improving transportation infrastructure level and the differences of its impact on the region. However, the scientific discussion of the results and the test of method application need to be verified by robustness test. On this basis, this paper further discusses the impact of transport infrastructure on transport efficiency, and analyzes the internal mechanism of the impact of the improvement of transport infrastructure on regional export trade.

Table 5. The impact of transportation infrastructure level on regional export trade before and after China's accession to the World Trade Organization

	(1)	(2)	(3)	(4)
Variables	Lnexport>2000	Lnexport<2001	exportgdp>2000	exportgdp<2001
Lnmileage	0.348*** (0.116)	-0.032 (0.347)	0.046* (0.026)	0.054 (0.061)
Constant	-0.053 (2.184)	4.533 (5.541)	-0.598 (0.486)	-0.393 (0.968)
Control variable	YES	YES	YES	YES
Province fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Observations	527	124	527	124
R-squared	0.880	0.647	0.284	0.230

¹ Standard errors in parentheses; ²*, **, *** are significant at the level of 10%, 5% and 1% respectively.

5.1. Robustness Test

In order to ensure the robustness of the benchmark regression results, this paper uses the method that all explanatory variables lag one period and replace the core explanatory variables to test the benchmark results again.

All explanatory variables lag one period. The results are shown in Table 6. It can be seen that there is no significant difference between the regression results and the benchmark regression results in Table 2 after all explanatory variables are lagged for one period, which indicates the robustness of the benchmark results in the previous paper.

Table 6. All explanatory variables lag one period

	(1)	(2)	(3)	(4)
Variables	Lnexport	Lnexport	gdpexport	gdpexport
L.Lnmileage	0.800*** (0.082)	0.615*** (0.089)	0.094*** (0.019)	0.090*** (0.020)
Constant	13.078*** (0.138)	4.511** (1.753)	0.003 (0.033)	-0.875** (0.396)
Control variable	NO	YES	NO	YES
Province fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Observations	620	620	620	620
R-squared	0.909	0.914	0.273	0.380

¹ Standard errors in parentheses; ²*, **, *** are significant at the level of 10%, 5% and 1% respectively.

Replace the core explanatory variable. Highway and railway freight volume can also measure the level of transportation infrastructure in a region. Therefore, this paper selects the highway and railway freight volume to replace the core explanatory variables, and the regression results are shown in Table 7. It can be seen that the improvement of transportation infrastructure measured by freight volume has significantly promoted the development of regional export trade, which further proves the robustness of the previous results.

Table 7. Replace the core explanatory variable

	(1)	(2)	(3)	(4)
Variables	Lnexport	Lnexport	gdpexport	gdpexport
Lnmileage	0.424*** (0.047)	0.322*** (0.060)	0.046*** (0.011)	0.068*** (0.013)
Constant	10.044*** (0.484)	5.453*** (1.766)	-0.307*** (0.116)	-0.050 (0.396)
Control variable	NO	YES	NO	YES
Province fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Observations	651	651	651	651
R-squared	0.910	0.916	0.258	0.390

¹ Standard errors in parentheses; ² *, **, *** are significant at the level of 10%, 5% and 1% respectively.

5.2 The Internal Mechanism of the Impact of Transportation Infrastructure Level on Regional Export Trade

Most of the existing studies believe that the improvement of transportation infrastructure is conducive to reducing trade costs and improving transport efficiency, so as to promote regional export trade and economic development. In this part, the regional freight turnover is selected to measure the regional transportation efficiency to test the impact of the improvement of transportation facilities on the freight turnover. The results are shown in Table 8. It can be seen that whether or not the control variables are added, the improvement of transportation infrastructure level increases the freight turnover and improves the transportation efficiency at a significant level of 1%. At the same time, the author divides China into different regions in the same way as before. Through regression analysis, it is found that the positive effect of infrastructure improvement on transportation efficiency is better in the northern region than in the southern region, and better in the eastern and central regions than in the western region. This shows that the improvement of transport infrastructure can promote the development of export trade by improving transport efficiency, and the effect of transport infrastructure improvement on transport efficiency is still different between regions in China.

Table 8. The influence of transportation infrastructure on transportation efficiency

	(1)	(2)
Variables	turnover	turnover
Lnmileage	0.229*** (0.087)	0.253*** (0.089)
Constant	5.885*** (0.148)	3.696** (1.545)
Control variables	NO	YES
Province fixed effect	YES	YES
Year fixed effect	YES	YES
Observations	651	651
R-squared	0.798	0.819

¹ Standard errors in parentheses; ² *, **, *** are significant at the level of 10%, 5% and 1% respectively.

6. Conclusions

Based on the relevant data of 31 provinces in China, this paper examines the impact of transportation infrastructure level on regional export trade. The results show that the improvement of transportation infrastructure will significantly promote the growth of regional export trade, and this result has passed the robustness test. At the same time, through the heterogeneity analysis of the impact of transportation infrastructure level on regional export trade, this paper finds that compared with the southern region, the improvement of transportation infrastructure plays a greater role in the northern region. Because of the geographical advantages and location advantages of the eastern and central regions, as well as the policy advantages of the eastern region, the improvement of transportation infrastructure plays a greater role in the eastern and central regions than in the western regions. Compared with before 2001, after China joined the World Trade Organization in 2001, the improvement of transportation infrastructure can further play its role in regional export trade. Further discussion shows that the improvement of transport infrastructure promotes the development of export trade by improving transport efficiency, and the effect of transport infrastructure improvement on transport efficiency is also different between regions in China. On this basis, this paper puts forward the following policy recommendations.

(1) The rapid development of China's high-speed railway can promote China's economic growth to a new level. The speed increase of China's railways can reduce the time cost and improve the transportation efficiency. The Chinese government should further promote the layout of high-speed railways and enhance the efficiency of regional interconnection.

(2) The effect of transportation infrastructure improvement on China's export in different regions is different. The improvement of transportation infrastructure to promote the development of export trade in Western China needs the joint action of other forces, such as releasing the power of transportation infrastructure improvement to promote the development of export trade in economically backward areas of Western China through industrial support and industrial transfer. For the economically developed areas, the transportation infrastructure has been gradually improved, and the space for improving the transportation infrastructure to promote export trade has been limited. The development of export trade needs to further improve the role of other factors, such as improving the innovation ability of enterprises through technological innovation and promoting the formation of high-value industrial chain.

(3) International trade organization can release the effect of transportation infrastructure on regional export. One band and one road, should be promoted to promote the development of export in the Western China.

Acknowledgments: Special thanks are given to Lynne Chester, Professor of Political Economy at the University of Sydney, and to Anders. Ekeland, expert at the National Statistics Office of Norway, for their advice.

References

Bai, C. E., & Ji, D. X. (2018). Transportation infrastructure and export: Evidence from national trunk lines in China. *The Journal of World Economy*, 41(1), 101-122. <https://doi.org/CNKI:SUN:SJJJ.0.2018-01-006>

- Deng, W. (2016). An empirical study on the impact of port efficiency on China's export trade. *Logistics Sci-Tech*, 8. <https://doi.org/0.13714/j.cnki.1002-3100.2016.08.027>
- Glaeser, E. L., & Kohlhase, J. E. (2003). Cities, regions and the decline of transport costs. *Papers in Regional Science*, 83(1), 197-228. <https://doi.org/10.1007/978-3-662-07223-39>
- Gong, J., & Yin, Z. M. (2016). One belt, one road strategy of Railway Construction: A study of trade effects based on stochastic frontier model from the perspective of transportation time and transport distance. *Journal of International Trade*, 2, 14-25. <https://doi.org/CNKI:SUN:GJMW.0.2016-02-002>
- Limão, N., & Venables, A. J. (2001). Infrastructure, geographical disadvantage, transport costs, and trade. *World Bank Economic Review*, 3, 451-479. <https://doi.org/info:doi/10.1596/0-1985-0908-1>
- Liu, S. L., & Hu, A. G. (2010). Transportation infrastructure and economic growth: From the perspective of regional disparity in China. *China Industrial Economics*, 4, 14-23. <https://doi.org/CNKI:SUN:GGYY.0.2010-04-003>
- Liu, B. L., & Liu, Y. H. (2011). Transportation infrastructure construction and inventory cost reduction of Chinese manufacturing enterprises. *China Industrial Economics*, 5, 69-79. <https://doi.org/CNKI:SUN:GGYY.0.2011-05-009>
- Liu, Q., & Shao, Z. (2018). Trade cost effect of transportation infrastructure: Theoretical analysis based on dual economic framework and China's experience. *World Economy Studies*, 2, 98-112+136. <https://doi.org/10.13516/j.cnki.wes.2018.02.009>
- Martínez, Z. I., & Suárez, B. C. (2005). Transport costs and trade: Empirical evidence for Latin American imports from the European Union. *Journal of International Trade and Economic Development*, 14(3), 353-371. <https://doi.org/10.1080/09638190500212121>
- Martincus, C.V., Carballo, J., & Cusolito, A. (2017). Roads, exports and employment: Evidence from a developing country. *Journal of Development Economics*, 125, 21-39. <https://doi.org/10.1016/j.jdeveco.2016.10.002>
- Persson, M. (2011). Trade Facilitation and the Extensive Margin. *Scottish Journal of Political Economy*, 22(5), 658-693. <https://doi.org/10.1080/09638199.2011.587019>
- Raballand, G., Kunth, A., & Auty, R. (2005). Central Asia's transport cost burden and its impact on trade. *Economic Systems*, 29(1), 6-31. <https://doi.org/10.1016/j.ecosys.2005.02.004>
- Shi, Z. K., Shao, J., & Pu, Z. N. (2018). Transport infrastructure improvement and productivity growth: Evidence from railway speed increase. *The Journal of World Economy*, 41(6), 127-151. <https://doi.org/CNKI:SUN:SJJJ.0.2012-01-008>
- Wang, Y. J., & Huang, Q. (2017). Transport infrastructure quality, time sensitivity and export performance. *Journal of Finance and Economics*, 43(10), 97-108. <https://doi.org/10.16538/j.cnki.jfe.2017.10.008>
- Wang, D. F., Dong, Q. L., & Yu, L. X. (2018). One belt, one road: National and regional logistics performance and China's foreign trade potential. *China Business and Market*, 2. <https://doi.org/10.14089/j.cnki.cn11-3664/f.2018.02.003>
- Wei, S. J., & Li, L. M. (2017). Analysis on the influence of port development between China and ASEAN countries on China's export to ASEAN: Gravity model checking based on Panel Data. *Social Sciences in Guangxi*, 3. <https://doi.org/10.3969/j.issn.1004-6917.2017.03.007>
- Xu, L. Z., Fang, S. C., & Wang, S. Y. (2012). An empirical study on the impact of China's transportation cost and efficiency on export trade. *Systems Engineering-Theory & Practice*, 32(5), 1057-1057. <https://doi.org/10.3969/j.issn.1000-6788.2012.05.018>
- Xu, J., Chen, K. M., Yang, S. F., & Lin, L. J. (2016). The international economic and trade effect of "one belt and one road" transportation infrastructure construction. *Asia Pacific economy*, 3, 3-11. <https://doi.org/CNKI:SUN:YTJJ.0.2016-03-003>
- Zhou, H., & Zheng, X. T. (2012). Transport infrastructure quality and economic growth: Evidence from China's railway speed increase. *The Journal of World Economy*, 1, 78-97. <https://doi.org/CNKI:SUN:SJJJ.0.2012-01-008>
- Zhang, P. F. (2018). One belt, one road Asian trade impact of infrastructure development: An analysis based on the gravity model expansion. *World Economy Studies*, 6, 70-82+136. <https://doi.org/CNKI:SUN:JING.0.2018-06-008>

New Infrastructure and Corporate Value Creation: Theory and Practice in China

Zhixin XUE* and Xiaojing CHAO

¹ School of Economics & Management, Research Institute of Economy and Development of Western China, Northwest University, Xi'an, China; xuezhixin0106@163.com

* Corresponding author: xuezhixin0106@163.com

Abstract: During the post-epidemic era, solving the problem of new infrastructure has become an urgent need to realize the value growth of Chinese companies. However, whether the process of new infrastructure will have a positive effect on China's corporate value has become a key issue that needs to be answered urgently. Based on the panel data of China's listed companies from 2010 to 2018, this paper makes an empirical study on the relationship between new infrastructure and corporate value of China's listed companies. The results of mean regression show that the strengthening of new infrastructure has a significant positive impact on the corporate value. In addition, technology intensive industries, private enterprises and growing enterprises have significant positive adjustment on the relationship between the new infrastructure and corporate value. Among them, the growth of enterprises has the greatest influence on them. Therefore, China should further strengthen the construction of new infrastructure to ensure its driving in the process of improving the company's value creation.

Keywords: new infrastructure; corporate value; adjustment effect; micro-enterprise behavior

JEL Classification: L2; O3; M2

1. Introduction

Industrial system and trade rules are facing severe challenges in the period of structural adjustment of China's economic development. If China wants to build a modernized socialist country, it must seize the new opportunities brought by the new round of scientific and technological revolution and industrial reform, and strive to achieve higher quality development. The core of high-quality economic development at the micro level lies in the promotion of enterprise value, and enterprise digital transformation is the key to the promotion of enterprise value. As a typical performance of enterprise digital transformation, new infrastructure pays more attention to the digital reconstruction of new technology, new mode and new format than traditional infrastructure. Therefore, will the new infrastructure replace the traditional infrastructure and have an impact on the company's value? How to promote enterprises to form a higher level of dynamic balance?

The existing literature mostly studies the corporate value from the micro and meso perspectives of EVA assessment, management incentive, political connection, family management relationship, corporate social responsibility, and industrial globalization (Chi

et al., 2013; Li et al., 2016; Zhan & Wang, 2013; Chen et al., 2017; Wang & Xu, 2016). However, there are few studies on the impact of infrastructure on corporate value at the macro level, mainly focusing on the impact of transportation infrastructure on enterprise inventory and resource allocation efficiency (Zhang et al., 2017; Li & Tang, 2014), Or the research on the effect of information infrastructure on export performance (Li et al., 2015), which pay less attention to the impact of new infrastructure on corporate value.

The new infrastructure is an infrastructure system formed by the evolution, integration and overlapping iteration of new generation information technologies such as 5G, Internet, industrial Internet, artificial intelligence, cloud computing and data center (Xu, 2020). It can not only expand the scope of data collected by enterprises, promote enterprises to extract data from heterogeneous resources more conveniently and smoothly, form the data scale effect, promote the enterprise value, but also enhance the collaboration among various departments and upstream and downstream enterprises through collaborative management in order to achieve self-strengthening and enhance enterprise value. Based on the above carding, this article believes that new infrastructure can promote the value of Chinese enterprises.

2. Methodology

The sample interval of this article is from 2010 to 2018, the data used are the operating data of Chinese listed companies in China. The data used in the above data are all from DRCNET Statistical database and CSMAR Service Center. Due to the lack of data in Tibet, Hong Kong, Macau, Taiwan provinces, and St & TT companies are excluded. While linear interpolation was used to supplement a small number of missing values, in order to avoid the influence of outliers on the regression results, a 1% bilateral tailing process was performed on all continuous variables.

Among them, referring to the practices of Liu and Zhang (2016) and Wu (2019), this article chooses to take Tobin Q value as the measure of the company value(ev). When measuring new infrastructure, this paper measures the new infrastructure of cities(di) in the following ways: Firstly, determine the new infrastructure related vocabulary. This paper holds that the word frequency reflecting the new infrastructure includes 5G, mobile communication and information technology and so on. Secondly, manually collect the government work reports of 30 provinces and autonomous regions from 2010 to 2018, and segment the government work reports; Thirdly, the frequency proportion of words related to the new infrastructure is counted. Finally, selects the allocation efficiency of prefecture level cities to multiply with the new infrastructure, and obtains the new infrastructure data at the prefecture level.

In addition, the following control variables are selected in this article: ① Operating cost ratio(ocr) is defined as the proportion of operating cost and operating income; ② Employee compensation payable(wage) is measured by the logarithm of per capita employee compensation payable of listed companies; ③ Enterprise age(age) is defined as the number of years from the listing to the research year; ④ Equity concentration (shr) is measured by the shareholding ratio of the top ten shareholders; ⑤ R&D investment level (rea) is

measured by the proportion of R&D investment in operating revenue; ⑥Enterprise scale (ass) is expressed as the total assets of the company after taking the natural logarithm.

Table1. Descriptive statistics of variables

Variable	Mean	St.d	Min	Max	N
ev	2.680949	1.94935	0.882626	11.90137	21,812
di	0.992293	1.026456	0	4.522082	22,791
ocr	0.7092179	0.174932	0.1736312	1.004333	22,784
wage	16.87911	1.664381	11.9073	21.2893	22,625
age	20.80849	5.193178	11	34	19,383
shr	59.56264	15.80558	22.41	94.61	22,773
rea	4.496068	4.345019	0.03	25.62	16,360
ass	22.03087	1.301655	19.47466	26.0246	22,791

In order to further understand the correlation between new infrastructure and corporate value, this paper makes a univariate analysis. It can be seen from the results in Table 2 that the average value of the group with high new infrastructure is higher, and they are all significant at the 1% level, which provides preliminary evidence that the increase of new infrastructure investment helps to enhance the value of the company.

Table 2. Mean test of new infrastructure and company value

	Category	N	Corporate value		
			Mean	Diff	T test
di	high	8,220	2.943787	0.4070491	14.8856***
	low	13,625	2.536738		

3. Results

3.1. Construction of the Economic Model

Based on the above theoretical analysis ideas, in order to capture the actual impact of new infrastructure on corporate value, this article builds the following basic measurement models:

$$ev_{it} = \alpha_0 + \alpha_1 di_{it} + \beta X_{it} + v_j + v_r + \varepsilon_{it} \quad (1)$$

Among them, the explained variable is ev_{it} , which represents the corporate value; i and t represent the enterprise and year respectively, and the core explanatory variable is di_{it} , which represents the degree of new infrastructure. X_{it} is a series of factors that affect the value of a company, including: operating cost ratio (ocr), employee compensation payable (wage), enterprise age(age), equity concentration (shr), R&D investment level (rea) and enterprise scale(ass). v_j , v_r are industry, regional dummy variables, respectively, reflecting industry fixed effects, regional fixed effects. ε_{it} is a random perturbation term.

3.2. Results of the Benchmark Model

In the benchmark regression section, the fixed effect model is used to estimate the role new infrastructure level of Chinese prefecture-level cities in 2010-2018 on the corporate value of local listed companies. Table 3 is the corresponding benchmark regression results. In column (1), the coefficient of *DI* is significantly positive and significant at the 1% confidence level, which indicates that the company value will increase significantly with each additional unit of new infrastructure. In column (2), the estimated coefficient of new infrastructure is significantly positive at the level of 1%, which is consistent with the results in column 1. In column (3), the new infrastructure coefficient is 0.514, and the direction does not change significantly, which is still significant at the level of 1%. It shows that the construction of new infrastructure can significantly enhance the company value.

Table 3. Impact of new infrastructure on company value

	Corporate value		
	(1)	(2)	(3)
di	0.350*** (0.0185)	0.508*** (0.0217)	0.514*** (0.0218)
control	YES	YES	YES
_cons	18.73*** (0.501)	18.50*** (0.442)	18.98*** (0.503)
v _j	YES	NO	YES
v _r	NO	YES	YES
N	12,600	12,603	12,600
R ²	0.382	0.373	0.398
F	303.1	408.3	322.4

3.3. Results of the Heterogeneity Test

The above basic econometric model mainly describes the positive promotion effect of new infrastructure on the company value in the mean range, ignoring their heterogeneity. Firstly, the impact of new infrastructure on the value of Companies in different industries may be different. Compared with non-technology-intensive industries, technology-intensive industries need more knowledge and information, and new infrastructure plays a more important role in promoting the value of technology intensive companies. Therefore, referring to the division basis of technology intensive industries by Lv et al. (2020), this paper divides all enterprises into two groups for technology-intensive industry and non-technology-intensive industry for empirical test. It can be seen from the results in the first two columns of Table 4 that when the new infrastructure increases by one unit, the company value of technology intensive industries will increase by 0.514 units, while that of non-technology intensive industries will increase by 0.496 units, which indicates that the new infrastructure has a greater promoting effect on the company value of technology intensive industries than that of non-technology intensive industries.

Secondly, compared with private enterprises, state-owned enterprises have problems in top-level design, technology integration and data management and control, which affect the promotion of new infrastructure to corporate value. Therefore, according to the nature of

equity, this paper divides all enterprises into state-owned enterprises and non-state-owned enterprises for empirical test. Columns (3) and (4) of Table 4 report the regression results of the impact of new infrastructure construction on corporate value under different ownership nature. The results show that new infrastructure construction can enhance the value of both types of ownership companies, and the promotion effect of new infrastructure construction on the value of non-state-owned companies is much higher than that on the value of state-owned companies.

Finally, for the division of different growth stages of enterprises, this paper divides the enterprises whose age is lower than the average age of the whole sample enterprises into growing enterprises, and the rest are mature enterprises. The regression results are shown in the last two columns of Table 4. It can be seen that the new infrastructure has a significant role in promoting the value of both growth and mature companies. However, as far as the regression coefficient is concerned, the regression coefficient of the new infrastructure of the growing enterprises is 1.39 times that of the mature enterprises, which means that the new infrastructure has a strong promotion effect on the growing enterprises. This may be due to the fact that growing enterprises need digitalization more. For example, the 2020 digital initialization index of small enterprises in China released by Dell IDC points out that more than 50% of small enterprises attach importance to digitalization, and most growing enterprises pay more attention to subdivision fields, with rapid growth and huge development potential. Therefore, new infrastructure as an important means to promote digital transformation, the higher the level of new infrastructure construction, the more conducive to the growth of enterprises to enhance their corporate value.

Table 4. Heterogeneity test of new infrastructure on corporate value

Estimation	Corporate value					
	Industry heterogeneity		Firm nature heterogeneity		Firm age heterogeneity	
	Technology-intensive industries	Non technology-intensive industries	State-owned enterprise	Non state-owned enterprise	Mature enterprise	Growth enterprise
di	0.514***	0.496***	0.273***	0.619***	0.412***	0.574***
	(0.0218)	(0.0258)	(0.0286)	(0.0283)	(0.0302)	(0.0301)
Control	YES	YES	YES	YES	YES	YES
_cons	18.98***	18.03***	16.18***	21.24***	18.57***	19.39***
	(0.503)	(0.580)	(0.772)	(0.745)	(0.840)	(0.671)
v _i	YES	YES	YES	YES	YES	YES
v _r	YES	YES	YES	YES	YES	YES
N	12,600	7,946	3,784	8,814	5,183	7,414
R ²	0.398	0.420	0.454	0.355	0.421	0.392
F	322.4	197.8	64.79	224.0	120.1	190.8

4. Discussion

In order to answer the key question whether new infrastructure can promote corporate value, this paper uses mean regression as experiments to test new infrastructure can promote corporate value. Compared with the existing research literature, this article mainly

expands the existing research from the following aspects: Firstly, enriching and expanding the theoretical research on the value of new infrastructure to the company. In addition, there is a significant difference between the new technology and the traditional infrastructure in the nature of the new infrastructure. Secondly, based on the panel data of China's A-share listed companies from 2010 to 2018, this paper systematically studies the driving effect of new infrastructure on corporate value. Few researches empirically test the impact of new infrastructure on corporate value from the perspective of macro level. This paper finds that the new infrastructure has obvious driving effect on corporate value. Finally, this paper tests the difference of the driving effect of new infrastructure on the company's value, which provides targeted decision-making basis for the formulation of new infrastructure related policies.

5. Conclusions

The driving characteristics of new infrastructure to China's economic development are continuously emerging. This paper investigates the theoretical mechanism of new infrastructure to company value based on the micro level, and analyzes the promotion effect and mechanism of new infrastructure to company value based on the panel data of China's listed companies from 2010 to 2018. The results show that: on the one hand, the new infrastructure significantly drives the company's value, so the new infrastructure construction is a new driving force for enterprises to obtain sustainable competitive advantage. On the other hand, new infrastructure plays a greater role in promoting the value of technology intensive industries, private enterprises and growing enterprises. Therefore, China should further strengthen the construction of new infrastructure. Focus on the segmentation of new infrastructure, strengthen the deployment of industrial Internet, 5G, data center, give full play to the scale effect and cluster effect of new infrastructure, and lead enterprises to realize value creation. At the same time, improve the efficiency of enterprise resource allocation. In the process of new infrastructure construction, Chinese enterprises need to fully consider their own situation and regional data level, and improve the construction of new infrastructure in non-technology-intensive industries, state-owned enterprises and mature enterprises, so as to realize the rational allocation of data resources more effectively.

Acknowledgments: This work was supported by Shaanxi Social Science Fund (Grant No 2019D018), Research on High Quality Development Strategy of Yellow River Basin, Special Support Plan for High-level Talents in Shaanxi Province and Support for Outstanding Young Talents in Shaanxi Province.

References

- Banerjee, A, Duflo, E., & Qian, N. (2020). On the road: Access to transportation infrastructure and economic growth in China. *Journal of Development Economics*, 145. <https://doi.org/10.1016/j.jdeveco.2020.102442>
- Chen, A. (2017). Big data and the development of regional economy. In *2016 International Conference on Modern Management* (pp. 177–181). Advances in Social Science, Education and Humanities Research. <https://doi.org/10.2991/mmets-16.2017.32>
- Chen, Z., Wu, M., & Chen, Z. (2017). The path of family management affecting the value of small and medium-sized family companies: a study of agency theory and efficiency theory based on industry competition. *China Industrial Economy*, 5, 113–132. <https://doi.org/10.19581/j.cnki.ciejjournal.2017.05.008>

- Chi, G., Wang, Z. & Yang, J. (2013). Does EVA improve company value? - Empirical evidence from Chinese state-owned listed companies. *Accounting Research*, 11, 60–66.
- Liu, X., & Zhang, C. (2016). Corporate governance, social responsibility information disclosure, and enterprise value in China. *Journal of Cleaner Production*, 142, 1075–1084. <https://doi.org/10.1016/j.jclepro.2016.09.102>
- Li, H., & Tang, L. (2015). Transportation infrastructure investment, spatial spillover effect and enterprise inventory. *Management World*, 4, 126–136. <https://doi.org/10.19744/j.cnki.11-1235/f.2015.04.012>
- Li, H., Fu, S., & Gao, P. (2016). Media attention, carbon information disclosure and corporate value. *Statistical Research*, 9, 63–69.
- Li, K., Shao, W., & Wang, Y. (2015). Information density, information infrastructure and enterprise export performance: theoretical and empirical analysis based on enterprise heterogeneity. *Management World*, 4, 52–65. <https://doi.org/10.19744/j.cnki.11-1235/f.2015.04.012>
- Li, X. (2016). Research on corporate value management system based on EVA. *Management World*, 8, 182–183. <https://doi.org/10.19744/j.cnki.11-1235/f.2015.04.012>
- Lv, Y., Gu, W., & Bao, Q. (2020). Artificial intelligence and Chinese enterprises' participation in global value chain division. *China Industrial Economy*, 5, 80–98. <https://doi.org/10.19581/j.cnki.ciejournal.2017.05.008>
- Wang, Q., & Xu, X. (2016). Value creation mechanism and empirical test of corporate social responsibility -- Based on stakeholder theory and life cycle theory. *China Soft Science*, 2, 179–192.
- Wu, G. (2019). Separation of ownership and corporate value: support Effect or tunneling effect. *Journal of Central University of Finance and Economics*, 9, 97–106.
- Xu, X., Zhang Z., & Guan, H. (2020). China's new economy: role, characteristics and challenges. *Finance and Trade Economy*, 1, 5–20.
- Zhan, L., & Wang, Y. (2013). Management incentive, over investment and corporate value. *Nankai Management Review*, 3, 36–46.
- Zhang, T., Gao, X., Bu, X., & Xie, X. (2017). Does China's transportation infrastructure construction improve the efficiency of enterprise resource allocation? - based on the analysis of highway construction and factor input of manufacturing enterprises. *Financial Research*, 8, 122–134.

Cost Calculation in Research and Development of New Validation Methods

Alexandra ZAHORSKA, Simona MUNZAROVA* and Jana KOSTALOVA

¹ University of Pardubice, Pardubice, Czech Republic; alexandra.zahorska@student.upce.cz;
simona.munzarova@upce.cz; jana.kostalova@upce.cz

* Corresponding author: simona.munzarova@upce.cz

Abstract: In this paper, we focus our attention primarily on management tools and techniques that could be applied in the pre-production stage of the production process, respectively in the R&D stage. Attention is focused on Strategic cost management and its tools in R&D. Innovations and R&D are necessary for business to build competitive advantage, but looking closer at R&D activities, we could see constantly increasing costs, the costs of professional staff, instrumentation, aids, etc. So, it is appropriate to find and apply proper management methods, tools and techniques of strategic cost management. This article is based on the results of research dealing with the cost analysis of a newly developed method for the toxicity testing of nanomaterials. For the purposes of analysis and cost calculation, one of the newly developed validation methods for determining the toxicity of nanomaterials was selected. In the conditions of laboratory research, it was found that mainly activities are the main cost object for cost calculations. It seems advantageous to use the Activity Based Costing method for managing or determining the costs at R&D laboratories or for cost calculations of the newly developed methods.

Keywords: costing; R&D activities; testing; nanomaterials; activity-based costing

JEL Classification: O32; O31

1. Introduction

Management and improvement of R&D is a continuous process that requires utilization of many strategic management practice, considering the specific nature of R&D costs. In today's world of economic change, globalization, digitization, or the threat of climate change, companies must make increasing efforts to adapt to continuous changes in the business environment, keep pace with rapidly changing market conditions, innovate their processes, adopt new concepts. The growing complexity of technologies, the rising costs of product innovations, including uncertainty in their development and implementation, require strong management tools and procedures. Strategy's success requires to apply suitable strategy tools that help managers to decide, at all the stages of strategic management, to improve processes and increase overall business performance. (Nouri et al., 2017; Qehaja et al., 2017; Tetreva, 2004). The results of the survey in several studies that analyzed the tools and techniques of strategic management indicated that it is necessary to continue to pay attention to their implementation in companies, their development and understanding. (Afonina et al., 2013; Bingöl et al., 2017; Clark, 1997)

When making strategic decisions about the actual implementation of research and development, long-term investments, purchases of services or products, or their own implementation, etc., it is necessary to have appropriate tools and techniques of strategic management accounting SCM (Berisha, 2017; El-Dyasty, 2007). Focus on optimization of the costs for future processes in the pre-production stages during investment decision-making phase can help create a solid foundation for these processes, which will not be subject to additional significant changes. At present, however, there is no comprehensive register of tools and techniques of strategic cost management in the literature. Following 10 tools and techniques of strategic cost management have appeared in literature with a higher frequency: Activity based costing, Balanced scorecard, Benchmarking, Competitor cost assessment, Customer accounting, Life cycle costing, Strategic costing, Strategic pricing, Target costing, Value based costing.

In the area of R&D cost management, the lack of use of economic management tools can be encountered, as Shields (1994) explained in the past by saying, "The creativity of scientists and technicians working in R&D laboratories should not be limited by cost concerns." The costs of R&D activities are constantly increasing, the costs of professional staff, instrumentation, aids, etc. are increasing. Thus, the application of new methods and tools of strategic cost management may be appropriate. It is necessary to study the R&D cost management environment and select appropriate procedures and tools and implement appropriate changes. Such a change was the application of the process approach to activity management, the implementation of the Activity Based Costing (ABC) method. The basic idea of this method is cost management based on cost relationship to activities as basic cost objects, which distinguishes ABC from traditional costing systems (Oseifuah, 2014). The starting point of the ABC method are three key assumptions: it is necessary to use activities to create products, activities consume resources, resources require money. This new approach for performing cost calculations has contributed to solving the problem of ever-increasing overhead costs for product production, which is mainly due to the strengthening of the production automation process in organizations and also more complex production processes (Almeida et al., 2017). ABC procedures as a suitable cost management tool could be also beneficial to use in laboratories, including laboratory research. McDowell (2005) examines the use of the ABC method for calculation of costs in hospital laboratories, looking for ways to remedy the ever-burdensome budget of laboratories, caused primarily by the increasing volume of tests and, as a result, the increasing need for persons. She described the calculation of costs using the ABC method as a suitable tool for cost management in laboratories and finding the optimal variant of the cost budget of these laboratories

Newly, also Hajighasemi and Azhdari (2020) suggests that the time driven model of Activity based costing reports better the cost of services. On the other hand, Price et al. (2020) discuss that in case of healthcare, ABC should move towards value-based approach paying attention also to its stakeholders.

Another tool and technique of strategic cost management for the calculation of research laboratory costs is Life cycle costing (LCC). One of the basic features of LCC is the evaluation of not only the costs of the production stage of the product, but its entire life cycle, the so-called gradle to grave (Knauer & Möslang, 2018). According to Lindholm and Suomala (2002), this method requires

a large amount of diverse hard-to-reach data, complicated calculations and long-term predictions. Kambanou (2020) and Olubodun (2010) also mention the deficit in demand for LCC technology, the lack of a standardized methodology, etc. On the contrary, according to Knauer and Möslang (2018), the LCC technique is an adequate strategic tool for organizations. It helps to determine the organization's cost of a product or service and to understand the behavior of individual cost elements at different stages of the life cycle (Lindholm & Suomala, 2002).

The development of new drugs and similarly nanomaterials is a highly innovative sector. Empirical analyzes of R&D costs are interesting at least for analyzes of return on investment in research and development, in the case of a new drug they affect the structure of innovation in pharmaceutical products. Many studies in biomedicine and drug testing deal with cost requirements or other economic analyzes. Following studies can be mentioned as an example: Simeons et al. (2017) deals with the role of budget impact analysis when assessing biosimilars, Moore et al. (2018) points out, based on a cost analysis of Pivotal Trials for Novel Therapeutic Agents Approved by the US Food and Drug Administration, that costs increase with the increasing number of patients enrolled in trials, or in connection with the need to prove that a new drug has the same or better clinical benefit than any other, already available drug. DiMasi et al. (2003) deals with investment cost for new drug development. Rovida and Hartung (2009) discuss costs for in vivo tests to accomplish REACH legislation pointing that it is the largest investment into consumer product safety ever. Prasad and Mailankody (2017) deal with cost of R&D to get a drug, particularly 10 cancer drugs, to Market and compares it with Revenues After its Approval.

Nanotechnology can currently be described as one of the highly innovative technologies of the 21st century, also due to its use in R&D activities, where it is considered to be extremely beneficial, especially when it comes to biotechnology, medical and pharmaceutical disciplines. This researched field can provide many solutions to unresolved issues related to the medical field, especially in the prevention, diagnosis but also the treatment of various diseases. (Leso 2019) At present, many authors have appeared, who in their contributions deal with the issue of the use of nanomaterials in medical practice. One of them is Boisseau and Loubaton (2011), as well as Kubinova and Sykova (2010), who deal with the use of nanotechnology in regenerative medicine, where they point to the application of nanomaterials in tissue engineering and cell therapy as a modern approach in disease therapy. In this area, nanomaterials can support cell growth and thus provide stimulation and subsequent regeneration of damaged tissues and organs. Nyström and Fadeel (2012) highlights nanotechnology as an exceptional opportunity for target drug delivery, where the efficacy of a drug at a target site may be improved by reducing its dose in surrounding tissues and thereby reducing its side effects. Fakruddin (2012) investigates further medical uses of nanomaterials, and points in particular to diagnostic applications, such as nucleic acid diagnostics, which allows the detection of damaged cells in the earlier stages of various diseases. It also draws attention to the application of nanomaterials as target probes and imaging instruments, but also to therapeutic applications of nanomaterials, such as their use in biomolecular engineering, biopharmaceuticals, cardiotherapy, dental treatment but also in the orthopedic sphere. One of the many other applications of nanomaterials in medicine is

also addressed by Kargoza and Mozarafi (2018), specifically the use of nanotechnology as a therapeutic tool, especially in the treatment of various cancers, where in many respects, nanotechnology is considered a more effective strategy in cancer therapy than conventional chemotherapeutics. Barkalina et al. (2014), on the other hand, emphasize the current growing trend in applications such as the use of nanomaterials in reproductive biology and medicine. The discovery of new nanomaterials and their applications also raises questions related to safety and sustainability.

However, there are currently limited data on the toxicity of nanomaterials and their behavior in the biological systems. At present, the main challenge for nanotoxicological processes is to analyze the significant difference in reported toxicity studies. Furthermore, it is also appropriate to assess the costs not only for the development and production of the product, but also for its evaluation / verification. The aim of this article is to evaluate the use of current methods and possibilities of using cost accounting procedures in the field of R&D and based on the results of research to present and discuss possible procedures for determining the costs of selected newly developed method for determining the toxicity of new nanomaterials.

2. Methodology

Primary qualitative research was carried out to identify current cost management practices and to determine the costs of R&D activities in a research facility dealing with the development of toxicity testing methods for newly developed nanomaterials.

First part of the research, the identification of current cost management practices, was carried out by the method of individual interviews with the managers of the relevant project and with a senior researcher who develops procedures for determining the toxicity of nanomaterials. The second part of the research was an in-depth analysis of individual types of costs and time frames of individual activities of pre-selected methods for determining the toxicity of nanomaterials, developed at the workplace. This part of the research was carried out both by separate measurements and by expert estimates of the main researcher. The sequence of steps was monitored for each individual method. In each of them, an in-depth analysis of costs, time, consumables, capital equipment, researchers, etc. was performed. Four testing methods were selected for the research, while an in-depth analysis was performed for two of these methods. Based on information on the costs and time required for specific testing toxicity methods a calculation of their costs was compiled. The analysis also included an evaluation of the proposed changes in the cost management system in case of modified usage of instruments by more validation methods and different type of depreciation.

3. Results

3.1. Characteristics and Structure of Project and Laboratory Expenses

Research of the costs and time consumption for developed methods was part of a research project for which a team of scientific experts was assembled and a special research infrastructure was created to develop and characterize new nanomaterials, modify them and

test the impact of these newly developed nanomaterials on the human body. The process of testing the toxicity of nanomaterials is very time-consuming, professionally and financially demanding. The key goal of the project is to create a multi-departmental center consisting of several top research institutes. Each workplace works with its own budget, so it was possible to compare the cost structure for the project at given workplace and for laboratory research of the workplace, where the project was realized.

Based on the analysis of project expenses in planned project budget and laboratory costs, these expenses were divided into six groups. The total value of individual expenses groups differs from each other and in the case of a project may be significantly affected by the requirements of the grant provider for the project. The following table 1 provides ascending expenses groups from the highest percentage items to the lowest expenditure items broken down by project and laboratory.

Table 1. Structure of project expenses and expenses in research laboratory department

Type of Expense	Project	Laboratories
Personal exp.	41.6%	32%
Investments	28%	31%
Operation exp. of research	15.1%	15%
Services	6%	6.3%
Travelling exp.	5.9%	9.2%
Administration overhead	3.8%	6.5%

Personnel expenses represent the most expensive item in the total budget. This category of expenses also includes social and health insurance and other statutory insurance. The salaries of researchers are set with regard to their qualifications. Capital expenses are related to the purchase of new laboratory equipment. The operating expenses for the implementation of research include mainly chemicals, biomaterials, small laboratory equipment, protective equipment, consumables, etc. Services and travel costs are equally demanding on the budget. Services include, in particular, instrument repairs, publication costs, outsourcing of special analyzes and costs of intellectual property protection. Travel expenses cover the participation of researchers in various professional conferences in the Czech Republic and abroad, internships to train researchers in working on new devices, trade fairs and innovation and investor forums to present research results and to establish partnerships. The last and lowest item is administrative expenses.

As it is possible to see the structure of expenses in terms of the whole project and also the department, resp. laboratory where the validation method is developed, is very similar in terms of percentage comparison. A smaller share of expenses in the monitored department compared to expenses for the entire project is represented by personal expenses, indicating the participation of experts with higher qualifications. Furthermore, it is possible to see higher capital expenses within the monitored department, which, however, can also be used for the project. At the same time, the department has a higher percentage for travel and administrative expenses.

3.2. Cost Analysis of Selected Developed Methods for Determining the Toxicity of Nanomaterials

The toxicity of nanomaterials could be assessed by various methods. Our final cost analysis focused on two key methods, which can be described as:

1. Setting method, which allows to find out the parameters for the second, routine analysis. One type of nanomaterial is tested by this method in a smaller number of concentrations and repetitions.
2. The routine method evaluates the possible toxicity of the tested nanomaterial. The testing process takes place in multiple concentrations, with more replicates and more cell incubations.

To analyze the possibilities of compiling a cost calculation, the costs were first divided into direct and indirect to the implemented methods of toxicity testing of nanomaterials. The direct costs were some laboratory supplies and materials. However, the cost analysis revealed that some laboratory aids and materials are used at the same time by several methods, several methods involve the same differently qualified laboratory technicians and researchers, different methods and their partial activities use some of the same instruments, in the same rooms, similarly, a number of items of small assets are consumed by several methods, i.e. these are indirect costs. Direct costs accounted for only about 12% of total costs. To calculate the indirect costs, the causal relationship between the expenditure of these costs and the implementation of the given method of testing the toxicity of nanomaterials was analyzed, in order to determine the appropriate scheduling basis. This analysis showed that the reason for these costs is the repetitive activities that make up the various methods for determining toxicity. At the same time, the relationship between individual activities and the volume of performed methods for testing the toxicity of nanomaterials was analyzed in order to complete the cost calculation.

The obtained data were determined for individual phases of the experiment, structured into individual laboratory activities, further according to persons and their qualifications, working time, and similarly for devices. The type of consumables and chemicals for each activity and their purchase price were determined.

Both above mentioned methods for determining the toxicity of nanomaterials differ in the number of concentrations of the analyzed sample, or in the number of repetitions of the experiment, but both methods are same in the four basic phases of testing that the experiment goes through. These are: the phase of preparation of nanomaterials, the phase of preparation of cells, the phase of incubation of cells with nanomaterials and the phase of determining the toxicity of nanomaterials. These phases again differ in the complexity of the individual steps (activities) in terms of time consumed, the place to perform the experiments, the relevant staff and instrumentation, as well as the necessary consumables and other materials. But again, as both methods are same in their phases, they are also same in activities within these phases, activities differ by number of iterations and time consumption, as indicated in the following Table 2, which shows part of the data obtained.

Table 2. Example of data sheet on time consumption by each activity in both testing methods

		Method 1		Method 2	
Phase	Activity	Time person (min)	Time equip. (min)	Time person (min)	Time equip. (min)
Experiment preparation	a	10	10	10	10
	b	10	35	10	35
	c	15	5	20	10
Cells preparation	d	80	infinite	80	infinite
	e	20	30	20	30
	f	1,080	1,080	1,800	1,800
	g	60	0	120	0
Incubation (NM with cells)	h	120	120	1,080	1,080
	i	30	30	270	270
	j	10	1,440	90	12,960
Toxicity of NM determination	k	10	10	90	90
	l	5	60	45	540
	m	120	0	540	0

Based on the obtained information, a cost calculation of the developed method for testing the toxicity of nanomaterials was compiled. First, the traditional way of determining costs on each method was performed. As the analysis showed that the objects that cause costs are mainly individual activities and number of these activities are repeated in the laboratory, or differ only in time consumption or number of repetitions, it could be useful to compile a cost calculation using the Activity Based Costing.

Furthermore, number of costs analyzes was performed, considering other factors, such as the inclusion of other methods for determining the toxicity of nanomaterials and thus bringing better use of laboratory capacity, or tax depreciation was changed to accounting depreciation, etc. These factors affect the total cost in the final cost calculation for these methods. The following Table 3 summarizes the influence of some factors on the total cost of the developed method for determining the toxicity of nanomaterials.

Table 3. Total cost of analyzed method under different factors

	Without time use	Time use considered, tax deprec.	Accounting deprec. (twice longer)	Instruments used by 4 methods, tax deprec.
Lab. material and equipment	13%	16%	16%	18%
Wages	46%	60%	58%	67%
Research instruments	42%	23%	26%	15%
Total cost (CZK)	24,118	18,353	19,049	16,591

The resulting total cost of the method varies by up to approximately 35%. These calculations differ in how the depreciation of the instruments was assigned to the method. The second column allocates the cost only between the two methods analyzed, which would make sense if only these two methods were implemented in the laboratory. The third column

works with the time use of instruments based on the results of the analysis of activities and essentially corresponds to the procedures of Time Driven Activity Based Costing. The fourth column takes into account the possibility of using the devices for twice as long as is set aside for tax depreciation, which better corresponds to the actual use of the devices in practice. The fifth column retains the original depreciation, but calculates it equally among the several methods that are implemented on the same devices.

4. Discussion

In order to clarify the cost calculation of the observed toxicity testing method, some factors were included in the discussion:

1. The calculation of the test method included the actual time of use of selected instruments obtained from the time analysis. Especially for new instruments that are purchased under the project for the analysis of these methods, they are not fully utilized but they have the potential to be used for further laboratory analyzes in the future. This may reduce the cost of the method, but provide, that we plan to use the instrument for further analysis.

2. The calculation of the test method considered the estimated actual length of use of the instruments compared to the one used for depreciation of these instruments. It was necessary to consult this fact with researches, who uses the instruments.

3. The calculations were verified on the basis of cost analysis that include implementation of other testing methods. It was confirmed that the objectives of costs are mainly activities. These can be both repeated for individual developed methods and also be specific to the given method, however, these are again also repeated in one method.

4. Activities are a relevant cost object not only for depreciation of equipment, but also in terms of consumption of other assets or labor costs, etc. Although their calculation has not been shown here, they can be approached again according to the principles of Activity Based Costing.

For future research, it could be interesting to bring more studies on best practices of managing research and development costs, to find appropriate procedures and tools. None of these could be processed only by cost managers, thee important role plays the discussion with researches that know the environment of R&D laboratories. Both for new nanomaterials and their use in biomedicine, as well as for new toxicity testing methods, markets are just beginning to emerge. Then, for example, Target Costing or value-based procedures could also be used. In the research and development phase, cost calculation using the LCC method can be considered, but for its data it would first be appropriate to process sustainability LCA.

Conclusion

This article focuses on the cost analysis of a newly developed method for testing the toxicity of nanomaterials. Analyzes were performed on newly developed validation methods for determining the toxicity of nanomaterials. In the conditions of laboratory research, it was found that the main cost object for cost calculation are mainly activities. The individual activities are repeated in some phases of the experiment and at the same time these activities also appear in other developed methods of testing the toxicity of nanomaterials within the

given project. It was therefore proposed to use cost-based costing procedures for cost allocation. For further analysis, it is worth using its modification, which is Time Driven Activity Based Costing, due to a number of repetitive steps that are equally demanding, for example, on the equipment used or human labor. We thus consider the Activity Based Costing and Management method to be an important tool for cost management in the environment of R&D laboratories, which currently use budgets primarily as cost management tools.

Acknowledgments: This work was supported by OP RDE project „Strengthening interdisciplinary cooperation in research of nanomaterials and their effects on living organisms“, reg. n. CZ.02.1.01/0.0/0.0/17_048/0007421.

References

- Afonina, A., & Chalupsky, V. (2013). Investigation of strategic management tools and techniques. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 61(4), 833–840. <https://doi.org/10.11118/actaun201361040833>
- Almeida, A., & Cunha, J. (2017). The implementation of an Activity-Based Costing (ABC) system in a manufacturing company. *Procedia Manufacturing*, 13, 932–939. <https://doi.org/10.1016/j.promfg.2017.09.162>
- Barkalina, N., Charalambous, Ch., Jones, C., & Coward, K. (2014). Nanotechnology in reproductive medicine: Emerging applications of nanomaterials. *Nanomedicine: nanotechnology, biology, and medicine*, 10(5), 921–938. <https://doi.org/10.1016/j.nano.2014.01.001>
- Berisha, V. (2017). Strategic Management of Costs: A New Tool to Gain Competitive Advantage. In N. Tsounis, & A. Vlachvei (Eds.) *Advances in Applied Economic Research* (pp. 239–254) Springer Proceedings in Business and Economics. https://doi.org/10.1007/978-3-319-48454-9_17
- Bingöl, D., Filizöz, B., Okan, T., & Çapkulaç, O. (2017). The Effect of The Strategic Management Tools on SMEs' Firm Performance. *The European Proceedings of Social & Behavioural Sciences –13th International Strategic Management Conference 2017* (pp. 352–362). <https://doi.org/10.15405/epsbs.2017.12.02.30>
- Boisseau, P., & Loubaton, B. (2011). Nanomedicine, Nanotechnology in medicine. *Comptes Rendus Physique*, 12(7), 620–636. <https://doi.org/10.1016/j.crhy.2011.06.001>
- Carlin, B. I. (2009). Strategic price complexity in retail financial markets. *Journal of Financial Economics*, 91(3), 278–287. <https://doi.org/10.1016/j.jfineco.2008.05.002>
- Clark, D. (1997). Strategic management tool usage: a comparative study. *Strategic Change*, 6, 417–427. [https://doi.org/10.1002/\(SICI\)1099-1697\(199711\)6:7%3C417::AID-JSC281%3E3.0.CO;2-9](https://doi.org/10.1002/(SICI)1099-1697(199711)6:7%3C417::AID-JSC281%3E3.0.CO;2-9)
- DiMasi, J. A., Hansen, R. W., & Grabowski, H. G. (2003). The price of innovation: new estimates of drug development costs. *Journal of Health Economics*, 22(2), 151–185. [https://doi.org/10.1016/S0167-6296\(02\)00126-1](https://doi.org/10.1016/S0167-6296(02)00126-1)
- El-Dyasty, M. M. (2007). A Framework to Accomplish Strategic Cost Management. *SSRN Electronic Journal*, 2–6. <https://doi.org/10.2139/ssrn.704201>
- Fakruddin, M. H. Z., & Afroz, H. (2012) Prospects and applications of nanobiotechnology: a medical perspective. *J Nanobiotechnol*, 10(31), 1–8. <https://doi.org/10.1186/1477-3155-10-31>
- Hajighasemi, M., & Azhdari, M. (2020). Comparative Examination of the Treatment Costs of Pediatric Digestion Patients Using Time-Driven Activity-Based Costing and Traditional Models (Case Study: Shahid Sadoughi Hospital, Yazd). *Journal of Accounting Research*, 10(3), 135–156. <https://doi.org/10.22051/ijar.2020.27016.1523>
- Kambanou, M. L. (2020). Life Cycle Costing: Understanding How It Is Practised and Its Relationship to Life Cycle Management - A Case Study. *Sustainability*, 12(8), 3. <https://doi.org/10.3390/su12083252>
- Kargozar, S., & Mozafari, M. (2018). Nanotechnology and Nanomedicine: Start small, think big. *Materials Today: Proceedings*, 5(7), 15492–15500. <https://doi.org/10.1016/j.matpr.2018.04.155>
- Knauer, T., & Möslang, K. (2018). The adoption and benefits of life cycle costing. *Journal of Accounting & Organizational Change*, 14(2), 188–215. <https://doi.org/10.1108/JAOC-04-2016-0027>
- Kubinova, S., & Sykova, E. (2010). Nanotechnologies in regenerative medicine. *Minimally invasive therapy*, 19(3), 144–156. <https://doi.org/10.3109/13645706.2010.481398>
- Leso, V., Fontana, L., & Iavicoli, I. (2019). Biomedical nanotechnology: Occupational views. *Nano Today*, 24, 10–14. <https://doi.org/10.1016/j.nantod.2018.11.002>

- Lindholm, A., & Suomala, P. (2002). Present and future of life cycle costing: reflections from Finnish companies. *Liiketaloudellinen Aikakauskirja*, 282–292.
- López-Robles, J. R., Rodríguez-Salvador, M., Gamboa-Rosales, N. K., Ramirez-Rosales, S., & Cobo, M. J. (2019). The last five years of Big Data Research in Economics, Econometrics and Finance: Identification and conceptual analysis. *Procedia Computer Science*, 162, 729–736. <https://doi.org/10.1016/j.procs.2019.12.044>
- McDowell, J. (2005). Using Activity-Based Costing to Aid in the Selection of Laboratory Equipment. *Laboratory medicine*, 36(5), 278–280. <https://doi.org/10.1309/5P8UFDCL9E04WP20>
- Moore, T. J., Zhang, H., Anderson, G. & et al (2018). Estimated Costs of Pivotal Trials for Novel Therapeutic Agents Approved by the US Food and Drug Administration, 2015–2016. *JAMA Intern Med.*, 178(11), 1451–1457. <https://doi.org/10.1001/jamainternmed.2018.3931>
- Nouri, B.A., & Soltani, M. (2017). Analyzing the Use of Strategic Management Tools and Techniques between Iranian Firms. *Academy of Strategic Management Journal*, 16(1), 263–272.
- Nyström, A., & Fadeel, B. (2012). Safety assessment of nanomaterials: Implications for nanomedicine. *Journal of controlled release*, 161(2), 403–408. <https://doi.org/10.1016/j.jconrel.2012.01.027>
- Olubodun, F., Kangwa, J., Oladapo, A., & Thompson, J. (2010). An appraisal of the level of application of life cycle costing within the construction industry in the UK. *Structural Survey*, 28(4), 254–265. <https://doi.org/10.1108/02630801011070966>
- Oseifuah, E. (2014). Activity based costing (ABC) in the public sector: Benefits and challenges. *Problems and Perspectives in Management*, 12(4), 581–588.
- Prasad V., & Mailankody S. (2017). Research and Development Spending to Bring a Single Cancer Drug to Market and Revenues After Approval. *JAMA Intern Med.*, 177(11), 1569–1575. <https://doi.org/10.1001/jamainternmed.2017.3601>
- Price, C., McGinley, P., & St John, A. (2020). Where Is the Value of Laboratory Medicine and How Do You Unlock It? *The Journal of Applied Laboratory Medicine*, 5(5), 1050–1060, <https://doi.org/10.1093/jalm/jfaa116>
- Qehaja, A. B., Kutllavci, E., & Pula, J. S. (2017). Strategic Management Tools and Techniques: A Comparative Analysis of Empirical Studies. *Croatian Economic Survey*, 19(1), 67–99. <https://doi.org/10.15179/ces.19.1.3>
- Rovida, C., & Hartung, T. (2009). Re-evaluation of animal numbers and costs for in vivo tests to accomplish REACH legislation requirements for chemicals - a report by the Transatlantic Think Tank for Toxicology (t4). *ALTEX - Alternatives to animal experimentation*, 26(3), 187–208. <https://doi.org/10.14573/altex.2009.3.187>
- Shields, M., & Young, S. M. (1994). Managing innovation costs: A study of cost conscious behavior by R&D professionals. *Journal of Management Accounting Research*, 6(1), 175–196.
- Simoens, S., Jacobs, I., Popovian, R., Isakov, L., & Shane, L. G. (2017). Assessing the Value of Biosimilars: A Review of the Role of Budget Impact Analysis. *Pharmacoeconomics*, 35(10), 1047–1062. <https://doi.org/10.1007/s40273-017-0529-x>
- Tetreva, L. (2004). The role of bonds in the process of ownership restructuring of firms. *Ekonomicky casopis*, 52(6), 669–683.

Security Concerns of Social Login Usage at the 3rd Party Cloud Services

Martin ZBOŘIL

Prague University of Economics and Business, Prague, the Czech Republic; zbom01@vse.cz

Abstract: Social login presents a method that facilitates authentication to cloud services and other applications where users leverage their already created accounts at social networks like Facebook or Twitter. This approach brings many benefits to the users, however, as with each technology, the social login is linked with multiple security concerns. These concerns might present a significant risk to the users and should be always considered when establishing social login authentication. This article is dedicated to the research of current security concerns related to social login usage. In total, the author of this article identified six main concerns and provided a detailed explanation of each of them. Some of the concerns cover cyber attacks that might be performed over the social account or the related services. At these attacks, the author included and designed simulations of them in a form of diagrams that contain the activities taken during the attacks.

Keywords: social login; social media; accounts; security; authentication; cloud services

JEL Classification: L86

1. Introduction

Laziness of people has always been a driving force that pushes solutions to be more effective, automatic, faster, and eligible. This fact is especially true in the nowadays world of information modern technologies. Examples of such technological innovations that came or became popular in the last years are the Internet of Things, Blockchain, Big Data, or Artificial Intelligence (Kim, 2020). The innovations are, however, visible not only in these greatly known and standalone technologies but also in smaller and not so obvious areas. One of these areas is the possibilities of user authentication that this article is dedicated to. This article, to be more precise, focuses on one particular authentication method – social login.

Social login might be defined as „the sign-in option that allows a user to access a website using their ID and password from a social network application like Yahoo! or Amazon. The social network for login is referred to as the social platform”. (JANUS Associates, 2016) Another definition talks about social login as „Social login, as used herein, refers to an authentication technique that allows a user to use a single account in order to access many different cooperating websites and services). The single account functions as the digital identity of a user for any number of services or websites.” (Roe, 2018) Examples of how the social login looks at the associated cloud services (mostly the Software-as-a-Service cloud services) are visible in Figure 1.

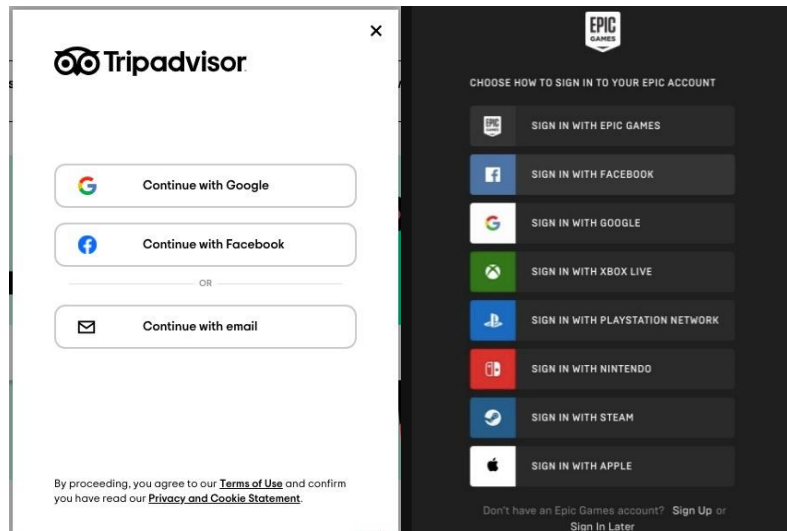


Figure 1. Example of social login at Tripadvisor and Epic Games

For the social login, not only traditional social networks like Facebook, Twitter, or Instagram are considered as a social network, but it involves also Google account. The number of users that leverage social login depends greatly on the number of social network users. From this point of view, social login has an extremely wide scope of potential users. According to the last researches at Statista, e.g. Facebook has currently 2,700 million users, Instagram has 1,150 million users and Twitter has 350 million users (Statista, 2020). Besides, 1,800 million active users have created Gmail that is linked with Google Account (SaaS Scout - Research Group, 2020).

The social login concept is useful also for the providers of social networks as the social login promotes the social networks and the providers collect more information about users. Even without the information of the associated cloud services, providers collect an enormous amount of information about all of the users. The examples of the issues linked with stored personal information and relevant security breaches are presented in (Oken-Tatum, 2019), (Rehman, 2019) and (Fuller, 2019).

The reason why social login is such a popular concept is that the providers of associated cloud services see this option as an opportunity to increase the usage of their service as the social login facilitates and quickens the process of user registration. Besides, another reason for its usage is that the big social network providers publicly offer the documentation on how to integrate the social login to their site where anybody may retrieve the information of APIs and other requirements to implement it.

Social login was already described and discussed in multiple articles, however, none of the articles focused clearly on the detailed description of the security concerns that are linked with the social login usage. The article (Schroers, 2019) describes the concept of authentication with social networks and discusses the benefits and issues linked with the usage. The technical solution of social login for mobile applications is explored in the article (Ho & Katuk, 2016). The authors focused on the description of the solution based on the OAuth protocol. The objective of a publication (Nissim & Gafni, 2014) was to identify and assess the

factors that affect the decision on using social login or not. One part of the article is the description of social login adoption benefits and barriers.

The main objective of this article is to provide the research of the most significant security concerns linked with social login.

2. Methodology

This article, as is stated above, is dedicated to the research with the aim to identify a comprehensive list of major security concerns related to social login. The author investigated a great number of recent articles that are related to social login and its security concerns. The author compared then the identified results to business reports and other types of resources and found that the investigated articles already contained all required and usable information.

The description of the conducted research is split into Sections 3.1–3.6 where each section is dedicated to one specific security concern linked with social login.

3. Results

Social login brings many usability benefits to the users; such examples are single account for multiple sites, spared time with faster registration, updates only on a single point, or personalization (Nissim & Gafni, 2014). Moreover, social login brings also several security advantages like the requirement for remembering only one password, trust in security mechanisms on a big social provider's side, or possible built-in multi-factor authentication (Janrain, 2012).

When considering the usage of social login, however, the security risks of this type of authentication need to be counted as they may negatively influence the security posture of your accounts.

3.1. Social Account Breach – Associated Services

The usage of social login, leveraging of one account from a social network at multiple cloud services, gives space for performing several scenarios of cyberattacks. The following paragraphs are dedicated to such attacks.

The first option for how the social login might be exploited is when a hacker successfully attacks the social network that's account is used also for other services. When users want to see a list of associated sites, they may get the information usually through the social network platform. An example is the Facebook setting in Figure 1 where usage of social login at TripAdvisor is visible.

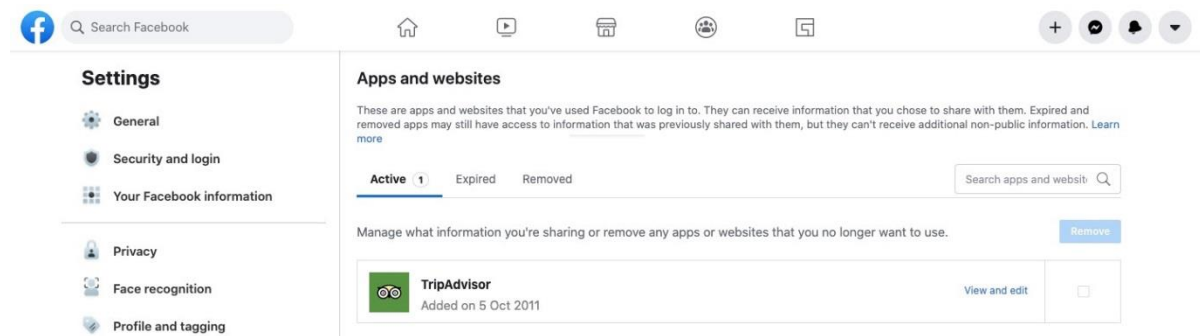


Figure 2. List of associated sites through the social network at Facebook

Attackers may then easily go to the breached account's setting and see there the sites where they may log in with the account. Everything in the IT world is moving to automatized solutions so also this exploitation needs not to be manual as described above but may be automatic with the usage of APIs. Social network providers offer users/developers documentation with described APIs that may use to connect to the network (e.g. www.developers.facebook.com for Facebook).

The exemplary simulation of the above-described scenario is shown in Figure 3.

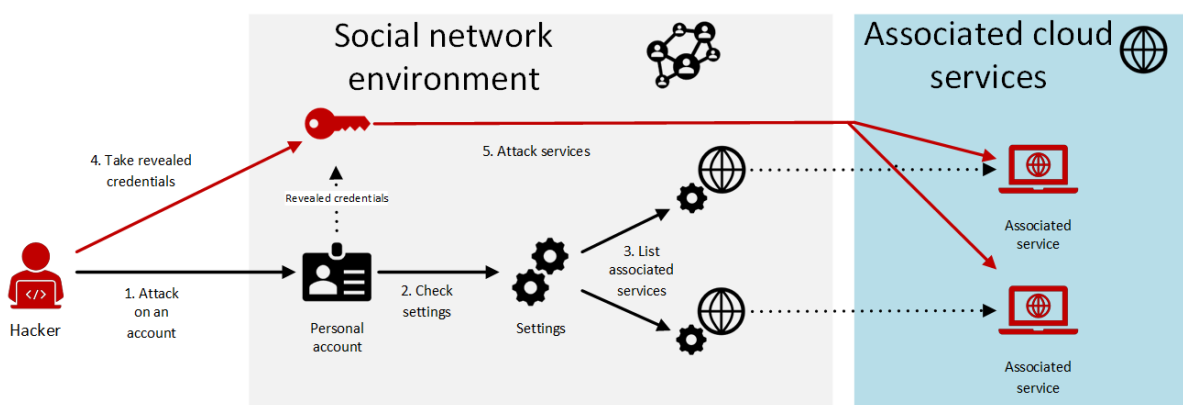


Figure 3. A simulated attack on associated services through listing the services on a hacked social network account

3.2. Social Account Breach – Leaked Credentials

The breached social accounts enable also another attack path without knowing the list of associated accounts. As mentioned in the Introduction, attackers also perform brute-force attacks with the usage of huge tables with credentials of breached accounts. In the previous scenario, the attackers always know where to successfully log in. In this scenario, however, they are guessing whether the account is present on a certain site or not.

From the implementation cost point of view, this scenario demands less manual or development work as attackers do not need to perform the steps manually or develop the scripts for leveraging the APIs, they just take already existing tools for performing the attack (e.g. available by default on Kali Linux instances). On the contrary, the attack requires higher computational power as they are trying to login with a countless number of credentials and they need to perform more attacks as the success rate is logically low.

The exemplary simulation of the above-described scenario is shown in Figure 4.

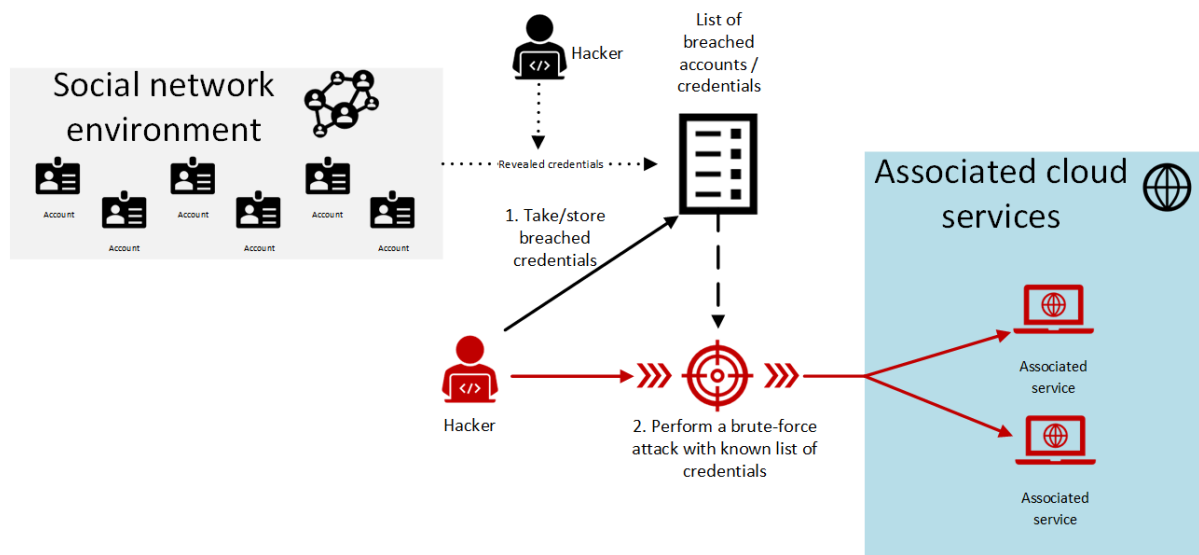


Figure 4. A simulated attack on associated services with the use of a list of breached accounts

3.3. Low Credentials Complexity

Social networks are open to all users and their primary objective is to gather and connect as many users as possible. This implies that social network providers do not want to discourage users with strong requirements for password/authentication complexity. As a result, users tend to create simple and easy-to-remember passwords. This fact is generally known among the security community but it was also proven by many kinds of research, like (Daojing et al., 2020), (Gärdekrans, 2017), (Yıldırım & Mackie, 2019) or (Choong, 2015).

An especially important factor linked to social networks and passwords is the usage of personal information for password creation as it eases users to remember created passwords. The reason why it is especially important is that the majority of personal information is often present on the user's accounts on social networks. Accordingly, attackers exploit this publicly available personal information to try to guess the password or use it for the brute force attack. Exactly this area was a part of the research presented at (Gafni, Pavel, Margolin, & Weiss, 2017). The results showed that according to the included questionnaire, 71% of respondents use personal data to create their passwords. Besides, 27% of respondents answered that they also use other family information, not only their own. However, this type of information is often also present on social networks and publicly accessible through the user's account.

The all above indicates that the password for social network accounts could have a weak password established. This implies that the weak password could be established also for all associated services through the social login if a user establishes a weak password at their social network account. As a result, all the accounts at the associated services are vulnerable to brute-force attacks.

The exemplary simulation of the above-described scenario is shown in Figure 5.

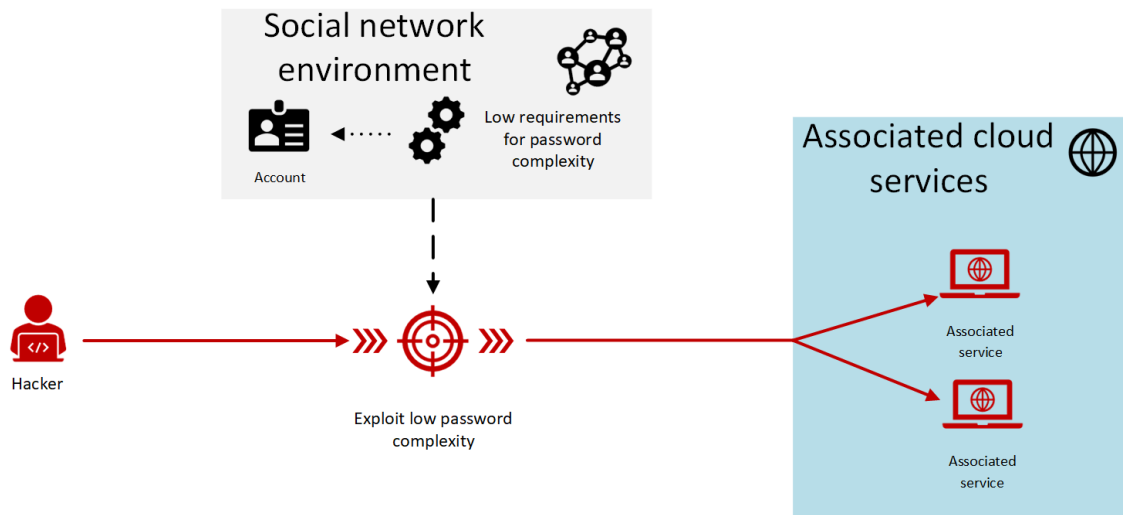


Figure 5. A simulated attack on a social network due to low password complexity configured at a social network.

3.4. Technical Vulnerabilities

Each technology and technical solution bring their vulnerabilities; social login implementations are not exceptions. The vulnerabilities of social login usage are primarily linked with authentication protocol vulnerabilities, such as Open ID. Common Vulnerabilities and Exposures, abbreviated as CVE, is a world-widely known database of commonly known vulnerabilities. **Chyba! Nenalezen zdroj odkazů.** provides an overview of vulnerabilities linked to social login, present in the official database of CVEs, with an official description:

Table 1. CVE vulnerabilities linked to “social login” – official descriptions (Common Vulnerabilities and Exposures, 2020).

ID	Description
CVE-2019-11015	A vulnerability was found in the MIUI OS version 10.1.3.0 that allows a physically proximate attacker to bypass Lockscreen based authentication via the Wallpaper Carousel application to obtain sensitive Clipboard data and the user's stored credentials (partially). This occurs because of paste access to a social media login page.
CVE-2017-3125	An unauthenticated XSS vulnerability with FortiMail 5.0.0-5.2.9 and 5.3.0-5.3.8 could allow an attacker to execute arbitrary scripts in the security context of the browser of a victim logged in FortiMail, assuming the victim is social engineered into clicking an URL crafted by the attacker.
CVE-2017-18501	The social-login-bws plugin before 0.2 for WordPress has multiple XSS issues.
CVE-2017-1000004	ATutor version 2.2.1 and earlier are vulnerable to a SQL injection in the Assignment Dropbox, BasicLTI, Blog Post, Blog, Group Course Email, Course Alumni, Course Enrolment, (...) Content Menu, Auto-Login, and Gradebook components resulting in information disclosure, database modification, or potential code execution.
CVE-2016-4048	An issue was discovered in Open-Xchange OX App Suite before 7.8.1-rev11. Custom messages can be shown at the login screen to notify external users about issues with sharing links. This mechanism can be abused to inject arbitrary text messages.
CVE-2015-5511	The HybridAuth Social Login module 7.x-2.x before 7.x-2.13 for Drupal allows remote attackers to bypass the user registration by administrator only configuration and create an account via a social login.

CVE-2015-4395	The HybridAuth Social Login module 7.x-2.x before 7.x-2.10 for Drupal stores passwords in plaintext when the "Ask user for a password when registering" option is enabled, which allows remote authenticated users with certain permissions to obtain sensitive information by leveraging access to the database.
CVE-2014-6092	IBM Curam Social Program Management (SPM) 5.2 (...) requires failed-login handling for web-service accounts to have the same lockout policy as for standard user accounts, which makes it easier for remote attackers to cause a denial of service (web-service outage) by making many login attempts with a valid caseworker account name.
CVE-2014-4576	Cross-site scripting (XSS) vulnerability in services/diagnostics.php in the WordPress Social Login plugin 2.0.3 and earlier for WordPress allows remote attackers to inject arbitrary web script or HTML via the xhrurl parameter.

3.5. Decreased Anonymity

As was already mentioned in previous the introduction, providers of social networks keep an enormous amount of data about their users. The described issues and current approaches imply that when a social login is used, users should also care about the fact that their anonymity on the Internet is decreased. The lower anonymity might be seen from two perspectives.

The first perspective was also touched on in the previous section and involves revealed information about the accounts between the social account provider and associated cloud service. For example, users should consider whether they want that Google knows what they are searching for on the Tripadvisor site if they are using a Google account for social login.

The second perspective involves the revealed information between the users themselves. The example is that a user leverages a Facebook account to login into an associated cloud service where the account/profile has the same name, nickname, email, and avatar/picture. Based on this information, some other users from the cloud service can find the user's profile on Facebook and much information about the user (personal details, pictures, friends, posts, favorite things, political opinion, sexual orientation, etc.). Regarding this issue, social networks offer usually configurations that may restrict such public visibility, as was shown in Figure 6.

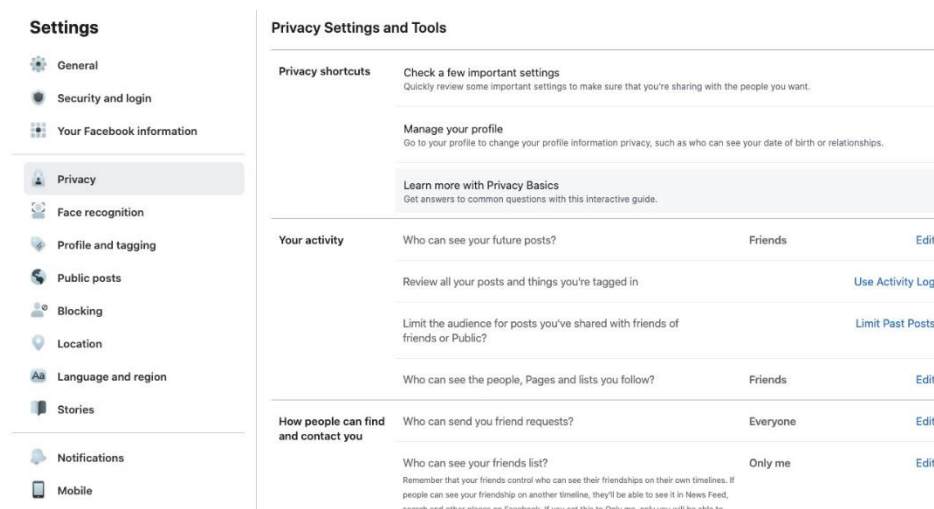


Figure 6. Exemplary configuration at Facebook

3.6. Account Lock

The last concern is not linked directly with security concerns, but with the usage of the cloud service. The accounts on social networks could be deleted, due to potential inactivity periods but mainly due to manual deletion of the accounts by users themselves. Since the authentication to associated cloud services is through the potentially deleted account, users would have issues with login into the cloud service. Then, it depends on the particular implementation of whether the access would be completely restricted or whether the inserted credentials would be compared to stored hashes. Nevertheless, the second option would bring also limitations, e.g. no possibility to reset passwords.

4. Discussion and Conclusion

Social login brings multiple benefits, however, security concerns should always be bared in mind when establishing this type of authentication. This article helped readers to get an overview of what main security concerns are linked with the social login. The security concerns were not only focused on the security in the technical meaning (Sections 3.1, 3.2, 3.3, 3.4) but touched also other parts of the security area, like decreased anonymity (Section 3.5), and account lock (Section 3.6). Users of social login have limited options on how to deal with the technical concerns, except for setting a nontrivial password. However, mainly the decreased anonymity concerns depend partly on the behavior and configuration of users themselves.

The social logins approach is significantly dependent on the protection of the social network account as is obvious from the described security concerns; therefore, users should sufficiently protect their accounts. The most fundamental countermeasure is to configure such a level of password complexity that assures the account's protection against brute-force and dictionary attacks. An additional and recommended level of protection is authentication through MFA (multi-factor authentication), where users e.g. insert a code from SMS that they receive or confirm the authentication on a special mobile application. MFA ensures that even though the brute-force attacks successfully reveal the user's credentials, the attackers are still not able to authenticate to the account. Although the protection requirements for a complex password and MFA are generally known, still many users are not touched with that and keep their simple and easy-to-guess passwords.

The author of this article plans to follow up with quantitative research focused on social login usage and awareness about security concerns and benefits.

References

- Common Vulnerabilities and Exposures*. (2020, December 4). Retrieved from <https://cve.mitre.org/cgi-bin/cvekey.cgi?keyword=social+login>
- Daojing, H., Zhou, B., Yu, H., Cheng, Y., Chan, S., Zhang, M., & Guizani, N. (2020). Group-based Password Characteristics Analysis. *IEEE Network*, 1-7. <https://doi.org/10.1109/MNET.001.1900482>
- Fuller, M. (2019). Big data and the Facebook scandal: Issues and responses. *Theology*, 122(1), 14-21. <https://doi.org/10.1177/0040571X18805908>
- Gafni, R., Pavel, T., Margolin, R., & Weiss, B. (2017). Strong password? Not with your social network. *Online Journal of Applied Knowledge Management*, 5(1), 27-41. [https://doi.org/10.36965/OJAKM.2017.5\(1\)27-41](https://doi.org/10.36965/OJAKM.2017.5(1)27-41)

- Gärdekrans, R. (2017). Password Behaviour. *Bachelor Degree Project*. University of Skövde. <https://www.diva-portal.org/smash/get/diva2:1109665/FULLTEXT01.pdf>
- Ho, L. K., & Katuk, N. (2016). Social Login with OAuth for Mobile Applications: User's View. In *IEEE Symposium on Computer Applications & Industrial Electronics (ISCAIE)* (pp. 741-759). <https://doi.org/10.1109/ISCAIE.2016.7575043>
- Choong, Y.-Y. (2015). *Employee Password Usability Survey*. Gaithersburg, MD, USA: National Institute of Standards and Technology. https://csrc.nist.gov/CSRC/media/Presentations/Employee-Password-Usability-Survey/images-media/day2_research_430-530pt2.pdf
- Janrain. (2012). *Privacy and Security Advantages of Social Login*. User Management Platform for the Social Web.
- JANUS Associates. (2016). *Social Login Security Risk Assessment For Massachusetts Libraries*. Stamford.
- Kim, B. (2020). Moving Forward with Digital Disruption: What Big Data, IoT, Synthetic Biology, AI, Blockchain, and Platform Businesses Mean to Libraries. *Library Technology Reports*, 56(2).
- Nissim, D., & Gafni, R. (2014). To Social Login or not Login? Exploring Factors Affecting the Decision. *Informing Science and Information Technology*, 11, 57-72. <https://doi.org/10.28945/1980>
- Oken-Tatum, B. (2019). Facebook will pay an unprecedented \$5B penalty over privacy breaches. *Central Penn Business Journal*.
- Rehman, I. u. (2019). Facebook-Cambridge Analytica data harvesting: What you need to know. *Library Philosophy and Practice*. University of Nebraska - Lincoln.
- Roe, P. (2018). *Detecting social login security flaws using database query features*. International Business Machines Corporation.
- SaaS Scout - Research Group. (2020). *Gmail Statistics, Users, Growth And Facts For 2020*. Retrieved from <https://saasscout.com/statistics/gmail-statistics/>
- Schroers, J. (2019). I have a Facebook account, therefore I am – authentication with social networks. *International Review of Law, Computers & Technology*, 33(2), 211-223. <https://doi.org/10.1080/13600869.2018.1475895>
- Statista. (2020, November 31). *Most popular social networks worldwide as of October 2020, ranked by number of active users*. Retrieved from <https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/>
- Yıldırım, M., & Mackie, I. (2019). Encouraging users to improve password security and memorability. *International Journal of Information Security*, 18(6), 741-759. <https://doi.org/10.1007/s10207-019-00429-y>

The Impact of Government Subsidies on Business Performance of Public Utility Companies

Weiwei ZHAO

Northwest University, Xi'an, China; zhaoweinwu@163.com

Abstract: Public utility enterprises are main providers of public utility products (quasi-public goods) in theory and practice. Special nature of products makes government subsidies important for the survival and development of public enterprises while focus on which is less, especially at the micro enterprise level. The purpose of paper is to quantify the impact of government subsidies on business performance of public utility enterprises which is important for evaluating and optimizing government financial subsidy policies and improving efficiency of public utility enterprises. Based on financial data of public utility enterprises in Guotai'an database from 2017-2019, the paper uses quartile statistical description method and weighted least squares regression method. The conclusions are as follows. There is a significant positive impact of government subsidies on the business performance of public utility enterprises which is larger and more significant for small & micro enterprises and private companies. So, differences in ownership nature and enterprise size need to be considered for government subsidies.

Keywords: government subsidies; public utility enterprises; business performance

JEL Classification: H71; H24; H41

1. Introduction

Public utility products (i.e., quasi-public goods) which has significant externalities and spillovers are the basic components to meet the needs of residents for a good life. Public utility products are usually provided by public utility enterprises in China. Therefore, government subsidies are important for the survival and development of public utility enterprises.

Scholars have discussed the performance of government subsidies from different perspectives (Luo et al, 2020; Zhong, 2020; Zheng et al, 2020; Yu et al, 2020), and the results and extent of impact varied. Research has focused on high-tech, new energy automobile, biomedical enterprises, food processing and other industries in China (Dong & Zhong, 2020; Rong & Zhong, 2020; Yu et al, 2020; Cao & Yi, 2018; Yang & Fan, 2015; Wu, 2019). But focus on government subsidy on public utility enterprises are less, especially at micro enterprise level.

Therefore, this paper uses an empirical analysis paradigm to quantify effects of government subsidies on business performance of public utility enterprises, which is important for adjusting and optimizing government subsidy policy and improving overall efficiency of public utility industry.

Most studies have confirmed government subsidies improve firm performance. Rong and Zhong (2020) confirmed that government subsidies significantly improved firm performance, using a sample of 450 high-tech firms in the China GEM from 2016-2018. Zheng et al (2020) confirmed that government subsidies have a significant positive effect on firm performance at back end of industry chain using Chinese tombarthite industry as an example. Wu (2019) confirmed that government subsidies can significantly increase firm profits using a sample of Chinese listed firms from 2007-2009. Dvouletý and Blažková (2019) confirmed that government subsidies in agriculture improve firm performance using Czech as a sample. Lu et al. (2016) selected listed manufacturing firms from 2012-2014 and found that government subsidies are significantly and positively related to firm performance. The main reason for positive impact may be that government subsidy funds, as a current benefit inflow to the firm, can cover the capital gap of firm and promote its capital turnover.

However, government subsidies may also reduce firm performance. Wang et al. (2017) found that government subsidies promote innovation performance but no effect on business performance which used a sample of listed companies in the new energy vehicle industry from 2010-2015. Cao and Yi (2018) analyzed sample of listed biopharmaceutical manufacturing companies from 2012-2015 and found that government subsidies had a negative impact on firm performance. Wang et al. (2015) analyzed negative effects of government subsidies that made IPO companies' surplus persistence worse and long-term performance lower. The main reason for negative impact is that government subsidies make firms dependent on the government and less motivated to operate.

It is also found that the impact of government subsidies on firm performance is uncertain. Yang and Fan (2015) selected listed renewable energy category companies from 2009-2012 and found that government subsidies have positive impact on financial performance but have negative impact on financial performance of state-controlled enterprises. Liu and Hu (2015) selected listed new energy companies from 2012-2014 and found government subsidies had significantly positive impact on current performance but had negative impact on long-term performance.

Although studies on government subsidies affecting business performance are mature, there is no consensus on the direction of the relationship. Furthermore, there are fewer studies discussing impact of government subsidies with public utility companies as the research target. The scientific issue is quantitative impact of government subsidies on business performance of public utility firms. On one hand, it can enrich the theory of policy support for public utility enterprises and provide a basis for financial performance evaluation. On the other hand, it can optimize government financial subsidy policies and improve efficiency of government subsidies of enterprises in practice.

Government subsidies are funds or other non-monetary assets given by government departments to support and encourage survival or development of certain types of industries or enterprises. Therefore, government subsidies can provide cash inflow in the current period which can improve the enterprise's capital turnover and enhance the profitability and profit level. So, the first hypothesis is proposed here.

Hypothesis 1: Government subsidies have positive effect on the current business performance of public utility enterprises.

Large enterprises have a wide range of financing channels and better financing ability. Therefore, government subsidies have a lower contribution to the current capital turnover of large enterprises than that of small enterprises. So, the second hypothesis is proposed here.

Hypothesis 2: Government subsidies have a greater contribution to the business performance of small enterprises.

State-owned enterprises have an advantage in obtaining policy support and government subsidies which determines ability to obtain more external funds. However, state-owned enterprises generally have lower productivity and capital efficiency than private firms. So, the third hypothesis is proposed here.

Hypothesis 3: Government subsidies have a greater contribution to the business performance of private enterprises.

2. Methodology

The following econometric model is set up using mixed cross-sectional data of Chinese listed firms from 2017-2019.

$$ROS_{it} = c + b Govsub_{it} + acontrol_{it} + \varepsilon_{it} \quad (1)$$

In equation (1), i denotes the firm and t denotes the year. ROS_{it} represents the business performance of the i firm in t year. $Govsub_{it}$ denotes government subsidy income received by the i firm in t year which is the key explanatory variable. b reflects the impact of government subsidy on the firm's operating performance. If the estimated result of coefficient b is positive, it means that government subsidies have positive effect on the business performance of the enterprise in the year. And if the estimated result of b is negative, it indicates negative effect. $control_{it}$ is matrix of control variables. ε_{it} is the random error term.

The explanatory variable-business performance. There are several choices of measures for business performance, such as profitability of sales, return on net assets, and earnings per share. Referring to previous studies and characteristics of the sample, the profit margin on sales (expressed as POS) is selected for the following reasons: profit is the core indicator for survival and development of enterprises and the basis for other profitabilities, and POS can reflect profitability of enterprise sales. Moreover, POS is easy to calculate. In addition to avoid potential endogenous problems of profitability indicators, the return on assets (expressed as ROA) is used as a robust test to verify the stability of findings. Specifically, POS =total profit/operating revenue, ROA =total profit/average total assets.

Explanatory variables-government subsidies. Considering the influence of enterprise size on intensity of government subsidies, in order to ensure the stability of results, two measures are adopted: one is the ratio of government subsidies relative to the total number of employees (per capita government subsidy income) expressed as $AGovsub$. In order to reduce the fluctuation of the value and the influence of price, the natural logarithm is taken here. The second is the ratio of government subsidy income relative to operating income which is expressed as $PGovsub$.

Seven control variables are included which are solvency, operating capacity, profitability, development capacity, fixed assets ratio, enterprise size, and years of operation. The solvency is measured by gearing ratio expressed as $gr = \text{total liabilities} / \text{total assets}$. Asset turnover ratio is to measure a company's operating capacity which is expressed as $rat = \text{operating income} / \text{average total assets}$. Net sales margin is used to measure profitability which is expressed as $nsn = \text{net profit} / \text{revenue}$. The growth rate of operating income is used to measure the ability of the enterprise to grow which is expressed as $ror = \text{operating income growth} / \text{operating income}$. The number of employees expressed as noe and operating income expressed as or are used to measure size of the enterprise that the natural logarithm is taken to eliminate the influence of heteroskedasticity and variability. In addition, fixed assets ratio expressed as $rfa = \text{fixed assets} / \text{total assets}$, and years of operation expressed as $yo = (\text{sample year} - \text{year of establishment} + 1)$ which are also used as control variables.

The micro data of public utility companies from 2017-2019 used in paper are obtained from the Guotai'an database. The specific data processing process is as follows: if there is any missing data of the sample, it is excluded; if the year of enterprise establishment is larger than the sample year, it is excluded; if the number of enterprise employees is less than or equal to zero, it is excluded. Finally, the sample frame is comprised by 322 samples in 2019, 282 samples in 2018 and 244 samples in 2017. The statistical software is Stata11.

After variable selection and data processing, the specific econometric model is shown in equation (2) below.

$$POS_{it} = c + bGovsub_{it} + a_1gr_{it} + a_2rat_{it} + a_3nsn_{it} + a_4ror_{it} + a_5noe_{it} + a_6or_{it} + a_7rfa_{it} + a_8yo_{it} + e_{it} \quad (2)$$

For the specific regression process, the weighted least squares regression method was used to avoid possible heteroskedasticity. To test the robustness and reliability of conclusions, supplementary regressions were performed by replacing the metrics of independent variable and categorization regression. In addition, in the descriptive statistics stage, the minimum, maximum, mean, median, and quantile values of government subsidies are used.

3. Results

3.1. Statistical Description

1. Government subsidies received by all public utility companies

All samples received government subsidies and statistical characteristics are shown in Table 1. The average value of subsidy income received by public utility enterprises from 2017 to 2019 was ¥41.6 million, ¥51.5 million, and ¥38.8 million. It seems that there is a fluctuating trend. At the same time, the minimum value of government subsidies received by enterprises was 0, while the maximum value was ¥1 billion in 2019. Difference is huge and extreme which is similar in 2018 and 2017. There are significant differences in government subsidy revenues of public utility enterprises. That is, the data distribution is suitable for the research task. Just for this reason, all samples are classified below and scale of government subsidies for different category are described in detail.

Table 1. Government subsidies received by all utility enterprises in 2017-2019 (Unit: 10 million yuan)

Year	sample size	mean	standard deviation	25% quantile	median	75% quantile	min	max
2019	322	3.88	8.18	0.65	1.62	3.74	0.00	100.00
2018	282	5.15	26.40	0.50	1.39	3.61	0.01	426.00
2017	244	4.16	14.50	0.41	1.13	2.75	0.00	174.00

Government subsidy income per capita of public utility enterprises is used to measure intensity of government subsidies. Interesting results are shown in Table 2. Mean of government subsidy income per capita is ¥29,800, ¥27,600, and ¥23,100 from 2017 to 2019 with a small decrease trend year by year. The median value is ¥0.77 million, ¥0.87 million, and ¥0.97 million with a steady increase year by year. The minimum value of government subsidy income per capita is close to ¥0 while the maximum value is ¥1.7 million in 2019. The same characteristics exist in 2018 and 2017. The difference between median and mean mainly due to the maximum value every year. Sample distribution has some differences and shows skewed characteristics. Intensity of government subsidies of public utility enterprises is relatively stable from 2017 to 2019 overall with skewed characteristics.

Table 2. Government subsidy income per capita of all samples in 2017-2019 (Unit: 10 thousand yuan)

Year	sample size	mean	standard deviation	25% quantile	median	75% quantile	min	max
2019	322	2.31	9.67	0.34	0.97	2.22	0.00	169.91
2018	282	2.76	15.99	0.3	0.87	2.17	0.01	266.24
2017	244	2.98	20.64	0.26	0.77	2.06	0.00	321.70

2. Government subsidies received by enterprises of different sizes

According to the above, government subsidies received by public utility enterprises may be related to the size of enterprises. Therefore, relative division method was used here according to number of employees in enterprise. Each quartile of employees is shown in Table 3. Then using three quartiles of Table 3 as standard, sample was divided into four categories: large enterprises, medium enterprises, small enterprises, and micro enterprises.

Table 3. Size of employees in public utility enterprises, 2017-2019 (Unit: persons)

Year	25% quantile	median	75% quantile
2019	764	1640	3558
2018	801	1562.5	3439
2017	724.5	1385	3119.5

Table 4 shows descriptive statistics results of four categories. The average value of government subsidies received by large enterprises during 2017-2019 is larger than that of other enterprises. Average value decreases gradually as the size of enterprises decreases. Same trend is shown with median data. For example, average value of large enterprises is 10 times higher than that of micro enterprises. The larger size of enterprise, the easier it is to obtain government subsidies. I.e., government subsidies tend to favor large enterprises.

Table 4. Government subsidies of different size of employees (Unit: 10 million yuan)

Year	type of enterprise	sample size	mean	standard deviation	25% quantile	median	75% quantile	min	max
2019	large	80	8.80	14.30	2.18	3.82	9.22	0.28	100.00
	medium	81	3.50	4.48	0.74	1.99	4.17	0.00	26.70
	small	80	2.06	2.97	0.30	1.13	2.79	0.01	18.60
	micro	81	1.21	1.37	0.26	0.81	1.60	0.01	7.38
2018	large	70	13.70	51.90	1.17	3.12	8.68	0.05	426.00
	medium	71	3.67	5.87	0.67	1.49	4.41	0.02	34.50
	small	70	2.02	2.45	0.31	1.03	2.64	0.03	14.90
	micro	71	1.26	2.05	0.23	0.66	1.45	0.01	15.00
2017	large	61	11.40	27.00	1.14	2.36	9.46	0.06	174.00
	medium	61	2.76	5.95	0.46	1.16	2.32	0.02	42.80
	small	61	1.72	1.98	0.28	1.09	2.44	0.02	11.00
	micro	61	1.19	1.78	0.24	0.57	1.02	0.00	10.10

3. Government subsidies received by enterprises of different ownership

Government subsidies obtained by public utility enterprises may be related to the nature of enterprise ownership. So here samples are classified according to nature of enterprise ownership: state-owned enterprises, private enterprises, and foreign enterprises. Statistical results of subsidies obtained by three categorical samples are shown in Table 5. Because sample size of foreign enterprises is too small, they are not analyzed. the average value of government subsidies obtained by state-owned enterprises from 2017 to 2019 is greater than that of private enterprises, even 10 times in 2018 and 2017. It can be seen that state-owned enterprises are more likely to receive government subsidies than private enterprises, i.e., government subsidies are more inclined to state-owned enterprises.

Table 5. Government subsidies of utility enterprises of different ownership (Unit: 10 million yuan)

Year	type of enterprise	sample size	mean	standard deviation	25% quantile	median	75% quantile	min	max
2019	state-owned	97	7.01	13.50	2.18	3.82	9.22	0.28	100.00
	private	222	2.56	3.52	0.60	1.42	3.24	0.00	26.60
	foreign	3	-	-	-	-	-	-	-
2018	state-owned	97	11.00	44.40	0.85	2.33	6.39	0.03	426.00
	private	183	2.13	2.87	0.38	1.04	2.66	0.01	17.20
	foreign	2	-	-	-	-	-	-	-
2017	state-owned	86	9.26	23.40	0.66	1.93	8.02	0.02	174.00
	private	156	1.56	1.88	0.37	0.93	2.07	0.00	10.10
	foreign	2	-	-	-	-	-	-	-

3.2. Basic Regression Results and Robust Test

White test showed that the general regressions with both subsidy income per capita and subsidy income as share of operating income as explanatory variables had heteroskedasticity. So weighted least squares was chosen as basic regression method. The results are shown in Table 6 Column reg1-2. Regardless of subsidy income per capita or share of subsidy income to operating income as the explanatory variables, government subsidies significantly increased sales margin, i.e., government subsidies improved the operating performance of public utility companies, which is consistent with Hypothesis 1.

To test the robustness of the results, the return on assets indicator was used as a proxy variable for business performance. The results are shown in Table 6 reg3-4. Government subsidies still improve business performance more significantly. Therefore, government subsidies have a significant positive impact on business performance of public utility companies, which is consistent with Hypothesis 1.

3.3 Extended regression analysis

The effect of government subsidies on business performance of utility enterprises may be sensitive to enterprise size. Therefore, a categorical regression using enterprise employee size as a criterion to classify enterprise types to test Hypothesis 2 is implemented which results are shown in Table 6 reg5-7. Coefficients of government subsidies for small and micro enterprises are larger and significant than those for medium and large enterprises, which is consistent with Hypothesis 2. Compared with small and micro enterprises, medium and large enterprises have more extensive financing channels and higher operating income. Therefore, inflow of government subsidies has less favorable impact on medium and large enterprises.

Table 6. All regression results

	reg1	reg2	reg3	reg4	reg5 for micro & small	reg6 for medium	reg7 for large	reg8 for state- owned	reg9 for private
dependent var	ROS	ROS	ROA	ROA	ROS	ROS	ROS	ROS	ROS
<i>Agovsub</i>	0.20* (1.73)		0.42* (1.91)		0.32* (1.81)	0.13 (0.76)	0.03 (0.70)	0.20 (1.32)	0.54* (1.68)
<i>Pgovsub</i>		0.04* (1.69)		0.39*** (2.20)					
<i>gr</i>	-0.01 (-0.74)	-0.01 (-0.71)	-0.01 (-0.35)	-0.01 (-0.30)	-0.02 (-0.95)	0.01 (0.65)	0.02 (1.40)	0.04 (0.43)	-0.03 (-1.58)
<i>rat</i>	-0.01** (-2.43)	-0.01** (-2.37)	-0.02*** (-3.45)	-0.02*** (-3.43)	-0.03*** (-3.72)	-0.00 (-0.71)	-0.00 (-0.29)	-0.01* (-1.75)	-0.01 (-1.58)
<i>nsm</i>	1.02*** (210.55)	1.02*** (208.15)	0.33*** (26.63)	0.34*** (26.91)	1.02*** (161.99)	1.12*** (49.96)	1.13*** (45.89)	1.17*** (59.80)	1.01*** (203.94)
<i>ror</i>	0.00 (0.79)	0.00 (0.73)	0.01*** (2.80)	0.00*** (2.77)	-0.00 (-0.32)	0.01 (0.97)	0.00 (0.49)	0.00 (0.80)	0.00 (0.39)
<i>rfa</i>	0.04*** (3.98)	0.04*** (3.83)	0.05** (2.25)	0.06** (2.34)	0.05*** (2.81)	0.05*** (4.16)	0.01 (1.13)	0.03** (2.50)	0.03** (2.10)
<i>noe</i>	-0.00** (-2.30)	-0.00* (-1.91)	-0.01* (-1.97)	-0.01** (-2.40)	-0.01* (-1.91)	-0.00 (-0.58)	0.00 (0.16)	-0.01 (-1.42)	-0.00 (-1.54)
<i>or</i>	0.00 (0.14)	-0.00 (-0.26)	-0.01* (-1.92)	-0.01** (-2.47)	0.01** (2.35)	-0.00 (-0.66)	-0.00 (-0.36)	-0.00 (-1.15)	0.00 (0.95)
<i>yo</i>	0.00 (1.12)	0.00 (1.01)	0.00 (0.47)	0.00 (0.23)	0.00 (0.40)	-0.00 (-0.03)	0.00* (1.71)	0.00 (0.62)	0.00 (0.27)
constant	0.05 (1.45)	0.06* (1.69)	0.13 (1.61)	0.19** (2.24)	-0.08 (-0.40)	0.10 (1.17)	0.00 (0.09)	0.11** (2.01)	0.01 (0.15)
Sample size	848	848	848	848	424	214	210	255	586
Ajusted R ²	0.99	0.99	0.73	0.73	0.98	0.97	0.97	0.92	0.94

Note: t-statistics in parentheses, * indicates significant at 10% level of significance, ** indicates significant at 5% level of significance, *** indicates significant at 1% level of significance.

The impact of government subsidies on operating performance of public utility enterprises may be sensitive to ownership of enterprises. Therefore, a categorical regression

using ownership as a criterion to classify enterprise types to test Hypothesis 3 is implemented which results are shown in Table 6 reg8-9. The coefficient of government subsidies on business performance of state-owned utilities is positive but insignificant; the coefficient of government subsidies on private utilities is positive, larger in absolute value and significant. This is consistent with Hypothesis 3. This result may be explained by fact that state-owned enterprises are relatively dependent on government subsidies. While private enterprises pursue profit and operational efficiency, use but do not rely on government subsidies. Therefore, they can use government subsidies efficiently and effectively to increase operational performance.

4. Discussion

Firstly, there is significant positive effect of government subsidies on the operating performance of public utility enterprises which is consistent with the results of previous studies (Dong & Zhong, 2020; Rong & Zhong, 2020; Wu, 2019). The specific path is that government subsidies increase current cash inflows of the enterprise. Then cash inflows improve its capital turnover capacity and enhance its profitability and profit level. This path is tested ever by Lu et al. (2016).

Secondly, the positive impact of government subsidies on the business performance is greater and more significant for small and micro enterprises. Compared with small and micro enterprises, large and medium-sized enterprises have more extensive financing channels and higher operating income. Because of law of diminishing marginal utility, government subsidies have less favorable effects on large and medium-sized enterprises. This conclusion is relatively innovative.

Thirdly, the positive impact of government subsidies on the operating performance is larger and more significant for private companies. State-owned enterprises do not have profit as their only goal and lack cost constraints. Lack of incentives makes them less efficient in using funds and more dependent on government subsidies. While private enterprises pursue profits and operational efficiency, therefore they can use subsidies efficiently to promote the growth of operating performance. This conclusion is also relatively innovative.

Therefore, government subsidies for public utility enterprises are necessary. Differences in ownership nature and enterprise size need to be considered to improve the efficiency of government subsidies. On one hand, government subsidy policy should be implemented for public utility enterprises. Production and operation of public utility enterprises is a process of realizing government functions and meeting the growing needs of Chinese residents for a better life. On the other hand, government subsidies for private and micro and small public utilities should be increased. And differences in efficiency of enterprises of different sizes and ownership systems should be taken into considered.

In further research, mechanism and role of government subsidies affecting business performance of public utility firms are needed to reason and test deeply. After these works, measures to improve government and enterprises efficiency can be proposed specifically.

There are two limitations in this study as follows. On one hand, for the specific research subject-public utility companies, only accounting performance is accounted for and the social

benefits of their positive externalities are not considered. This approach may underestimate the positive impact of government subsidies. On the other hand, the panel data used here is a short panel of three years, and the results reflect more short-term effects. The long-term trend between government subsidies and business performance is not fully reflected.

Acknowledgments: The financial support from the Key Scientific Research Program of Shaanxi Provincial Education Department (No.20JZ091) is acknowledged.

References

- Cao, Y., & Yi, Q. (2018). The impact of government subsidies on R&D investment and performance: an empirical study based on biomedical manufacturing. *Science and Technology Management Research*, 38(1), 40-46. <https://doi.org/10.3969/j.issn.1000-7695.2018.01.007>
- Dvouletý, O., & Blažková, I. (2019). Assessing the microeconomic effects of public subsidies on the performance of firms in the Czech food processing industry: a counterfactual impact evaluation. *Agribusiness*, 35(3), 394-422. <https://doi.org/10.1002/agr.21582>
- Liu, P., & Hu, X. (2015). The impact of government subsidies on the performance of new energy listed companies. *Finance and Accounting Monthly*, (33), 74-78. <https://doi.org/10.19641/j.cnki.42-1290/f.2015.33.014>
- Lu, S., Feng, S., & Liao, Y. (2016). Nature of ownership, government subsidies and firm performance - empirical evidence from listed manufacturing companies. *Communication of Finance and Accounting*, (06), 45-48. <https://doi.org/10.16144/j.cnki.issn1002-8072.2016.06.012>
- Luo, X., et al. (2020). Government subsidies and firm performance: Evidence from high-tech start-ups in China. *Emerging Markets Review*, (24), <https://doi.org/10.1016/j.ememar.2020.1007>
- Rong, F., & Zhong, X. (2020). Empirical Test on Correlation Between Government Subsidy, R&D Investment and Enterprise Performance. *Statistics & Decision*, (5), 161-166. <https://doi.org/10.13546/j.cnki.tjyc.2020.05.037>
- Wang, K., Yang, G., Liu, J., & Li, X. (2015). IPO Resource competition, government subsidies and company performance. *Management World*, (9), 147-157. <https://doi.org/10.19744/j.cnki.11-1235/f.2015.09.012>
- Wang, W., Li, H., Qiao, P., & Gui, J. (2017). An influence study on the new energy automobile enterprise performances by government subsidies. *Science & Technology Progress and Policy*, 34(23), 114-120. <https://doi.org/10.6049/kjbydc.201708X082>
- Wu, L. (2019). A study of financial crisis transmission channels, government subsidies, and firm performance. *Inquiry into Economic Issues*, (03), 40-50.
- Yang, Y. & Fan, Y. (2015). Impact of government subsidies on corporate financial performance - evidence from renewable energy firms. *Communication of Finance and Accounting*, (25), 42-45. <https://doi.org/10.16144/j.cnki.issn1002-8072.2015.25.013>
- Yu, F., Wang, L., & Li, X. (2020). The effects of government subsidies on new energy vehicle enterprises: the moderating role of intelligent transformation. *Energy Policy*, 141, 111463. <https://doi.org/10.1016/j.enpol.2020.111>
- Zhang, T., & Ji, Y. (2016). Government subsidies, R&D investment, and business performance of listed agricultural companies - based on the mediation effect. *Journal of Hubei University of Science and Technology*, 36(5), 47-50. <https://doi.org/10.16751/j.cnki.hbkj.2016.05.012>
- Zheng, M., Dong, J., & Zhong, C. (2020). Influence of government subsidies on the performance of rare earth enterprises in China. *China Science and Technology Forum*, (10), 93-104. <https://doi.org/10.13580/j.cnki.fstc.2020.10.0>

The Level of Job Satisfaction in the Czech Republic

Vaclav ZUBR* and Marcela SOKOLOVA

University of Hradec Kralove, Hradec Kralove, Czech Republic; vaclav.zubr@uhk.cz;
marcela.sokolova@uhk.cz

* Corresponding author: vaclav.zubr@uhk.cz

Abstract: The job satisfaction is very important for organizations due to its influence on motivation of employees, their productivity and therefore the organizational performance. Therefore, the aim of this study is to evaluate the level of job satisfaction in the Czech Republic in relation to the type of organizational culture (bureaucratic, innovative, and supportive). The Wallach's Organizational Culture Index questionnaire was used to obtain the data. A cross-sectional survey was provided between January – February 2019 and 1,271 respondents from different fields and organizations participated in this study. The results shown that the best value of job satisfaction has the supportive culture (4.054), the bureaucratic and innovative cultures have almost the same value of job satisfaction (difference 0.058). From organizations that exhibit the characteristics of multiple cultures, the best total satisfaction value has the organization where are all three cultures represented (4.028). Overall, the average of total satisfaction is usually between three to four (the maximum is 6 points), which corresponds to the results of studies already performed in the Czech Republic and since 2014, the job satisfaction shows stable values without major fluctuations.

Keywords: job satisfaction; organizational culture; Czech Republic

JEL Classification: J28; M54; M14

1. Introduction

The job satisfaction has been described by many authors in past years. One of the most widely used definition is definition by Locke (1976) who described the job satisfaction as an emotional state (pleasurable or positive) as a result of the evaluation of work experience.

Job satisfaction plays important role in organizations. It has been shown that the job satisfaction has positively influence the level of employee's motivation, their productivity, or their commitment to the organization. If the employees are satisfied, they have a lower tendency to turnover and absenteeism (Onyebuchi et. al., 2019). In general, it can be said that the job satisfaction has a positive effect on organizational performance (Onyebuchi et. al., 2019; Miah, 2018).

The job satisfaction is affected by many factors dependent on the field of study, e. g. the satisfaction of nurse educators is affected by gender, age, marital status, work and teaching experience, leadership styles, leader's expectations, managers support etc. (Arian et al., 2018) while in teachers the main factors affecting the job satisfaction can be the salary of teacher, growth opportunities or the relationship to co-workers and the effect of supervision (Iwu et

al., 2018). It has been also conducted that the level of teacher's job satisfaction is positively affected by psychological capital (Demir, 2018). In general, the main factors influencing employee job satisfaction include salary, working and service condition, colleague, and opportunity (Bashir, 2017).

1.1. Organizational Culture

The organizational culture has been described in many ways and the term "organizational culture" is usually used for the culture of whole organization. The term organizational culture describes the environment in which people work, and how this environment affects the thinking, acting and experience of work by these people (Warrick et al., 2016; Warrick, 2017). According to past conducted studies (Sharma, 2017; Soomro & Shah, 2019; Meng & Berger, 2019; de Carvalho et. al., 2018), the relationship between the organizational culture and job satisfaction exists. Soomro & Shah (2019) found that job satisfaction affects organizational culture and according to Meng & Berger (2019) the strong impact of organizational culture on job satisfaction exists.

The organizational culture is usually differentiated into four types – the clan, adhocracy, market, and hierarchy culture (Rumijati, 2019; Di Stefano, et. al., 2017; Naranjo-Valencia et al., 2019). In 1983, Wallach (1983) defined the Organizational Culture Index (OCI) that differentiated culture into bureaucratic, innovative, and supportive dimension. In the bureaucratic culture, work is systematic, organized, and the control and power are usually the base of culture. Innovative culture can be characterized as dynamic and exciting, people in this culture are creative and take risks. In the supportive culture the interpersonal relationships play the main role (friendly people, trust, collaborative) (Wallach, 1983). The Wallach's questionnaire OCI can be used for evaluating the organizational culture.

There are not too many studies focused on job satisfaction in the Czech Republic (Franěk et al., 2014; Čech et al., 2015; Lehmann, 2015; Mysíková & Večerník, 2016; Sokolova et al., 2016; Zubr et al., 2016; Mohelska et al., 2020) which presents an opportunity for further studies. Therefore, the aim of this study was to evaluate the level of job satisfaction in the Czech Republic in relation to the type of organizational culture. The main research question was identified:

- What is the level of job satisfaction (in relation to individual organizational cultures) in the Czech Republic?

2. Methodology

The questionnaire survey using the Wallach's Organizational Culture Index questionnaire in the Czech translation was conducted January–February 2019. The questionnaire has 24 items, the 4-point Likert scale (0 – does not describe our organization, 3 – describes our organization in most cases). The basic demographic issues focused on age, gender and the level of education attained are included in the questionnaire as well as questions focused on the business area, ownership of organization where respondent work (Czech or foreign ownership, international corporation, public/governmental organization),

respondent's position and the organization's size (up to 50 and up to 250 employees, 500 employees and more).

The part focused on the job satisfaction contained 9 sections, each with 4 questions. Each section represented one factor with potential influence on the job satisfaction (e. g. co-workers, communication, etc.). For the total job satisfaction, a maximum of 6-points can be reached.

The questionnaire was filled out via students at our college in a distance program who filled a questionnaire also with their colleagues in their workplace. These students work in different fields and types of organizations so the respondents' sample like cross-sectional was created.

The data were evaluated for bureaucratic, innovative, and supportive culture. To evaluate the data Microsoft Excel 2019 and IBM SPSS version 26 were used. Descriptive statistics tools were used to evaluate the data.

In total, 1,350 questionnaires were obtained, 1,271 questionnaires were processed. Due to incompleteness, 79 questionnaires were excluded from the study.

3. Results

In total, 1,271 questionnaires were evaluated. A total of 43.1% male and 56.9% female participated in the study. The most represented age group was respondents in age 21-30 years old (34.7%) with high school education (42.2%). The most represented organization type was organization with Czech ownership (51.5%). The detailed respondents' demographic profile is described in Table 1.

Table 1. Respondents' demographic profile (n = 1,271)

	n	%
Gender		
Male	548	43.1
Female	723	56.9
Age		
less than 20	51	4.0
21-30	441	34.7
31-40	275	21.6
41-50	329	25.9
51-60	151	11.9
61 and more	24	1.9
Education		
Primary school	20	1.6
Trained	126	9.9
High school	536	42.2
Higher vocational school	80	6.3
College	416	32.7
College student	93	7.3
Organization type		
Czech ownership	655	51.5
Foreign ownership	243	19.1
International corporation	133	10.5
Public/governmental organization	240	18.9

If we compare the average of total satisfaction values in relation to type of the organizational culture, the highest value of total satisfaction has supportive culture. The bureaucratic and innovative culture provides almost same results where the bureaucratic culture has obtained only 0.058 more points than the innovative culture. In some cases, it is hard to decide what culture is the most represented in organization. In our study we identified some organizations that exhibit the characteristics of multiple cultures. From these “mixed-culture” organizations have the best satisfaction rating organizations in which all three cultures are represented (bureaucratic/innovative/supportive, the value of total satisfaction average 4.028). The detailed results are described in Table 2.

Table 2. The average of total satisfaction in relation to organization culture

Type of culture	Total satisfaction average
Bureaucratic	3.568
Innovative	3.510
Supportive	4.054
Bureaucratic/innovative	3.622
Bureaucratic/innovative/supportive	4.028
Bureaucratic/supportive	3.848
Innovative/supportive	3.875

4. Discussion

This article focuses on job satisfaction in relation to the type of organizational culture in the Czech Republic. Although 56.9% of women participated in this study, we can say that the male/female ratio was relatively balanced. Furthermore, according to job satisfaction data from Eurostat, the job satisfaction assessments by gender are not very different (Eurostat, 2017). The age group 21-30 years old was the most represented, which is probably due to the way of distributing questionnaires via students at our university in distance form of study. The mostly represented were organizations with Czech ownership, which corresponds to the distribution of business owners in the Czech Republic. A total of 80% of organizations in the Czech Republic was in the Czech ownership, 10% of organizations have a owner from the European Union countries and 10% of organizations have foreign owners from countries outside the European Union (Třešňák, 2019).

In the years 2003-2014, the evaluation of job satisfaction among employees in the Czech Republic remained at approximately the same level, except for small fluctuations. Between 2013 and 2014 a 5% decrease in job satisfaction was shown (Lehmann, 2015). While job satisfaction at the European Union level is often solved at different levels and job fields (Bastida et al., 2018; Serafin et al., 2019; Hünefeld et al., 2020), in the Czech Republic is the job satisfaction solved in long-term study by Public Opinion Research Centre, Institute of Sociology of the Academy of Sciences of the Czech Republic (CVVM) and only a few other authors focus on job satisfaction in the Czech Republic, mostly researches from University of Hradec Kralove (CVVM, 2020; . Franěk et al., 2014; Sokolova et al., 2016; Zubr et al., 2016; Mohelska et al., 2020).

According to the actual study conducted by CVVM in July 2020, almost 70% of employees in the Czech Republic are satisfied with their job (CVVM, 2020). If we relate our results to this information, it could be said that both findings are consistent. When comparing the results with other studies performed in the Czech Republic since 2014, it can be said that the value of job satisfaction is relatively constant without major fluctuations with values from three to slightly exceeding four (Franěk et al., 2014; Sokolova et al., 2016; Zubr et al., 2016; Mohelska et al., 2020).

According to Eurostat data related to the job satisfaction in 2013 only 19.4% of respondents were low satisfied with their job in EU-28, medium-satisfied were 55.8% of respondents (Eurostat, 2013). Job satisfaction has improved over the next years and in 2017 it reached values of around 90% for most age groups in EU-28 (Eurostat, 2017). Comparing our results with data on job satisfaction values in the EU-28, our findings appear to show a lower value of job satisfaction than in EU-28 in 2017.

4.1. Limitations of the Study

A possible limitation may be the distribution of questionnaires through distance learning students, although we tried to ensure the greatest possible cross-sectional distribution. As another limitation, we can mention the focus of the study only on total satisfaction without evaluating the individual factors that contribute to all factors of job satisfaction.

5. Conclusions

The job satisfaction is very actually and discussed topic mainly due to its impact on organizational performance. The job satisfaction across the sectors in the Czech Republic in relation to the type of organizational culture has usually slightly better values than the middle value (3-4 points from 6-points as a maximum). The best job satisfaction rating was described for the supportive culture.

The level of job satisfaction is relatively constant during past years in the Czech Republic. Although the job satisfaction in the Czech Republic is at a relatively good level, there is still some space for its improvement. It would be appropriate in the future to analyze the level of job satisfaction for individual factors that affect job satisfaction and focus on improving the factors with the lowest rating.

Acknowledgments: The paper was written with the support of the specific project 2021 grant "Determinants of Cognitive Processes Impacting the Work Performance" granted by the University of Hradec Králové, Czech Republic and thanks to help of students František Hašek and Anna Borkovcová.

References

- Arian, M., Soleimani, M., & Oghazian, M. B. (2018). Job satisfaction and the factors affecting satisfaction in nurse educators: A systematic review. *Journal of Professional Nursing*, 34(5), 389–399. <https://doi.org/10.1016/j.profnurs.2018.07.004>
- Bashir, L. (2017). Job Satisfaction of Teachers in Relation to Professional Commitment. *The International Journal of Indian Psychology*, 4(4), 52–59. <https://doi.org/10.25215/0404.007>
- Bastida, R., Marimon, F., & Carreras, L. (2018). Human resource management practices and employee job satisfaction in nonprofit organizations. *Annals of Public and Cooperative Economics*, 89(2), 323–338. <https://doi.org/10.1111/apce.12181>

- Carvalho, C. R. S. P., Castro, M. A. R., Silva, L. P., & Carvalho, L. O. P. (2018). The Relationship Between Organizational Culture, Organizational Commitment and Job Satisfaction. *Rebrae*, 11(2), 201–215. <https://doi.org/10.7213/rebrae.v11i2.23772.g22698>
- CVVM. (2020). *Postoje české veřejnosti ke svému zaměstnání – červenec 2020*. https://cvvm.soc.cas.cz/media/com_form2content/documents/c6/a5280/f77/eu200921.pdf
- Čech, P., Beránek, M., & Chromý, J. (2015). Job Satisfaction of Managers Working for Hotels and Hotel Chains in the Czech Republic. In Khalid S. Soliman (Ed.), *Proceedings of the 26th International Business Information Management Association Conference; Innovation Management and Sustainable Economic Competitive Advantage: From Regional Development to Global Growth*. (pp. 668-676). Madrid: International Business Information Management Association.
- Demir, S. (2018). The Relationship between Psychological Capital and Stress, Anxiety, Burnout, Job Satisfaction, and Job Involvement. *Eurasian Journal of Educational Research*, 75, 137–154. <https://doi.org/10.14689/ejer.2018.75.8>
- Di Stefano, G., Scrima, F., & Parry, E. (2017). The effect of organizational culture on deviant behaviors in the workplace. *The International Journal of Human Resource Management*, 30(17), 2482–2503.
- Eurostat. (2013). *Satisfaction with job and commuting time, EU-28, 2013*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Satisfaction_with_job_and_commuting_time,_EU-28,_2013.png
- Eurostat. (2017). *Job satisfaction, by sex and age class, EU-28, 2016 (% satisfied with job)*. [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Job_satisfaction,_by_sex_and_age_class,_EU-28,_2017_\(%25_satisfied_with_job\)_AE2019.png&oldid=449234](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Job_satisfaction,_by_sex_and_age_class,_EU-28,_2017_(%25_satisfied_with_job)_AE2019.png&oldid=449234)
- Franěk, M., Mohelská, H., Zubr, V., Bachmann, P., & Sokolová, M. (2014). Organizational and Sociodemographic Determinants of Job Satisfaction in the Czech Republic. *SAGE Open*, 4(3), 1-12. <https://doi.org/10.1177/2158244014552426>
- Hünefeld, L., Gerstenberg, S., & Hüffmeier, J. (2020). Job satisfaction and mental health of temporary agency workers in Europe: a systematic review and research agenda. *Work & Stress*, 34(1), 82–110. <https://doi.org/10.1080/02678373.2019.1567619>
- Iwu, C. G., Ezeudui, I. O., Iwu, I. Ch., Ikebuaku, K., & Tengeh, R. K. (2018). Achieving Quality Education by Understanding Teacher Job Satisfaction Determinants. *Social Sciences*, 7(2), 25. <https://doi.org/10.3390/socsci7020025>
- Lehmann, Š. (2015). *Czech Republic: Job satisfaction of workers falls slightly*. Eurofound. <https://www.eurofound.europa.eu/publications/article/2015/czech-republic-job-satisfaction-of-workers-falls-slightly>
- Locke, E. A. (1976). *The nature and causes of job satisfaction*. *Handbook of industrial and organizational psychology*.
- Meng, J., & Berger, B. K. (2019). The impact of organizational culture and leadership performance on PR professionals' job satisfaction: Testing the joint mediating effects on engagement and trust. *Public Relations Review*, 45, 64–75. <https://doi.org/10.1016/j.pubrev.2018.11.002>
- Miah, M. (2018). The impact of employee job satisfaction toward organizational performance: A study of private sector employees in Kuching, East Malaysia. *International Journal of Scientific and Research Publications*, 8(12), 270–278. <https://doi.org/10.29322/IJSRP.8.12.2018.p8437>
- Mohelska, H., Sokolova, M., Cierniak-Emerych, A., & Dziuba, S. T. (2020). Employment in High-technology Industries in the European Union and Job Satisfaction – Case Study Czech Republic and Poland. *Economic Research-Ekonomska Istraživanja*, 33(1), 639-651. <https://doi.org/10.1080/1331677X.2019.1697723>
- Mysíková, M., & Večerník, J. (2016). Life and Job Satisfaction in the Czech Republic. *Politická ekonomie*, 64(7), 851-866. <https://doi.org/10.18267/j.polek.1093>
- Naranjo-Valencia, J. C., Jiménez-Jiménez, D. & Sanz-Valle, R. (2019). Organizational culture effect on innovative orientation. *Management Decision*, 49(1), 55–72. <https://doi.org/10.1108/0025174111094437>
- Onyebuchi, O., Lucky, O., & Okechukwu, O. (2019). Impact of Employee Job Satisfaction on Organizational Performance. *Academic Journal of Current Research*, 6(12), 6–12.
- Rumijati, A. (2019). The Types of Organizational Culture in Private Higher Education. In *Proceedings of the 6th International Conference on Community Development (ICCD 2019)*. Paris, France: Atlantis Press. <https://doi.org/10.2991/iccd-19.2019.23>
- Serafin, L., Bjerså, K., & Doboszyńska, A. (2019). Nurse job satisfaction at a surgical ward – a comparative study between Sweden and Poland. *Medycyna Pracy*, 70(2), 155–167.

- Sharma, P. (2017). Organizational culture as a predictor of job satisfaction: the role of age and gender. *Management – Journal of Contemporary Management Issues*, 1, 35–48.
- Sokolová, M., Mohelská, H., & Zubr, V. (2016). Pay and Offer of Benefits as Significant Determinants of Job Satisfaction – the Czech Republic. *E&M Economics and Management*, 19(1), 108–120.
<https://doi.org/10.15240/tul/001/2016-1-008>
- Soomro, B. A., & Shah, N. (2019). Determining the impact of entrepreneurial orientation and organizational culture on job satisfaction, organizational commitment, and employee's performance. *South Asian Journal of Business Studies*, 8(3), 266–282. <https://doi.org/10.1108/SAJBS-12-2018-0142>
- Třešňák, P. (2019). *Kapitál českých společností přesahuje dva biliony korun, většina pochází ze zahraničí*. Euro.cz.
<https://www.euro.cz/byznys/kapital-ceskych-spolecnosti-presahuje-2-biliony-korun-vetsina-pochazi-ze-zahranici-1452171>
- Wallach, E. J. (1983). Individuals and Organizations: The Cultural Match. *Training and Development Journal*, 37(2), 28–36.
- Warrick, D. D. (2017). What leaders need to know about organizational culture. *Business Horizons*, 60, 395–404.
<https://doi.org/10.1016/j.bushor.2017.01.011>
- Warrick, D. D., Milliman, J. F., & Ferguson, J. M. (2016). Building high performance cultures. *Organizational Dynamics*, 45(1), 64–70.
- Zubr, V., Sokolova, M., & Mohelska, H. (2016). The Influence of Selected Factors on Overall Job Satisfaction. *Littera Scripta*, 9(2), 169–184.

Hradec Economic Days

Volume 11

Issue 1

Proceedings of the International Scientific Conference

Hradec Economic Days 2021

March 25–26, 2021.

Editors: Jan MAČÍ, Petra MAREŠOVÁ, Krzysztof FIRLEJ, Ivan SOUKAL.

Hradec Economic Days are published annually.

Edition size: electronic edition only.

Published: March 25, 2021.

Publisher: University of Hradec Králové.

Publisher's office: Rokitanského 62, Hradec Králové 3, 500 03, Czech Republic.

VAT ID: CZ62690094.

ISSN 2464-6059 (Print)

ISSN 2464-6067 (Online)

ISBN 978-80-7435-822-7

DOI: 10.36689/uhk/hed/2020-01-000



University of Hradec Králové
Faculty of Informatics and Management

