FACTA UNIVERSITATIS

SERIES **ECONOMICS AND ORGANIZATION**

FACTA UNIVERSITATIS

SERIES **ECONOMICS AND ORGANIZATION**
Vol. 17, N° 2, 2020

UNIVERSITY OF NIŠ

INSTRUCTIONS FOR CONTRIBUTORS

Contributions should be (preferably) in English, French or German.

Under the paper title, the name(s) of the author(s) should be given while the full name, official title, institute or company affiliation and the like should be placed at the end of the paper together with the exact mail and e-mail address, as well as short (running) title of paper.

Manuscript format. A brief abstract of approximately 100 to 150 words in the same language and a list of up to six key words should precede the text body of the manuscript. Manuscripts should be prepared as doc. file, Word version 6.0 or higher. Manuscript should be prepared using a Word template (downloaded from web address http://casopisi.junis.ni.ac.rs/index.php/FUEconOrg/about/submissions#authorGuidelines).

Manuscript length. Brief articles and discussions (10 pages or less) are encouraged. Otherwise, papers should present well-focused arguments of approximately 16 pages.

Style requirements. **Letters, figures and symbols** should be clearly denoted.

Equations should be typewritten and, with the number, placed in parentheses at the right margin. References to equations should be in the form "Eq. (2)" or simply (2). For equations that cannot be entered in a single line, use the Equation Editor in MS Word. In equations and in the text, *italicize* symbols that are used to represent variables or parameters, including subscripts and superscripts. Only use characters and symbols that are available in the Equation Editor, in the *Symbol font* or in *Times New Roman*.

All illustrations (figures, photographs, line drawings, graphs) should be numbered in series and all legends should be included at the bottom of each illustration. All figures, photographs, line drawings and graphs, should be prepared in electronic form and converted in TIFF or JPG (max quality) file types, in 300 dpi resolution, for superior reproduction. Figures, line drawings and graphs prepared using elements of MS Drawing or MS Graph must be converted in form of pictures and unchangeable. All illustrations should be planned in advance so as to allow reduction to 12.75 cm in column width. Please review all illustrations to ensure that they are readable.

All **tables** should be numbered with consecutive Arabic numbers. They should have descriptive captions at the top of each table and should be mentioned in the text.

References should follow the **APA Style** convention, in alphabetical order at the end of the manuscript. The list of references should be formatted so that the second row in each entry is indented (Paragraph Indentation, Special - choose Hanging, by 0.5cm). Wherever possible, the DOI number should be provided, too, in addition to other reference data.

The APA style **citation** is applied in the text (according to the instructions that can be downloaded from the link http://www.apastyle.org/ or using samples given in the template). Citations in the text should be given in brackets, stating the author's surname, year of publication and, possibly, pages, if it is a direct quote).

Electronic submission. Papers for consideration should be submitted to the Series Editor in electronic form via the Journal's home page: http://casopisi.junis.ni.ac.rs/index.php/FUEconOrg.

INDUSTRY 4.0 DEVELOPMENT CONDITIONS IN THE REPUBLIC OF SERBIA

UDC 004.9

Vladimir Mićić

University of Kragujevac, Faculty of Economics, Serbia

Abstract. *The fourth industrial revolution is about the development of Industry 4.0, the changing of the production paradigm and economic digitalization. The research subject are the development conditions of Industry 4.0 in the Republic of Serbia. The main research objective is to point out the importance of the efficient development of Industry 4.0 and the implementation of structural changes through the process of digitalization and application of technological innovation in the manufacturing industry. The method of analysis is used to identify the concepts of Industry 4.0 and the new industrial paradigm. The comparative method is used to compare technological criteria and changes. The development conditions of Industry 4.0 are analyzed indirectly through technological criteria and innovation, i.e. data obtained from survey on innovation, individual innovation and technology indicators and composite indicators. Industry 4.0 is an important factor in technological and structural change, economic growth and competitiveness. The research results show that the Republic of Serbia lacks incentives for the development of Industry 4.0. The research results are useful to industrial policy makers as they point to some of the key factors and directions of change to create the conditions for the development of Industry 4.0, the manufacturing industry and the digital transformation of the economy.*

Key words: *Industry 4.0, manufacturing industry, digitalization, innovation, technological change*

JEL Classification: O14, O30, O33

1. INTRODUCTION

The fourth industrial revolution concerns the development of Industry 4.0 (Industry 4.0 – I4.0) or networked "smart" industries and factories of the future, which is related to the concept of smart (intelligent) production. The fourth industrial revolution and "smart factories" are creating a world that enables virtual and physical production systems to engage in global and flexible collaboration. This allows for complete customization of products and creation of new business models (Schwab, 2017).

The concept of I4.0 is thought to be the main driver of the fourth industrial revolution (Stankovic, et al., 2017), and is based on knowledge and a range of new trends and technologies, notably artificial intelligence, new generations of digital technology and infrastructure, artificial intelligence, machine learning, robotics, the Internet, nano technology, genetic modification, new types and modes of energy and information storage, quantum computing, genetics and biotechnology. The fourth industrial revolution relies on digital revolution technology, which focuses on artificial intelligence, nano technology and mobile devices. "These innovation platforms provide limitless opportunities for knowledge creation and transfer. They rapidly multiply innovations, which affects development of a society, its structure and dynamics, its value system, as well as people's daily lives" (Bazić, 2017).

The start of the fourth industrial revolution links to the 2011 Hanover Industrial Technology Fair in Germany. It has become a driving force of exit from recession, re-industrialization, competitiveness growth and recovery of EU economies.

In the fourth industrial revolution, new technology and innovation are introduced much faster, and in some parts of the world revolutions are not over yet. The fourth industrial revolution is also unique because of the increasing integration of different disciplines and discoveries (Schwab, 2017). Certainly the most significant change and challenges lie in new and efficient technologies, but also a profound impact on the industry dynamics and structure, the need for new industrial policy, digital globalization, and the changing role of training and education (Vujović, 2019).

Although focusing on the manufacturing industry, I4.0 is broader in scope than the fourth industrial revolution, and it is widely believed that I4.0 is the driver and structural component of the revolution. The fourth industrial revolution relies on digital revolution, which means new ways for technology to become a building block of the economy, and is marked by the emergence of technological innovation in numerous domains of human society. Compared to the previous ones, it develops at an exponential pace, and the breadth and depth of its changes influence the transformation of production, management and governance (WEF, 2016).

I4.0 is a new industrial paradigm that embraces the application of modern technologies in industrial production (Pereira & Romero, 2017), such as cyber-physical systems (CPS), Internet of Things (Internet of Things-IoT), Internet of Services (IoS), Robotics, Computer-Aided Design (CAD), Big Data Analytics, Cloud Computing, Augmented Reality, and so on.

In this regard, the research subject in this paper are the conditions for the development of I4.0 in Serbian manufacturing industry. The main research objective is to point out the importance of efficient development of Industry 4.0 and implementation of structural changes through the process of digitalization and application of technological innovations in the manufacturing industry of the Republic of Serbia.

2. DEVELOPMENT AND CHARACTERISTICS OF INDUSTRY 4.0

I4.0 is described as digitalization or full automation. It is also defined in relation to new technologies. Although digitalization has led to I4.0, it cannot be defined solely through the technological paradigm, due to the convergence of industries, transformation of businesses, changes in business models, organization and culture (WEF, 2016).

The way the Internet creates tremendous value by connecting people virtually, the Internet of Things does this by connecting things. "Cyber-physical systems lead to smart manufacturing, with intelligent products, machines, networks and systems that independently communicate and interact with each other during the manufacturing process. The advances in digital technologies and their impact on I4.0 are profound, leading to a change in boundaries between industry and other sectors, as well as between buyers and sellers. What is more, the roles of the public and private sectors change, as well as the conditions of market competition. Current production systems, driven by global value chains, become more dynamic, flexible, efficient and sustainable, with personalization capabilities" (Stankovic, et al., 2017).

The concept of I4.0 was introduced by the German Scientific Research Association in 2011, and comes from the German government's strategic initiative aimed at digitalizing the manufacturing industry, i.e. creating a production process completely independent of man (Buhr, 2015). It is a strategic initiative within a high-tech strategy, and the goal is for SMEs to take advantage of I4.0 capabilities, especially in the areas of standardization, norms, security, legal frameworks, research and workforce transformation.

The I4.0 concept is "a comprehensive concept and new trend in the manufacturing industry and relevant sectors, based on the integration of a range of technologies that enable the ecosystem of intelligent, autonomous and decentralized factories and integrated products and services" (Stankovic, et al., 2017). The I4.0 concept is also associated with "smart data and information gathering and deployment in real time, as well as networking of all elements, to reduce operation complexity, increase efficiency and effectiveness, and reduce costs over the long term" (Santos, et al., 2017).

I4.0 goal is to turn machines into self-aware ones to improve maintenance, performance and interaction with the environment. I4.0 aims to build an open, smart manufacturing platform for deploying information across an industrial network. The main requirements of I4.0 are real-time data monitoring, product monitoring and positioning, and management of production process control instructions. I4.0 is an emerging structure where CPS uses a global ICT network for automated information sharing, with production and business processes aligned. The main drivers of I4.0 are the Internet of Things, the Industrial Internet of Things, the Industrial Cloud and smart manufacturing, which helps transform the manufacturing process into a digitalized and intelligent production model (Vaidya, et al., 2018).

I4.0 concerns the development phase in the organization and management of the industry value chain. I4.0 consists of nine pillars linking production into an integrated, automated and optimized flow, resulting in greater efficiency and change in supplier, manufacturer and consumer relationships, as well as between humans and machines. The nine pillars are: (1) Big Data and Big Data Analytics, (2) Autonomous Robots, (3) Simulation, (4) Horizontal and Vertical System Integration, (5) Industrial Internet of Things, (6) Cyber Security and CPS, (7) Cloud, (8) 3D printing, (9) Augmented reality (GTAI, 2014; Vaidya, et al., 2018; Xu, Xu, & Li, 2018).

The I4.0 concept is being implemented in the EU, especially in the German industry. In the US, I4.0 also uses the terms Internet of Things, Internet of Everything and Industrial Internet. What they have in common is that industry and manufacturing are influenced by digitalization. For now, I4.0 is more of a vision than a reality, but it has an impact on business digitalization so that machines do most of the work as people develop and control them. While traditional manufacturing methods and factors retreat, innovators make progress. New business and organizational models, products, services, and distribution channels develop. People, processes, services and data network, and production become faster and more flexible. Productivity grows because resources are used more efficiently (Finance, 2015).

The concept of I4.0 contributes to productivity growth through ICT-based real-time control and the use of robots. Key success factors are knowledge, flexibility, creativity and innovation. The application of ICT in industry is increasing, leading to the development of manufacturing processes. The state should support I4.0 with appropriate policies, with other stakeholders who need to embrace the importance of innovation for digitalization, because change does not only affect industry, but the whole economy (Stankovic, et al., 2017). Digitalization of manufacturing in factories also creates new skill requirements, with automation leading to redundancies while creating new jobs (Links, 2013).

I4.0 is the result of digitalization where everything in the value chain is networked with direct information exchange. The consequences of I4.0 are automation, decentralization, new business models, accelerated value creation process, flexibility, transparency, personalized production, more efficient use of resources. The larger the company, the more seriously it takes the need for digitalization, while SMEs lag behind (Buhr, 2015). The main features of I4.0 are interoperability, virtualization, decentralization, real-time functioning, service orientation and modularity (Smit, et al., 2016).

In addition to industry, I4.0 has an impact on services, business models, market, work environment, skills (Pereira & Romero, 2017). I4.0 has the biggest impact in the manufacturing industry through productivity and competitiveness growth. Structural changes in the manufacturing industry are influenced by digitalization and automation, as well as the integration of manufacturing sites into a comprehensive value chain (Roblek, Meško, & Krapež, 2016).

The potential for I4.0 is huge, taking into account individual requirements and customization of products. Faster and more flexible production reduces the use of resources and risks, highlights its own benefits, facilitates data processing, increases quality, reduces manufacturing errors, develops infrastructure. All this contributes to the creation of greater added value (Finance, 2015).

In I4.0, data collection and analysis is the standard for real-time decision making. Collecting and analyzing data between machines brings a faster and more flexible process of producing higher-quality products at lower costs, modifying the workforce profile. This leads to productivity growth, competitiveness and industrial growth. Productivity levels determine the rate of return, the rate of economic growth and the growth of investment (WEF, 2018).

New technology brings greater efficiency and changing relationships between suppliers, manufacturers and customers, as well as between humans and machines. The production uses robots for complex operations, as well as simulations for creating virtual models, which allows testing and optimizing machines before deployment, thus reducing

production time. This means faster response to consumer needs, improving flexibility, speed, productivity and production quality. The connection between machines and humans requires new standards that define the interaction of these elements in the digital factory of the future (Rüßmann, et al., 2015).

I4.0 starts with production in the manufacturing industry, but its impact extends to other segments of society, including utilities, smart buildings, roads, cities, where activities are coordinated to meet the increased energy needs of smart grids. New technologies develop to manage the broad ICT infrastructure (Stankovic, et al., 2017).

The fourth industrial revolution is causing radical changes in the industry. The breadth and depth of these changes transforms the system of production, management and public administration. Today, it is impossible to predict all the potentials of I4.0 (Lodder, 2016). It is still partly a visionary conception. There are certain challenges that arise during its development such as: (1) intelligent decision-making and negotiation mechanisms, (2) smart high-speed wireless network protocols, (3) industry-specific big data and analytics, (4) system modelling and analysis, (5) cyber security, (6) modularized and flexible physical objects, (7) size problems (Vaidya, et al., 2018).

3. CHANGE IN THE INDUSTRIAL PARADIGM AND WORKFORCE COMPETENCES IN THE DIGITALIZATION ERA

I4.0 is a shift in the production paradigm from centralized to decentralized smart manufacturing. It computerizes production and creates smart factory (the factory of the future), in which physical objects are integrated into the information network. Production systems are vertically networked with business processes in factories, and horizontally linked to real-time value-creation networks, managed from the moment of order to outbound logistics. "This interaction between implemented systems, based on special software and the user interface, which is integrated into digital networks, creates a new world of system functionality for horizontal and vertical integration" (Chukalov, 2017).

The distinction between industry and services is increasingly blurred. Digital technologies are linked to products and services into hybrids. In smart factories, CPS and networks monitor physical processes, create virtual physical systems, and make decisions. By using IoT and CPS, systems communicate and interact with each other and with people, while through IoS, participants in the value chain offer and use internal and inter-organizational services. Smart data is collected throughout the product life cycle. This optimizes smart, flexible supply chains and distribution models, and leads to efficient and optimized use of machinery and equipment. Businesses are able to make faster, smarter decisions, responding quickly to requests, while minimizing costs (Stankovic, et al., 2017).

It is expected that I4.0 will in the long run in four ways affect the changing industrial paradigm as well as the structure of the manufacturing industry. Above all, by changing and improving the relationship between factories and nature, factories and the local community, factories and value chains, and factories and people (Santos, et al., 2017).

Changing industrial paradigm comes from new technologies that make it possible to produce faster and cleaner products, at a lower cost. Higher newly created values will be the result of innovation, and technologies will reshape production, the way additive manufacturing does. When technological solutions are fully integrated into products and

networks, they facilitate the ways in which products are designed, manufactured, offered and used. The difference between cheap mass products and pricier custom products will drop due to the number and types of products. New digital technologies will bring personalization with a direct customer contribution to the design, allowing custom products to be produced in shorter production cycles, at a lower cost. The producer and the buyer will work together to create new value (Foresight, 2013).

I4.0 development and the digitalization of the economy require a wide range of value chain skills, and a whole new approach to education (Smit, et al., 2016). Digitalization and new technologies change both the type of workers and the type of skills required. Smart manufacturing requires workers with multidisciplinary knowledge, i.e. hybrid capabilities that include technical specialization and business awareness (Foresight, 2013).

The EU is of the view that competence in science, technology, engineering and mathematics is becoming an important part of literacy in the knowledge economy. Formal and informal education and knowledge acquisition in natural sciences are important in order to raise awareness of various technologies, and to respond to the challenges of STEM (STEM Education, 2019).

STEM defines the areas in which I4.0 professionals will develop, and the most successful will be those that connect multiple areas. Sustainable interaction between the various educational institutions, research and innovation funding institutions, the practicing industry, as well as policymakers (European Commission, 2019a) is important. Research has shown that the employment of STEM workforce in the EU is on the rise, but that there are differences between member states and that part of the increase is a result of migration policy and labor mobility (Caprile, M. et al., 2015). In 2016, the EU launched digitalization and implementation of measures to create a single digital market. Part of the measures refers to digital skills (European Commission, 2019b).

The EU seeks to identify the challenges of digitalization, strengthen the role of industry and research organizations to take action. It seeks to improve the understanding of the skills needed for new technologies, which is part of Horizon 2020, which promotes the development of digital skills, and to launch the creation of digital innovation centers (European Commission, 2019c).

Research on EU member states' prospects for the development of I4.0 based on digitalization by criteria of industrial excellence and value networks shows four groups of economies (Dujin, Geissler, & Horstkötter, 2014):

(1) Leaders – Members who are making good progress in the digitalization and development of I4.0 (Germany, Sweden, Austria and Ireland);

(2) Potentialists – Members where the industrial base is weak but the corporate sector is modern and has potential (UK, France, Belgium, Denmark, the Netherlands);

(3) Traditionalists – Members with a large industrial base, but few of which have initiated the development of I4.0 (Czech Republic, Slovakia, Slovenia, Hungary and Lithuania);

(4) Undecided – Members with an industrial base but low financial capacity to develop I4.0 (Italy, Spain, Estonia, Portugal, Poland, Bulgaria and Croatia).

4. RESEARCH METHODOLOGY AND HYPOTHESES

The analysis method is used to identify the concepts of I4.0 and the new industrial paradigm. The synthesis method is applied when integrating elements of I4.0 concepts and technological changes into a single whole and conclusions. The comparative method is used when comparing technological criteria and changes, manufacturing industry of the Republic of Serbia and selected EU member states.

The concept of I4.0 mostly concerns the digitalization of the manufacturing industry and the development of a range of new high technologies. In order to examine the conditions of development of I4.0, the paper analyzes technological changes and innovations, which are diverse and dominantly shape all areas of production. The complex nature of technological change in industry can also be explained by the characteristics of innovation (Evangelista, et al., 1997). The connections and relationships between I4.0 innovation and development are complex in nature and will therefore be the result of an indirect analysis of technological criteria (Galindo-Rueda & Verger, 2016). Some of the relevant criteria are process sophistication, quality of workforce, innovation, patents, added value and openness of the industry (Dujin, Geissler, & Horstkötter, 2014).

The paper uses the survey on innovation, individual innovation and technological indicators and composite indicators in the assessment and innovation processes. The most commonly used innovation measurement survey is the Community Innovation Survey (CIS) (Biagi, Pesole & Stancik, (2016). Indicators are mostly covered by high-tech statistics in the knowledge-intensive industry, with employment, science, technology, innovation, patents, based on technological intensity. The sectoral approach is used to identify the intensity of technology, which groups the activities of the manufacturing industry according to the degree of technological intensity, i.e. the amount of investment in research and development, with a production approach that considers the level of technological intensity of products and trade in high-tech products. The list of products is based on R&D intensity and total sales. High-tech product groups are determined on the basis of the Standard International Trade Classification. Total R&D expenditures in GDP are important indicators of the conditions for the development of science, technology, production, and digitalization tech-intensity, which is one of the key indicators of the Europe 2020 Strategy.

Composite indicators of the productive capabilities of industries that measure technological change used in the analysis are the Summary Innovation Index (SII), the Knowledge Economy Index (KEI), the Global Innovation Index (GII), the Global Competitiveness Index (GCI 4.0) and the Competitive Industrial Performance Index (CIP).

In order to determine the conditions and the potentials for the development of Industry 4.0, especially in relation to EU members from Central Europe with a large industrial base, the following hypotheses are tested in the paper:

Hypothesis 1: Innovation processes influence technological changes, improve and increase technological level of production of manufacturing industry in Serbia.

Hypothesis 2: Investment in R&D affects the digitalization of the manufacturing industry in the Republic of Serbia

Data from Eurostat, EBRD, WIPO (World Intellectual Property Organization) and UNIDO databases is used in the analysis of selected EU member states and Serbia.

5. RESEARCH RESULTS AND DISCUSSION

According to CIS, the share of manufacturing industry companies in the Republic of Serbia that introduced at least one type of innovation was about 43.2% in 2016, so it can be concluded that manufacturing industry is innovative (Table 1). Although the share is below the EU average and above the share of some of the observed members, especially from the region, this share is well below the leading members in the process of digitalization and transformation. However, when it comes to product and process innovation, the share of innovative businesses is much lower. Technological innovation of products and processes is insufficient, with inefficient mechanisms of practical application of the manufacturing industry research results.

Table 1 CIS – Manufacturing enterprises that have introduced an innovation, 2016 (%)

	All types	Product innovative
EU28	53.2	11.1
Bulgaria	25.1	6.8
Czech R.	44.9	8.4
Croatia	47.5	5.1
Hungary	27.6	8.3
Romania	9.8	1.2
Slovenia	37.4	10.0
Slovakia	29.3	7.3
R. Serbia	43.0	14.5

Source: Author's calculation based on Eurostat database, 2019

The economy and industry of the Republic of Serbia belong to the group of countries that are moderate innovators and whose innovative performance has increased since 2011. Relative performance relative to the EU was 63.7% in 2018 (Table 2). According to the dimensions of SII, the Republic of Serbia is below the EU average, with the best results in the area of enterprise investment, owing to the level of innovation expenditures of enterprises not related to R&D. The most disadvantaged position is in the area of intellectual property and the research system (Hugo, Nordine & Iris, 2019). The comparison shows that Serbia has a higher SII than some selected EU member states, but significantly lower values than the members with a large industrial base, which indicates modest innovation performance of the manufacturing industry.

Table 2 Indicators of innovative and productive ability, 2018.

	SII	KEI	GII
Value	0 min -100 max	1 min-10 max	0 min -100 max
Czech R.	89.4	6.28	49.43
Hungary	69.0	5.33	44.51
Slovenia	87.6	6.65	45.25
Slovakia	69.1	5.40	42.05
Romania	34.1	5.01	36.76
Bulgaria	48.7	5.18	40.35
Croatia	59.6	5.62	37.82
R. Serbia	63.7	5.13	35.71

Source: Author's based on Hugo, Nordine & Iris, 2019, EBRD, WIPO, 2019

KEI is an aggregate indicator that measures the ability to develop a knowledge-based economy and industry. According to the EBRD, in 2018, the KEI value for the Republic of Serbia was 5.13 (Table 2). It ranked 13th out of 37 ranked states. It has the best record in the ICT infrastructure pillar (EBRD, 2019). With the exception of Romania, according to the value of KEI, the Republic of Serbia lags far behind all selected EU member states, especially those with developed industries, with almost all pillars of the knowledge economy.

Serbia has the lowest GII value compared to selected EU member states, although it has improved in value but not the rank since 2011 (Table 2). According to GII, out of 129 countries, the Republic of Serbia ranked 62nd in 2018. The value of innovation inputs is greater than innovation outputs. With innovation inputs, the best result is with institutions and human resources and research. On the side of innovation outputs, values are greater in the field of knowledge and technological outputs than in creative outputs (WIPO, 2019).

According to the GCI 4.0 methodology for the competitiveness of economies, innovation at all levels and the development of human capital are needed at the time of I4.0 development. Of the four groups of factors, innovation concerns the dynamic environment and the ability to innovate, i.e. the ability to create and apply new technologies and innovative products, as well as to conduct quantitative R&D. What is good for the growth of the competitiveness of the Serbian economy is the growth of the rank and value of the pillar of innovation, where at the level of individual pillars business dynamics recorded 54th, and the ability to innovate 59th position out of 141 ranked countries in 2018 (Table 3). Pillar ability to innovate has the lowest value among GCI 4.0 pillars. The innovation pillar saw growth in value due to a slight increase in inventions, patents, R&D expenditures in GDP, as well as the development of clusters and increased collaboration between employees, businesses and universities. However, the comparison points to a large gap between the rank and value of the two pillars in comparison to EU member states. The reason, when it comes to product and process innovation, is the low share of innovative manufacturing industry companies. The rise in value is primarily in the purchase and transfer of new products and processes, digital technologies, not their development through internal R&D activities, which is the case in other observed industries.

Table 3 GCI- 4.0 Innovation Ecosystem, 2018.

	Business dynamism		Innovation capability	
	Rang/141	Value	Rang/141	Value
Germany	5	79.5	1	86.8
Slovenia	26	70.1	28	58.2
Czech R.	32	68.7	29	56.9
R. Serbia	54	63.1	59	40.2
Slovakia	55	62.8	44	46.3
Bulgaria	61	61.9	48	45.0
Romania	72	59.7	55	42.3
Hungary	83	58.1	41	47.4
Croatia	101	54.7	73	37.8

Source: WEF. (2019). The Global Competitiveness Report 2019. WEF.

Despite the rise in value and the improvement of rank, as measured by the CIP index, the competitiveness of the manufacturing industry of the Republic of Serbia is low. With a CIP value of 0.0416 in 2018, it has the lowest value and ranking of competitiveness, i.e. the worst performance against EU members. That it is low and does not sufficiently improve the competitiveness of the manufacturing industry is confirmed by the fact that of 41 ranked European countries, Serbia was ranked 31st in 2017 (Table 4). The value of the CIP index changes little due to its slow change in the short term due to technological changes that are not intensive enough in the Serbian manufacturing industry and supported by technological innovations.

Table 4 Rank and value of CIP index in 2018.

	Rank in Europe		CIP index	
	2012	2018	2018	Δ2012
Czech R.	11	11	0.2148	-0.0067
Slovakia	16	15	0.1604	-0.0103
Hungary	17	16	0.1493	-0.0085
Slovenia	21	18	0.1109	-0.0055
Romania	22	22	0.1015	-0.0109
Croatia	30	28	0.0552	0
Bulgaria	31	29	0.0524	-0.0023
R. Serbia	35	31	0.0416	0.0109

Source: Author's calculation based on UNIDO database. 2019.

High-tech manufacturing in the manufacturing industry of the Republic of Serbia employed 0.5% of employees in 2018, while this percentage in the EU was 1.1 (Table 5). The share differs significantly from the observed EU member states, and even more so when looking at the number of employees per 1,000, with Hungary and the Czech Republic ahead, while R. Serbia has only 14 per 1,000 employees. In the EU, the average employment growth rate in the high-tech industry was negative during 2011-2018. There are differences among members when comparing employment changes. Some have seen a decrease as a result of the economic crisis. R. Serbia saw a slight increase in high-tech production.

Table 5 Employment in high-tech manufacturing. 2018.

	Total in 1000's	% of total employment	Δ2011
EU28	441	1.1	-0.4
Bulgaria	22	0.7	-2.4
Czech R.	88	1.7	2.1
Croatia	12	0.7	-1.4
Hungary	114	2.6	0.7
Romania	71	0.8	4.3
Slovenia	20	2.0	2.3
Slovakia	39	1.5	-1.1
R. Serbia	14	0.5	0.6

Source: Author's calculation based on Eurostat database. 2019

High-tech products accounted for 15.4% of total EU exports in 2018, with considerable differences between member states (Table 6). The highest share, as well as the increase in the share of high-tech products in the observed period, was recorded in Ireland, Germany, and Austria, as the leaders of digitalization, but also countries with a large industrial base, such as the Czech Republic and Hungary, which recorded the largest decrease in share. It is clear that in terms of quality and export of high-tech products, the manufacturing industry of the Republic of Serbia is lagging behind the EU member states. Exports are dominated by products that are intensive with natural resources and low skilled and cheap labor.

Table 6 Exports of high technology products as a share of total exports

	2011	2018	Δ2011
EU28	15.4	17.9	2.5
Bulgaria	3.7	5.9	2.2
Czech R.	16.4	17.8	1.4
Croatia	5.8	8.1	2.3
Hungary	20.9	15.6	-5.6
Romania	8.8	8.4	-0.4
Slovenia	5.3	5.8	0.5
Slovakia	6.6	9.6	3.0
R. Serbia	2.0	1.9	-0.1

Source: Author's calculation based on Eurostat database. 2019

Exports of high-tech products from the Republic of Serbia are significantly different from EU members. The Electronics-Telecommunications and Aviation product groups account for 29.2% of high-tech exports, one-and-a-half times lower than the 2017 EU level. Pharmaceuticals follow with 15.1%, computers with 12.9% and Scientific Instruments with 11.8%. Other groups account for 31% of exports (Table 7). The fact is that the technological level of production has not improved, and digitalization is a condition for raising the share of high-tech products and increasing their exports. Intensive structural changes are needed in the forthcoming period, which would increase the technological level of production and exports, through domestic innovations and their commercialization, as well as technology transfers from abroad.

Table 7 Exports of high-tech group of products as a share of total exports, 2017.

	Electronics-telecommunications	Aerospace	Computers	Pharmacy	Scientific instruments	Other
EU28	28.2	17.5	12.4	18.7	13.4	9.8
Czech R.	43.0	2.8	38.8	1.8	6.3	7.3
Slovenia	25.6	4.6	7.2	26.1	15.8	20.7
Slovakia	76.6	0.2	13.2	0.9	3.8	5.3
Hungary	45.5	0.6	19.8	8.8	13.9	11.4
Croatia	19.6	2.1	3.1	47.4	7.7	20.1
Bulgaria	48.3	2.7	10.6	13.1	13.6	11.7
Romania	62.0	1.5	3.9	2.7	21.4	8.5
R. Serbia	26.6	2.6	12.9	15.1	11.8	31.0

Source: Author's calculation based on Eurostat database, 2019

The level of R&D expenditure in the EU increased from 1.24% in 2011 to 1.36% of GDP in 2017 (Table 8). The members of Central Europe seek to increase the quality of the industrial base and have significant overall R&D allocations from the manufacturing industry, while recording their growth. Despite recorded growth, data on the share of total R&D expenditures is extremely unfavorable for the Republic of Serbia. The situation is even more unfavorable when considering the share of manufacturing industry allocations for R&D. It is also a very modest expenditure in absolute terms, especially given the importance of R&D expenditures for the digitalization and development of I4.0. Therefore, the aim is to increase investment in the manufacturing industry R&D, which will enable the development and application of knowledge through the development of new products and processes.

Table 8 R&D expenditure, percentage of GDP

	All sectors			Manufacturing		
	2011	2017	Δ2011	2011	2017	Δ2011
EU28	1.24	1.36	0.12	/	/	0.17
Czech R.	0.86	1.13	0.27	0.48	0.55	0.07
Slovenia	1.79	1.39	-0.40	1.22	1.14	0.12
Slovakia	0.25	0.48	0.23	0.15	0.27	/
Hungary	0.74	0.99	0.25	0.46	0.43	-0.84
Croatia	0.34	0.42	0.08	0.13	0.26	-0.03
Bulgaria	0.28	0.53	0.25	0.03	0.2	0.07
Romania	0.18	0.29	0.11	0.09	0.1	-0.08
R. Serbia	0.06	0.32	0.26	0.01	0.02	0.17

Source: Author's calculation based on Eurostat database, 2019

Data on the share of total domestic R&D expenditure financed by the private sector is unfavorable for the Republic of Serbia because it is several times lower than in the EU member states. The situation is somewhat different when the state expenditure is taken into consideration, which is at a similar level (Table 9).

Table 9 R&D expenditure by sectors, percentage of GDP, 2017.

	All sectors	Business enterprise sector	Government sector	Higher education sector
EU28	2.06	1.36	0.23	0.45
Czech R.	1.79	1.13	0.31	0.35
Slovakia	0.88	0.48	0.18	0.22
Slovenia	1.86	1.39	0.26	0.21
Hungary	1.35	0.99	0.17	0.18
Romania	0.5	0.29	0.16	0.05
Bulgaria	0.75	0.53	0.17	0.04
Croatia	0.86	0.42	0.19	0.25
R. Serbia	0.87	0.32	0.24	0.32

Source: Author's calculation based on Eurostat database, 2019

In most of the countries observed, the private sector contributes with over 0.5 to R&D expenditure, while this percentage in the Republic of Serbia in 2017 was 0.32% of GDP. The reason is the lack of integration of the private sector into the innovation system. The private sector in the EU member states seeks to expand and enhance the structure of the industrial base and increases the relative allocations of the private sector to domestic R&D expenditures, which enhances the process of digitalization and the creation of a single digital market. It can be estimated that R&D allocations, both private and public, as well as allocations for science in the Republic of Serbia are not at the level that could make a significant contribution to creating conditions for the process of digitalization and development of I4.0.

Patents represent R&D results and are indicators of inventive activity, yet indirectly show the results of innovative activities. R. Serbia has a low patent activity compared to the observed EU members (Table 10).

Table 10 Patent Applications, 2018.

	Resident	Non-Resident	Abroad
Czech R.	921	54	1,330
Slovakia	267	14	293
Slovenia	355	23	383
Hungary	529	36	811
Romania	1,150	47	351
Bulgaria	212	18	247
Croatia	135	15	66
R. Serbia	172	11	136

Source: Author's based on WIPO, 2019.

According to the number of resident patent applications, Croatia had worse results than Serbia in 2018. The low inventive activity of residents is due to the low investment in R&D, the small number of researchers and the underdevelopment of the industry. The inventive activity of non-residents is also very low due to patent regulation and competition. This is the reason for high filing abroad.

6. CONCLUSION

The fourth industrial revolution is the emerging one and is about the development of I4.0 or smart industries and factories. It is based on a number of emerging trends and digital and other technologies. The fact is that it is now impossible to predict all the potentials of I4.0. What is certain is that countries will develop I4.0 at different speeds and modes, directing the process of digitalization and re-industrialization. The fourth wave of technological advancement due to digitalization is benefiting the industry by increasing productivity, value added, employment and investment in R&D, manufacturing new products, and rise in productivity, affecting economic development.

The new paradigm of industrial production will be not only a condition of productivity growth, global industrial competitiveness, but also of transformation and development of markets, qualifications and education, and sustainable development of society as a whole. Just as all the previous radical technological novelties have formed the structural basis for

this revolution, so I4.0, in the future, will enable the development of the next technological revolution, new industries, the paradigm of industrial production and new production effects.

Data from innovation surveys, technological indicators and criteria, both individual and composite, indicate that the technological level has not improved or that no effective technological changes have been made. This does not confirm the first hypothesis that innovation processes influence technological changes, improvement and increase of technological level of the Serbian manufacturing industry. The reason is the insufficient number of technological innovations of products and processes, but also the practical application of the results of domestic scientific and research activities. Data on R&D expenditures at the sector level, especially in the manufacturing industry, as well as patents and inventive activity, also do not confirm the second hypothesis that the digitalization of the manufacturing industry in the Republic of Serbia is affected by investing in R&D.

EU member states with a large industrial base in Central Europe create conditions for the transition of the manufacturing industry, based on natural and physical resources, into industries based on intellectual resources, application of knowledge and new digital technologies, resulting in I4.0 and smart future factories that are high-technology-intensive. The analysis confirms transition and digital transformation. The creation and effective use of digital and new technologies is important in the global competitiveness of the observed EU member states. High-tech industries and smart businesses will be the drivers of their economic and productivity growth, and will increase competitiveness, structure and level of added value and employment. In these EU member states, industrial policy develops I4.0 and at the same time drives re-industrialization.

An important research finding indicates that the conditions and potentials of I4.0 development are very small compared to the EU member states in Central Europe with a large industrial base, and even more modest than the old members which are making good progress in the digitalization and development of I4.0. Digitalization in the Republic of Serbia is not driven by the results of science, technology and innovation. The re-industrialization of the economy needs to be done on these grounds. The obtained research findings are very useful for industrial policy makers in the Republic of Serbia as they point to some of the key factors and directions of change in order to create the conditions for the development of I4.0, the manufacturing industry and the digital transformation of the economy.

REFERENCES

Bazić, J. R. (2017). Trendovi promena u društvu i obrazovanju koje generiše Četvrta industrijska revolucija [Trends of Changes in society and education generated by the Fourth Industrial Revolution]. *Sociološki pregled, 51*(4), 526-546.

Biagi, F., Pesole, A., & Stancik, J. (2016). *Modes of ICT Innovation: Evidence from the Community Innovation Survey* (No. JRC101636). Joint Research Centre (Seville site).

Buhr, D. (2015). *Social Innovation Policy for Industry 4.0, Division for Social and Economic Policies*. Friedrich-Ebert-Stiftung, 8-15. Retrieved from: https://library.fes.de/pdf-files/wiso/11479.pdf

Caprile, M., Palmén, R., Sanz, P., & Dente, G. (2015). *Encouraging STEM studies Labour Market Situation and Comparison of Practices Targeted at Young People in Different Member States*. Policy Department A, 12.

Chukalov, K. (2017). Horizontal and vertical integration, as a requirement for cyber-physical systems in the context of industry 4.0. *Industry 4.0, 2*(4), 155-157.

Dujin, A., Geissler, C., & Horstkötter, D. (2014). Industry 4.0 The new industrial revolution How Europe will succeed. *Rol. Berger Strateg. Consult*, 1-24.

EBRD. (2019). *Introducing the EBRD Knowledge Economy Index.* EBRD. London

European Commission. (2019a). *Science Education.* Retrieved from: https://ec.europa.eu/programmes/horizon2020/en/h2020-section/science-education, Accessed on: 20 July 2019.

European Commission, (2019b). *STEM action plan.* Retrieved from: https://rio.jrc.ec.europa.eu/en/library/stem-action-plan, Accessed on: 20 July 2019.

European Commission, (2019c). *Digital Skills & Jobs,* Retrieved from: https://ec.europa.eu/digital-single-market/en/policies/digital-skills, accessed on: 20 July 2019.

European Commission. (2019d). *Eurostat database.* Retrieved from: https://ec.europa.eu/eurostat/web/science-technology-innovation/data/database.

Evangelista, R., Perani, G., Rapiti, F., & Archibugi, D. (1997). Nature and impact of innovation in manufacturing industry: some evidence from the Italian innovation survey. *Research policy*, *26*(4-5), 521-536.

Finance, A. T. C. C. (2015). Industry 4.0 Challenges and solutions for the digital transformation and use of exponential technologies. *Finance, Audit Tax Consulting Corporate: Zurich, Swiss*, 1-12

Foresight, U. K. (2013). The future of manufacturing: a new era of opportunity and challenge for the UK. *Summary Report, The Government Office for Science, London*, 20.

Galindo-Rueda, F., & Verger, F. (2016). OECD taxonomy of economic activities based on R&D intensity, 6.

GTAI. (2014). Industries 4.0-Smart Manufacturing for the Future. Berlin: GTAI, Retrieved from:
https://ec.europa.eu/digital-single-market/en/policies/digital-skills, Accessed on: 16 April 2019.

Hugo H., Nordine E., & Iris M. (2019). The European innovation scoreboard. *Measuring creativity. European Commission Joint Research Centre Luxembourg*, 42-79.

Links, P. (2013). *Emerging trends in global advanced manufacturing*. University of Cambridge, 12.

Lodder, J. (2016). Četvrta industrijska revolucija i obrazovni sustav - kako reagirati [The Fourth Industrial Revolution and the Education System - How to Respond]. *Poslovni savjetnik*, *129*, 16-19.

Pereira, A. C., & Romero, F. (2017). A review of the meanings and the implications of the Industry 4.0 concept. *Procedia Manufacturing*, *13*, 1206-1214.

Roblek, V., Meško, M., & Krapež, A. (2016). A complex view of industry 4.0. *Sage Open*, *6*(2), 1-11.

Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P., & Harnisch, M. (2015). *Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries.* The Boston Consulting Group Inc., 5-12.

Santos, C., Mehrsai, A., Barros, A. C., Araújo, M., & Ares, E. (2017). Towards Industry 4.0: an overview of European strategic roadmaps. *Procedia Manufacturing*, *13*, 972-979.

Schwab, K. (2017). *The fourth industrial revolution*. Currency.

Smit, J., Kreutzer, S., Moeller, C., & Carlberg, M. (2016). *Industry 4.0: Study*. EU Parliament.

Stankovic, M., Gupta, R., & Figueroa, J. (2017). Industry 4.0 Opportunities behind the challenge. *United Nations Industrial Development Organization*, 8-9.

STEM Education (2019). *European Schoolnet*. Retrieved from: http://www.eun.org/focus-areas/stem, Accessed on: 18 July 2019.

Vaidya, S., Ambad, P., & Bhosle, S. (2018). Industry 4.0–a glimpse. *Procedia Manufacturing*, *20*, 233-238.

Vujović, D. (2019), The challenges of income convergence at times of the fourth industrial revolution. *Ekonomika preduzeća, 67*(1-2), 73-82.

WEF. (2016). Agenda Fourth Industrial Revolution. Retrieved from: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond, Accessed on: 25 July 2019.

WEF. (2018). *The future of jobs report 2018*. World Economic Forum, Geneva, Switzerland, 6-44.

WEF. (2019). *The Global Competitiveness Report 2019*. WEF. Geneva.

WIPO. (2019). *Global Innovation Index 2019.*(World Intellectual Property Organization. Geneva.

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.

UNIDO. (2019). *Industrial Statistics Database*. Retrieved from: https://www.unido.org/researchers/statistical-databases Accessed on: 25 September 2019.

USLOVI RAZVOJA INDUSTRIJA 4.0 U REPUBLICI SRBIJI

Rezime: Četvrta industrijska revolucija se odnosi na razvoj Industrija 4.0, promenu proizvodne paradigme i digitalizaciju ekonomije. Predmet istraživanja rada su uslovi razvoja Industrija 4.0 u R. Srbiji. Osnovni cilj istraživanja je da ukaže na značaj efikasnog razvoja Industrija 4.0 i sprovođenja strukturnih promena kroz proces digitalizacije i primene tehnoloških inovacija u prerađivačkoj industriji. Metod analize korišćen je za identifikovanje koncepata Industrije 4.0 i nove industrijske paradigme. Komparativni metod je korišćen prilikom poređenja tehnoloških kriterijima i promena. Uslovi razvoja Industrija 4.0 su analizirani posrednim putem preko tehnoloških kriterijuma i inovacija tj. podataka iz ankete o inovacijama, pojedinačnih inovacionih i tehnoloških indikatora i kompozitnih indikatora. Industrije 4.0 su važan faktor tehnoloških i strukturnih promena, ekonomskog rasta i konkurentnosti. Rezultati istraživanja pokazuju da nepostoje dovoljno podsticajni uslovi za razvoj Industrija 4.0 u R. Srbiji. Rezultati ovog istraživanja su korisni kreatorima industrijske politike jer ukazujuju na neke od ključnih faktora i pravaca promena kako bi se stvorili uslovi za razvoj Industrija 4.0, prerađivačke industrije i digitalnu transformaciju ekonomije.

Ključne reči: *Industrija 4.0, prerađivačka industrija, digitalizacija, inovacije, tehnološke promene*

Original Scientific Paper

EXPLORING THE INFLATIONARY EFFECT OF OIL PRICE VOLATILITY IN AFRICA'S OIL EXPORTING COUNTRIES

UDC 622.323:338.5(6)

Sina Jimoh Ogede, Emmanuel Oladapo George, Ibrahim Ayoade Adekunle*

Olabisi Onabanjo University, Nigeria

Abstract. *A range of explanations had been offered for the apparent change in oil price-inflation relationship outcomes ranging from the possible use of alternate energy sources, change in the structure of output regarding fewer oil intensive sectors and the role of fiscal and monetary in the affected oil-exporting countries. These changes had drawn the attention of stakeholders, government and the society at large to the anecdotal relationship among oil price volatility, inflation, and output in Africa oil-exporting countries. This study leans empirical credence to the impact of oil price volatility on inflation and economic performance in the Africa oil-exporting countries from 1995 through 2017. We employed the Pool Mean Group estimation procedure with the inference drawn at a 5% level of significance. We found that oil price volatility had a negative and significant effect on inflation in Africa oil-exporting countries. The study concluded that oil price volatility had a substantial impact on inflation in the Africa oil-exporting countries. The study, therefore, recommended that Africa oil-exporting countries should adopt precautionary measures to monitor inflation potentials due to different responses of inflation to positive and negative oil price shocks.*

Key words: *Oil Price Volatility; Inflation; Growth Outcomes; Pool Mean Group; Africa.*

JEL Classification: C33, O55, Q41

1. INTRODUCTION

The significance of crude oil and its resulting volatilities of prices have been studied expansively since the oil price fluctuations of 1973 and 1979, the Yom Kippur war and the Iran Crisis, amongst others. The significant changes in the oil prices from the first quarter of 1975 to the fourth quarter of 2016 revealed some striking features in the global economies. In the 1970s, economies around the world witnessed growing inflation rates that were subsequently ensured by a rapid increase in global oil prices (Mohaddes & Pesaran, 2017). In contrast to the 1970s experiences, a downward trend of oil prices and inflation was witnessed in 1980s and 1990s, respectively, and further attributed to dwindling oil prices in global markets (Hamilton, 1996). In the 2000s, oil prices steadily increased with sharp thwart in 2008, followed by a substantial decrease in 2009 and remained throughout the fourth quarter of 2014, and rebound after that (Bala, Chin, Kaliappan & Ismail, 2017). Prominent volatility of price in these developments and thereafter will deepen the understanding of all economic agents, namely government, firms and households on the sizeable effects of oil price volatility on inflation in both oil-exporting and importing economies (Shafiee & Topal, 2010).

Theoretically, oil price volatility should affect oil importing and exporting countries differently at microeconomic and macroeconomic levels (Mohaddes & Pesaran, 2017). For oil-importing countries, at the macro level, the decrease in oil prices should support robust growth, reduce inflation, and expand fiscal stabilities, which should mitigate macroeconomic weaknesses and, consequently, broaden policy scope. Conversely, increases in oil prices reduce active household income in various ways. Firstly, households pay more for energy-intensive products they consume directly (Zhang, Broadstock, & Cao, 2014). Secondly, an increase in oil prices intensifies the prices of all goods and services that use fossil fuels and the associative by-product of crude for domestic purposes (Elder & Serletis, 2010). Higher oil prices reduce the growth rate of GDP and consequently reduce the household income (Ahmed, Bhutto & Kalhoro, 2018).

For Africa's oil-exporting countries within the OPEC, oil price volatilities have exerted enormous consequences on their economies due to over-reliance on oil earnings as their primary source of revenue. Raising oil prices generates a supplementary income for oil-producing economies which can be used to develop infrastructure or diversify the local economy and subsequent investment in the foreign economies (Omojolaibi, 2013). Conversely, the rising oil prices not only hinder output growth but also ignite the overall rise in the price level in the economy due to the significance of oil as a respective input for the production (Kilian, 2014). An increase in input costs would compel a further rise in the cost of final products. A slight increase in oil prices compels carrying a charge and other allied fees of piloting economic activities to increase, which are eventually borne by final consumers (Salisu, Isah, Oyewole & Akanni, 2017). This perception mostly induces both firms and households to lessen their consumptions and investments. Hence, how much variations in the consumer price index can be credited to oil price volatility? Which structural policy frameworks govern the size of the inflationary effect of oil price volatility? Forms significant policy and research questions if we are serious about redefining the scope of oil price stability and associative welfare implications that are usually threatened by the inflationary factor.

It is challenging that most of the recent studies on the impact of oil price volatility on inflationary effect have mainly focused on developed countries, oil-importing countries and country-specific without considering Africa's group of OPEC's oil-exporting countries despite

their growing importance in oil consumption arena. Selected Africa's oil-exporting countries, namely Nigeria, Angola, Gabon, Libya and Algeria control 6.95% and 6.46% of the global oil production and the world's oil reserves respectively (OPEC, 2016). These countries are not only oil-exporting nations, but they also engage in the importation of petroleum products which might be attributed to low national oil production, environmental factors and national oil reserve. Besides, for more than a decade now, both oil-exporting and importing countries in Africa have been experiencing macroeconomic instabilities of remarkable magnitude (Bashiri Behmiri & Pires Manso, 2013; Chironga, Leke, van Wamelen, & Lund, 2011; Ordway, Naylor, Nkongho, & Lambin, 2017). An indispensable feature described by sizeable fiscal disparity, inflation, recession, weakening output, increasing unemployment and alarming weakening characterises Africa's oil-exporting OPEC member countries (George, 2012).

This study is significant for two reasons. First, it examines the dynamic relationship between oil price volatility and inflation in a group of countries that possesses about 8.82% of the world's proven oil reserves in 2017 (OPEC, 2018). With their vast oil reserves, Africa's oil-exporting countries within the OPEC have become significant players in the global oil market. Secondly, oil is a crucial input factor in production, and a primary driver of economic performance in the majority of OPEC member's countries as their government revenues and Gross Domestic Product (GDP) depend heavily on oil revenues. It then becomes apt to appropriate data and methodology to lean experimental proof to the underlying structural relationship between oil price volatility and inflation in Africa's oil-exporting countries that are members of OPEC. The study attempts to explain the fundamental dynamics of the oil-price-inflation nexus in Africa with a view of coming up with crucial policy implications and for research purposes.

2. LITERATURE REVIEW

Sequel to the empirical work of Hamilton (1983) on examination of the effects of oil price changes on economic activities, the author resolves that oil price uncertainty has a sizeable impact on the U.S economy following World War II. However, Hamilton's empirical results have been subjected to empirical confirmation by several subsequent studies (Mork, 1989; Hooker, 1996 and Mork, Olsen, & Mysen, 1994), thereby renewing the examination of the effects of oil price fluctuations on diverse economic variables with a given country or other. For instance, Cuestas and Gil-Alana (2018) investigate the impact of oil price movements on unemployment in Central and Eastern Europe. Wei and Guo (2016) examine the implications of oil price shocks on China's stock market. Allegret, Couharde and Coulibaly (2014) investigate the effects of oil price fluctuations on the current account position for 27 selected oil-exporting countries. In another study, Nusair (2016) examines the impacts of oil price shocks on the real GDP of the Gulf Cooperation Council (GCC) countries through nonlinear ARDL model. The authors report evidence of asymmetries in all the samples or groups. Contrastingly, Tang, Wu, and Zhang (2010) employ a structural vector autoregressive (SVAR) model on a study on China and affirm that an oil price increase negatively influenced investment and output, and positively influenced inflation rate and interest rate respectively. Álvarez, Hurtado, Sánchez and Thomas (2011) examine the impact of oil price fluctuations on consumer price inflation in Spain and the euro area and resolve that the inflationary impact of oil price increases in both economies is

negligible. The authors report that the 10 percent changes in oil prices are linked to averages 0.2 percent points of consumer price inflation shifts in both Spain and the euro area, which is a relatively small number.

Given the oil price-inflation relationship, extant literature predominately focuses on developed and developing countries with almost no studies on Africa's oil-exporting countries. For example, using the nonlinear ARDL model, Lacheheb and Sirag (2019) suggest that oil price increases have a positive and significant effect on inflation in Algeria, but insignificant falling oil prices. Lorusso and Pieroni (2018) resolve that U.K. inflation increases in response to adverse oil supply shocks. Utilising symmetric and asymmetric panel ARDL models, Salisu *et al.* (2017) report a significant long-run and positive influence on inflation as induced by variations in oil price in selected oil-exporting and oil-importing countries. There exist mixed results for the short-run effect. They also find that the cost of oil has a more significant impact on inflation in the long-run in net oil-importing countries than in net oil-exporting countries and that oil price asymmetries are more critical for oil-exporting countries. Kun (2017) explored the effects of oil prices fluctuations on Malaysia's domestic price inflation at disaggregated levels using both linear and nonlinear autoregressive distributed lag (ARDL) techniques. The author provides evidence of symmetric and asymmetric pass-through effects of oil price changes on domestic prices across sectors. Oil price changes lead to the positive impact of higher output growth but may directly cause higher import and production prices in the long run through cost channels. On the other hand, oil price changes have a limited direct effect on consumer prices in the long term. The impact of oil prices on consumer prices occurs indirectly through transmission from import prices and production costs.

Bala *et al.* (2017) report a positive relationship between the oil prices and inflation in an autoregressive distributed lag (ARDL) of the model of Malaysia. While Artami and Hara (2018) analyse the asymmetric impact of oil price fluctuations on the economic growth of and inflation in Indonesia through the vector autoregressive (VAR) estimation model spanning from the first quarter of 1990 to the fourth quarter of 2016. The authors resolve that oil price-growth relationship is asymmetric. The resultant implications of favourable and unfavourable fluctuations of oil prices are established to be not statistically significant to inflation. In order to investigate the long-run effect of oil exports and food output on inflation in OPEC member countries in Africa, Bala and Chin (2018) explore the ARDL model. The models gauge oil price-inflation relationship and reveal there is a negative relationship between the index of food production and inflation, indicating that a rise in food supply decreases the rate of inflation. The results also show that oil exports have a significant positive impact on inflation. Also, Choi, Furceri, Loungani, Mishra and Poplawski-Ribeiro (2018) consider the impact of oil price fluctuations on domestic inflation of selected developed and developing economies over the period from January 1970 to December 2015. The authors report that an increase in oil inflation by ten percent would initiate about 0.4 percent increases in domestic inflation in both developed and developing countries. They also report a case of asymmetric, suggesting that positive oil price shocks are having a more substantial effect than adverse oil price shocks. They resolve that such results have declined over time due to a credible monetary policy put in place and less reliance on energy imports by the domestic economy.

In selected Central and Eastern European countries, Živkov, Đurašković, and Papić-Blagojević (2020) examine the effect of oil price fluctuations on the consumer price. The authors explore a Markov wavelet-based switching technique to split different time

horizons between the impacts. The findings show that in Central and Eastern European countries, the transmission of oil price increases to inflation is relatively low to about 1–6 percent points as an oil price increase to 100 percent. However, the findings show that exchange rates are not a significant factor in the transmission of oil shocks to inflation, even when high depreciation occurs. By and large, one can conclude that, despite the vast literature related to inflation and oil price volatility, there is no shared consensus. There are few studies in oil-exporting nations, but such studies are carried out majorly when the oil price was increasing and before the global financial crisis of 2008. Studies that integrated the crisis and boom periods to examine both symmetric and asymmetric effects on output growth and overall price level are almost non-existent in the literature.

3. DATA AND METHODOLOGY

3.1. Data

The dataset explored to estimate the models were sourced from the World Development Indicators (WDI), International Monetary Fund's International Financial Statistics (IFS) database, while oil price data were obtained from OPEC (2018) Annual statistical bulletin. The variables considered in this study included the Consumer Price Index (CPI), real Gross Domestic Product (GDP) growth rate, oil prices, and government final consumption expenditure and, the data used in the study were quarterly, covering a period from 1995 to 2017. This data included the periods of the global food crisis and the recession of 2008 to 2009 because the macroeconomic performances of mostly all the economies were affected and this brought about significant volatility in macroeconomic indicators and oil prices. The choice of the macroeconomic variables was based on the submission of Hooker (1996). Real GDP as a measure of growth outcomes agrees with the exact standard measure in the literature (see Cunado *et al.*, 2015; Akinleye & Ekpo, 2013; Iwayemi & Fowowe, 2011; Hooker, 1996 for examples). Thus, the import from the previous empirical studies on oil prices and economic activities revealed that two different features ranging from the approach at which oil prices are used at their levels and employs various volatility measures to capture the oil price uncertainty. These two methods differ in the way in which they integrate oil price into their models. In divergence to the vast number of studies that examine the impact of oil price shocks, this study investigated the effect of oil price volatility on inflation by considering realised volatility. The realised oil price volatility (R.V.) was chosen following Rafiq and Salim (2014) as the oil price volatility index in the study. Realised volatility is based on the idea of using the sum of squared intraday returns to generate more accurate daily volatility measures. According to Andersen and Bollerslev (1998), the daily realised volatility is estimated as the sum of squared intraday returns. It is viewed as an alternative measure of volatility due to an unbiased and highly efficient estimator of the volatility of returns, as reported in Barndorff-Nielsen and Shepherd (2002).

3.2. Methodology

A fundamental assumption is that the economic responses to oil price volatility can be explained using both supply and demand channels. We illuminated the diverse impact of the oil price volatility and inflation in the period of review for selected Africa's oil-exporting countries within OPEC. The study panel sample has five (5) countries and 23

years, and so has more years than cross-sample observation; some of the variables were stationary at a level while others at the first difference I(1). Given this, the most appropriate model is the Pool Mean Group Autoregressive Distributed Lag (ARDL) model proposed by Pesaran, Shin and Smith (1999). According to the authors, the superiority of the ARDL model over dynamic panel models relies on the ability to produce consistent estimates and ability to produce country-specific results. A dynamic heterogeneous panel regression was written by using ARDL (p, q) approach where 'p' is the lags of the dependent variable and 'q' is the lags of the independent variables (Pesaran *et al.*, 1999). The model estimated has the form of an ARDL (p, q…q) as:

$$CPI_{it} = \sum_{j=1}^{p} \propto_{ij} CPI_{i,t-j} + \sum_{j=0}^{q} \gamma_{ij}'X_{i,t-j_1} + \mu_t + \varepsilon_{it} \qquad (1)$$

where X represents the vector of explanatory variables. Modifying equation (1) turns to:

$$\Delta CPI_{it} = \varphi_i\big(CPI_{i,t-1} - \beta_i'X_{it}\big) + \sum_{j=1}^{p-1} \propto*_{ij} \Delta CPI_{i,t-j} + \sum_{j=0}^{q-1} \delta*_{ij}' \Delta X_{i,t-j} + \mu_t + \varepsilon_{it} \qquad (2)$$

Equation (2) was transformed as:

$$CPI_{it} = a_{1i}CPI_{i,t-1} + a_{2i}RV_{i,t-1} + a_{3i}Y_{i,t-1} + \sum_{j=1}^{p-1} v_{ij} \Delta CPI_{i,t-j} + \sum_{j=0}^{q-1} v_{ij} \Delta CPI_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (3)$$

where μ_i and i denoted the group-specific effect and the number of groups respectively. t represented the number of periods while CPI_{it} gives the semi derivatives of consumer price index used as a proxy for inflation. y_t denoted the logarithm of economic performance (proxy by real GDP growth rate) and RV_t is the logarithm of oil price volatility. The log transformation of these series facilitates the computation of elasticity coefficients that are time-invariant for the oil price-inflation relationship.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Panel Unit Roots and Cointegration Tests

We begin by presenting results from the modelling of the effect of oil price volatility on inflation. The preliminary tests of univariate properties of variables affirmed that none of the variables was integrated of the order of 2, that is I(2). Presence of variables of order I(2) would require greater exponential smoothening of the model. Four conventional unit root tests, the Levin-Lin-Chu (L.L. test) Im, Pesaran and Shin (IPS test), Fisher ADF test and Fisher PP test were conducted to ascertain the preliminary properties of the data set. The test results are reported in Tables 1-3, respectively.

Table 1 Levin-Lin-Chu Panel Unit Root Test

Variables	Level		1st difference		Order of Integration
LnCPI	1.95556	(0.0253)**			I(0)
lnIR	-0.75431	(0.2253)	-7.72287	(0.0000)*	I(1)
lnRGDP_GR	2.75957	(0.9971)	-2.04247	(0.0206)**	I(1)
RV	-9.43083	(0.0000)*			I(0)
GEXP	0.64438	(0.7403)	-1.91495	(0.0277)**	I(1)

* represents a 1% level of significance
** represents 5% level of significance

Table 2 Im, Pesaran and Shin Test

Variables	Level		1st difference		Order of Integration
LnCPI	1.83222	(0.9665)	-8.07326	(0.0000)*	I(1)
lnIR	0.08348	(0.5333)	-9.29338	(0.0000)*	I(1)
lnRGDP_GR	-2.4241	(0.0077)*			I(0)
RV	-7.86806	(0.0000)*			I(0)
GEXP	2.15631	(0.9845)	-5.30161	(0.0000)*	I(1)

* represents 1% level of significance

Table 3 Fisher ADF and Fisher PP Panel Unit Root Test

Variables Unit Root	Fisher ADF Test			Fisher PP Test		
	Level	1st difference	Order of Integration	Level	1st difference	Order of Integration
LnCPI	3.66617 (0.9612)	89.5012 (0.0000)*	I(1)	4.27335 (0.9342)	120.182 (0.0000)*	I(1)
lnIR	10.6403 (0.2229)	91.7322 (0.0000)*	I(1)	12.2613 (0.1399)	113.115 (0.0000)*	I(1)
lnRGDP_GR	29.1377 (0.0012)		I(0)	35.6923 (0.0001)*		I(0)
RV	80.2751 (0.0000)*		I(0)	142.001 (0.0000)*		I(0)
GEXP	1.89689 0.9971)	50.0835 (0.0000)*	I(1)	2.95446 (0.9825)	30.9297 (0.0006)*	I(1)

* represents 1% level of significance

Tables 1, 2 and 3 show the p-values obtained from the four different unit root tests. Both level and first difference of the unit-roots were carried out to ensure all variables are stationary. Thus, given the findings of the various unit root tests, all the under-listed variables were suitable to be included in our panel models. The cointegration test results were reported in Table 4. The Pedroni cointegration test presented the Pedroni cointegration test with seven different sets of residual-based tests. These residual-based tests were divided into two groups. Four out of the seven trials were within-dimension tests (the panel v-statistic test, the panel rho-statistic test, the panel PP-statistic test, and the panel ADP-statistic test). The remaining three tests were between-dimension tests (the group rho-statistic test, the group PP-statistic test, and the group ADF-statistic test). Within-dimension regression was based on pooling the estimators in the autoregressive coefficient across individual countries on the residuals, while between-dimension regression was based on averaging the individual coefficient estimators of each country. The table showed the Pedroni residual cointegration test with different deterministic trend specification model assumptions. The within-dimension tests presupposed standard Auto-Regressive (A.R.) coefficients among cross-sections while the between-dimension presupposed individual A.R. coefficients. The lag length was determined with Schwarz information criterion while the spectral estimation and bandwidth were done with the Bartlett method and with Newey-West procedure respectively.

From Table 4, the null hypothesis of the test is that there is no cointegration amongst these variables. Thus, given the results, as seen in Table 4, we rejected the null hypothesis more times than accepting. Consequently, we drew the same conclusion for each of the

deterministic trend specifications on the Pedroni test. These tests, therefore, suggested that there was no cointegration amongst the variables in the model.

Table 4 Pedroni Residual Cointegration Test for Panel Data

Alternative hypothesis: Common AR coefficients. (within-dimension)						
Pedroni's Technique	Group 1		Group 2		Group 3	
	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	-20.38685	1.0000	-28.92190	1.0000	-19.67369	1.0000
Panel rho-Statistic	-2.389373	0.0084	-4.062819	0.0000	-2.766529	0.0028
Panel PP-Statistic	-2.459962	0.0069	-4.713079	0.0000	-2.748783	0.0030
Panel ADF-Statistic	-2.670857	0.0038	-4.954406	0.0000	-2.912634	0.0018
Group rho-Statistic	0.576641	0.7179	-0.028946	0.4885	0.229310	0.5907
Group PP-Statistic	0.084655	0.5337	-0.949898	0.1711	-0.634294	0.2629
Group ADF-Statistic	-0.121212	0.4518	-0.780730	0.2175	-0.782130	0.2171

Note: All statistics are from Pedroni's procedure (1999) where the adjusted values can be compared to the N (0, 1) distribution. The Pedroni (2004) statistics are one-sided tests with a critical value of -1.64 (k < -1.64 implies rejection of the null), except the v-statistic that has a significant value of 1.64 (k > 1.64 suggests rejection of the null).
Source: Author's computation (2019)

4.2. Estimation Results

Table 5 presented the results of the panel ARDL/PMG estimate of the effect of oil price volatility on inflation of five (5) Africa oil-exporting countries.

Table 5 Oil Price Volatility and Inflation ARDL/PMG Results

Variable	Coefficient	t-Statistic	Prob.
Long Run Equation			
RV	-0.025568	-2.018450	0.0442[**]
LNRGDP_GR	-0.238907	-3.881039	0.0001[**]
LNGEXP	0.388006	8.522404	0.0000[**]
Short Run equation			
ECT	-0.030077	-1.754551	0.0801
D(RV)	0.000547	1.346863	0.1788
D(LNRGDP_GR)	-0.022931	-0.588841	0.5563
D(LNGEXP)	0.014575	0.850065	0.3958
C	-0.084903	-1.500434	0.1343

Notes: Dependent variable is the log of CPI
[*]significant at 5 percent level
Source: Author's computation (2019)

The results of the model were presented in Table 5. Table 5 showed the summary of the PMG estimation results for the panel containing the sample of all African countries where the long-term and short-term coefficients are based on the elasticity of CPI in Equation (3). The PMG estimation results in Table 5 showed that oil price volatility is negatively and statistically significant with the inflation in the long-run. This suggested that if there is any deviation from long-run equilibrium, the error term will modify the model such that it returns to equilibrium. The ARDL PMG estimator results in Table 5 revealed that in the long run, a percentage increase in the global oil price volatility would

lead to a 0.02 percent decrease in inflation, proxy with consumer price index (CPI) of African OPEC members' countries. While Table 5 revealed further that inflation is positively related to fiscal policy measure, government final consumption expenditure increases in the long run. The results showed that in the long term, a percentage increase in the government final consumer expenditure would lead to a 0.38 percent increase in inflation.

Meanwhile, the results seem to be diverse and insignificant in the short-run. The country-specific effects of oil price volatility on inflation were presented in Table 6. As noted in the corresponding table, a result of the estimate of four all countries appeared to have a significant error correction term (ECT) within the range of 0 and -2 which specified the appropriateness of the model. The results, however, the PMG ECT p-value of the model confirmed the short-run relationship for all countries. This implied that the short-run for each country (Algeria, Angola, Gabon, Libya, and Nigeria) were the same. For five countries, they confirmed our expectations that all the variables were correlated in the short term. The results in Table 6 suggested, however, for the cross-countries analyses data that the PMG estimators allow for heterogeneity in short-run coefficients. The short-run results revealed that global oil price volatility has a positive and significant effect on the economies of four of the 5 African OPEC members' countries, namely Algeria, Angola, Gabon, and Nigeria. All things being equal, a 1% increase in global oil price volatility significantly increases inflation by 0.01%, 0.17%, 0.07% and 0.07% in Algeria, Angola, Gabon, and Nigeria respectively. While a negative relationship was exerted in the case of Libya (-0.00067; p=0.000) suggesting that a 1 % increase in global oil price volatility significantly decreases inflation (CPI) by 0.06%.

Table 6 Country-specific results of the effect of oil price volatility on inflation in the Africa oil-exporting countries

Country	Variables	Coefficient	t-Statistic	Prob.
Algeria	ECT	-0.041131	-133.9829	0.0000[**]
	D(RV)	0.000120	234.3942	0.0000[**]
	D(LNRGDP_GR)	0.001157	0.031546	0.9768
	D(LNGEXP)	-0.026727	-23.61686	0.0002[**]
Angola	ECT	-0.004751	-874.5635	0.0000[**]
	D(RV)	0.001799	684.9063	0.0000[**]
	D(LNRGDP_GR)	-0.058337	-1.059066	0.3673
	D(LNGEXP)	-0.014226	-30.42526	0.0001[**]
Gabon	ECT	-0.014013	-146.5629	0.0000[**]
	D(RV)	0.000717	1715.846	0.0000[**]
	D(LNRGDP_GR)	0.081021	10.88570	0.0017[**]
	D(LNGEXP)	0.032834	57.85326	0.0000[**]
Libya	ECT	-0.092124	-212.9785	0.0000[**]
	D(RV)	-0.000667	-212.9785	0.0000[**]
	D(LNRGDP_GR)	0.012605	695.2135	0.0000[**]
	D(LNGEXP)	0.069366	61.52553	0.0000[**]
Nigeria	ECT	0.001635	24.15500	0.0002[**]
	D(RV)	0.000767	528.3258	0.0000[**]
	D(LNRGDP_GR)	-0.151101	-2.434628	0.0929
	D(LNGEXP)	0.011627	14.65194	0.0007[**]

Notes: Dependent variable is the log of CPI
[*]significant at 5 percent level
Source: Author's computation (2019)

Table 6 further revealed that, in the short-run individual country analysis, fiscal policy measure, proxy with government final consumption expenditure is positively related to inflation in Gabon (0.033 P=0.000), Libya (0.069; p=0.000) and Nigeria (0.012; p=0.007) respectively, but negatively related to inflation in Algeria and Angola. All things being equal, a 1% increase in government final consumption expenditure significantly increases inflation (consumer price index) by 3.3% 6.9% and 1.2% in Gabon, Libya, and Nigeria respectively. Also, the GDP growth, proxy of economic performance is positively linked to inflation in Algeria (0.001; p=0.976), Gabon (0.08 P=0.001) and Libya (0.012; p=0.000), but exerted negative relationship with inflation in Angola (-0.058; p=0.3673) and Nigeria (-0.151; p=0.093), though, insignificant.

4.3. Discussion of findings

The broad objective of this study was to examine the impact of oil price volatility on inflation in selected Africa's oil-exporting countries within OPEC. This study employed both descriptive statistics and econometric techniques to analyse quarterly data from the selected African OPEC countries from 1995 to 2017. The panel ARDL/PMG results reveal an antagonistic relationship for the persistent rise in the general price level (inflation) as induced by volatility in the price of oil in African OPEC's oil-producing nations. The ARDL/PMG revealed that in the long run, a percent increase in the global oil price volatility would lead to a 0.02 percent decrease in inflation. Studies such as Mork (1989); Mork, *el al* (1994); Blanchard and Gali (2007); and Hamilton (1996) have affirmed the existence of oil price-inflation relationship. The findings also explained that inflation is positively related to fiscal policy, measured with government final consumption expenditure in the long run. The results revealed that in the long run, a percent increase in the government final consumer expenditure would lead to a 0.38 percent increase in inflation. This suggested that the central authorities in the selected countries need to implement a practical expansive monetary cum restrictive fiscal policy measures to achieve price stability target. We found an inconsequential short-run association in the model estimated. The country-specific effects of oil price volatility on inflation results revealed that global oil price volatility has a positive and significant effect on the economies of four of the five Africa oil-exporting countries within OPEC, namely Algeria, Angola, Gabon, and Nigeria. All things being equal, a % increase in global oil price volatility significantly increases inflation by 0.01%, 0.17%, 0.07% and 0.07% in Algeria, Angola, Gabon, and Nigeria respectively. While a negative relationship was exerted in the case of Libya (-0.00067; p=0.000) suggesting that a % increase in global oil price volatility significantly decreases inflation by 0.06%. The fiscal policy measure, proxy with government final consumption expenditure is positively related to inflation in Gabon (0.033 P=0.000), Libya (0.069; p=0.000) and Nigeria (0.012; p=0.007) respectively, but negatively related to inflation in Algeria and Angola. All things being equal, a % increase in government final consumption expenditure significantly increases inflation by 3.3% 6.9% and 1.2% in Gabon, Libya, and Nigeria respectively. Also, the GDP growth, is positively linked to inflation in Algeria (0.001; p=0.976), Gabon (0.08 P=0.001) and Libya (0.012; p=0.000) but exerted negative relationship with inflation in Angola (-0.058; p=0.3673) and Nigeria (-0.151; p=0.093), though, insignificant.

5. CONCLUSIONS AND POLICY IMPLICATION

The study explored an empirical analysis of the impact of oil price volatility on inflation and economic performance in Africa's oil-exporting countries. Given that a vast number of studies on the effects of oil volatility on both oil-exporting and importing countries and such studies have primarily driven theoretical propositions about the oil, inflation and economic performance relationship, the uniqueness of this study is that oil price volatility was measured using realised volatility, and focused mainly on selected members of the organisation of petroleum exporting countries (OPEC). The result of the effect of oil price volatility on inflation showed that oil price volatility (β= -0.0255; t=0.044) had a negative and significant impact on inflation in OPEC's Africa oil-exporting countries. The study concluded that oil price volatility had a significant effect on inflation in the OPEC's Africa oil-exporting countries in the long run, but seemed to be diverse in the short run. This conclusion further confirms the apparent weakening of the relationship between oil price-economy and inflation relationship due to monetary and fiscal dynamics that have characterised the African economy over time. The finding that an increase in oil price initiates the inflation rate deserves singular attention. Each of selected OPEC's Africa's oil-exporting countries should diversify their export structures and develop their manufacturing export capability. Each of them should encourage domestic food production both in quantity and quality since food production is anti-inflationary. Precisely, the agricultural administrators of these OPEC's Africa's oil-exporting countries need to come up with effective programs that would scale up food production to benefit their economies during oil price hikes. Consequently, each authority should also upkeep and inspire the private sector to invest in and grow the agricultural industry. Other intervention tools that policy-makers can use to combat inflation and improve economic performance are monetary and fiscal policies, and these should be maximally optimised for social welfare gains.

REFERENCES

Ahmed, K., Bhutto, O., & Kalhoro, M. (2018). Decomposing the links between oil price shocks and macroeconomic indicators: Evidence from the SAARC region. *Resources Policy*, *61*, 423-432. https://doi.org/10.1016/j.resourpol.2018.03.001

Akinleye, S. O., & Ekpo, S (2013). Oil Price Shocks and Macroeconomic Performance in Nigeria. *Economía Mexicana Nueva Epoca*, *Cierre d'Época (II)*, 565-624. http://www.economiamexicana.cide.edu/num_anteriores/Cierre-2/08_EM_(DOS)_SO_Akinleye_(565-624).pdf

Allegret, J-P., Couharde C., & Coulibaly D. (2014). Current accounts and oil price fluctuations in oil-exporting countries: the role of financial development. *Journal of International Money Finance, 47*, 185-201. https://doi.org/10.1016/j.jimonfin.2014.06.002

Álvarez, L. J., Hurtado, S., Sánchez, I., & Thomas, C. (2011). The impact of oil price changes on Spanish and euro area consumer price inflation. *Economic Modelling*, *28*, 422–431.

Andersen, T. G., & Bollerslev, T. (1998) Answering the Skeptics: Yes, Standard Volatility Models Do Provide Accurate Forecasts. *International Economic Review*, *39*(4), 885-905. http://dx.doi.org/10.2307/2527343

Artami, R., & Hara, Y. (2018). The Asymmetric Effects of Oil Price Changes on the Economic Activities in Indonesia. *Signifikan: Jurnal Ilmu Ekonomi, 7*(1), 59-76. http//dx.doi.org/10.15408/sjie.v7i1.6052

Bala, U., & Chin, L. (2018). Asymmetric Impacts of Oil Price on Inflation:An Empirical Study of African OPEC Member Countries. *Energies*, 11, 3017.doi:10.3390/en11113017

Bala, U., Chin, L., Kaliappan, S. R., & Ismail, N. W. (2017). The Impacts ofOil Export and Food Production on Inflation in African OPEC Members.*International Journal of Economics and Management*, *11*(S3), 573-590.

Barndorff-Nielsen, O. E., & Shephard, N. (2002), Econometric analysis of realised volatility and its use in estimating stochastic volatility models. *Journal of the Royal Statistical Society*, *64*(2), 253-280.

Bashiri Behmiri, N., & Pires Manso, J. R. (2013). How crude oil consumption impacts on economic growth of Sub-Saharan Africa? *Energy*, *54*(1), 74–83. https://doi.org/10.1016/j.energy.2013.02.052

Chironga, M., Leke, A., van Wamelen, A., & Lund, S. (2011). *The globe: Cracking the next growth market*: Africa: Harvard Business Review.

Choi, S., Furceri, D., Loungani, P. Mishra, S., & Poplawski-Ribeiro, M. (2018). Oil prices and inflation dynamics: Evidence from Advanced and Developing Economies, *Journal of International Money and Finance*, *82*, 71–96. https://doi.org/10.1016/j.jimonfin.2017.12.004

Cuestas, J., & Gil-Alana, L. (2018). Oil price shocks and unemployment in central and Eastern Europe. *Economic System*, *42*(1), 164-173. https://doi.org/10.1016/j.ecosys.2017.05.005

Cunado, J., Jo, S., & Perez de Gracia, F. (2015). Macroeconomic impacts of oil price shocks in Asian economies. *Energy Policy*, *86*, 867-879. https://doi.org/10.1016/j.enpol.2015.05.004

Živkov, D., Đurašković, J., & Papić-Blagojević, N. (2020). Multiscale oil-stocks dynamics: the case of Visegrad group and Russia. *Economic Research-Ekonomska Istraživanja 33*(1), 87-106. https://doi.org/10.1080/1331677X.2019.1708772

Elder, J., & Serletis, A. (2010). Oil price uncertainty. *Journal of Money, Credit and Banking*, *42*(6), 1137–1159. https://doi.org/10.1111/j.1538-4616.2010.00323.x

George, E. O. (2012). *Diabetic Economy: A Paradox and a Dilemma*. 59th Inaugural Lecture, Olabisi Onabanjo University: Mass Communication Press, OOU.

Hamilton, J. (1983). Oil and the Macroeconomy since World War II. *Journal of Political Economy 91*(2), 228-248. https://www.jstor.org/stable/1832055?seq=1#metadata_info_tab_contents.

Hamilton, J. D. (1996). This is what happened to the oil price - Macroeconomy relationship. *Journal of Monetary Economics*, *38*(2), 215–220. https://doi.org/10.1016/S0304-3932(96)01282-2

Hooker, M. (1996). What happened to the Oil Price Macroeconomic Relationship? *Journal of Monetary Economics 38*(2), 195-213. https://doi.org/10.1016/S0304-3932(96)01281-0

Iwayemi, A. & Fowowe, B. (2011). Oil and the macroeconomy: Empirical evidence from oil-exporting African countries. *OPEC Energy Review*, *35*(3), 227-269. https://doi.org/10.1111/j.1753-0237.2011.00195.x

Kilian, L. (2014). Oil Price Shocks: Causes and Consequences. *Annual Review of Resource Economics*, *6*(1), 133–154. https://doi.org/10.1146/annurev-resource-083013-114701.

Kun, S. (2017). Impact of oil price changes on domestic price inflation at disaggregated levels: Evidence from linear and nonlinear ARDL modelling. *Energy*, *130*, 204-217. https://doi.org/10.1016/j.energy.2017.03.152

Lacheheb, M., & Sirag, A. (2019). Oil price and inflation in Algeria: a nonlinear ARDL approach. *The Quarterly Review of Economics and Finance*, *73*, 217-222. https://doi.org/10.1016/j.qref.2018.12.003

Lorusso, M., & Pieroni L. (2018). Causes and consequence of oil price shocks on the UK economy. *Economic Modelling, 72*, 223-226. https://doi.org/10.1016/j.econmod.2018.01.018

Mohaddes, K., & Pesaran, M. H. (2017). Oil prices and the global economy: Is it different this time around?. *Energy Economics*, *65*, 315–325. https://doi.org/10.1016/j.eneco.2017.05.011

Mork, K., Olsen, O., & Mysen, H. (1994). Macroeconomic responses to oil price increases and decreases in seven OECD countries. *Energy Journal*, *15*(4), 19-35. https://www.jstor.org/stable/41322565?seq=1#metadata_info_tab_contents

Mork, K. (1989). Oil Shocks and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results. *Journal of Political Economy*, *97*(3), 740-744. https://www.jstor.org/stable/1830464?seq=1#metadata_info_tab_contents

Nusair, S. A. (2016). The effects of oil price shocks on the economies of the Gulf Co-operation Council countries: Nonlinear analysis. *Energy Policy*, *91*, 256–267. https://doi.org/10.1016/j.enpol.2016.01.013

Omojolaibi, J. (2013). Does Volatility in Crude Oil Price Precipitate Macroeconomic Performance in Nigeria?. *International Journal of Energy Economics and Policy*, *3*(2) 143-152.

Ordway, E. M., Naylor, R. L., Nkongho, R. N., & Lambin, E. F. (2017). Oil palm expansion in Cameroon: Insights into sustainability opportunities and challenges in Africa. *Global Environmental Change*, *47*, 190–200. https://doi.org/10.1016/j.gloenvcha.2017.10.009

Organisation of the Petroleum Exporting Countries OPEC (2016). Annual Statistical Bulletin. Available at www.opec.org

Organisation of the Petroleum Exporting Countries OPEC (2018). Annual Statistical Bulletin. Available at www.opec.org

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association*, *94*(446), 621–634. https://doi.org/10.1080/01621459.1999.10474156

Rafiq, S., & Salim, R. (2014). Does oil price volatility matter for Asian emerging economies?. *Economic Analysis and Policy*, *44*(4), 417-441. https://doi.org/10.1016/j.eap.2014.11.002

Salisu, A., Isah, K., Oyewole, O., & Akanni, L. (2017). Modelling oil price-inflation nexus: The role of asymmetries. *Energy, 125*, 97-106.

Shafiee, S., & Topal, E. (2010). A long-term view of worldwide fossil fuel prices. *Applied Energy*, *87*(3), 988–1000. https://doi.org/10.1016/j.apenergy.2009.09.012

Tang, W., Wu, L., & Zhang, Z. (2010). Oil Price Shocks and Their Short and Long-Term Effects on the Chinese Economy. *Energy Economics Journal*, *32*(1), 3-14. https://doi.org/10.1016/j.eneco.2010.01.002

Wei, Y., & Guo, X. (2016). An empirical analysis of the relationship between oil prices and the Chinese macro-economy. *Energy Economics*, *56*, 88-100. https://doi.org/10.1016/j.eneco.2016.02.023

Xuan. P. P., & Chin, L. (2015). Pass-through Effect of Oil Price intoConsumer Price: An Empirical Study. *International Journal of Economics andManagement*, *9*, 143-161.

Zhang, D., Broadstock, D. C., & Cao, H. (2014). International oil shocks and household consumption in China. *Energy Policy*, *75*, 146–156. https://doi.org/10.1016/j.enpol.2014.08.034

ISTRAŽIVANJE INFLANTORNOG UTICAJA NA VOLATILNOST CENE NAFTE U AFRIČKIM ZEMLJAMA-IZVOZNICIMA NAFTE

Rezime: Ponuđen je niz objašnjenja za očiglednu promenu u ishodima odnosa između cene nafte i inflacije, od mogućeg korišćenja alternativnih izvora energije, preko promena u strukturi proizvodnje u okviru naftno-intenzivnog sektora, do uloge fiskalne i moneterne politike u zemljama koje su izvoznici nafte. Ove promene su privukle pažnju stejkholdera, vlada i celokupnog društva na anegdotski odnost između volatilnosti cene nafte, inflacije i proizvodnje u afričkim zemljama – izvoznicama nafte. Ova studija oslanja se na empirijsku verodostojnost uticaja volatilnosti cene nafte na inflaciju i ekonomski učinak afričkih zemalja- izvoznica nafte od 1995. do 2017. godine. Koristili smo proceduru procene objedinjene srednje grupe sa zaključkom izvedenim na nivou značaja od 5%. Utvrdili smo da volatilnost cene nafte ima značajan uticaj na inflaciju u afričkim zemljala-izvoznicama nafte. Studija, prema tome, predlaže da afričke zemlje-izvoznice nafte treba da preduzmu mere predostrožnosti i da prate inflatorne potencijale usled različitih odgovora inflacije na pozitivne i negativne skokove cene nafte.

Ključne reči: *Volatilnost cene nafte; Inflacija; Ishodi rasta; Objedinjena grupa; Afrika.*

Original Scientific Paper

DEVELOPING A MODEL
TO PREDICT CORPORATE BANKRUPTCY
USING DECISION TREE IN THE REPUBLIC OF SERBIA

UDC 347.736(497.11)

Sanja Vlaović Begović[1], Ljiljana Bonić[2]

[1]School of Business Novi Sad, Serbia
[2]University of Niš, Faculty of Economics in Niš, Serbia

Abstract. *Decision trees made by visualizing the decision-making process solve a problem that requires more successive decisions to be made. They are also used for classification and to solve problems usually addressed by regression analysis. One of the problems of classification that arises is the proper classification of bankrupt companies and non-bankruptcy companies, which is then used to predict the likelihood of bankruptcy. The paper uses a random forests decision tree to predict bankruptcy of companies in the Republic of Serbia. The research results show the high predictive power of the model with as much as 98% average prediction accuracy, and it is recommended for auditors, investors, financial institutions and other stakeholders to predict bankruptcy of companies in Republic of Serbia.*

Key words: *decision trees, bankruptcy, prediction, model*

JEL Classification: C44, C53, G33

1. INTRODUCTION

A quantitative method that iteratively detects links between attributes, data subject to testing, is called data mining. Data mining relies on decision trees that visualize the decision-making process to solve a problem that requires several successive decisions (Sikavica, et al., 2014, p. 476). Decision trees are often used to solve classification problems, i.e. to determine belonging to a particular class, and to solve regression problems.

One of the classification problems is the proper classification of bankruptcy and non-bankruptcy companies, thus making a prediction of corporate operations. Identifying business difficulties that lead to bankruptcy is a core task for numerous stakeholders. Banks, managers, investors, customers, suppliers avoid major losses by timely discovering unstable operations leading to bankruptcy. However, forecasting bankruptcies under current business conditions has become an increasingly significant challenge for analysts due to the globalization and complexity of companies, as well as the fact that certain economists perceive the initiation of bankruptcy as a strategic solution for the limitation of liability arising from court-imposed penalties (Kliestik et al., 2018). Various bankruptcy prediction models have been developed bearing in mind the significance of bankruptcy forecasting to numerous market participants and factors that affect the forecasting accuracy. Decision trees are categorized as contemporary models which, based on input data (numeric and categorical), predict bankruptcy.

The remainder of this paper is structured as follows. First, the theoretical and methodological basis of the decision tree is given, as well as an overview of some of the models used to predict bankruptcy. The advantages and disadvantages of the decision tree are highlighted as well as the previous research results in this area. Finally, a decision tree is implemented to predict corporate bankruptcy in Republic of Serbia. An overview of the influence of individual variables on the prediction result is also given.

2. THEORETICAL AND METHODOLOGICAL BASES OF MODELS FOR CORPORATE BANKRUPTCY PREDICTION USING DECISION TREE

Decision trees can be a graphic overview of decision making by experts based on a hand-created tree. In addition to the expert's decision, decision trees can rely on data finding its mutual links to obtain predictive values. Such trees are called Classification and Regression Trees (CART) and were developed by a group of American statisticians, Breiman, Friedman, Olshen, and Stone (1984). The goal of classification trees is to assign attributes to a subset of known classes. Specifically, the attribute space is divided into several different regions that do not overlap. A new object is determined to belong to one of the regions based on the values of the attributes describing the object (for example, corporate business operations are described by financial ratios). The object will be assigned to the class that dominates the region in which the object is located (James, et.al. 2013 p. 311) (for example, the class may be to continue business or go bankrupt).

The regression trees were developed in a similar way to the classification trees, except that the result of the analysis does not represent belonging to a class but an approximation of an unknown regression function. Regression trees are estimated using non-parametric regression functions (Härdle & Simar, 2007, 401).

The decision tree is based on recursive, binary splitting data, moving from a higher (tree) to a lower (leaf) level. Each tree node represents one test of the input attribute (variable) value, and each branch stemming from the node shows one of the possible attribute values. A leaf represents a class to which subset attributes belong (Stanojević, et al. 2017 p. 94). The tree is then formed by splitting the input dataset into subsets based on data value testing. The figure 1 shows a decision tree for predicting company bankruptcy, classifying each company as succeeding or failing. Assuming one of the attributes is ratio

1 − working capital/total assets, then the first splitting rule is to branch the tree into two sides, as follows (Gepp & Kumar, 2015, p. 398):

- ▪ "Left sub-tree, if ratio is $1 \leq 0,11$, or
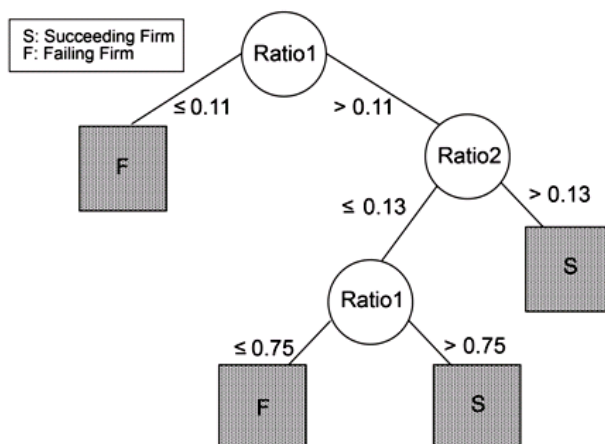- ▪ Right sub-tree, if ratio is $1 > 0,11$".

Fig. 1 An example of a decision tree classifying company operations
Source: Gepp, A., & Kumar, K. (2015). Predicting financial distress: a comparison of survival analysis and decision tree techniques. Procedia Computer Science, 54, p. 398.

In addition to classification and regression trees (CART), there are other popular algorithms that use top-down recursive data splitting, such as ID3 (Quinlan, 1986) and C4.5 (Quinlan, 1993). In the decision tree development process, the C4.5 and CART algorithms include two conceptual phases, namely: the growth phase and the tree pruning phase. Other algorithms only apply the growth phase when developing the decision tree.

Methods such as bagging, random forests and boosting methods are often used when developing the decision tree. The paper uses the random forests method, which is an advanced bagged decision tree. The difference to the bagged tree is that the modified decision tree algorithm "at each candidate split in the learning process selects a random subset of features" (James, et al. 2013 p.319).

3. AN OVERVIEW OF STUDIES ON THE USE OF THE DECISION TREE TO DEVELOP BANKRUPTCY PREDICTION

Unlike the frequent use of neural networks to predict corporate bankruptcy, researchers in the field of economics do not widely use decision trees. Although the first model was developed back in 1985, studies scarcely address the decision tree application to predict corporate bankruptcy.

1) Halina Frydman, Edward Altman, and Duen-Li Kao (1985) were the first to apply the decision tree, as a non-parametric model, to predict corporate bankruptcy and circumvent assumptions imposed by discriminant analysis and logistic regression. They used a recursive partitioning algorithm to develop a decision tree. The sample consisted of 58 bankrupt

companies and 142 active manufacturing and trading companies. The survey covered the period from 1971 to 1981. The authors used 20 financial ratios they considered significant for predicting bankruptcy in previous studies.

In relation to the number of input variables, the authors developed 2 decision tree models (larger, more complex, and smaller, simpler decision trees) and 2 models based on discriminant analysis (one model containing 4 and one with 10 variables). The research results showed the superiority of the decision tree model over the discriminant analysis models. In line with expectations, smaller decision tree showed better results, while complex decision trees highlighted the potential risk of over-training and poorer predictive results.

2) Thomas E. McKee (1995a) implemented the ID3 inductive inferencing algorithm to predict the bankruptcy of 60 US publicly traded companies. Half of the sample companies were bankrupt companies and the other half were active companies. The survey covered the period from 1986 to 1989. The input variables were 8 financial ratios (McKee, 1995a. p. 30):

- "Net income/Total assets
- Working capital/Total assets
- Current assets/Current liabilities
- Cash/Total assets
- Current assets/Sales
- Long-term debt/Total assets
- Accounts receivable/Sales revenue".

As the final research result, the author proposed a bankruptcy prediction model containing only two financial ratios, namely: current assets to current liabilities ratio and net income to total assets ratio. The model showed to predict the sample company bankruptcy with 97% accuracy. The author notes that the model should be tested using a larger sample, but still recommends auditors, investors and other stakeholders to use the model to predict bankruptcy.

In the same year, the author McKee (1995b) developed a recursive partitioning algorithm to predict bankruptcy, with the rule that if the current liquidity ratio was greater than or equal to 0.64 and the ratio of net income to total assets greater than or equal to 0, then the company will not file for bankruptcy, otherwise it is believed that the company will file for bankruptcy. The model was developed and tested using a sample of 202 companies, half of which were bankrupt and the other half actively operating. A few years later, McKee and Greenstein (2000) tested the robustness of the same model using an extended sample over a different time period and with different data. The results of the study showed that the developed model had a higher average percentage of prediction accuracy than the logit model and the neural network model. However, when it comes to predicting bankrupt company bankruptcy, the developed model showed less predictive power than the other models examined.

3) Adrian Gepp, Kuldeep Kumar, and Sukanto Bhattacharya (2010) extended the Frydman et al. research, applying different decision tree algorithms to predict corporate bankruptcy. In addition to the recursive partitioning algorithm, the authors implemented the CART and See5 algorithm. They compared the results of different decision trees, but also compared the results of the decision tree with the discriminant analysis model. Interestingly, the authors conducted a survey using the sample used by Frydman et al, with the same number of input variables.

Algorithms play a role in managing the decision tree development process, with two main tasks (Gepp, et.al. 2010 p. 540):

- Selection of the best splitting rule of data at each node distinguishing between active and bankrupt companies, and
- Managing the complexity of the decision tree (number of nodes). Many algorithms first develop a very complex tree, and then prune it to the desired complexity.

The results of the study confirmed the results of previous studies that smaller and simpler decision tree models "are better predictors than more complex models" (Gepp, et.al. 2010 p. 546). The authors emphasize that the recursive partitioning algorithm is a superior classifier and predictor of corporate bankruptcy. On the other hand, the See5 algorithm showed the best classification ability but also the worst predictive power. The CART algorithm showed very similar results to the recursive partitioning algorithm. Compared to the discriminant analysis model, all decision tree models showed their superiority.

4. ADVANTAGES AND DISADVANTAGES OF CORPORATE BANKRUPTCY PREDICTION MODELS USING DECISION TREE

„Decision trees are powerful classification algorithms that are becoming increasingly popular due to intuitive explanatory features" (Olson, et al. 2012 p. 466). Nayab (A Review of Decision Tree Analysis Advantages, Retrieved from: https://www.brighthubpm.com/project-planning/106000-advantages-of-decision-tree-analysis/, 11/08/2019) summarized the benefits of a decision tree in several points:

- Transparency – Decision trees explicitly provide all possible alternatives and present each alternative to a final conclusion, thus enabling alternatives to be compared;
- Specificity – The ability of the decision tree to assign certain values to the decisions (problem) and results of each decision, thereby reducing ambiguities in decision making
- Comprehensiveness – Decision trees provide a comprehensive analysis of the consequences of any decision that may end with a definitive conclusion, uncertainty or lead to new issues that require a repeat of the process;
- Ease of use – Decision trees provide a graphical representation of problems and alternatives in a simple and easy to understand format that requires no further explanation;
- Flexibility – The ability of the decision tree to handle different types of data (value and categorical);
- Resilience – Decision trees focus on the relationship between different events, depicting the natural course of events. That way, they remain robust to error, provided the input is correct;
- Confirmation – Decision trees are used as a quantitative analysis of problems in corporate operations, but also for validation of the results of statistical tests.

Because of their structure, decision trees are believed to be similar to human decision making, and graphical representation facilitates interpretation, especially with small trees. The ability to manage qualitative predictors does not require the introduction of dummy variables (James, et al. 2013 p. 315).

Developing a decision tree is possible by applying different algorithms, which have their advantages and disadvantages. One of the most famous algorithms for generating a

decision tree is the ID3 algorithm. Noting the shortcoming of an original decision tree, reflected in dealing with noisy and/or incomplete data, Quinlan (1986) compares two ways to modify methodology and overcome the shortcoming by introducing a new algorithm.

Quinlan (1987) investigated four methods for simplifying decision trees in a way that does not compromise predictive accuracy to ensure ease of use. The author concludes that the „pessimistic pruning method is faster than other applied methods and does not require a special test sample for validation". At the same time, the author states that the reduced error pruning method requires a separate test sample, and another weakness of the method is that parts of the original tree that are less frequent and specific cases are not presented in the test sample and can be cut. Finally, the author concludes that the simplifying to production rules method has proven particularly powerful.

Nayab found disadvantages of the decision tree (A Review of Decision Tree Disadvantages. Retrieved form: https://www.brighthubpm.com/project-planning/106005-disadvantages-to-using-decision-trees/, 11 August 2019) in the following features:

- Instability – Reliability of information in the decision tree depends on the accuracy of the input data. Even a small change in data entry can cause major changes in the tree, which may require the development of a new tree;
- Complexity, Unwieldy – Although the decision tree is easy to use compared to other models, developing a decision tree is a complex and time-consuming process. Complexity is particularly pronounced in large trees with many branches, and expertise and experience are crucial to solving such problems. Large trees are often cumbersome, leading to difficulties and incomprehensibility in their presentation;
- Costs – As already mentioned, developing large trees requires human training and expertise, and training costs for using a decision tree are imposed as a necessity;
- Information overload – Although decision trees are capable of generating large amounts of data, which is considered a positive feature, it may sometimes be that decision makers face a wealth of information. In these circumstances, it takes time for the decision maker to process all the data, making the decision-making process time-consuming and costly.

Compared to other regression and classification approaches, the decision tree generally does not have the same level of prediction accuracy. However, by modifying the decision tree by introducing different methods such as bagging, random forests, and boosting, predictive power significantly improves (James, et al. 2013 p. 316).

Kim and Upneja (2014) used a decision tree and an adaboosted decision tree to examine the key factors for the financial failure of a publicly traded restaurant in the US. The authors found that restaurants with financial problems had a higher share of debt in the capital structure, a lower rate of increase in assets, a lower profit margin, and a lower current liquidity ratio than restaurants that were not financially disadvantaged. Due to the good performance of predicting business failure, the authors recommend using an adaboosted decision tree.

In the credit rating evaluation, Bastos (2008) applied a boosted decision tree. Considering that the boosted decision tree outperformed multilayer perceptron and the support vector machines, the author concludes that the model is competitive with other credit rating models.

Shirata (1998) applies classification and regression trees (CART) to select the variables that will be used in the discriminant analysis model to predict the bankruptcy of

Japanese companies. Using CART, it is possible to calculate significance for each variable. In order to predict the bankruptcy of Huarng, Yu and Chen (2005) applied CART and demonstrated its superiority over other models. The main objection to their research is that the sample included only 12 companies and 5 variables. Li, Sun and Wu (2010) also confirmed the superiority of CART, highlighting the positive sides reflected in ease of application and results, accuracy and stability, non-linear estimation and non-parametric model. Durica et al. (2019) applied the CARD and CHAID decision tree algorithm to predict the bankruptcy of Polish companies, whereby the average prediction accuracy of the final models was 97.9% for the CART model and 98.2% for the CHAID model. Application simplicity, handling of missing data and easy interpretation of results were the most prominent advantages of these models.

Cha and Tappert (2009) applied a genetic algorithm to make decision trees compact and near-optimal. By limiting the height of the tree, the authors state that the derived model offers the same or better results than the best known algorithms.

Although they prefer to use the decision tree to predict corporate bankruptcy over logistic regression models, neural networks and support vector machines, Olson et al. state that comprehensibility, as a major advantage of the decision tree, is undermined by too many rules in developing the tree itself. Avoiding this problem is possible by controlling the „number of rules obtained from decision tree algorithms to a certain degree, by setting different minimum levels of support" (Olson, et al. 2012 p. 464).

5. IMPLEMENTATION OF THE DECISION TREE TO DEVELOP BANKRUPTCY PREDICTION MODELS OF MANUFACTURING AND TRADE COMPANIES IN THE REPUBLIC OF SERBIA

For the research purposes, a sample of 204 (large and medium-sized) manufacturing and trade companies operating in Republic of Serbia was formed. Half of the sample companies are bankruptcy companies from 2011 to 2017. The other half is made up of non-bankruptcy companies, timed with those in bankruptcy. Companies that initiated bankruptcy proceedings were selected on the basis of a list of active bankruptcy proceedings published by the Bankruptcy Licensing Agency (Bankruptcy Statistics, 2018). Non-bankruptcy companies are those that continuously and unhindered carry out their business activity, matched by industry (manufacturing and trade companies) and asset size with bankruptcy companies, selected from the database of the Business Registers Agency (Unified Search, 2018).

The total sample is divided into two parts. One part represents the training sample and is used for model development, while the other part is the validation sample and is used to control, i.e. to check the predictive power of the developed model (Banasik, Crook, & Thomas, 2003). The largest part of the total sample should be related to the model construction, and it is accepted in practice that this ratio can be 80:20 or 70:30 in favor of the training sample (Nikolić, et al. 2013). 80:20 ratio, 42 companies in validation sample and 162 companies in training sample were used in the paper.

Based on previous studies dealing with the corporate bankruptcy prediction, 56 initial variables were selected. After a t-test that eliminated variables that did not significantly influence bankruptcy prediction and eliminated multicollinearity, there were 15 variables left to use to develop the decision tree:

- (EBIT + amortization) / Interest expense
- Net income / Sales
- Net income / Total assets
- Total liabilities / (Retained earnings + Amortization)
- Working capital / Total assets
- Current assets / Current liabilities
- Total debt / Equity
- Sales / Accounts receivable
- Retained earnings / Total assets
- Sales / Total assets
- Cuurent assets / Sales
- Total assets (log)
- Cash flow from operation / Current liabilities
- Current assets / Total assets
- Long-term debt / Total assets

The paper uses a random forests decision tree. The results of the accuracy of bankruptcy prediction of the analyzed companies are presented in Table 1.

Table 1 Bankruptcy prediction using a random forests decision tree

Companies	Precision	Recall	F1-score	Support
Bankruptcy	0.95	1.00	0.98	21
Non-bankruptcy	1.00	0.95	0.98	21
Avg / total	0.98	0.98	0.98	42

Source: Authors' calculations

Precision is a measure of the success of a classifier that shows the percentage that actual bankruptcy companies make relative to all companies designated as bankruptcy companies. Based on Table 1, it can be concluded that the decision tree correctly classified 95% of bankruptcy companies in relation to the number of companies designated as bankruptcy. Also, it can be concluded that all actual non-bankruptcy companies are properly classified in relation to companies designated as non-bankruptcy.

Recall is a classifier performance measure that shows what percentage of companies are classified as bankruptcy relative to all companies that are truly bankruptcy. The survey results show that the decision tree classified all bankrupt companies in the bankruptcy class. However, some non-bankruptcy companies were also classified into bankruptcy class.

The F1-score is a measure of the success of a qualifier that combines precision and recall allowing a simpler comparison of different algorithms. The F1-score gives equal importance to precision and recall and is 0.98 equal to the average accuracy of predicting bankruptcy of a company using a decision tree.

As compared to the results of the study conducted by Stanišić et al. (2013) who, by comparing the predictive power of models based on discriminatory and logit analysis, neural networks and decision trees, found that decision trees had accurately classified 49 of 65 bankrupt and active companies (75.4% accuracy), our results show a far greater predictive power of the decision tree.

The results obtained are in line with the Bastos (2008) study, which established a generalization accuracy of 94.03% for Australian data using boosted decision trees. Largely similar results were obtained by Durica et al. (2019) who established an average accuracy of the bankruptcy prediction model in cases of Polish companies of 97.9% for the CART and 98.2% for the CHAID decision tree.

Berent et al. (2017) consider that the focus of research has shifted from maximizing the accuracy of predictive models to analyzing the informational significance of individual predictor variables. Berent et al. (2017) consider that the focus of research has shifted from maximizing the accuracy of predictive models to analyzing the informational significance of individual predictor variables. Depending on the business conditions, explanatory variables in models vary from country to country (Kovacova et al., 2019). Thus observed, the specifics of individual activities may also affect the selection of variables. Using the decision tree, the relative importance of variables in bankruptcy prediction first for all sample firms and then individually for manufacturing and trading companies was examined.

Figure 2 shows three variables affecting the prediction result by more than 15%. These are the following:

- (EBIT + amortization) / Interest expense
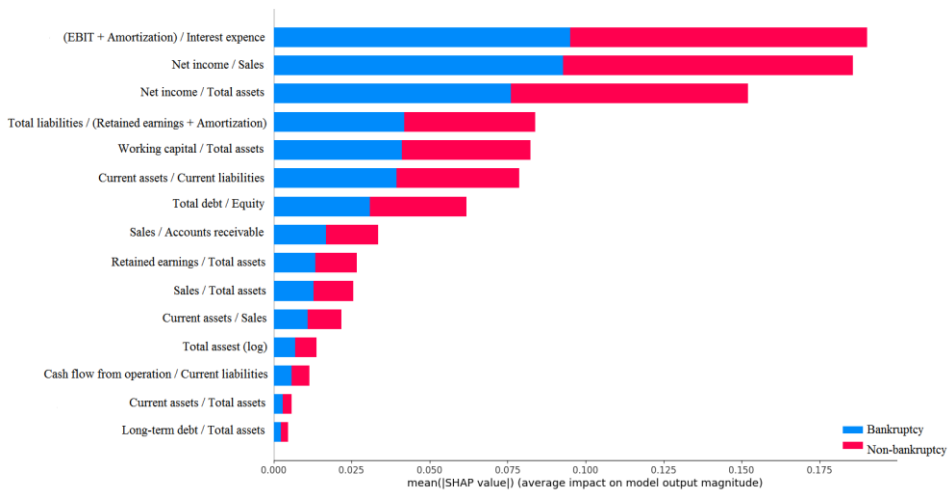- Net income / Sales
- Net income / Total assets.

Fig. 2 The average variable impact on the prediction result

Profitability and indebtedness had the greatest average impact on the bankruptcy prediction of the sample companies. However, if only manufacturing companies are observed, the variables that have the greatest impact on the prediction result also change, as Figure 3 shows.
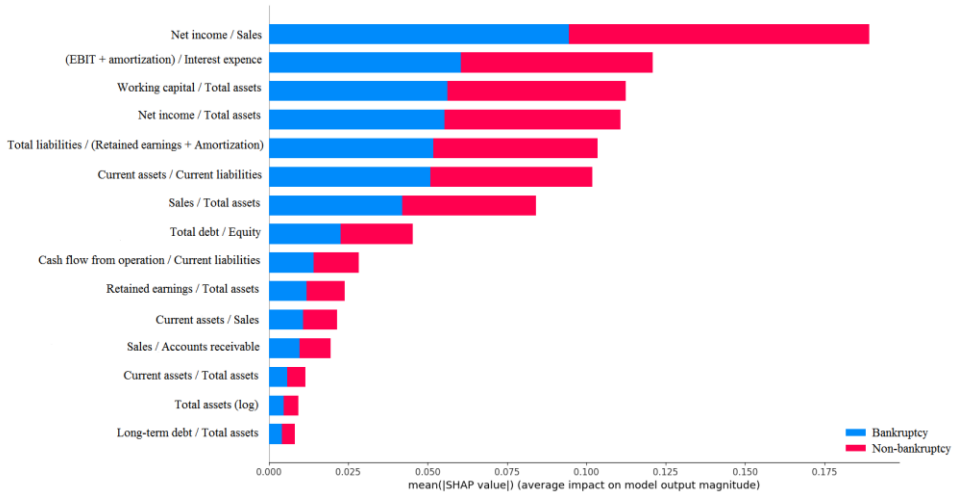
Fig. 3 Average variable impact on the prediction result of manufacturing companies

The highest average impact on the bankruptcy prediction of manufacturing companies is the ratio of net income to sales, with more than 17%. It is followed by indicators of indebtedness, profitability and liquidity.

Figure 4 shows the average impact of variables on bankruptcy prediction of trading companies.
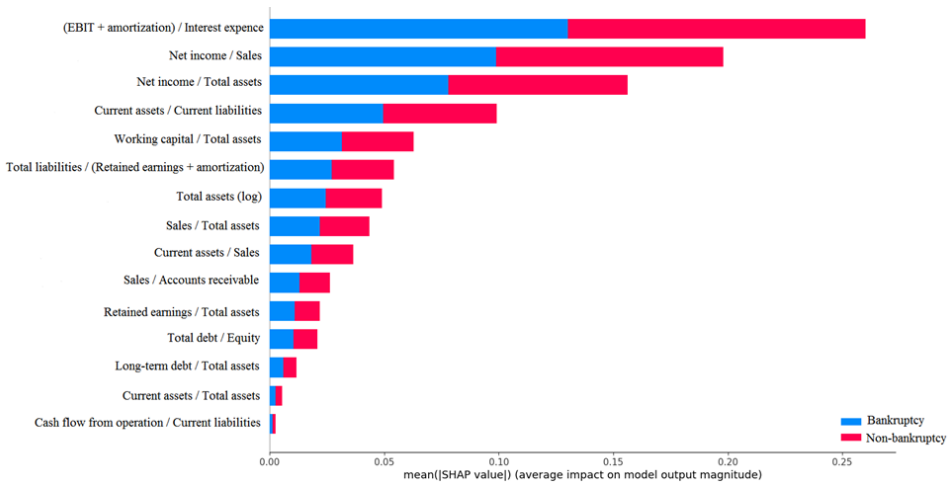

Fig. 4 The average variable impact on prediction result of trading companies

Figure 4 shows that the same variables (the first three) have the greatest average influence on the prediction result of trading companies, when looking at the total sample. Significant variables include liquidity ratios.

The variable that has proven significant for bankruptcy in all companies is the net income and total assets ratio, which is one of two variables used by McKee (McKee, 1995b; McKee & Greenstein, 2000) in their decision tree models to predict bankruptcy. Net income to total assets ratio is the most commonly used variable in bankruptcy prediction models (Bellovary, et al. 2007 p. 42)

6. CONCLUSION

The need to predict the business failure of a company facing bankruptcy proceedings has led researchers to search for a model that will most accurately predict future business. From discriminant analysis, logistic regression, to neural networks and various hybrid models, new models that may be the most appropriate to predict the bankruptcy of companies operating in a specific economic environment are constantly emerging.

Compared to traditional bankruptcy prediction models (discriminatory, logit and probit models), decision trees have a number of advantages, which are reflected in the simplicity of implementation, easy interpretation of results, handling of different data types and overcoming data deficiency issues. Flexibility and customization enable using decision trees to predict the bankruptcy of companies operating in different economies. In addition, the differences in predicting bankruptcies of companies engaged in various activities are perceived with ease.

However, the underlying issues appearing upon the application of a decision tree arise from its instability, where even slight alterations of input data may lead to a significant change in the tree and its prediction power. A relatively broad data sample is desirable for tree development; otherwise, there is a risk of quick overfitting (Weissova et al., 2016). Understandability, as one of the advantages of using decision trees, may be undermined by too many rules related to tree development; this may be avoided by controlling the number of rules by setting up various minimum support levels.

The paper uses a random forests decision tree to predict bankruptcy of companies in Republic of Serbia. The research results show the high predictive power of the model with as much as 98% average prediction accuracy, and it is recommended for managers of companies and financial institutions, investors, the Bankruptcy Licensing Agency, as well as other stakeholders in predicting the bankruptcy of a particular company in the Republic of Serbia.

REFERENCES

Agencija za licenciranje stečajnih upravnika (2018). Statistika stečajnih postupaka [Bankruptcy statistics]. Retrieved from: http://alsu.gov.rs/statistika-stecajnih-postupaka/ Accessed on 01.05.2018.

Agencija za privredne registre (2018). Objedinjena pretraga [Unified Search]. Retrieved from: http://pretraga2.apr.gov.rs/unifiedentitysearch Accessed on 10.05.2018.

Banasik, J., Crook, J., & Thomas, L. (2003). Sample selection bias in credit scoring models. Journal of the Operational Research Society, 54(8), 822–832.

Bastos, J. (2008). Credit Scoring With Boosted Decision Trees. Retrieved from: http://mpra.ub.unimuenchen.de/8156/, Accessed on 12.08.2019.

Bellovary, J. L., Giacomino, D. E., & Akers, M. D. (2007). A review of bankruptcy prediction studies: 1930 to present. *Journal of Financial education*, *33*(Winter 2007) 1-42.

Berent, T., Bławat, B., Dietl, M., Krzyk, P., & Rejman, R. (2017). Firm's default — new methodological approach and preliminary evidence from Poland. Equilibrium. *Quarterly Journal of Economics and Economic Policy, 12*(4), 753-773.

Breiman, L., Friedman, J. H., Olshen, R., and Stone, C. J. (1984). *Classification and Regression Trees*. Wadsworth & Brooks

Cha, S. H., & Tappert, C. C. (2009). A genetic algorithm for constructing compact binary decision trees. *Journal of pattern recognition research, 4*(1), 1-13.

Frydman, H., Altman, E. I., & Kao, D. L. (1985). Introducing recursive partitioning for financial classification: the case of financial distress. *The Journal of Finance, 40*(1), 269-291.

Gepp, A., Kumar, K., & Bhattacharya, S. (2010). Business failure prediction using decision trees. *Journal of forecasting, 29*(6), 536-555.

Gepp, A., & Kumar, K. (2015). Predicting financial distress: a comparison of survival analysis and decision tree techniques. *Procedia Computer Science, 54,* 396-404.

Härdle, W., & Simar, L. (2007). *Applied multivariate statistical analysis*. Berlin: Springer.

Huarng, K., Yu, H. K., & Chen, C. J. (2005). The application of decision trees to forecast financial distressed companies. In *2005 International Conference on Intelligent Technologies and Applied Statistics*, Taipei, Taiwan.

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning*. New York: Springer.

Kim, S. Y., & Upneja, A. (2014). Predicting restaurant financial distress using decision tree and AdaBoosted decision tree models. *Economic Modelling, 36,* 354-362.

Kliestik, T., Misankova, M., Valaskova, K., & Svabova, L. (2018). Bankruptcy prevention: new effort to reflect on legal and social changes. *Science and Engineering Ethics, 24*(2), 791-803.

Kovacova, M., Kliestik, T., Valaskova, K., Durana, P., & Juhaszova, Z. (2019). Systematic review of variables applied in bankruptcy prediction models of Visegrad group countries. *Oeconomia Copernicana, 10*(4), 743-772.

Li, H., Sun, J., & Wu, J. (2010). Predicting business failure using classification and regression tree: An empirical comparison with popular classical statistical methods and top classification mining methods. *Expert Systems with Applications, 37*(8), 5895-5904.

McKee, T. E. (1995a). Predicting bankruptcy via induction. *Journal of Information Technology, 10*(1), 26-36.

McKee, T. E. (1995b). Predicting bankruptcy via an inductive inference algorithm: an extension. *Artificial Intelligence in Accounting, Finance and Tax,* Huelva, 87-98.

McKee, T. E., & Greenstein, M. (2000). Predicting bankruptcy using recursive partitioning and a realistically proportioned data set. *Journal of forecasting, 19*(3), 219-230.

Nayab, N. (n.d.). *Review of Decision Tree Analysis Advantages*. Retrieved from: https://www.brighthubpm.com/project-planning/106000-advantages-of-decision-tree-analysis/, Accessed on 11.08.2019.

Najab, N. (n.d.). *Review of Decision Tree Disadvantages*. Retrieved form: https://www.brighthubpm.com/project-planning/106005-disadvantages-to-using-decision-trees/, Accessed on 11.08.2019.

Nikolić, N., Zarkic-Joksimović, N., Stojanovski, D., & Joksimović, I. (2013). The application of brute force logistic regression to corporate credit scoring models: Evidence from Serbian financial statements. Expert Systems with Applications, 40(15), 5932-5944.

Olson, D. L., Delen, D., & Meng, Y. (2012). Comparative analysis of data mining methods for bankruptcy prediction. *Decision Support Systems, 52*(2), 464-473.

Quinlan, R. (1986). Induction of decision trees. *Machine learning, 1*(1), 81-106.

Quinlan, R. (1987). Simplifying decision trees. *International journal of man-machine studies, 27*(3), 221-234.

Quinlan, R. (1993). *C4.5: Programs for Machine Learning*. Morgan Kaufmann, San Mateo.

Shirata, C. (1998). Financial ratios as predictors of bankruptcy in Japan: an empirical research (pp. 437–445). *Proceedings of the Second Asian Pacific Interdisciplinary Research in Accounting Conference*, Osaka, Japan.

Sikavica, P., Hunjak, T., Begičević Ređep, N., & Hernaus, T. (2014) *Poslovno odlučivanje* [Business decision making]. Zagreb: Školska knjiga.

Stanišić, N., Mizdraković, V., & Knežević, G. (2013). Corporate Bankruptcy Prediction in the Republic of Serbia. *Industrija. 41*(4), 145-159.

Stanojević, S., Đorđević, N., & Volf, D. (2017). Primena kvantitativnih metoda u predviđanju poslovanja privrednih društava [Applying the Machine Learning Method in Predicting Business Winners vs. Losers through Financial Reports]. *Oditor-časopis za Menadžment, finansije i pravo, 3*(1), 92-101.

Weissova, I., Siekelova, A., & Kramarova, K. (2016). Modeling of company´s default probability in relation to its credit risk. *Global Journal of Business, Economics and Management: Current Issues, 6*(2), 130-137.

RAZVIJANJE MODELA ZA PREDVIĐANJE STEČAJA ZASNOVANOG NA STABLU ODLUČIVANJA U REPUBLICI SRBIJI

Stabla odlučivanja vizuelizacijom procesa odlučivanja rešavaju problem koji zahteva donošenje više sukcesivnih odluka. Često se koriste i za rešavanje problema klasifikacije i regresije. Jedan od problema klasifikacije koji se pojavljuje jeste pravilno klasifikovanje preduzeća u stečaju i aktivnih preduzeća, na osnovu čega je moguće predviditi verovatnoću pokretanje stečaja. U radu je primenjeno random forests stablo odlučivanja za predviđanje stečaja preduzeća u Republici Srbiji. Rezultati istraživanja pokazuju visoku prediktivnu moć modela sa čak 98% prosečne tačnosti predviđanja, te se preporučuje njegovo korišćenje revizorima, investitorima, finansijskim institucijama i ostalim stejkholderima za predviđanje stečja preduzeća u Republici Srbiji.

Ključne reči: *stabla odlučivanja, stečaj, predviđanje, model*

Original Scientific Paper

CUSTOMIZATION – INNOVATION WHEN OFF-THE-SHELF IS OUT OF THE QUESTION

UDC 330.341.1:658.8

Milan Stamatović[1], Aleksandar Jovičić[2], Danijela Parojčić[1*]

[1]University Union–Nikola Tesla, Faculty of Business and Law, Serbia
[2]Fidelity National Information Services Inc – FIS, Serbia

Abstract. *Appointment scheduling applications (ASA) are used by service providers (hair salons, dentists, physicians), i.e. B2B customers, and service consumers (people), i.e. B2C customers. The objective is to investigate if innovation, i.e. customization may be applied to enable the product to support specificities of the Serbian market (SSM). Based on the environmental and competitive (internal and external) analysis and comparison of global vs. customized product (ASA) we recommend the launch of customization and sales departments aiming to place the customized product on the Serbian market. Applied research methodologies include SWOT and PESTEL analysis, strategic group mapping, Porter's value chain, Boston consulting group matrix, McKinsey's seven 'S' model, COMB analysis, Porter's five forces, Ansoff's matrix, stakeholder's analysis, and the balanced scorecard. The result is a business plan for the market entry of a software producer on the Serbian market. Appropriate combination of strategies – innovation and customization is formulated on the operational level.*

Keywords: *Customization, innovation, appointment scheduling application*

JEL Classification: M13, M14, M16

INTRODUCTION

Software applications for appointment scheduling are used by service industry providers (hair salons, dentists, spas, physicians) and final customers. Based on current market situation and the level of IT development, it appears to be the right time for a company to focus on the Serbian market. Existing foreign applications use English language and do not support requirements of the local market. Existing domestic applications are mostly in the early stage of development. Consequently, it appears to be the right time for a company to invest in a new product – customized foreign application that should use Serbian language and support local specificities. Serbian office should function as a standalone company offering to foreign companies two key services – customization of foreign applications according to Serbian specificities and sales on the Serbian market. Feasibility is estimated using both internal (environmental and competitive) analysis and external analysis of the Serbian office. The idea is to use the existing know how i.e. select a foreign application and enhance it to support Serbian specificities such as Serbian language and local payment system. Strategic approach will be used to create a customized product and propose the appropriate entry strategy (Table 1).

Table 1 Research objectives and research methods

#	Research objectives	#	Research method (tool)
1	Propose the method for *external analysis* of company's environment and competitors.	1 2 3 4	SWOT analysis. PESTEL analysis. Strategic group mapping. Delphi scenario building.
2	Propose the method for *internal analysis* of a company.	5 6 7 8	Porter's value chain. Boston consulting group matrix. McKinsey's seven 'S' model. COMB analysis.
3	Propose few *strategy options*. What should a company do?	9 10 11	Porter's five forces. Ansoff's matrix. Stakeholders analysis.
4.	Propose the method for *monitoring* the strategy implementation.	12	Balanced scorecard.

Source: The results of the research conducted by the authors

1. THE BUSINESS CONCEPT

Two business entities are analyzed; global company and Serbian office. Global company is software producer and its key product is the appointment scheduling application (ASA). Product is offered by service providers and it enables the final customer to schedule the appointment using the application (in English). We analyze the Serbian market for the product and answer to the key questions: is there a space for a product on the Serbian market and how the product should be customized to meet the specific requirements of the Serbian market (SSM). The product (ASA) is a computer application designed to automatize the

business processes of scheduling an appointment (Table 2). Global company produces appointment scheduling applications for various service providers: hair salons, dentists, spas, physicians (Table 3). Office customizes company products (Table 4).

Table 2 Product and market

#	Entity	Business	Product	Market
A	Global IT	Production.	Appointment	World
B	company.	Sales.	Scheduling	Market.
C	Serbian	Customization.	Application.	Serbian Market.
D	office.	Sales.	(ASA)	

Source: The results of the research conducted by the authors

Table 3 Organizational structure of the global company

#	Department	Activities	Number of employees	Percent of employees
A	Production.	Coding the *ASA*.	10	29%
B	Sales.	Sales on the world market.	20	57%
C	General.	Database, network, payment support.	5	14%
D	Total		35	100%

Source: The results of the research conducted by the authors

Table 4 Organizational structure of the Serbian office

#	Department	Activities	Number of employees	Percent of employees
A	Customization.	Coding the *ASA* to support the *SSM*.	4	40%
B	Sales.	Sales on the Serbian market.	2	20%
C	General.	Database, network, payment support.	4	40%
D	Total		10	100%

Source: The results of the research conducted by the authors

Company produces and sells the product on the world market while Serbian office is focused on customization and sales on the Serbian market. Key company business is application production while key office business is application customization. Key markets for the product are world market and local (Serbian) market. Company produces and sells the product on the global market while office customizes and sells it on the Serbian market.

Regarding the customers, company customers are service providers (hair salons, dentists) which offer ASAs to service consumers (people) on the world market (Table 5). Office customers are service providers on the local market.

Table 5 Customers – service providers and service consumers

#	Product	B2B clients service providers	B2C clients service consumers
A		Provider 1: hair salons.	Customer 1: Andreja books online an appointment with a hairdresser.
B	Appointment Scheduling Application (ASA)	Provider 2: dentists.	Consumer 2: Aleksandar books online an appointment with a dentist.
C		Provider 3: physicians.	Consumer 3: Milica books online an appointment with a doctor.
D		Provider 4: legal advisors.	Consumer 4: Đorđe books online an appointment with a legal advisor.

Source: The results of the research conducted by the authors

Regarding the competitors, *ASA* producers are classified as global, regional, and local IT companies. Local companies have a market share (MS) of 95% on the Serbian market vs. the MS of 5% held by global and regional companies. Regarding the business idea, the company strategy is to produce the best product. Serbian office should start with product customization and offer a customized product on the Serbian market. Regarding the added value, a customized product should support specificities of the Serbian market. GUI should be modified to provide optimal customer experience with existing average internet connection speed. The additional options should be included, such as the option to cancel the appointment in the last minute, the option to include average delay time caused by the customer being late, and the option to modify the price of the service based on the difference between scheduled and actual time of customer arrival. Key opportunity is the fact that most Serbian service providers have not started to use any ASA – they receive appointment requests from final customers traditionally by phone.

2. RESEARCH PURPOSE AND QUESTIONS

The purpose of this research on the strategic level is to formulate a strategy for product customization. Serbian office should answer two questions: should the product be customized and sold on the Serbian market. On the operational level, the purpose is to determine local market requirements that should be used to customize the ASA. Office is expected to investigate which ASAs are currently used and estimate which additional features of the product are expected to be used by Serbian customers in the close future.

Regarding the problem definition, a few questions have appeared. Regarding the first question on customization, the problem is how service providers choose the ASA. General factors are costs (price and annual renewal fee), performance with slow internet connection speed, and number of additional options supported. Service specific factors are support response time in case of failure, and franchise practice to use specific ASA for all branches, such as pizza hut ordering application. Regarding the second question on sales, the problem is who decides on the choice of the ASA? The answer would be – the service provider managers. Regarding the third question on current competition, the problem is which options do Serbian customers use? Answer would be simple – to schedule and cancel the appointment. Regarding the fourth question on the potential for the ASA enhancements, the problem is which options are Serbian customers going to use

in the future? The answer would be a list of additional features, such as: the ability to pay in domestic and foreign currency, the option to locate available service providers by geolocation and the option to offer discounts based on client loyalty and ability to arrive on time. Regarding the internal aspect of research, questions would focus on office strengths and weaknesses. Regarding the external aspect, questions would focus on key factors that affect the ASA selection, priority (quality vs. price), decision makers and future client expectations. Regarding the data, analysis is based both on primary and secondary data (Table 6).

Table 6 Data collection

#	Type	Primary	Secondary
1	Quantitative.	n/a	Data on Serbian ASA market. Future market trend estimates.
2	Qualitative.	Qualitative data related to office mission, vision, and objectives.	Data on factors that affect the product selection.

Source: The results of the research conducted by the authors

2.1. External analysis

External analysis is related to company environment. The following four methods are used: SWOT, PESTEL, strategic group mapping, and Delphi method of scenario analysis.

2.1.1. SWOT Analysis

SWOT combines internal and external analysis. Internal aims to identify "resources required to maintain competitive advantage", while external aims to identify chances and threats from the environment. Competitive environment consists of: "competitor's resources", "industry environment" identified by Porter's five forces, and "general environment" analyzed with the PESTEL analysis (Sammut-Bonnici T., 2015).

Table 7 SWOT analysis for the Serbian office

1 Strengths	1	Meaningful product, because scheduling conflicts and lost appointments cause serious problems for service providers.
	2	Group of similar products with same core engine (hair salons, physicians, dentists, spas).
	3	Well educated workforce with the innovative potential.
	4	Low cost of the workforce.
2 Weaknesses	1	Small number of existing clients in Serbia.
	2	Product (ASA) requires a change in costumer habits.
	3	Lack of information regarding the local market.
	4	Absence of sales track-record for the similar industry.
3 Opportunities	1	Absence of competition from global companies in Serbia.
	2	Improve product (ASA) quality using best practice from developed countries.
4 Threats	1	Potential for other competitors to enter the Serbian market.
	2	"High level of migration may devaluate the positive effects" of educated workforce. (Jovičić, Stamatović, 2018).

Source: The results of the research conducted by the authors

2.1.2. PEST(EL) analysis

PEST(EL) analysis represents the framework for the environment analysis, where environment consists either of four (PEST) or six factors PEST(EL).

Table 8 PESTEL analysis for the Serbian office

#	Perspective	#	Facts
1	Political	1	Expected tax decrease in the IT industry.
		2	Expected increase in competition following the admission of Serbia into the European Union.
2	Economic	1	Expected decrease of unemployment.
		2	Currently, service sector is not grouped and it may be regrouped into few big service providers.
		3	Demand for the ASAs is expected to increase.
		4	Service sector is developed.
		5	Service sector is expected to be stable.
3	Social	1	Awareness of internet based scheduling benefits.
		2	Millennials tend to use applications.
4	Technological	1	ASAs should be able to function in Serbian technical environment where average user has lower internet connectivity speed and less advanced smart phone (compared to EU average).
		2	Serbian users expect ASAs to support domestic payments.
5	Ecological	1	High temperatures in summer time should motivate people to schedule appointments and avoid unnecessary exposure to extreme weather.
6	Legal	1	EU admission should attract service franchises and increase the ASA usage.

Source: The results of the research conducted by the authors

2.1.3. Strategic group mapping

Strategic group consists of "competitors with similar approach and market position that are subject to same mobility barriers – forces that disable the company to move from one into another strategic group" (McGee, 2015). Maping compares: A – Serbian office which offers customized foreign product (ASA); B – local company which offers Serbian product; C – global company which offers not–customized product, and D – existing 'absence of ASA' where customers use traditional phones for appointment scheduling (Figure 1). Comparison provides two conclusions. Key competitor of A is B for two reasons: the usage of Serbian language and general ease of use. Key weakness of A is pricing. Customized product is expected to be more expensive compared to competitor's generic product.
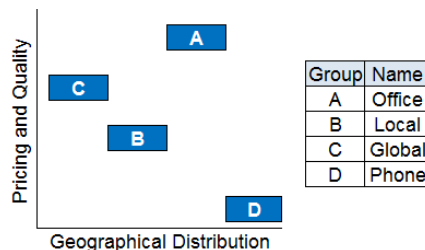

Fig. 1 Strategic group mapping
Source: The results of the research conducted by the authors

2.1.4. Delphi Method

Delphi observes a future as "multiple of possible futures with accociated probabilites that can be estimated and to some extent manipulated" (Helmer, 1967). Delphi is used to identify stakeholders, their objectives and prioritites (Okoli, Wang, 2015). Decision Delphi is a type of Delphi where research is *customized* to specific problem (Campbell, Fransi, 2017). Delphi "provides the consensus within the expert group and decreases the gap between total ignorance and *disciplined guess*" (Velez-Pareja, 2003). Delphi may analyse industries (Duru, Bulut, Yoshida, 2013) and technologies (Aichholzer, 2002). Delphi should estimate future requirements of Serbian ASA users.

Table 9 Delphi method – future demand on the Serbian ASA market

#	Topic	#	Scenario
1	*Expectations* on future demand for the product (ASAs).	1	Oriented towards low end smart phones.
		2	Expected entry of big franchises should increase the usage and quality of ASAs.
		3	Expected entry of global competitors will increase usage of non-customized ASAs.
2	*Recommendations* for the product (ASAs) customization.	1	Should work on low end smart phones.
		2	Should support payments in RSD.
		3	Should support payments in EUR.
		4	Should support various providers (hair salons, physicians, dentists, spas).

Source: The results of the research conducted by the authors

2.2. Internal analysis

The following four methods are used: Porter's value chain analysis, BSG Matrix, McKinsey's seven 'S' Model and COMB analysis.

2.2.1. Porter's value chain analysis

Internal analysis is related to the company. Four methods are used: Porter's value chain, BCG matrix, McKinsey's seven 'S' model and COMB analysis.

Generic value chain formulated by Michael Porter illustrates the circulation of goods and services within the company. *Recent critique* stipulates that model is outdated due to appearance of social networks and internet (Merchant, 2012). *Value cycle* concept introduces additional factors – IT and risk management (Cordery, Woods, Collier, 2011). *E-commerce value chain* introduces a new factor – online trading (Kleindl, 2014).

Table 10 Porter's value chain analysis for the Serbian office

	Group	Job description	Employees	Total
Primary activities	A	Coding related to customization.	20%	
	B	Functional spec writing and testing related to customization.	20%	60%
	C	Sales of customized product on the Serbian market.	20%	
	Group	Job description	Employees	Total
Support activities	D	Application support.	10%	
	E	Database support.	10%	40%
	F	Network and payment support.	10%	
	G	Training and education.	10%	

Source: The results of the research conducted by the authors

A) Developers write new code to enable the customization.
B) Functional specification writing and testing related to customization.
C) Sales of customized product on the Serbian market.
D) Customer support team should provide the application support to clients.
E) Database support team should provide the database maintenance.
F) Should provide fixing of network issues as well as settlement issues.
G) Office staff should provide the training for each new service provider.

2.2.2. Boston Consulting Group (BCG) Product Portfolio Matrix

A product usually starts as a "*problematc child*" and becomes either a "dog", if market share growth is not significant, or a "star" (if growth is significant), and after that a "cash cow" (when growth declines). "Many of todays cows used to be stars, as noted in the Matrix Flow" (Figure 2 – Mohajan, 2018).
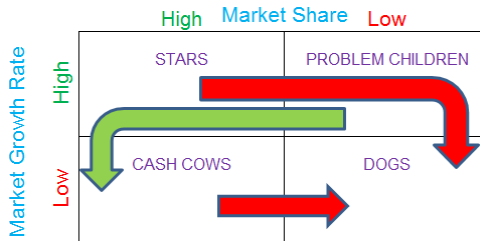
Fig. 2 BCG matrix flows
Source: Mohajan, 2018

As office has only one product (*ASA*), modified matrix is used to display two scenarios. Success, where consumers increase the usage of *customized* ASA (Figure 3). On the left we see the initial product launch. In the middle we see (A) moving to "stars", and the introduction of (B). On the right we see the market saturation, where (A) moves to "cash cows", and (B) moves to "stars".
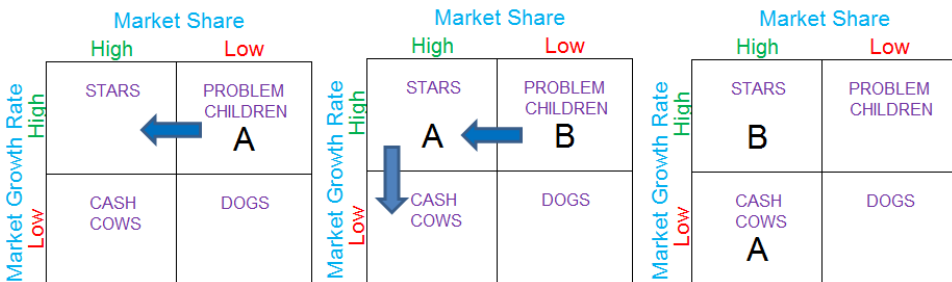

Fig. 3 BCG Matrix – scenaro of success
Source: The results of the research conducted by the authors

Failure, where consumers decrease the usage of *customized* ASA (Figure 4). On the left we see the initial product launch. In the middle we see (A) moving to "dogs", and the introduction of (B). On the right we see (B) moving to "dogs". Office failed because consumers did not start to use *ASA*.
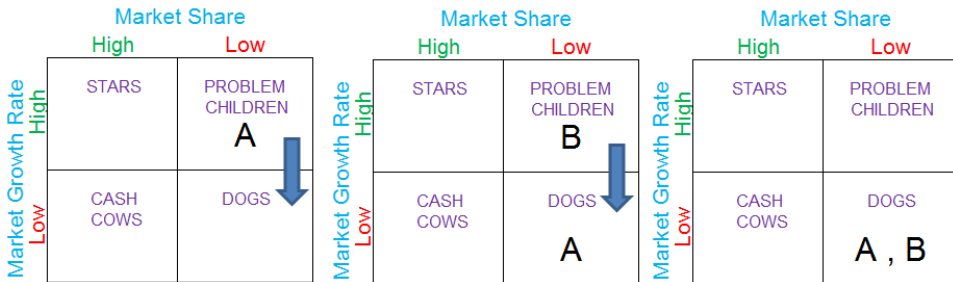

Fig. 4 BCG matrix – scenario of failure
Source: The results of the research conducted by the authors

2.2.3. McKinsey's seven 'S' model

Model is based on seven key "elements that define the organization personality" (Peters, 2014). It is a technique based on "inerdependance of seven key factors of organizational effectivenes" (Heery, Noon, 2017).

Table 11 McKinsey's seven 'S' Model

#	Perspective	#	Comments
1	Strategy	1	Strategy is to enter the Serbian market based on enhanced customer experience provided by customization. i.e. innovation and development of the existing product aiming to suport the *SSM*. First and second phase of customization will introduce new opitons into existing product. Third phase will integratie *ASA* with the food/products online ordering application, i.e. create a new product.
2	Structure	1	*Serbian office* should be independent entity. From the business perspective, office will depend on the global company, as it will customize its product – that is good as office will use the know-how, but on a different market (world vs. Serbian market).
3	Staff	1	20% developers, 50% business analysts and 30% salesforce. Office should be able to find educated staff at a reasonable price.
4	Skills	1	Analysts should understand what enhancements are required by the local market. Sales should present the advantages of customized product to clients.
5	Systems	1	Office structure should be activity based: analysts group, developers group, sales group, support group (database, network, and payments).
6	Management style	1	Management techniques should be modified aiming "to adjust for Serbian cultural specificities" (Jovičić, Đokić, Stamatović, 2018).
7	Shared values (culture)	1	Company and office share the same idea–introduce innovations based on the ASA customization.
		2	All employees (company and office) want to provide the best customer experience to clients.

Source: The results of the research conducted by the authors

2.2.4. COMB analysis

COMB chart "helps to estimate what is relevant for a consumer, to what extent our product meets the customer requirements, and how do we stand against the competitors" (Cross, 2007). Limitation is based on the fact that Serbian office does not exist and its performance is based on our estimation.
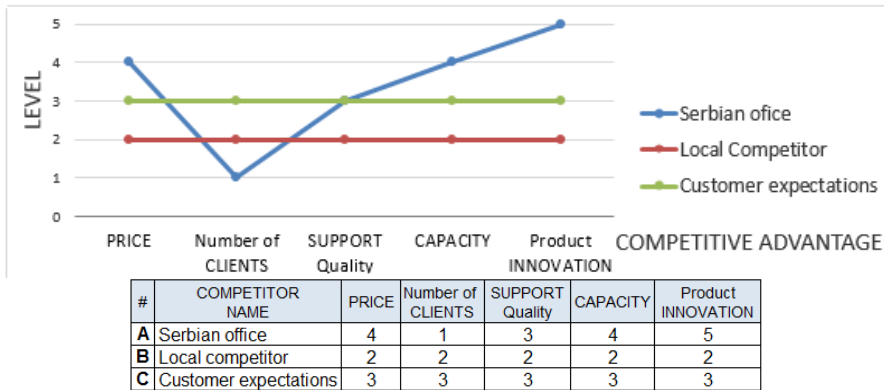

#	COMPETITOR NAME	PRICE	Number of CLIENTS	SUPPORT Quality	CAPACITY	Product INNOVATION
A	Serbian office	4	1	3	4	5
B	Local competitor	2	2	2	2	2
C	Customer expectations	3	3	3	3	3

Fig. 5 COMB chart for the Serbian office

Source: The results of the research conducted by the authors

Table 12 COMB findings and recommendations

#	Type	#	Comment
1	Findings	1	Key competitors (Local) are well positioned on the local market
		2	Comparing local competitor's (B) to customer expectations (C), chart shows that (B) is worse than (C).
		3	Comparing (B) to (A), chart shows that (B) is better only in terms of clients. Key advantage of (A) is innovation.
		4	Comparing (A) to (C), chart shows that (A) is better than (C) in most segments. Key advantage of (A) is innovation.
2	Recomm-endations	1	There is a space for customized product on the local market.
		2	Key office advantage is customized product and investment in the customization department makes sense.

Source: The results of the research conducted by the authors

2.3. Human resources

Table 13 Porter's value chain – Serbian office human resources

	Group	Job description	Employees	Total
Primary activities	A	Coding related to customization.	2	
	B	Functional spec writing and testing related to customization.	2	6
	C	Sales of customized product on the Serbian market.	2	
Support activities	D	Application support.	1	
	E	Database support.	1	4
	F	Network and payment support.	1	
	G	Training and education.	1	

Source: The results of the research conducted by the authors

2.4. Mission, vision, and core values

Before a strategy is formulated, we need to define mission, vision and core values. In reality, a lot of these definitions are "an insult to the inteligence and represent generic nonsense or bland gibberish" (Beaver, 2000).

Table 14 Serbian office - mission, vision, and core values

Category	#	Statement
Mission		Provide *customized* ASA to meet the requirements of Serbian customers.
Vision		Be recognized by global IT companies as a leader on the Serbian ASA market.
Core values	1	Client focused – include all client requirements and support all Serbian specialties.
	2	Multi product oriented – cover multiple product types
		(hair salons, dentists, spas, physicians).

Source: The results of the research conducted by the authors

3. STRATEGY OPTIONS

3.1. Strategic analysis: Porter's five forces

Two strategic analysis tools are used: Porter's five forces and Ansoff's matrix. Each industry has different forces. Analysis should show which factor (out of five) actually provides the profitability in a specific idustry.

Table 15 Porter's five forces on the Serbian ASA market

#	Force	#	Findings
1	Suppliers' bargaining power.	1	Low as *B2C* clients rarely use ASAs.
		2	Will increase when customers accept the ASA usage.
		3	Office will be the only supplier of customized ASAs.
2	Buyers' bargaining power.	1	Most service providers have not started to use ASAs.
		2	Service providers will increase the usage of ASAs.
		3	Service providers are not grouped in the franchises.
		4	Service providers will increase the demand for ASAs once they are regrouped into franchises.
3	Threats of substitution.	1	Currently, substitutes do not exist.
		2	In the future, substitutes are not expected to appear.
4	Threat of new entrants.	1	Currently, new entrants do not exist.
		2	In the future, new entrants may appear, thus we need to launch the business as soon as possible.
5	Rivalry among competitors.	1	Competitors exist, but they sell the non-customized product, i.e. do not support additional options.
		2	Existing competitors sell a low-quality product, made without the appropriate experience.

Source: The results of the research conducted by the author s

3.2. Ansoff's matrix

Products A, C and D bear the maximum risk, thus company should invest in advertising to raise the brand awareness. Phase-2 should be launched promptly, while phases 3-4 should wait for the B to increase its market share.
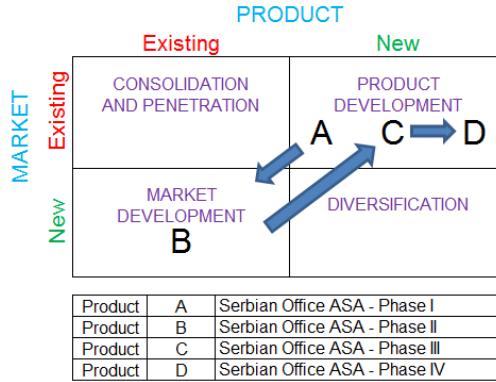

Product	A	Serbian Office ASA - Phase I
Product	B	Serbian Office ASA - Phase II
Product	C	Serbian Office ASA - Phase III
Product	D	Serbian Office ASA - Phase IV

Fig. 6 Ansoff's Matrix for the Serbian Office
Source: The results of the research conducted by the authors

3.3. Stakeholders analysis

Strategy selection should be based on the stakeholders analysis, using the stakeholders matrix (Figure 7). Office should move (E) to top-left quadrant as it is a key partner. Useful information on registered service providers may be obtained from (I), thus office should move it to top-left quadrant as well.

Stakeholder	A	B2B Clients, Service Providers
Stakeholder	B	B2C Clients, Service Consumers
Stakeholder	C	Serbian companies, direct competitors
Stakeholder	D	Serbian companies, in direct competitors
Stakeholder	E	Global companijes, suppliers
Stakeholder	F	Serbian Chamber of Commerce
Stakeholder	G	Serbian Medical Chamber
Stakeholder	H	Serbian Statistical Office
Stakeholder	I	Serbian Tax Authority

Fig. 7 Stakeholders power interest matrix for Serbian ASA market
Source: The results of the research conducted by the authors

Option one would be an independent entity engaged in customization and sales of global ASAs on the Serbian market. Option two would be a department within a global company. Stakeholder analysis shows that option one is better for the Serbian Office as it enables the cooperation with many global companies (E), i.e. disbursement of fixed costs on multiple products.

3.4. Information systems for sales support

Decision support system (DSS) is often used to optimize the allocation of limited resources to most promising activities (Tables 16, 17 and 18).

Table 16 Information systems for sales support

#	KPI - key performance indicator	is type	is description	comparative advantage
1	Number of service providers in our database.	Decision support system.	Sales planning system for customer prioritization.	Sales staff is focused on most potential B2B customers.

Source: The results of the research conducted by the authors

Table 17 Key performance indicator (KPI) of decision support system

#	Objective	KPI	Target
1	Focus on service providers with the highest ordering potential.	Ratio of service providers in database over total number of service providers.	↑ KPI by 10% in each year.

Source: The results of the research conducted by the authors

Table 18 Decision support system (DSS) for the Serbian office

#	Type		#	Description	#	Comparative advantage
1	Decision support system	Inputs	1	Allocate sales force on the best choice group.	1	Allocate sales force on the best choice group.
			2	Sales Dpt.: # of presentations per year to sales providers.		
		Outputs	1	List of service providers within the best choice group.	2	Improve sales results.

Source: The results of the research conducted by the authors

3.5. Critical success factors (CSF)

CSFs are evasive and hard to define becuse "actual CSF on the market will usually be different than those identified by decision makers. Various psychological mechanisms cause the wrong perception of the success factors" (Grunert & Ellegaard, 1992).

Table 19 Critical success factors on the operational level

#	Function	#	Critical success factor
1	Customization	1	Ability to identify requirements specific for the local market (SSM).
		2	Ability to customize product to support the identified requirements (SSM).
2	Sales	1	Availability of experienced sales staff.
		2	Ability of B2B clients to understand the advantages and accept the usage of ASAs.

Source: The results of the research conducted by the authors

3.6. Balanced scorecard (BSC)

Performance measurement consists of "choice of the appropriate indicators and the interpretation of results" (Ittner, 2015). It is estimated that "70% organizations use *BSC*" (Russell, 2015). *BSC* is a technique for monitoring and evaluation of the success of the business plan implementation, based on four pillars: perspective, objectives, indicators and targets.

Table 20 BSC for Serbian office sales department

#	Perspective	Objective	KPI	Target
1	Customer	↑ Knowledge of service providers on ASAs.	Number of sales presentations to service providers per year.	1st year: 20 % of customers.
				2nd year: ↑ KPI by 20% in 1 year.
2	Finance	↑ Market share.	Market share of ASA on the Serbian market.	1st year: MS 20%.
				2nd year: ↑ KPI by 20% in 1 year.
3	Processes	↑ ASA ability to support Serbian specific requirements.	Number of enhancements introduced to meet Serbian market requirements.	1st year: One enhancement monthly.
				2nd year: ↑ KPI by 25% in 1 year.
4	Staff	↑ Staff knowledge on sales & marketing.	Number of trainings attended by sales staff.	1st year: 5 trainings per year. 2nd year: ↑ KPI by 10% in 1 year.

Source: The results of the research conducted by the authors

CONCLUSION

In this research, four techniques (SWOT, PESTEL, strategic group mapping, and Delphi method of scenario analysis) have been applied to analyze company's environment and competitors. Further, four tehniques for the internal analyis of a company have been used (Porter's value chain, Boston consulting group matrix, McKinsey's seven 'S' model and COMB analysis). Two tools (Porter's five forces and Ansoff's matrix) have been used to propose strategic options and one (stakeholders matrix) to evaluate and select the best one. The conclusion of a strategic analysis is: Serbian office should function as a standalone company offering to foreign companies two key services: (1) customization of foreign applications aiming to meet specific requirements of the Serbian market and (2) sales of the customized product (ASA) on the Serbian market. Strategic analysis has identified four critical success factors (Table 19). Finally, company should use decision support system (DSS) to optimize the allocation of limited resources to most promising activities and balanced scorecard (BSC) to monitor the implementation of a business plan.

REFERENCES

Aichholzer, G. (2002). *Das Expertinnen-Delphi: Methodische Grundlagen Und Anwendungsfeld' Technology Foresight*. Assessment Working Paper No. ITA-02-01, Institute of Technology.
Beaver, G. (2000). The significance of strategic vision, mission and values. Strategic Change: Briefings in Entrepr. *Finance, 9*(4), 205-207.

Campbell, J. B., & Fransi, E. C. (2017). La gestión de las fuerzas de ventas, un estudio exploratorio a través del método Delphi. *RAN - Revista Academia Negocios, 2*(2).

Cordery, C. J., Woods, M., & Collier, P. M. (2011). *From Value Chain to Value Cycle: The Role of Risk Management and ICT*.

Cross, S. (2007). *Strategy Toolkit: 7 really useful tools to help build winning strategies and drive great results*. Morgan Cross Consulting.

Duru, O., Bulut, E., & Yoshida, S. (2013). *Delphi Forecasting for Shipping Industry and Technology: Performance and Validity*.

Grunert, K. G., & Ellegaard, C. (1992). *The Concept of Key Success Factors: Theory and Method.* The Mapp programme working paper no 4.

Heery, E., & Noon, M. (2017). *A Dictionary of Human Resource Management (3 ed.).* Oxford University Press.

Helmer, O. (1967). Analysis of the Future - Delphi Method. *Rivista Italiana di Administrazione Industriale*. Retrieved from: https://www.rand.org/pubs/papers/P3558.html

Ittner, C. D. (2015). *Performance Measurement, Implementation Issues.* Wiley Encyclopedia of Management.

Jovičić, A., Đokić, A., & Stamatović, L. (2018). Management in the Serbian IT sector – specificities and recommendations. *FBIM Transactions*, *6*(2), 44-53.

Jovičić, A., & Stamatović, L. (2018). *Can migration reduce the positive effect of investments in education?* (pp. 211-214). International Scientific Conference "Theoretical and Empirical Aspects of Economic Science - 60 years of Challenges and Opportunities", Belgrade.

Kleindl, B. (2014). *Value Chain Analysis*. The Internet Encyclopedia.

Merchant, B. N. (2012). Why Porter's Model No Longer Works. *Harvard Business Review*. Retrieved from: https://hbr.org/2012/02/why-porters-model-no-longer-wo

McGee, J. (2015). *Strategic groups*, Wiley Encyclopedia of Management.

Mohajan, H. K. (2018). An Analysis on BCG Growth Sharing Matrix. *Noble International Journal of Business and Management, 2*(1), 01-06.

Okoli, C., & Wang, N. (2015). *Insights from a Delphi Study.* Proceedings of the 21st Americas Conference on IS. Puerto Rico, 2015.

Peters, G. (2014). The Big Ida Magnificent Seven S. *London Business School Review, 25*(2), 74-75.

Russell, R. H. (2015). *Balanced Scorecard*. Wiley Encyclopedia of Management.

Sammut Bonnici, T. (2015). *SWOT Analysis*. Wiley Encyclopedia of Management.

Velez-Pareja, I. (2003). *El Metodo Delphi*. Politecnico Grancolombiano, Riesgo e Incertidumbre. Retrieved from: https://www.researchgate.net/profile/Ignacio_Velez-Pareja/publication/5006691_El_Metodo_Delphi/links/549f17560cf281d393a2540e.pdf

KASTOMIZACIJA – INOVACIJA GLOBALNIH PROIZVODA ZA LOKALNO TRŽIŠTE

Aplikacije za zakazivanje termina (AZT) koriste davaoci usluga – B2B klijenti (frizerski saloni, zubari, lekari) i korisnici usluga – B2C klijenti (potrošači). Traži se odgovor na pitanje – da li postoji potreba da se postojeće softverske aplikacije inoviraju tj. kastomizuju da bi se podržali specifični zahtevi srpskog tržišta (SST). Na osnovu interne i eksterne strategijske analize tj. na osnovu poređenja postojećih nekastomizovanih proizvoda (AZT) sa lokalnim tj. kastomizovanim, zaključuje se da postoji tražnja za lokalnim proizvodima i preporučuje se kastomizacija i prodaja kastomizovanih proizvoda na srpskom tržištu. U sklopu interne analize primenjene su sledeće tehnike: SWOT, PESTEL, mapiranje strategijskih grupa i Delfi. U okviru eksterne analize su primenjeni: Porterov lanac vrednosti, BCG matrica, KekKinzijev model sedam 'S' i COMB analiza. Predlog strategijskih opcija se vrši na osnovu analize Porterovih pet snaga i matrice Ansofa. Izbor optimalne opcije se vrši na osnovu analize stejkholdera. Formulisan je detaljan plan za ulazak kompanije na srpsko tržište za AZT i "balanced scorecard" za praćenje implementacije tog plana. Odgovarajuće strategije – kastomizacija i inovacija su formulisane na operativnom nivou.

Ključne reči: *kastomizacija, inovacija, aplikacija za zakazivanje termina.*

Original Scientific Paper

THE RELATIONSHIP BETWEEN POPULATION AGEING AND MEDICAL EXPENDITURES IN ROMANIA

UDC 316.346.32:[657.474:615.2(498)

Lucian Adrian Sala*

University of Craiova, Romania

Abstract. *With recent developments in the medical field and faster access to medical professional and healthcare services providers, accompanied by better education and a higher level of hygiene, life expectancy for both males and females in Romania is increasing at a steady pace. From a medical point of view, this is a remarkable accomplishment when compared with past decades when the average life expectancy was much lower than in recent times. A longer life span will automatically, for the most part, have the unwanted effect of increasing spending on medical services on behalf of the state to ensure a better quality of life for the elderly. Therefore, the public health system will be placed under additional pressure on behalf of healthcare providers to offer higher quality services to the elderly. This paper aims to explore the degree of influence that age and income have on the growing costs of medical expenditures on a per capita level. The method employed in exploring to what extent the growing share of elderly individuals and income can explain the rise in medical expenditures is a multiple linear regression model. The expected results are that as the share of elderly individuals grows within Romania's population and similarly as income on a per capita bases rises, there will be a noticeable increase in per capita medical expenditures.*

Key words: *population ageing, population decline, demographic transition, healthcare expenditures, multiple linear regression*

INTRODUCTION

During the last decades, European Union Member States (EU MS) have gone through considerable changes in the age structure and size of their populations, this trend being reflected to a pronounced degree in Romania (European Commission, 2018).

The number of individuals with ages of 65 years and older has increased at a steady pace as a result of natural demographic transition factors presented in the scientific literature and recognised within scientific circles as population ageing and as one of the dominant demographic phenomena of the 21st century (Feldstein, 2006).

Population ageing represents "the shift in the distribution of a country's population toward older ages" mainly due to "an increase in the population's mean or median age, a decline in the fraction of the population composed of children, or a rise in the fraction of the population that is elderly are all aspects of population ageing" (Weil, 2006, p. 3).

This demographic trend is expected to continue over the coming decades with adverse effects on social, economic and political spheres of influence, but most notably on the healthcare industry that may come under tremendous stress from a sharp increase in healthcare expenditures (HCE). The general perception is that as the share of individuals over the age of 65 years and older increases, so will per capita healthcare expenditures, as there exists a strong relationship between the two.

Similarly, as income per capita increases further due to economic development, the demand on behalf of the population for medical services will soar, adding further to costs.

In a study published by the Organisation for Economic Co-operation and Development (OECD), projections support the argument that gains in the share of elderly (65 years and older) may increase age-related social expenditures from an average of 19% of Gross Domestic Product to 26% by 2050 with increases in both long term HCE and public pension schemes (Dang et al., 2001). Comparable results are expected within Romania, where an increase in healthcare expenditures will be initiated by the restructuring efforts of governing bodies at the local level combined with demographic factors.

Population ageing will exert a direct effect on the level and structure of healthcare expenditures in Romania, due to the accelerated ageing process that is currently underway.

The focus of this paper is on analysing to what extent the rising share of the population ages 65 years and older and 80 years and older and Gross Domestic Product (GDP) per capita can explain the variation in HCE on a per capita basis within Romania's population using a multiple linear regression model. Through the utilisation of econometric techniques, the current paper introduces an element of novelty, supplementing the existing literature that covers the effects of ageing on healthcare in Romania.

The expected results are the existence of a strong relationship between healthcare expenditures on a per capita basis, the elderly share of the population and GDP on a per capita basis, demonstrated by way of correlation analysis. Equally, it is expected that the variation in healthcare expenditures will be explained to a high degree by the selected explanatory variables. Most notably the factors that contribute the most to the rise in HCE are expected to be the share of the population ages 80 years and older followed by GDP per capita. It is crucial to underline that the rise in healthcare expenditures in Romania's given its economic perspective may prove to be more burdensome than for other EU MS, thus it should take a more central role in decision-making processes at an administrative level.

The paper is structured in five parts, with the first part covering the relevant scientific literature encompassing works on the relationship between population ageing and healthcare expenditures. The second part contains an overview of the present and future trends regarding population ageing and healthcare in Romania. In the third section, the reader is introduced to the applied research methodology and the selected data sets utilised in the analysis. The fourth section covers the application of the research methodology accompanied by an assessment of the results obtained in connection to similar research papers. The final section contains concluding remarks and observations based on the results obtained, including policy implications and future research directions.

1. THE LINK BETWEEN POPULATION AGEING AND HEALTHCARE EXPENDITURES

The behaviour and requirements of a population have historically been influenced by *demographic changes*, while *technological breakthroughs*, such as early detection of life-threatening illness, non-invasive procedures and revolutionary treatments have helped to extend it (Thimbleby, 2013).

Demographic changes are shaped by two significant forces, most notably fluctuations in the mortality and fertility rate, that in certain combinations affect the development and structure of a population (Caselli & Vallin, 1990).

The effects of a decline in the *mortality rate* in a population are much more complicated than the decrease in the *fertility rate*, where the decline in mortality among infants and children has the effect of rejuvenating the population and at older ages of increasing the proportion of adults in the population. Historically, declines in mortality among younger generations have led to gains in life expectancy, so a shift from high mortality rates to moderate mortality rates tends to change the structure of the population over time (Sanderson & Scherbov, 2007).

Increases in *life expectancy* or *longevity* result in a more significant share of individuals surviving to advanced ages, this "life-changing" phenomenon leads to lower mortality rates in later stages of life (Beltrán-Sánchez et al., 2015; Dormont et al., 2010).

At present, the phenomenon of *demographic ageing* is expected to continue over the coming decades with adverse effects on social, economic and political spheres of influence, but most notably on the healthcare industry (HI) that may come under tremendous stress from a sharp increase in healthcare expenditures. The general perception is that as the share of individuals over the age of 65 years and older increases so will per capita HCE, as there exists a strong relationship between the two.

When taking into consideration more extended periods of time, it has been observed that HCE have a lower contribution in decreasing mortality in comparison to other factors such as nutrition and general public health measures (B. Harris, 2004). But in recent decades, the decline in mortality for older generations can be accredited in a more direct manner to the surge in HCE (Cutler et al., 2006).

The main factors driving the increase in HCE are the rise in income per capita and the share of the elderly individual's ages 65 years and older. Some additional factors that contribute to the rise in HCE include: the process of urbanisation; the number of hospitals; the number of physicians and nurses and the education level of individuals.

Demographic ageing is linked to the rising number of illnesses disproportionately burdening older generations and to the additional years gained due to increases in longevity that are characterised by health impairments, which often lead to the limitation of mobility and work capacity (Shergold et al., 2015; WHO, 2011).

When examining the causes of increases in HCE over time, the main factors contributing can be grouped into two broad categories, namely *social* and *individual factors* that are interlinked and that exert a certain degree of influence on indvidualisation of healthcare services.

Socials factors can determine how access and care is provided to patients based on standard guidelines establish within a healthcare system, on *medical breakthroughs* and implementation of technologies and devices that might encourage individuals to access treatment (i.e. new drugs, robotic prosthetics, non-invasive surgery, etc.).

Likewise, the income and cost side of accessing treatment is fundamental when making health related choices (i.e. more expensive treatment may be scarcer and might require waiting lists).

The development of *medical breakthroughs* can be accredited to a desire to push the known limitations of science and to develop a better understanding of current medical conditions and of the human body. Thus, the desire to sustain medial progress can be seen as one of the main drivers of HCE growth through research and development (R&D), producing new innovations that will at first have higher costs (Weisbrod, 1991).

Innovation through R&D in the medical field has the effect over time of reducing costs, but this added benefit in return tends to increase the use of new medical devices resulting in spikes in cost at first (Morris, 2010). Medical novelties are centred around illnesses that affect for the most part elderly individuals; this can be seen as one of the main factors for a longer life span for this age group (Christensen et al., 2009).

The increase in technological advancements and implementation of revolutionary medical equipment is one of the primary factors driving the increases in medical expenditure. It has been argued that, due to technological factors, a "compression of morbidity" may occur, where individuals' lifespans are not greatly increased but the quality of healthy life would improve causing a decrease of medical expenditures since the proximity to death will become more manageable (Aristovnik, 2015; Chappell & Hollander, 2011; Dormont et al., 2010).

A series of studies support the assertion that increasing medical expenditures can be more directly attributed to the rise in medical interventions and demand for emerging curative technologies in the pharmaceutical and medical fields as opposed to the general belief that the rising share of elderly individuals is the main driver of healthcare expenditure increases (Aristovnik, 2015; Baltagi et al., 2017; Xu et al., 2018).

Income per capita has a direct effect on HCE since health expenditures are "more sensitive to per capita income cyclical movements than to trend movements, and that the adjustment to income changes in those countries with a higher share of private health expenditure over total expenditure is faster" (Lago-Peñas et al., 2013, p. 1).

As income per capita fluctuates so will HCE, the intensity differing based on the size of disposable income, signalling that healthcare preferences will change as income per capita shifts (Lago-Peñas et al., 2013).

On an individual basis, as income increases over time due to increases in productivity and the specialization of labour, so does the inclination to rely more heavily on healthcare providers (T. Getzen, 2000; T. E. Getzen, 1992).

The demand for *prescription drugs* is also likely to increase at a more rapid pace due to higher demand on behalf of elderly individuals. As individuals age, pharmaceutical drugs help to keep chronic diseases at a manageable level. However, as drug tolerance increases so does the need for higher dosages to help keep in check life-threatening conditions raising demand and costs.

Proximity to death plays an essential role in the latter stages of life, when prescription drug usage increases sharply as individual needs for pharmaceutical and pharmacological drugs rise (Kildemoes et al., 2006). Kildemoes et al. (2006) estimate that the latter two years of life are the costliest in terms of prescription drug usage and other HCE. Thus, it can be argued that age per se is not as an essential factor as proximity to death and the costs of dying are.

Individual factors form the second category and refer to issues that influence the utilisation of public or private healthcare services based on health, behaviour and demographical factors (age, gender, sex, status). These factors exert an influence on an individual basis or in synergy determining to a certain extent how individuals utilise available resources.

 When considering an individual's *health and behaviour,* the medical literature suggests that a great deal of chronic diseases can be prevented by the decline and prevention of habits that include smoking, drinking and dietary change (Beltrán-Sánchez et al., 2015; WHO, 2007). Furthermore, increasing physical activities in addition to habit and dietary change may prove to be a cost-effective solution to lowering medical expenditures (Berwick et al., 2008; Chappell & Hollander, 2011).

The World Health Organization has estimated that for every dollar invested in physical activity programs, a reduction of approximately 3.2 dollars can be achieved in medical expenditures over the course of life (Chappell & Hollander, 2011; WHO, 2002, 2007). A similar investment has been observed to reduce medical expenditures between 6 and 8 dollars for every single dollar invested in health-related awareness campaigns (WHO, 2002).

When analysing the changes in *medical expenditures per age groups*, the share of costs attributed to young adults is lower than the cost of caring for elderly individuals. Then the main cause can be linked to the decreasing share of young adults in the total population due to lower birth rates and the increasing share of elderly individuals due to population ageing, offsetting medical costs to some degree (Beltrán-Sánchez et al., 2015).

Medical expenditures per age groups tend to increase at a much faster pace for individuals ages 50 years and older, due to an acceleration of the ageing process. A significant increase in HCE occurs for newborns due to medical expenditures associated with giving birth and primary medical care services available for infants and young adults (European Commission, 2018).

A mirroring of this tendency occurs for women that give birth where HCE tend to increase during childbirth, these costs peaking between the ages of 25 and 30 years. Another interesting aspect of age-related expenditures occurs after the age of 50 years where HCE for women are rising at a slower pace due to a better health condition than men (European Commission, 2018).

2. POPULATION AGEING AND HEALTHCARE TRENDS IN ROMANIA

During the last three decades, Romania has faced a wave of changes within its demographic structure. These changes, for the most part, can be summarized as increases in life expectancy, declines in birth rates and an increasing proportion of old adults in the total population that can be summed up as population ageing (European Commission, 2017; Feldstein, 2006; Mihai, 2016).

According to the estimates of the National Institute of Statistics (INS), between 2017-2060, the proportion of the population ages 60 years and older will grow at an accelerated pace. The number of centenaries will rise from 1,558 in 2015, to 5,094 in 2030, reaching about 22,587 centenarians alive by 2060 (INS, 2017).
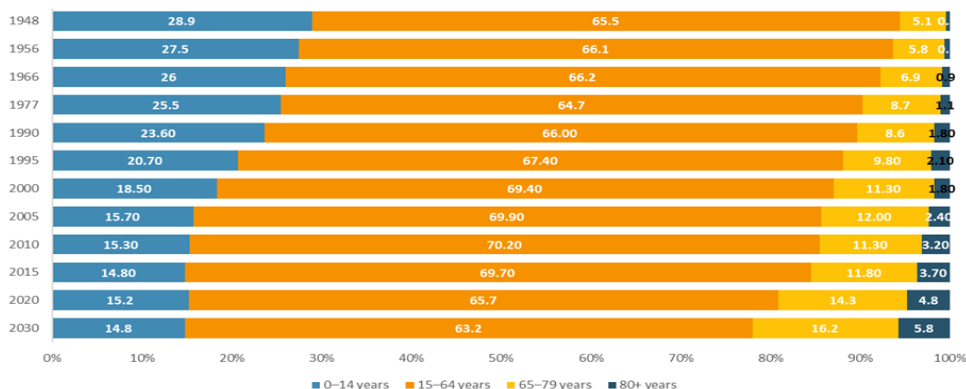
Fig. 1 Population by age groups projections, Romania
Source: Own creation, based on Eurostat data

To further support these claims, we can observe in Figure 1, the decline in the share of individuals ages 0-14 years old in the period between 1948 and 2015 from 28.9% to 15.7% and based on projections a further decline to 14.8 % is expected by 2030 (INS, 2017). The opposite scenario is emerging for age groups between 65 and 79 years old and 80 + years, that has increased at an accelerated pace, with projections for 2030 of 16.2% for individuals ages 65 to 79 years and 5.8% for individuals age 80 years and above (INS, 2017).

Similarly, *the old-age dependency ratio* is expected to follow an upward trend, since the number of elderly individuals is expected to rise in comparison to individuals active in the labour market. Thus, the cost of social services and HCE will increase to match demand becoming costlier over the long run.

Between 1980 and 2010, the old-age dependency ratio has steadily grown to reflect the rising share of elderly individuals within the population and the declining size of the workforce. This process has been accelerated to some extent by the high levels of economic emigrants that have traversed to neighbouring countries for better working conditions and higher remuneration (Figure2) (Enache & Pânzaru, 2012; Horváth & Anghel, 2018).

The old-age dependency ratio (Figure 2) is expected to rise to 28.8% in 2020 and to 50% by the year 2050, as the population ageing phenomenon advances. This expected increase will lead to increased stress on social security and healthcare programs in

Romania due to sharp increases in expenditures (Cylus et al., 2018; Eurostat, 2019e; Thimbleby, 2013; Vladescu et al., 2016).
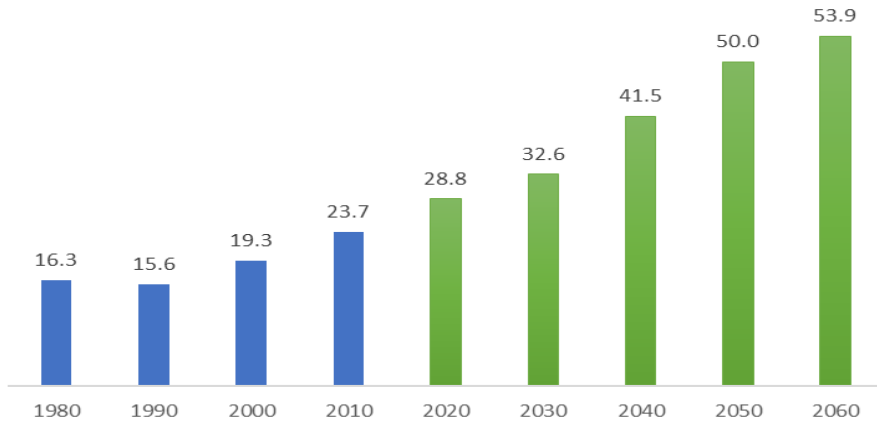

Fig. 2 Old-age dependency ratio projections, Romania
Source: Own creation, based on Eurostat data

Life expectancy at birth in Romania has increased between 2000 and 2017, for males by 4 years from 61.7 years to 71.7 years and by 4.3 additional years from 74.8 years to 79.1 years for females in the same period of time (Eurostat, 2019d). However, despite these remarkable improvements in longevity, Romania is lagging behind the EU MS average for both men and women (Eurostat, 2019d).

A major cause of concern for Romania's healthcare system is the high level of *infant mortality* recorded, that is among the highest of EU MS with 6.7 deaths per 1000 live births in 2017, the number of infant mortalities recorded is almost double that of average figures recorded at the level of EU MS (Eurostat, 2019c).

Some of the main factors that lead to the early demise of individuals and that contribute to the increase in HCE are diseases of the cardiovascular system, different forms of cancer that have increased abruptly and infectious diseases, Romania having the highest incident of tuberculosis with a third of the cases presenting drug-resistant strains (Savin, 2014; Simionescu et al., 2019).

Other significant determinants of the health status of Romania's population represent the high consumption of alcohol that has increased both among men and women paired with the increasing cases of obesity among adults and children that raise the risk of cardiovascular diseases (Simionescu et al., 2019).

Healthcare expenditures per capita have grown from 236.10 Euros in 2000 to 1376.46 Euros in 2017- a near six-fold increase. However, Romania is positioned among the lowest places when it comes to healthcare expenditures on a per capita basis within the EU MS (Eurostat, 2019a). Healthcare expenditures as a percentage of GDP in Romania recorded a value of 5.16% in 2017, representing the lowest level of all 28 EU MS, below the average of 9.9% (Eurostat, 2019b).

Among some of the main factors contributing to the poor state of Romania's healthcare system is the lack of universal coverage for all citizens, where a discrepancy exists between access to and the quality of healthcare services in rural and urban areas.

These aspects can be traced back to the unsuccessful reform of the public health system and to political instability. In effect, due to the deficiency in medical infrastructure, staff and necessary medicine, Romania is slightly above the average when considering unmet medical and healthcare needs within the EU MS (Eurostat, 2019f).

A series of attempts have been made to decentralise the public health system with limited result. Currently, the Ministry of Health provides the general policy direction and administers regulatory oversite in an inefficient and burdensome manner, with local authorities responsible for the delivery of services (Vladescu et al., 2016).

To the effect of the information described above, it is acceptable to state that population ageing coupled with a poorly governed healthcare system produces a great deal of social and political implications.

To offset these effects a series of policy contributions on behalf of government bodies have been implemented in a gradual manner to help mitigate the effects of an ageing population (increasing the retirement age, legislative changes that are aimed at improving working conditions for women, changes in the public health insurance system, increasing investments in adult education programs) (Bodogai & Cutler, 2014).

Despite the efforts and government measures focused at easing the transition to a "silver economy", Romania's population will continue to decline resulting in a significant restructuring within all age groups, from a regional to a national level, with significant declines in the number of newborns and increases in the share of older adults (Cristea & Mitrica, 2016).

3. MATERIALS AND METHODS

In order to understand to what degree longevity and income explain the variation within healthcare expenditures in Romania, a series of data sets have been collected from official sources. The data collected for the purposes of econometric analysis (Table 1), have been gathered from Eurostat in the form of time series and contain data on *healthcare expenditures per capita*, *the share of the population ages 65 years and older and 80 years and older* and *Gross Domestic Product per capita*. The period is between 2000 and 2017, based on the availability of published data.

Table 1 Variable inputs for econometric model

Abbreviation	Description	Denominator
spr_exp	Health expenditures per capita	Euros/capita
Pop_65	Share of population age 65 years and over	Percentage (%)
Pop_80	Share of population age 80 years and over	Percentage (%)
GDP_cap	Gross domestic product per capita	Euros/capita

Source: Own creation, based on Eurostat data

The utilisation of econometric techniques may help in shedding some light on the effects that a growing share of elderly individuals has on healthcare expenditures on a per

capita basis. Linear regression methodology can be traced back to the 18th Century, being applied by researchers as a least squared method approach in various fields from biology to astronomy (Draper & Smith, 2014; Yan & Su, 2009). Most notably in 1809, Carl Friedrich Gauss in his paper titled "*Theoria Modus Corporum Coelestium*" used a least squared approach to address the challenge of "determining from astronomical observations the orbits of bodies around the sun" (Chatterjee & Simonoff, 2013; Yan & Su, 2009).

Regression analysis can be defined as a "method to discover the relationship between one or more response variables (also called dependent variables, explained variables, predicted variables, or regressands, usually denoted by y) and the predictors (also called independent variables, explanatory variables, control variables, or regressors)" (Yan & Su, 2009, p. 2). Depending on the requirements and the number of variables, researchers can utilise a simple linear regression that models the linear relationship between two variables or a multiple linear regression that models the relationship between one dependent and more than one independent variables (Davison & Tsai, 1992; Draper & Smith, 2014).

The multiple linear regression model employed in this paper can be represented as follows (1.1) (Yan & Su, 2009, p. 3):

$$y_i = \beta_0 + \beta_1 x_{1i} + \cdots + \beta_p x_{pi} + \varepsilon_i \tag{1.1}$$

where:

y   – dependent variable;

x_{pi} – independent variable;

β_p – parameter;

ε_i – error.

One of the purposes of running a multiple regression analysis on a selected data sets is to determine the degree to which a set of independent variables can explain the variation within the dependent variable (Olive, 2017). When running a multiple linear regression analysis, a two-step process needs to be adopted that consists of, firstly, preparing the data sets, and secondly, employing a series of statistical tests meant to evaluate the validity and relative fit of the selected model (Weisberg, 2013; Yan & Su, 2009).

The required tests will be applied in Stata 16 to assess the assumptions that "there should be homoscedasticity of residuals (equal error variances); there should be no multicollinearity; there should be no significant outliers, high leverage points or highly influential points; and the errors (residuals) should be approximately normally distributed" (Laerd Statistics, 2019; UCLA, 2019).

One of the first tests to be applied to the data sets is to verify the independence of variables. Thus, the Durbin-Watson test is computed to verifying the absence of 1st-order correlation within the regression model. The Durbin-Watson test is computed utilising the following formula (1.2) (Yan & Su, 2009, p. 235):

$$DW = \frac{\sum_{i=2}^{n}(\hat{\varepsilon}_i - \hat{\varepsilon}_{i-1})^2}{\sum_{i-1}^{n}\hat{\varepsilon}^2{}_i} \tag{1.2}$$

where $\hat{\varepsilon}_i = y_i - \hat{y}_i$ represents the residuals from the ordinary least squares fit.

4. RESULTS OF ANALYSIS

In the process of running a multiple regression model, one of the first advised steps consists of plotting a scatter plot matrix as well as running a correlation analysis in order to asses the nature and strength of the bivariate relationships between the selected variables included in the model (Uyanık & Güler, 2013). A scatter plot matrix permits visual inspections of the relationship between variables, helping to determine the existence of gaps and outliers within the data sets.

When analysing the scatter plot matrix in Figure 3, we can observe a close relationship between healthcare expenditures on a per capita basis, GDP per capita and the share of population ages 65 years and older and 80 years and older.
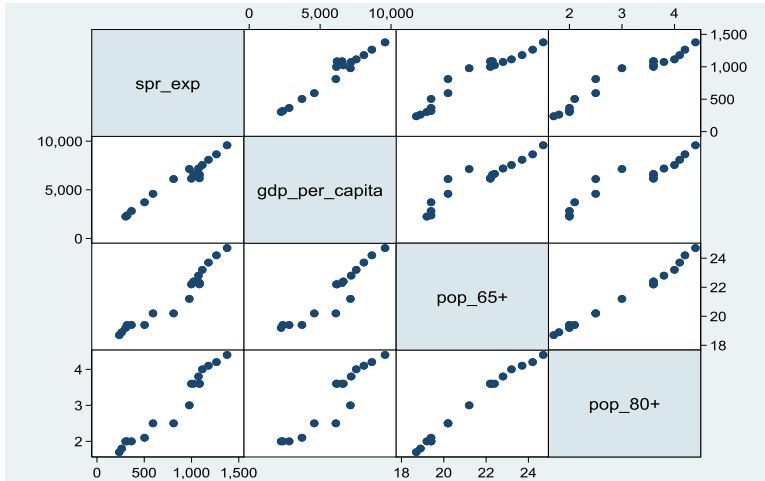
Fig. 3 Scatter plot matrix
Source: own processing in Stata 16

Similarly, we can observe the results obtained in the form of a correlation matrix (Table 2), as a result of running a Pearson correlation between the variables included in the model, where a strong relationship can be observed.

Table 2 Matrix of correlations

Variables	(1)	(2)	(3)	(4)
(1) spr_exp	1.000			
(2) gdp_capita	0.978	1.000		
(3) pop_65	0.956	0.937	1.000	
(4) pop_80	0.968	0.933	0.991	1.000

Source: own processing in Stata 16

The rise in healthcare expenditures on a per capita basis in Romania can be explained to a great extent by the rise in GDP per capita and the share of population ages 65 years and older and 80 years and older through the results obtained by way of the linear regression model (Table 3).

Table 3 Linear regression results

spr_exp	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
gdp_cap	0.101	0.014	7.41	0.000	0.072	0.131	***
pop_65	-135.635	45.693	-2.97	0.012	-235.192	-36.079	**
pop_80	430.944	93.176	4.63	0.001	227.931	633.958	***
Constant	1838.476	692.881	2.65	0.021	328.818	3348.134	**

Mean dependent var	879.281	SD dependent var		350.772
R-squared	0.989	Number of observations		16.000
F-test	359.363	Prob > F		0.000
Akaike crit. (AIC)	167.752	Bayesian crit. (BIC)		170.842

*** p<0.01, ** p<0.05, * p<0.1
Source: own processing in Stata 16

The variables included in the multiple linear regression can explain with a high level of confidence the level of healthcare expenditures per capita in Romania, $F(3, 12) = 359.36$, p $< .0005$, accounting for 98.90% of the variation in healthcare expenditures per capita with an adjusted value for $R^2 = 98.62\%$, which represents a high level according to Cohen (1988).

The linearity of the variables was assessed with the help of scatter plots of healthcare expenditures against GDP per capita, the share of individuals ages 65 years and older and the share of individuals ages 80 years and older, in each case a regression line has been superimposed.

After inspecting the resulting graphs, a linear relationship was confirmed in all cases. Further analysis indicated that residuals were normally distributed, and there is homoscedasticity (Draper & Smith, 2014). To determine the independence of residuals, the Durbin-Watson test was applied with a result of 1.875, indicating no autocorrelation (Durbin & Watson, 1971).

For outlier detection, a standard visual inspection and a statistical analysis of studentized residuals were employed, confirming that no outliers were detected. The resulting predicted equation for the multiple regression model can be presented as follows (1.3):

$$\text{spr}_{\text{exp}}=1838.48+0.101\times\text{gdp}_{\text{per capita}}-135.64\times\text{pop}_{65}+430.94\times\text{pop}_{80} \tag{1.3}$$

As can be observed in Table 3, GDP per capita is statistically significant at $p < 0.01$ with a value of 0.101; similar results have been observed in the scientific literature, where an increase in income does not necessarily translate to an equal increase in medical expenditures (Baltagi et al., 2017).

The main reason being that even with an increase in earning power, ageing individuals that are healthy will have only moderate increases in healthcare expenditures. In the presence of illness, expenditures will begin to increase and as the proximity to death window narrows, expenditures will begin to sharply increase for the final years of life (de Meijer et al., 2013; Gray, 2005)

An increase in the segment of the population ages 65 years and older seems to exert a negative effect at a significance level of $p < 0.05$, confirming previous studies that underlie increases in healthcare expenditure as a result of health and not necessarily of age (Gray, 2005).

Finally, the variable that seems to contribute the most to healthcare expenditure per capita is the segment of the population ages 80 years and older at a significance level of $p < 0.05$. The sharp increase in healthcare expenditures attributed to the segment of individuals ages 80 years and older has been observed in most developed countries and reflected in seminal research papers (de Meijer et al., 2013; Dormont et al., 2008; A. Harris & Sharma, 2018). As this share of the population continues to grow, an expected rise in healthcare expenditures is expected, thus an adequate response is in order to help alleviate some of the pressure on the healthcare system (A. Harris & Sharma, 2018; Vladescu et al., 2016).

Some of the main policy responses available include: a better management of resources within the public healthcare system; reducing the number of hospital days for elderly individuals in favour of out of hospital care when it is permitted; active measures that are aimed at reducing the risk of illness and that support an active and healthy ageing process; awareness campaigns through the use of mass media targeting the most common causes of morbidity and disability (diet, drinking, smoking, lack of physical exercise) (Rechel et al., 2009).

5. CONCLUSION

Population ageing presents a set of formidable provocations on the healthcare sector, driving innovation of new technologies through R&D but at a greater cost for society over the long run. As more investment capital flows into R&D, economic growth may be spurred in the medical field and other adjacent fields like electronics and the information technology industry. However, this capital transfer will come at the cost of other developments in industrial production, transportation, education and other key branches of the economy. When trying to understand how healthcare expenditures will change over the coming periods, it becomes difficult to predict a certain outcome due to the lack of a well-defined framework since it becomes unclear which demographic aspects have the sturdiest effects on healthcare expenditures.

The variables with most influence being the number of individuals that surpass a certain age, the number of individuals that suffer from illness or disability and the expected number of years that individuals cope with an illness or disability until demise also known as "time till death" (OECD, 2019).

One of the key policies adopted at a global level has been the active ageing policy, introduced in 2002 by the World Health Organisation, that has been established with the purpose of empowering individuals to pursue lifelong goals of self-improvement and societal contribution to the highest extent, under the premise of good health, high mobility and peak mental performance. The concept of active ageing has been further refined by healthy ageing policies and objectives aimed at "emphasising the need for action across multiple sectors and enabling older people to remain a resource to their families, communities and economies" (WHO, 2019).

Healthy ageing can be defined as "the process of developing and maintaining the functional ability that enables wellbeing in older age" (WHO, 2019). These measures introduced some critical aspects of a healthier lifestyle, having been adopted to some extent by EU MS but changing health and work habits paradigms will require a more extensive effort on behalf of member states.

The implementation of active ageing and healthy ageing measures requires "constant policy rethinking, adequate strategies, measures and tools for the active ageing population support" with the objective of integrating elderly individuals in all meaningful areas of life (Thalassinos et al., 2019, p. 9). Adopting and integrating active ageing and healthy ageing policies in Romania will require a long-term commitment with involvement on behalf of public and private partners in a variety of areas from environmental to economic, health and social services.

Good stewardship of the healthcare system and healthy living programs represent a big part of the *healthy ageing* agenda, where individuals are encouraged to maintain and improve the quality of life by exercising more, changing dietary habits, reducing alcohol consumption and smoking (WHO, 2007).

In regards to policy implication, the most important measures implemented to curb the effects of population ageing on social security services and healthcare providers has been the decision to increase the mandatory retirement age. This decision has the added benefit of supporting the workforce through a longer working life on behalf of employees. Thus, since a bigger share of older individuals is involved in an active way in the workforce for longer periods of time, the balance will shift in favour of active individuals, lowering the dependency ratio for the elderly.

Declines in healthcare expenditures can be further supported by informal caregiving offered by family members to elderly individuals in need of assistance. Thus, as caregiving is transferred to local communities, the cost will tend to decrease in favour of public care facilities and hospitals lowering the overall burden on public healthcare services (Chappell & Hollander, 2011; WHO, 2002). Informal caregiving must be supported by well-governed and implemented policies and must be done more directly only with the support and guidance of healthcare professional (Chappell & Hollander, 2011; Simionescu et al., 2019).

Research limitations encompass the limited data sets and a general lack of statistical information available, limiting the possibility of more in-depth analysis. Likewise, the lack of a well-defined framework within the healthcare industry makes it difficult to evaluate and predict how healthcare expenditures might react to shift in the population structure. Based on current results, the application of a vector autoregression model (VAR) might help in assessing how healthcare expenditures may respond to changes in the population structure due to the ageing phenomenon and GDP per capita.

REFERENCES

Aristovnik, A. (2015). *Efficiency of the Healthcare Sector in the EU-28 at the Regional Level*. 9.

Baltagi, B. H., Lagravinese, R., Moscone, F., & Tosetti, E. (2017). Health Care Expenditure and Income: A Global Perspective. *Health Economics*, *26*(7), 863–874. https://doi.org/10.1002/hec.3424

Beltrán-Sánchez, H., Soneji, S., & Crimmins, E. M. (2015). Past, Present, and Future of Healthy Life Expectancy. *Cold Spring Harbor Perspectives in Medicine*, *5*(11). https://doi.org/10.1101/cshperspect.a025957

Berwick, D. M., Nolan, T. W., & Whittington, J. (2008). The Triple Aim: Care, Health, And Cost. *Health Affairs*, *27*(3), 759–769. https://doi.org/10.1377/hlthaff.27.3.759

Bodogai, S. I., & Cutler, S. J. (2014). Aging in Romania: Research and Public Policy. *The Gerontologist*, *54*(2), 147–152. https://doi.org/10.1093/geront/gnt080

Caselli, G., & Vallin, J. (1990). Mortality and Population Ageing. *European Journal of Population / Revue Européenne de Démographie*, *6*(1), 1–25. JSTOR.

Chappell, N., & Hollander, M. (2011). An Evidence-Based Policy Prescription for an Aging Population. *HealthcarePapers*, *11*(1), 8–18. https://doi.org/10.12927/hcpap.2011.22246

Chatterjee, S., & Simonoff, J. S. (2013). *Handbook of regression analysis*. Wiley.

Christensen, K., Doblhammer, G., Rau, R., & Vaupel, J. W. (2009). Ageing populations: The challenges ahead. *Lancet (London, England)*, *374*(9696), 1196–1208. https://doi.org/10.1016/S0140-6736(09)61460-4

Cristea, M., & Mitrica, A. (2016). Global Ageing: Do Privately Managed Pension Funds Represent a Long Term Alternative for the Romanian Pension System? Empirical Research. *Romanian Journal of Political Science*, *16*(1), 63.

Cutler, D., Deaton, A., & Lleras-Muney, A. (2006). The Determinants of Mortality. *Journal of Economic Perspectives*, *20*(3), 97–120. https://doi.org/10.1257/jep.20.3.97

Cylus, J., Normand, C., & Figueras, J. (2018). Will Population Ageing Spell the End of the Welfare State? A review of evidence and policy options. *WHO Regional Office for Europe*, 43.

Dang, T.-T., Antolín, P., & Oxley, H. (2001). *Fiscal Implications of Ageing: Projections of Age-Related Spending*. https://doi.org/10.1787/503643006287

Davison, A. C., & Tsai, C.-L. (1992). Regression Model Diagnostics. *International Statistical Review / Revue Internationale de Statistique*, *60*(3), 337–353. https://doi.org/10.2307/1403682

de Meijer, C., Wouterse, B., Polder, J., & Koopmanschap, M. (2013). The effect of population aging on health expenditure growth: A critical review. *European Journal of Ageing*, *10*(4), 353–361. https://doi.org/10.1007/s10433-013-0280-x

Dormont, B., Martins, J. O., Pelgrin, F., & Suhrcke, M. (2010). Health expenditures, longevity and growth. In Ageing, Health, and Productivity: The Economics of Increased Life Expectancy. In *The Growth of Health Expenditures: Ageing vs. Technological Progress*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199587131.001.0001

Dormont, B., Oliveira Martins, J., Pelgrin, F., & Suhrcke, M. (2008). Health Expenditures, Longevity and Growth. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1130315

Draper, N., & Smith, H. (2014). *Applied Regression Analysis, 3rd Edition*. Wiley. https://www.wiley.com/en-us/Applied+Regression+Analysis%2C+3rd+Edition-p-9781118625682

Durbin, J., & Watson, G. S. (1971). Testing for serial correlation in least squares regression.III. *Biometrika*, *58*(1), 1–19. https://doi.org/10.1093/biomet/58.1.1

Enache, C., & Pânzaru, C. (2012). *Romanian Migration Flows In European Countries: Does social security matter?* 11.

European Commission. (2017). *The 2018 ageing report: Underlying assumptions and projection methodologies*. https://ec.europa.eu/info/sites/info/files/economy-finance/ip065_en.pdf

European Commission. (2018). *The 2018 ageing report economic & budgetary projections for the 28 EU Member States (2016-2070)*. https://ec.europa.eu/info/publications/economy-finance/2018-ageing-report-economic-and-budgetary-projections-eu-member-states-2016-2070_en

Eurostat. (2019a). *Health care expenditure in the EU*. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20181129-2

Eurostat. (2019b). *Healthcare expenditure across the EU: 10% of GDP*. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190904-1

Eurostat. (2019c). *Infant mortality rates—Eurostat*. https://ec.europa.eu/eurostat/web/products-datasets/-/demo_minfind

Eurostat. (2019d). *Life expectancy at birth by sex—Eurostat*. https://ec.europa.eu/eurostat/web/products-datasets/product?code=sdg_03_10

Eurostat. (2019e). *Record high old-age dependency ratio in the EU*. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20180508-1

Eurostat. (2019f). *Unmet health care needs statistics—Statistics Explained*. https://ec.europa.eu/eurostat/statistics-explained/index.php/Unmet_health_care_needs_statistics

Feldstein, M. S. (2006). *The Effects of the Ageing European Population on Economic Growth and Budgets: Implications for Immigration and Other Policies* (Working Paper No. 12736). National Bureau of Economic Research. https://doi.org/10.3386/w12736

Getzen, T. (2000). Health Care is an Individual Necessity and a National Luxury: Applying Multilevel Decision Models to the Analysis of Health Care Expenditures. *Journal of Health Economics*, *19*, 259–270. https://doi.org/10.1016/S0167-6296(99)00032-6

Getzen, T. E. (1992). Population Aging and the Growth of Health Expenditures. *Journal of Gerontology*, *47*(3), S98–S104. https://doi.org/10.1093/geronj/47.3.S98

Gray, A. (2005). Population Ageing and Health Care Expenditure. *Oxford Institute of Ageing*, *Ageing Horizons*(2), 15–20.

Harris, A., & Sharma, A. (2018). Estimating the future health and aged care expenditure in Australia with changes in morbidity. *PLoS ONE*, *13*(8). https://doi.org/10.1371/journal.pone.0201697

Harris, B. (2004). Public Health, Nutrition, and the Decline of Mortality: The McKeown Thesis Revisited. *Social History of Medicine - SOC HIST MED*, *17*, 379–407. https://doi.org/10.1093/shm/17.3.379

Horváth, I., & Anghel, R. (2018). *Migration and Its Consequences for Romania*.

INS. (2017). *Proiectarea populaţiei României, în profil teritorial. La orizonul anului 2060*. Editura Insitutului Naţional de Statistică. http://www.insse.ro/cms/en/content/projection-romanian-population-horizon-2060

Kildemoes, H., Christiansen, T., Gyrd-Hansen, D., Kristiansen, I., & Andersen, M. (2006). The impact of population aging on future Danish drug expenditure. *Health Policy (Amsterdam, Netherlands)*, *75*, 298–311. https://doi.org/10.1016/j.healthpol.2005.03.013

Laerd Statistics. (2019). *How to perform a Multiple Regression Analysis in Stata | Laerd Statistics*. https://statistics.laerd.com/stata-tutorials/multiple-regression-using-stata.php

Lago-Peñas, S., Cantarero-Prieto, D., & Blázquez-Fernández, C. (2013). On the relationship between GDP and health care expenditure: A new look -. *Economic Modelling*, *32*, 124–129. https://doi.org/doi.org/10.1016/j.econmod.2013.01.021

Mihai, C. (2016). Dimensions of population ageing in Romania. *Agricultura – Ştiinţă Şi Practică*, *3*, 19–81.

Morris, J. (2010). Human rights and healthcare: Changing the culture. *Age and Ageing*, *39*(5), 525–527. https://doi.org/10.1093/ageing/afq094

Olive, D. J. (2017). *Linear Regression*. Springer.

Rechel, B., Doyle, Y., Grundy, E., & McKee, M. (2009). How can health systems respond to population ageing ? *Health Systems and Policy Analisys*, *10*, 43.

Sanderson, W. C., & Scherbov, S. (2007). A new perspective on population aging. *Demographic Research*, *16*(2), 27–58. https://doi.org/10.4054/DemRes.2007.16.2

Savin, S. (2014). *Cancer Country Profile*. 2.

Shergold, I., Lyons, G., & Hubers, C. (2015). Future mobility in an ageing society – Where are we heading? *Journal of Transport & Health*, *2*(1), 86–94. https://doi.org/10.1016/j.jth.2014.10.005

Simionescu, M., Bilan, S., Gavurova, B., & Bordea, E.-N. (2019). Health Policies in Romania to Reduce the Mortality Caused by Cardiovascular Diseases. *International Journal of Environmental Research and Public Health*, *16*(17), 3080. https://doi.org/10.3390/ijerph16173080

Thalassinos, E., Cristea, M., & Noja, G. G. (2019). Measuring active ageing within the European Union: Implications on economic development. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *14*(4), 591–609. https://doi.org/10.24136/eq.2019.028

Thimbleby, H. (2013). Technology and the Future of Healthcare. *Journal of Public Health Research*, *2*(3). https://doi.org/10.4081/jphr.2013.e28

UCLA. (2019). *Introduction to Regression with SPSS Lesson 2: SPSS Regression Diagnostics*. https://stats.idre.ucla.edu/spss/seminars/introduction-to-regression-with-spss/introreg-lesson2/

Uyanık, G. K., & Güler, N. (2013). A Study on Multiple Linear Regression Analysis. *Procedia - Social and Behavioral Sciences*, *106*, 234–240. https://doi.org/10.1016/j.sbspro.2013.12.027

Vladescu, C., Scîntee, S. G., Olsavszky, V., Hernández-Quevedo, C., & Sagan, A. (2016). *Health Systems in Transition. Romania, Health system review*. *18*(4), 203.

Weil, D. N. (2006). *Population Aging* (Working Paper No. 12147). National Bureau of Economic Research. https://doi.org/10.3386/w12147

Weisberg, S. (2013). *Applied Linear Regression, 4th Edition*. Wiley. https://www.wiley.com/en-us/Applied+Linear+Regression%2C+4th+Edition-p-9781118386088

Weisbrod, B. (1991). The Health Care Quadrilemma: An Essay on Technological Change, Insurance, Quality of Care, and Cost Containment. *Journal of Economic Literature*, *29*, 523–552.

WHO. (2002). *WHO | Active ageing: A policy framework*. http://www.who.int/ageing/publications/active_ageing/en/

WHO (Ed.). (2007). *Global age-friendly cities: A guide*. World Health Organization.

WHO. (2011). *Global Health and Aging* (p. 32). https://www.who.int/ageing/publications/global_health.pdf

WHO. (2019). *WHO | What is Healthy Ageing?* WHO. http://www.who.int/ageing/healthy-ageing/en/

Xu, K., Soucat, A., Kutzin, J., Brindley, C., Maele, N., Toure, H., Garcia, M., Li, D., Barroy, H., Flores, G., Roubal, T., Indikadahena, C., Cherilova, V., & Siroka, A. (2018). *Public Spending on Health: A Closer Look at Global Trends. Geneva: World Health Organization*.

Yan, X., & Su, X. (2009). *Linear regression analysis: Theory and computing*. World Scientific.

ODNOS IZMEĐU STARENJA POPULACIJE I MEDICINSKIH TROŠKOVA U RUMUNIJI

Rezime. Sa skorašnjim razvojem na polju medicine i bržim pristupom medicinskim stručnjacima i negovateljima, uz dodatak boljeg obrazovanja i višeg nivoa highene, dužina života se u Rumuniji stalno povećava, i za muškarce i za žene. Sa medicinske tačke gledišta, ovo je izvanredno postignuće kad se uporedi sa prošlim dekadama kada je očekivani životni vek bio mnogo kraći nego u poslednje vreme. Duži životni vek će automatski, u najvećem broju slučajeva, imati i neželjeni efekat povećane potrošnje na medicinske usluge od strane države da bi se starijima omogućio bolji kvalitet života. Stoga, javni zdravstveni sistem će biti izložen dodatnom pritisku od strane pružalaca zdravstvenih usluga da bi se starijima pružile kvalitetnije usluge. Ovaj rad ima za cilj da istraži nivo uticaja koji godine i prihodi imaju na povećanje medicinskih troškova na per capita nivou. Metoda koja je korišćena u istraživanju do kog nivoa rastući deo starijih i prihoda mogu da objasne povećanje medicinskih troškova je višestruki model linerane regresije. Očekivani rezultati su da procenat starijih osoba raste u populaciji Rumunije i slično tome, kako prihod na per capita nivou raste, javiće se i vidno povećanje u medicinskim troškovima per capita.

Ključne reči: *starenje popuilacije, opadanje populacije, demografska tranzicija, zdravstveni troškovi, višestruka linearna regresija.*

Review Paper

INFORMATIONAL SCOPES AND THE AREA OF APPLICATION OF THE EQUITY METHOD

UDC 658.14

Vojislav Sekerez

University of Belgrade, Faculty of Economics, Serbia

Abstract. *The equity investments in other entities may result in different level of control over their activities and different consequential relationships between the investors and investees. For the purposes of valuation of the investments in associates and joint ventures, which are followed by significant influence or joint control of the investor, it is necessary to use the equity method. Its application is connected with the number of specific issues that result in a completely different accounting treatment of some business transactions in relation to the acquisition method and consolidation of subsidiaries. The aim of this paper is to analyze the key features and area of application of the equity method, which will be accompanied by the reference to some of its most obvious advantages and disadvantages.*

Key words: *significant influence, joint control, equity method, consolidated financial statements, separate financial statement.*

INTRODUCTION

The development of modern capital markets leads to a growing number of transactions that result in significant equity investments in other companies. Investors decide to make such investments for various reasons, so the nature of relations established and intensity of control over the investees will be determined not only by the ownership level, but also by a number of other specific factors. Accounting treatment and valuation of these investments will primarily depend on whether they have resulted in absolute, significant, joint or common control over the investee's activities. Majority equity investments, which are

---

followed by the control over the subsidiaries, need to be consolidated with the use of the acquisition method.On the other hand, the equity method needs to be used to account for investments in the associates and joint ventures, which are accompanied by the investor's significant influence or joint control. Finally, minority equity investments that are not followed by significant influence of the investor (ownership interest is usually between 10% and 20%), should be valued in accordance with IFRS 9 – Financial instruments. Therefore, different levels of control and different consequential relations between the investor and investees require a different ways of accounting for investment.

The fact that the equity method is widely used in practice, which is accompanied by a specific treatment of certain business transactions during the valuation of investments, imposes the need for a detailed analysis of its features and informational scopes. Research in this paper will be focused on the basic characteristics and the way of functioning of the equity method, with special reference to the comparative analysis of differences in accounting treatment of the most important aspects of investments' valuation, those occurring from the application of equity method and acquisition method. Since the percentage of ownership interest (as a financial criterion) serves only as a starting point for determining whether there is a significant influence or joint control of the investor, in this article a detailed analysis of the key prerequisites for the implementation of the equity method will be made. Also, a reference will be made to a significant expansion of the area of application of the equity method, which occurred in the last few years due to changes in professional regulation. Finally, at the end of the paper, some of the most significant weaknesses and shortcomings of the equity method that have been noticed in practice during its application will be presented.

1. PREREQUISITES FOR THE APPLICATION OF THE EQUITY METHOD

The equity investments in other companies can be made with different motives and in a wide range of percentage share in equity of investees. From a financial reporting angle, its percentage share represents only a starting point for determining the nature of investment and appropriate accounting method for their valuation. This means that it is necessary to take a broader approach when determining the nature of the relationship between investor and investee, in order to supplement the initial information on the percentage of ownership interest with a clear insight in the intensity of control that is actually achieved. The point is that the intensity of control (significant or absolute) and the resulting investor-investee relationship will crucially determine further accounting treatment and the way of investment's valuation. In that sense, a framework for ranking equity investments according to the percentage share has been established in accounting regulations and practice, which should provide a starting point for determining the degree of control over the investees.

According to the financial criterion shown in Table 1, investments in range from 20 to 50% of voting rights are considered as significant ownership interests and they are the initial basis for applying the equity method, but under the condition that they allow significant influence over the associate or joint control over the joint venture. Starting with the assumption that significant equity investment in most cases should allow the significant control for investor, IAS 28 - Investments in associates and joint ventures in

paragrapf 16 additionally emphasizes that exercising significant influence or having joint control is the primary criterion to be fulfilled in order to apply the equity method. This means that the significant equity investment is only the starting point for exercising significant influence, because it, by itself, is not enough since the investor must demonstrate this possibility in practice. The same standard says that "significant influence is the power to participate in the financial and operating policy decisions of the investee but is not control or joint control of those policies" (IAS 28, 2011, par.3). Thus, having more than 20% of the voting rights of investee suggests that there is significant influence, unless it can be clearly demonstrated that this is not the case. Similarly, having less than 20% of the voting rights initially implies that there is no significant influence, unless the existence of such influence can be clearly demonstrated.

Table 1 Financial criterion for accounting treatment of equity investments

Type of equity investment	Ownership level	Control level	Applicable accounting method
Common	10-20%	Absence of significant influence	Cost method (initially) and fair value
Significant	20-50%	Significant influence	Equity method
Majority	More than 50%	Control	Consolidation (acquisition method)

Source: Hoyle, J.B., Schaefer, T. F, & Doupnik, T.S. (2011). Advanced Accounting. 10th edition, New York: McGraw-Hill/Irwin, p. 6. (table was modified by author)

Therefore, having a significant ownership interest in practice does not guarantee the exercise of significant influence, nor does having a majority ownership interest of more than 50% of voting rights always guarantee the control over an entity. IAS 28 in paragraph 6 offers a list of criteria whose fulfillment may indicate that there is significant influence. None of them should be used solely, as a basis for conclusion, but should be viewed simultaneously to determine the investor's ability to exercise significant influence over the investee. These criteria are: representation on the board of directors or equivalent governing body of the investee; participation in policy-making processes (including participation in decisions about dividends); significant transactions between the entity and its investee; interchange of managerial personnel and provision of essential technical information (IAS 28, 2011). It is interesting to say that, within FASB ASC 323, the above criteria are joined by one additional: extent of ownership by the investor in relation to the size and concentration of other ownership interests in the investee (Hoyle, 2010).

It is noticeable that the ability to exert significant influence, as a primary criterion for the application of the equity method, is obviously very broadly and vaguely defined, which opens the room for subjective judgment and free interpretations in practice. The range of 20-50% of voting rights has been pretty much arbitrarily established, merely to provide clear and consistent guidance for financial reporting purposes. However, the investor's ability to exercise significant influence, which should be the consequence of the significant ownership interest, often does not exist in practice. Therefore, if the ability to exercise significant control is not manifested or, oppositely, if there is control over the investee, equity method should not be applied, regardless of the fulfillment of the initial financial criterion that voting rights are in range between 20% and 50%. For example, the equity method should not be applied (regardless of the fulfillment of the initial financial criterion) in situation when an agreement between investor and investe requires suspension

of investor's significant influence or when investor fails in attempts to obtain representation on the investee's board of directors of (Hoyle, 2010).

In the examples above, the investor should treat his ownership interest as common and use the fair value for its further valuation, in accordance with IFRS 9 - Financial instruments. In contrast, in situations where an investor with 50% or less of voting rights is capable of establishing control over its investee, it is necessary to apply the acquisition method instead of the equity method and to consolidate controlled entity. In such situations, control is achieved through contractual and other arrangements that specify decision making power. Therefore, some companies (Walt Disney Company, for example) have been required to reclassify their former equity method investees as so called variable entity investees and to consolidate them.

Contrary to the examples above, which limited the application of the equity method, despite the fact that investors held 20-50% of voting rights, there are also situations where applying the equity method is necessary, even though investors own less than 20% or more than 50% of voting rights in investee. For example, AT&T, Inc. used the equity method to account for its 9% equity investment in America Movil, a wireless provider in Mexico. This is explained by the fact that AT&T is a member of the consortium that holds voting control of the America Movil, providing it with significant influence. The other extreme, which also makes it possible to apply the equity method, is a situation where investor owns majority ownership interest, but the veto power of minority shareholders prevents him from exercising control over that company. Similarly, the lack of control can also occur in situations where the majority owner agrees to share management and control with another investor (Hoyle, 2010).

Hence, the arbitrariness of the starting financial criterion of 20-50% of voting rights imposes the need for a broader approach when determining the existence of investor's significant influence, which is additionally aggravated by the lack of clarity and precision of the supplementary criteria, offered by the IAS 28 or ASC 323. The previous discussion suggests that the determination of the existence of significant influence is followed by a number of case-specific characteristics and may be accompanied by a high dose of subjectivity.

Finally, it is important to say that, due to the lack of space, in this place we will not go into more detail on the concept of joint control, whose existence is a crucial criterion for the application of the equity method in the case of joint venture investments. It should be only emphasized that determining whether an investor engages in joint control brings with it no less difficulties compared to determining the existence of significant influence over the associates. The problem of defining the concept of joint control is addressed by the IFRS 11 – Joint arrangements, which emphasizes that "joint control is the contractually agreed sharing of control of an arrangement, which exists only when decisions about the relevant activities require the unanimous consent of the parties sharing control" (IFRS 11, 2011, par. 7). Accordingly, in a joint arrangement, no single party controls the arrangement on its own, but all the parties (or a group of the parties) control the arrangement collectively by acting together to direct the relevant activities that significantly affect the variable returns of the arrangement. In the case of joint ventures (as a type of joint arrangements which is different from joint operations according to IFRS 11), joint control allows parties' rights to the entity's net assets and obliges them to use the equity method (Leitner-Hanetseder et al., 2014).

2. BASIC CHARACTERISTICS OF THE EQUITY METHOD

As we have previously emphasized, the investor makes a significant ownership interest when owning 20-50% of shares in the investee's equity, which is often the basis for exercising significant influence over its business. For the purpose of counting for investments in associates or joint ventures, over which the investor exercises significant influence or joint control, it is necessary to use the equity method, according to IAS 28. It is the accounting method whereby the investment is initially recognized at cost and adjusted after the acquisition date for the changes in the investor's share of the net assets of the investee (IAS 28, 2011 par.3). As a consequence, the investor's profit and loss statement will include the related share of the profit or loss of the investee, and its other comprehensive income includes its share of the other comprehensive income of the investee. In contrast, an acquisition method is used for accounting for majority ownership interests (that allow parent's control over a subsidiary) and reporting on them in the consolidated financial statements. Accordingly, different levels of control and resulting relationships between investors and investees require the application of different accounting methods for equity investments' valuation and consolidation.

The initial recognition is only the first step in applying the equity method and it is carried out in the amount of the cost of the acquired equity share. This means that, unlike the majority ownership interests, which are initially measured at fair value, the costs of significant ownership interests also include any transaction costs that are associated with the acquisition (stock exchange fees, costs of legal and other services etc.). In anticipation of above average returns, when buying an equity share, investor may decide to pay more than the share of the net fair value of the identifiable assets and liabilities of associate or joint venture. This difference between the higher acquisition costs and the lower fair value of the related portion of the investee's net assets represents goodwill, which is included in the carrying amount of the investment (as its integral part) within investor's Statement of financial position. Therefore, goodwill is not disclosed separately, as it is the case when acquiring subsidiaries, and not tested for impairment, but subject of that test is investment as a whole. On the other hand, if the carrying amount of the investment is lower than the related portion of the fair value of the investee's net assets (a lower amount is paid), the investor on that occasion made an income, which should be disclosed in its Statement of comprehensive income (Škarić-Jovanović, 2014).

The essential idea underlying the equity method is that the subsequent investment's valuation should present the close relationship that has been established between the investor and investee, as a result of significant or joint control. Therefore, in accordance with this method, the value of equity investment is constantly changing in line with the changes in net assets of investee, so it can always reflect the associated portion of investee's net assets in the investor's Statement of financial position. These changes are most often caused by: the subsequent investment or withdrawal of a portion of the investor's ownership interest, the profit or loss of the investee or changes in the fair value of the investee's assets. Consequently, through the changes in the value of its equity investment, the investor actually bears full responsibility for the results of associates or joint ventures, given that it exercises a significant influence on their business.

In this regard, the subsequent equity investment in associates or joint ventures increases their net assets and, therefore, the amount of investor's participation, regardless of whether

there will be a change in the percentage of ownership interest. If a subsequent investment turns significant ownership interest into a majority interest, the investor should discontinue the use of equity method and the accounting for the investment is further carried out in accordance with IFRS 3 - Business combinations and IFRS 10 - Consolidated financial statements. On the other hand, reduction of ownership interest in the associates or joint ventures, whereby the investor retains significant influence and continues to use the equity method, implies that it should reclassify to profit and loss statement the proportion of the gain or loss that had previously been recognised in other comprehensive income, relating to that reduction in ownership interest (IAS 28, 2011, par.25). The application of the equity method should be also discontinued if the investor sells part of its ownership interest, whereby the retained remaining interest does not allow exercising significant influence over the investee, that is, when the investee ceases to be an associate or joint venture. If the retained ownership interest is a financial asset, it should be measured at the fair value, in accordance with IFRS 9 - Financial instruments (IAS 28, 2011, par.22).

As we have noted above, the associated portion of the investee's profit should be recognized as revenue from investment in the investor's Statement of comprehensive income, while the value of the equity investment also increases by the same amount in the Statement of financial position. This amount is derived by applying a percentage of the ownership interest to investee's profit after taxation. In the case that an associate or joint venture incurs a loss, the investor's participation would be proportionally impaired. This approach of investment's valuation fully reflects the basic idea of the equity method and it is one of the key differences with respect to the acquisition method, where only a portion of the subsidiary's profit (dividend paid) is recognized as income from the parent's participation. IAS 28 in paragraph 11 emphasizes that revenue recognition, based on the distribution of investee's profit (as with the acquisition method), does not have to be an adequate measure of income earned by an investor, because the dividend distribution policy itself often has little to do with the performance of investees. Therefore, it is considered that the application of the equity method offers more useful and relevant information on the real value of investments, net assets and profit or loss of investor (IAS 28, 2011). In this regard, it is important to emphasize that the equity method and the acquisition method differ not only in determining the amount of investor revenues, but also in the moment of their recognition. Namely, the equity method implies that the related investor's revenue is recognized in the same accounting period in which the profit of the investee was earned, while the acquisition method requires that the parent's revenues (dividend income) be recognized and reported only in the following year relative to the year in which the distributed profit of subsidiary was earned (Škarić-Jovanović, 2014).

Hence, unlike the accounting treatment of dividend with parent companies, which is recognized as investment's income in the amount charged, the equity method requires that the value of the investor's participation should be reduced by amount of the dividend received. This is completely in line with the basic idea of the equity method that any change in the amount of the investee's net assets simultaneously changes the amount of the related investor's proportionate interest. Given that dividends paid reduce the investee's net assets, it is correct to reduce the amount of investors participation by amount of received dividend. In addition, the investor has previously already recognised income and increased the amount of its investment by the related part of the investee's profit (of which dividends are an integral part), so treating the dividend as income would double them. Therefore, according to the

equity method, dividends are not income, but the conversion of part of the equity investment in cash (Hoyle et al., 2011).

The amount of the net assets of an associate or joint venture may also change in situations where the fair value of certain items of their assets changes (IAS 28, 2011, par.10). In such cases, achieved unrealized gains/losses are recognized in the investee's other comprehensive income, as a component of equity. Considering the fact that in the spirit of the equity method, the investor participates not only in the investee's profit or loss, but also in its other comprehensive income, these changes in the amount of the investee's net assets consequently change the amount of the investor's participation. Accordingly, in the case of unrealized gains on the change in the fair value of the investee's assets, both the amount of investor's share and its other comprehensive income increases proportionately. On the other hand, the proportionate portion of unrealized losses (in the case of a decrease in the fair value of the investee's assets) will simultaneously reduce the amount of the investor's interest and its other comprehensive income (Škarić-Jovanović, 2014).

Finally, another reason for the subsequent decrease in the amount of equity investment are the internal gains/losses that arise as a result of making deliveries or providing services between the investor and its associates or joint ventures. According to the equity method, these internal results are treated as unrealized, because the investor and investee are viewed as a single entity. The recognition of the mentioned results is deferred in the investors' financial statements until their external realization to third parties. Therefore, at the time of preparation of the financial statements, the investor simultaneously reduces the amount of its investment and the amount of the investment's income for the part of that unrealized profit, which is proportional to its ownership interest. In contrast, the existence of unrealized losses would entail a simultaneous increase in the amount of the investor's participation and its income for the related part of loss (Škarić-Jovanović, 2015).

It is important to emphasize that the internal results are viewed from the perspective of investee, as they are presented in full in its individual financial statements, without the need for elimination. At the same time, they affect the amount of disclosed result, as a basis for subsequent adjustment of investor's participation. Therefore, the internal profit will occur when the investee makes a delivery (or provide service) to the investitor with gain (uprstream transaction), or when the investor makes a delivery to the investee with loss (downstream transaction), because then the assets were purchased at a price below their costs and the investee's income was unjustifiably increased by this amount of internal profit. In the case of internal losses, the mentioned transactions will proceed in the opposite direction and with opposite effects. Therefore, starting from the fiction that investor and investee are one single entity, the internal results must be eliminated when calculating the amount of equity investment and income from it in investor's financial statements. Also, the fiction of a single entity and the resulting need for elimination of internal results is very close to the principles of the full consolidation of parent company and subsidiaries, whereby the acquisition method is used. However, despite the similarity noted above, there is also another important difference between the equity and the acquisition method. Namely, the application of the equity method does not require complete consolidation of assets, liabilities, equity, revenues and expenses, as is the case with the acquisition method, so internal results are not eliminated from the value of inventories (which are not an object of consolidation), but the investor's participation is adjusted for their amount.

It should be noted that entities that are exempt from the obligation to prepare consolidated financial statements (in accordance with IFRS 10) are not required to apply the equity method. This method, also, does not have to be applied when all of the following factors are present:

- The entity is a wholly or partially-owned subsidiary of some other entity, and its other owners (including those without voting rights) are informed about it and do not object that equity method is not applied;
- The entity's debt or equity instruments are not traded in a public market;
- The entity did not fill its financial statements with a securities commission, with the aim of issuing debt or equity instruments in a public market;
- The ultimate or any intermediate entity's parent company already prepares public financial statements that comply with IFRS (IAS 28, 2011, par. 17).

3. EXPANDING THE SCOPE OF APPLICATION OF THE EQUITY METHOD

In recent years, certain changes in professional regulation have led to a significant expansion of the scope of application of the equity method. Namely, the IASB (*International Accounting Standards Board)* has decided that this method, after several years of pause, can be used again from 2016 as one of the options for equity investments' valuation in separate financial statements. It is important to say that the separate financial statements are individual reports prepared by the parent companies and investors (with joint control or significant influence over the investees), primarily with the purpose of disclosing the value of their investments in the equity of these entities. IAS 27 – Separate financial statements, in this respect, explicitly emphasizes that the financial statements of entities that do not have investments in subsidiaries, associates or joint ventures are not separate financial statements (IAS 27, 2011, par. 7). This means that holding the majority and significant ownership interests in other companies, followed by the absolute or significant control over their businesses, is a prerequisite for the preparation of separate financial statements. On the other hand, entities that are exempted from the obligation to prepare consolidated financial statements (in accordance with IFRS 10) and entities that are exempted from the obligation to use the equity method (in accordance with IAS 28), can prepare separate, as their only financial statements. Consequently, we may conclude that IAS 27 does not prescribe which entities are required to prepare separate financial statements, but they are prepared when the parent companies and investors voluntarily opt for it or when they have such an obligation in accordance with national regulations. Therefore, separate financial statements are reports that *can* (but, also, don't have to) be prepared together with consolidated or financial statements of investors applying the equity method. Otherwise, it should be said that the financial statements of investors in associates and joint ventures are not considered as a consolidated financial statements in the strict sense, because there is no complete consolidation of assets and liabilities (only equity investments are consolidated).

Therefore, although in a broad sense separate financial statements belong to the category of individual financial statements, the specific requirements of their users make it essential to differentiate them substantially from all other individual financial statements, prepared by the entities that do not have majority or significant ownership interests. It is important to emphasize that the growing importance of consolidated financial statements in the conditions of internationalization of business does not diminish the need for the publication of individual

or separate financial statements of companies, which are the holders of majority and significant investments in the equity of other entities. Separate financial statements of parent companies and investors primarily serve as a means of protecting the interests of users, such as owners, creditors and government bodies, which in this field often make more specific information requirements than what they expect from the consolidated financial statements. This fact has initiated the IASB to publish a particular standard - IAS 27, which explicitly addresses the issues of their preparation and presentation.

In this respect, after the revision of IAS 27 - Consolidated and separate financial statements and IAS 28 - Investments in associates in 2003, the equity method has been eliminated as a tool for valuation of investments in subsidiaries, associates and joint ventures within the separate financial statements, although it had been used for many years as one of the options for the purposes mentioned. At that point, companies were given the opportunity to use the cost or fair value (in accordance with IAS 39 – Financial instruments: reconition and measurement) for all investments in subsidiaries, associates and jointly controlled entities included in the separate financial statements. The IASB explained this decision by saying that the information provided by the equity method is reflected in consolidated and other financial statements of investors (especially where IAS 28 was applied), and that there is no need to provide the same information in the separate financial statements.

However, it turned out that such a decision, which was nominally motivated by a reduction in the number of options under IFRS and increased comparability of financial statements, had the opposite effect in practice. Specifically, in a number of countries, local regulators require listed companies to prepare separate financial statements and, on that occasion, use the equity method for valuation purposes. As a result, incomparability emerged, because the only difference between the financial statements prepared in accordance with national rules the financial statements prepared in accordance with IFRS was in (non) use of equity method. It turned out that this was a strong enough argument for returning the equity method to the set of allowable tools for the valuation of equity investments in separate financial statements, so in May 2012 the IASB decided to launch an initiative in this field (IASB, 2013). A draft proposal was issued in December 2013, and after discussions and opinions collected, an amendment to IAS 27 was issued in August 2014. This amendment permits that the equity method can be used again (as regulated by IAS 28) for the purposes of accounting for investments in subsidiaries, associates and joint ventures when preparing separate financial statements. After this decision, the companies had a choice between equity method, cost and fair value (in accordance with IFRS 39 – Financial instruments) for the purpose of valuation of the equity investments, but once selected option had to be consistently applied to all categories of equity investments. The effective implementation of this decision began on January 1st 2016, with early adoption permitted. Also, the IASB has ordered retroactive application of the equity method for all accounting periods from the date of acquisition, which undoubtedly increases the complexity and costs of financial statements' preparation.

It should be noted that, during this process, EFRAG (*European Financial Reporting Advisory Group*) was not opposed to returning the equity method to a set of permitted techniques for accounting for investments within separate financial statements, although it increases the number of options in IFRS and potentially reduces the comparability of financial information. EFRAG explained this by the fact that the equity method offers a relevant and useful information on the economic value of investor's net assets and profit

or loss in its separate financial statements. This attitude is in line with the opinion of the IASB that "information may be relevant even if some users are already aware of it from other sources. Consequently, the fact that equity method provides information that is already reflected in consolidated financial statements does not mean that it would not provide relevant information" (IASB, 2013, par. BC8). However, while considering changes to IAS 27, EFRAG expressed concern that full retrospective application would increase the complexity and costs of preparing the financial statements for entities that opt to use the equity method to account for subsidiaries in their separate financial statements. In addition, EFRAG also considered that the IASB had not provided a sufficiently clear explanation for the treatment of differences that occur between the value of majority ownership interests in the consolidated and separate financial statements of parent companies that opt to use the equity method. These differences arise from the different accounting treatment that the equity method and the acquisition method have for transactions such as: costs of acquisition, impairment of goodwill, distribution of dividends, elimination of intercompany gains and losses etc., so EFRAG conluded that the IASB in this regard should offer an additional guidance within IAS 28 (EFRAG, 2014a).

Nevertheless, in its final report, EFRAG surprisingly softened its position and accepted all the proposed amendments to IAS 27, stating that the differences between separate and consolidated financial statements are understandable to users as consolidated and separate financial statements reflect totally different views – the view of group and the view of an individual entity. EFRAG finally considered that "following the methodology given by IAS 28 as applicable to an associate or a joint venture to account for subsidiaries in separate financial statements will not add undue complexity to the extent that it may impair reliability" (EFRAG, 2014a, p.7). Also, costs for preparers and users, incurred on that occasion, are one-off costs, which should not be significant, given the fact that application of equity method is optional. Ultimetely, the decision to make the transition to the equity method will be based on expected benefits that will arise from that change.

Finally, in addition to the possibility of using the equity method for the preparation of separate financial statements, the expansion of scope of its application was also influenced by the he adoption of IFRS 11 - Joint arrangements, which have replaced the old IAS 31 - Investments in Joint ventures since January 1st 2013. On that occasion, the equity method has replaced the proportional consolidation method for the purpose of accounting for investments in joint ventures, which also significantly increased the number of its users. This decision of the IASB was motivated primarily by reducing the number of options in standards to increase comparability with US GAAP (Ašenbrenová, 2016). Also, it should be noted that this change has caused numerous reactions in the academic and professional community. Analysis of the pros and cons of eliminating the proportional consolidation method and its effects on the practice of financial reporting and the quality of information has been performed by Demerens et al., (2014) and So et al., (2018).

4. DISADVANTAGES OF THE EQUITY METHOD

Notwithstanding the widespread use of the equity method and its positive characteristics, primarily in the domain of providing relevant and useful information on the real economic value of equity investments, this method also exhibits certain shortcomings in practice, which will be briefly highlighted here. The first of them refers to the *absence of clear and*

firm criteria for determining the existence of investor's significant influence, as a major prerequisite for the application of the equity method. Although in accounting regulations an attempt has been made to correct this deficiency by offering a clear range of 20-50% of the voting rights, as a framework for demonstrating investor's significant influence, this financial criterion is only the starting point for determining the significant influence, whose existence is conditioned by the specific circumstances and characteristics of the particular investment. Thus, in practice, situations may arise where the investor who owns 50% of voting rights fails to exercise significant influence over the investee and does not have to apply the equity method. Oppositely, the second investor, who also owns 50% of voting rights, may exercise control on a contractual basis and, thus, become a parent company, which also precludes the application of the equity method. Finally, the third investor may make a significant influence with 50% of ownership interest in the investee (which is the most common case in practice) and therefore be obliged to use the equity method. So, hypothetically, three different investors, with identical ownership interest of 50%, may have three different levels of control over their investees and apply three different methods to account for their investments.

In the first part of this paper we have emphasized that the collection of evidence of the presence of significant influence should be based on the guidance, provided by the IAS 28 and FASB ASC 323, which opens the door for subjective judgment and, in some situations, manipulations in financial reporting. In this regard, many companies have developed the ways to control other entities, despite the fact that their equity participation is 50% and below. Such a way of acquiring control is supported by a variety of contractual arrangements, which limit one firm's ability to act without the approval of another, or which concern membership of the board of directors. Consequently, an entity may avoid consolidation of financial statements with explanation that control technically does not exist, because the participation is lower than 51% (Hoyle, 2010).

Another disadvantage of the equity method is the fact that *it allows and encourages off-balance sheet financing,* because its implementation does not entail full acquisition and consolidation of the assets, liabilities, revenues, expenses and capital of associates and joint ventures. Investors' financial statements only show the amount of the equity investment and the revenue it brings, while the value of that investment is affected only by changes in the net assets of the investee. The fact that investors, those using the equity method, do not show liabilities and assets of associates and joint ventures leads to a non-transparency and creates conditions for possible misuse of financial reporting. Above all, this can motivate companies to manipulate the concept of control and value certain investments using the equity method, rather than to carry out their full consolidation, because it will cover inefficient investments and all the risks involved. In support of this, let us just remember the negative example of company Enron regarding to hiding enormous amounts of investee's debts in its consolidated financial statements.

Non-disclosure of assets and liabilities of investees, those resulting from the application of the equity method, raises a justifiable question whether the investor should be responsible only for the acquired portion of net assets or should his responsibility also refer to all assets and liabilities of investees. Users of investors' financial statements are thus abridged for valuable information that would allow them to more realistically view the risks associated with investing in such entities. The best example of this lack of equity method is the practice of the company Coca-Cola, which in one period structured many of its investments in

companies at just below a 50% of ownership level, following the strict rule that if ownership is 50% or less, control technically does not exist, that is consolidation should be based only on financial control. It allowed Coca-Cola to legally avoid consolidation of these entities, despite the fact that it had control over majority of them (Hsu et al., 2015). Also, avoiding the involvement of some entities in the consolidation cycle and the consequent application of the equity method allows companies to eliminate unrealized gains (resulting from intercompany transactions) only in proportion to the ownership interest, while in the case of consolidation, they would be eliminated completely. This suggests that the equity method encourages an increase in the volume of intercompany transactions that are followed by unrealistically high profits, behind which (especially in the case of multinational companies) can be the pursuit of tax savings and manipulation.[2]

Therefore, not including the investee's assets and liabilities in the financial statements of investors opens the possibility of off-balance sheet financing, which is followed by the presentation of a lower level of indebtedness, higher rates of return for assets and sales and higher earnings per share. Hence, the application of the equity method requires additional information about assets, liabilities, revenues, expenses and income of associates and joint ventures to be presented in notes of financial statements. An adequate providing of this additional information (that missing in the main body of financial statements), in some respects may be even an advantage of the equity method, because that kind of information cannot be identified separately in the case of consolidation. This should allow users of financial statements to obtain all relevant information and recognize all financial risks associated with off-balance sheet financing. But, regardless of the level and quality of these additional disclosures, in practice managers are generally motivated to apply the equity method, because the realization of various contractual arrangements, such as managerial compensations, is based primarily on the ratio indicators from the official financial statements (Hoyle, 2010).

The last important weakness of the equity method is its *negative impact on investor's cash flows and liquidity*, because the revenues from the investment are only partially accompanied by the cash inflows from dividends. Therefore, the investor's cash inflows will be lower than his revenues exactly for the portion of the investee's profit that has been retained and not distributed through dividends. In addition, higher revenue from investment, recognized in the amount of the part of investee's profit that is commensurate with equity participation, and not in the amount of the dividend paid (as with the acquisition method), increasing investor's profit, as a basis for taxation and distribution, which additionally threatens its liquidity (Škarić-Jovanović, 2014).

---

[2] It should be noted that the risks associated with covering up unsuccessful investments and poor financial performances in the consolidated financial statements are reduced by broadening and more comprehensively defining the control concept in accounting regulation (as it is done under IFRS 10, for example). This allows consolidation of entities in which investor's ownership interests is 50% or less, but over which there is an effective investor's control. At the same time, it creates barriers for firms which attempt to use a simple ownership rule to avoid consolidation.

Conclusion

Equity investments in other entities result in different levels of control of the investor over the investees. Accounting treatment of these investmens will primarily depend on whether on that occasion investor achieves absolute, significant, joint or common control. The equity method is used to account for investments in associates and joint ventures, over whose business the investor exercises significant influence or joint control. In determining whether there is a significant influence, as a primary criterion for applying the equity method, acquired voting rights in the range of 20-50% represent only a starting point. It needs to be supplemented by an analysis of other criteria, whose fulfillment proves that the investor exerts a significant influence over the investee. The lack of clarity of these criteria in practice often opens the door for subjective judgement and abuses in financial reporting. It is most often caused by management's intention to demonstrate more successful company performances and carried out by manipulating the concept of control and avoiding consolidation of subsidiaries.

The application of the equity method results in a different accounting treatment of certain business transactions with respect to their treatment when the acquisition method is applied under the consolidation of subsidiaries. Examples of these differences, that significantly affect the investor's financial performance, are different treatment of: impairment of goodwill, distribution of dividends, costs of acquisition, elimination of intercompany profits and losses etc. After the analysis of the information scopes of the equity method, we can conclude that it allows a close relationship between the value of equity investment and the net assets of investee, which results in providing of relevant information about the real economic value of the investor's assets. It is likely that these informational qualities of the equity method have led to a significant expansion of its scope in recent years, primarily within the separate financial statements and valuation of joint venture investments.

However, the application of the equity method in practice also manifests certain serious shortcomings, which are often emphasized by representatives of the academic and professional public. Namely, non-inclusion of investee's assets and liabilities in the investor's financial statements opens the possibility of off-balance sheet financing and presentation of a lower level of indebtedness. Consequently, the users of the financial statements are deprived of information that could allow them to more realistically consider all the risks associated with investing in a particular entity. Also, the application of the equity method has a negative effect on investor's cash flows, since the revenue from investment is only partially accompanied by the cash inflows from dividends received.

References

Ašenbrenová, P. (2016). Disclosure of Joint Ventures and Associates in Financial Statement under IFRS. *European Financial and Accounting Journal, 11*(3), 85-94.

Demerens, F., Le Manh, A., Delvaille, P., & Pare, J. L. (2014). An ex ante analysis of change in reporting methods: the example of Joint Ventures. *Gestion 2000*, *31*(4), 65-89. doi:10.3917/g2000.314.0065

EFRAG. (2014*). Comment Letter - Equity Method in Separate Financial Statements ED/2013/10,* Retrieved from: https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FProject%20Documents%2F30 1%2FEFRAG%20Comment%20Letter%20-20Equity%20Method%20in%20Separate%20Financial%20 Statements%20ED%202013%2010.pdf, Accessed on: 11 November 2019.

EFRAG. (2014a). *Final Endorsement Advice on IAS 27 - Equity Method in Separate Financial Statements*. Retrieved from: https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing% 2FLists%2_FProject%20News%2FAttachments%2F215%2FAmendments_to_IAS_27_EFRAG__Letter_to_the_ EC.pdf, Accessed on: 13 November 2019.

Hoyle, J.B., Schaefer, T. F, & Doupnik, T. S. (2011). *Advanced Accounting*. 10th edition, New York: McGraw-Hill/Irwin

Hsu, A. W., Boochun, J., & Pourjalali, H. (2015). Does International Accounting Standard No. 27 Improve Investment Efficiency?. *Journal of Accounting, Auditing & Finance*, *30*(4), 484- 508.

IASB. (2013). *Exposure Draft: Equity Method in Separate Financial Statements,* ED/2013/10. London: IFRS Foundation.

IASB. (2011). *IAS 27 – Separate financial statements*. London: IFRS Foundation

IASB. (2011). *IAS 28 – Investments in associates and joint arrangements*. London: IFRS Foundation

IASB. (2011). *IFRS 11 – Joint arrangements.* London: IFRS Foundation

Leitner-Hanetseder, S., & Stockinger, M. (2014). How does the elimination of the proportionate consolidation method for joint venture investments influence European companies? *ACRN Journal of Finance and Risk Perspectives, 3*(1), 1-18.

So, S., Wang, K. S., Zhang, F., & Zhang, X. (2018). Value relevance of proportionate consolidation versus the equity method: Evidence from Hong Kong. *China Journal of AccountingResearch, 11*(4), 255-278. https://doi.org/10.1016/j.cjar.2018.06.002

Škarić-Jovanović. K. (2014). Uticaj primene metode udela na performanse investitora [Impact of the equity method's application on investor's performances]. *Acta economica*, *XII/20*, 59-75.

Škarić-Jovanović. K. (2015). Zajednički aranžmani – računovodstveni i izveštajni aspect [Joint arrangements – accounting and reporting aspect]. *Finrar*, *07/15*, 4-15.

INFORMACIONI DOMETI I DELOKRUG PRIMENE METODE UDELA

Ulaganja u kapital drugih preduzeća mogu da rezultiraju različitim intenzitetom kontrole nad njihovim poslovanjem i različitim proizilazećim odnosima između investitora i entiteta u koji je investirano. Za potrebe vrednovanja učešća u kapitalu pridruženih preduzeća i zajedničkih poduhvata, koja su praćena značajnim uticajem ili zajedničkom kontrolom investitora, koristi se metoda udela. Njenu primenu prati niz specifičnosti, koje rezultiraju potpuno drugačijim računovodstvenim tretmanom određenih poslovnih transakcija u odnosu na njihov tretman kada se primenjuje metoda sticanja i vrši puno konsolidovanje zavisnih entiteta. Cilj ovog rada se sastoji u analizi ključnih karakteristika i područja primene metode udela, što će biti praćeno posebnim osvrtom na neke od njenih najuočljivijih prednosti i nedostataka.

Ključne reči: *značajan uticaj, zajednička kontrola, metoda udela, konsolidovani finansijski izveštaji, separatni finansijski izveštaji.*

Review Paper

COMPARATIVE ANALYSIS OF PPP PROJECTS SECTORAL STRUCTURE IN DEVELOPED AND DEVELOPING COUNTRIES

UDC 005.8:352.07
658.114.2

Aleksandar Đorđević[1], Biljana Rakić[2]

[1]University of Niš, Innovation Center, Serbia
[2]University of Niš, Faculty of Economics, Serbia

Abstract. *This paper aims to compare the type of public-private partnership (PPP) projects and their sectoral structure in developed and developing countries. This will be done through a comparative analysis of eight countries that belong to the categories of developed and developing countries and besides that implement numerous PPP projects. The results of the analysis indicate that developed countries chosen for this analysis implement more projects and record a higher total value of projects. Their projects are more diversified and apart from economic infrastructure encompass social infrastructure, which does have a higher number of projects, and in some developed countries higher value than economic infrastructure sectors. There is some overlapping between the groups and the sectors as this is not a strict rule that could be applied to all the countries, as each economy is an individual and specific case. As adequate PPP structure leads to economic growth and prosperity of the national economy, it is recommended to adjust the institutional framework, laws and regulations for PPP, attract more private capital, develop basic economic infrastructure and with its help attempt to converge the PPP project structure of developing countries to that of developed countries. The final goal is to have well developed economic infrastructure and then invest more in social infrastructure projects that can affect the wellbeing of all residents in an economy.*

Key words: *public-private partnership, sectoral structure, developed countries, developing countries*

1. INTRODUCTION

Throughout the history developed countries have always tried not only to hold their position and not allow undeveloped and developing countries to get close to them, but they even worked on widening the gap between the level of economic development between them. The behaviour is not much different concerning the public-private partnership (PPP). The first ones to adopt the concept were the most developed countries as it first appeared in the UK, France and USA. Initially they were implemented in sectors of infrastructure, more specifically for building toll roads and bridges. There are some assumptions that even old Romans have assigned some road concessions to the Salasi tribe for maintenance of a road through a mountain range, obliging them to keep the passage clean and secure the signs for it. (Grimsey & Lewis, 2004). Afterwards, a "Turnpike system" for toll roads was used in the UK and USA, a subway was built in London from the year 1894 to 1907. In France, the main type of PPP was concession development. Many channels and roads have been built under this model. In recent history, public-private partnership started its wider implementation in the 1990s, mostly in the already developed countries. Western European countries, as well as the United States of America, were some of the biggest beneficiaries of the newly adopted concept followed by developing countries in the BRICS area. Regarding the structure, it was mainly used in infrastructure projects, building roads, hospitals, power plants, airports, metros, etc. In recent years it is also being introduced to other sectors like information technology, education, entertainment, and other profitable areas of public services (Sredojević, 2010).

Another difference between developed and developing countries is about the size of the PPP projects being implemented. Developed countries have already secured a stable economic growth and thus tend to have more micro and small projects which will solve some personal and individual problems or small group problems. On the other hand, developing and undeveloped countries tend to balance their public finances and thus have more macro projects involving big national companies, usually natural monopolies, that can affect the whole economy and make a significant impact on economic growth and development. Public-private partnership does not have a specific world agreed definition. Generally, it is a contract between a public and a private entity made for providing usually an infrastructure asset or service. Throughout the history, public and private sector have cooperated, but their interests and motives for partnership have changed, so defining PPP is not the same today as it was before (Rakić, 2011, p.8).

Therefore, "the main characteristics of public-private partnership are as follows:
- Long-term contractual cooperation – 25 or 30 years
- The contract defines the integration of all phases of the project, sharing of investments, responsibilities and credits for as long as the contract is valid
- The contract defines demanded performances as the final, output specifications
- The public partner is the one that defines the aims of the construction in the public interest and sets the demands in terms of construction, maintenance and service quality standards
- The private partner takes the risk, that would otherwise be taken by the public sector, although risk-sharing differs in each individual case
- The public partner pays the fee to the private partner for the construction and operation of the constructed building and undertakes the obligation to use the building for the contract-envisaged purpose
- After the expiration of the contractual period, the constructed building is returned into the public sector ownership." (Rakić & Rađenović, 2011, p. 209).

In this paper, the analysis of different developed and developing regions, representative countries from those regions and their available data will be presented and compared.

2. THEORETICAL BACKGROUND

Public-private partnership has not been a very popular subject for researchers, especially the differences between developed and developing countries. However, some works could be found and used to enhance this research and the paper. Usually, the literature compares two specific countries, one from the group of developed, and another from undeveloped or developing countries. There is no comprehensive analysis of more countries from both groups. For example, Kahyaoğullari (2013) has made a comparison between the UK and Turkey. Some of the points in his paper were about the differences between developed and developing countries where the author listed five items: "(i) how PPP policy penetrates into the political agenda, (ii) with what aims PPP policy is adopted, (iii) the sectoral distribution, (iv) the form it takes and (v) the regulatory framework, differs between developed and developing countries." (Kahyaoğullari, 2013, p.268) For the first, the author states that developed countries are motivated from a national level while developing are faced with the international and outer pressure to implement PPP projects rather than that being a national strategy. The second part explains that developed countries use PPP to solve some microeconomic problems while developed countries still solve macroeconomic problems. Third implies that developed countries use PPP more in social sectors while developing countries use it predominantly for economic infrastructure. Next, he claims that developed countries use different forms, more complex and innovative, insist on collaboration and transparency; on the other hand developing countries use basic forms, mostly concessions, and tend to keep these contracts and their details a secret. Regulations and institutions are far better and precise in developed countries. For the purpose of this paper, the third point where sectoral distribution is mentioned is the most relevant, while undoubtedly other aspects are also remarkably interesting. As an economy progresses and becomes more developed, the differences melt and developing countries converge towards developed ones also regarding the PPP and aforementioned remarks. What is interesting is that public-private partnership helps a country to improve and grow from developing into a developed one, thus creating a dynamic development system.

Governments usually use PPP for economic or social infrastructure. Under economic infrastructure there are sectors such as energy, electricity, roads, airports, ports, railways transport, while social infrastructure includes education, health, water and sanitation and urban or rural development. (Grimsey & Lewis, 2004). Sectors which developing countries implement require a substantial initial investment, as they do not have a good public finance situation. As a national economy develops, it tends to get from economic to social infrastructure, invest more in the quality of services like health, education and entertainment, although physical infrastructure, i.e. roads and telecommunications need to be maintained to keep social services reachable (Kahyaoğullari, 2013).

Osei-Kyei and Chan (2017) examined implementation constraints in public-private partnership in developing and developed countries by analysing the economies of Ghana and Hong Kong as respective examples. Before making a questionnaire and distributing it they found some of the constraints appearing in available literature about: "corruption, weak institutional structure, very costly end charges to the users, lack of competition in the

procurement process, unstable macroeconomic indicators, immature financial market and incomplete risk transfer"(Osei-Kyei, R. & Chan, A, 2017, p. 92). On the other hand, developed countries have some other issues which differ and encompass: "high transaction and participation costs, lengthy contract negotiations, a great deal of management time spent in contract transaction, confusion over government objectives and evaluation criteria" (Osei-Kyei, R. & Chan, A, 2017, p. 92). Authors made a questionnaire and distributed it among PPP professionals and people who have dealt with it in their career. Survey had fifteen constraints that should be marked by respondents. Results showed that six out of fifteen factors were perceived differently in these countries confirming differences between developed and developing countries. Most of these factors are about the general investment climate, lack of experience and institutions and regulations. Long-lasting negotiations process and political support showed the importance in both countries while the negative public image was not highly ranked as a constraint in either of the countries.

Under the leadership of Thatcher and Reagan, who insisted on privatisation and had neo-liberal attitudes, UK and USA were among the first economies to implement the concept of public-private partnership (Mitchell-Weaver & Manning, 1991). After witnessing the success and development of the mentioned countries, other developed and developing countries started the implementation of the concept. However, the way of implementation and issues encountered along were considerably different. Another author named Michael Busler (2014) in his paper "The role of properly structured public-private partnerships in promoting economic development" examines the proper structuring of the PPP and notes that firstly it is important to form a national agency which deals with these projects and tracks its progress. Afterwards, industries and sectors to be invested in should be defined. Next step is deciding on the private actors of the partnership, determining their key characteristics and choosing the ones who will participate in a PPP. Lastly, this author says that an exit strategy for the public part must exist, so when a company is doing well the public partner can leave it out completely to the private part. Agency should be run by elected officials. Public part in the partnership should be less than half so the management could be done by the private part. Busler (2014) introduces a logic of implementing PPP projects in different sectors and markets by using Maslow`s hierarchy of needs. Firstly, low developed countries invest in the agriculture industry, which can become more productive with investing capital in mass production facilities, to satisfy the basic needs for food. After that is met, partnerships are made for acquiring security, and then for satisfying higher degrees of needs. Another remark is that a well-structured PPP strategy leads to economic growth (Busler, 2014).

3. METHODOLOGY AND DATA ANALYSIS

For the purpose of this research comparative method analysis will be implemented. Concerning the issue, some things could be concluded by analysing the list of implemented projects, while the other ones require more detailed research and specific information from companies and governments. The hypothesis which would be assessed in this paper include the following:
1. Developed countries have more PPP projects from the group of social infrastructures while developing countries have more economic infrastructure projects.
2. Developed countries have more micro while developing countries have more macro PPP projects.

3. Technologically more advanced projects are implemented in developed countries.
4. Developed countries have a bigger number of small projects while developing countries have larger infrastructure projects.

There are a lot of constrains regarding the available data about this subject; first, it must be said that a comprehensive database where all the data from all the countries could be found does not exist. Even when referring to some world databases, there are significant discordances with national statistics and public offices dealing with public-private partnership. There is a paper by Prats, Demaestri & Chiara (2018) questioning the congruence of national and international databases. International databases tend to provide information for researchers and investors, while national databases focus more on the investors and promoting PPP as a concept. If an investment agency makes the database, it is leaned towards the investors' needs and if the Ministry of Finance makes it then transparency and objectivity are its main focuses. The number of projects included in international and national databases is not the same and national ones include in some cases several times more projects. Most bases, whether national or international, have information about before the finish of the project and do not provide the profitability after finalization. Some do not possess or do not present contact details concerning specific PPP project. Information about the final financial construction and the benefits for the private and public partners tend to miss out from the available data. Risk sharing and its allocation among the involved entities are not presented in either of the datasets (Prats, Demaestri & Chiara, 2018). This inevitably implies some limitations to this research and paper. Some of the sources for the international data about PPP are: ifraPPP, EPEC, PPI World Bank database, PPIAF, and more. National databases are usually from special agencies or ministries of Economics or Finances department. After thorough research the most detailed base is infraPPP for the developed and PPI World Bank database for the developing, with regards that the first one represents a private company, thus requiring payment for the data.

3.1. Geographical structure of PPP implementation

According to a research paper done by KPMG (2015) made for Australian infrastructure development through PPP, an overview of the global PPP market has been made. Some of the key aspects of the market according to the report indicate a rise of social infrastructure compared to the economic one, stagnation of the UK market, advancing of North America, and rise from the developing economies such as Brazil and India. On the following figure 1, world PPP market and its saturation are presented.

United Kingdom was the pioneer of the PPP concept but now experiences a downward trend due to the maturity of the market. North America is taking over the leading role as a growth market, including Canada and United Stated who have a vast pipeline of projects, strong political support, and a good institutional base with detailed laws and regulations. Emerging markets are found in India, Latin America and South-East Asia. They are also using PPP to attract foreign direct investment. China is promoting the concept as a reform tool and procurement method for building infrastructure and attracts both foreign and domestic private sector. Australia is a mature PPP market, although it still has a good flow of projects for building infrastructure (KPMG, 2015).
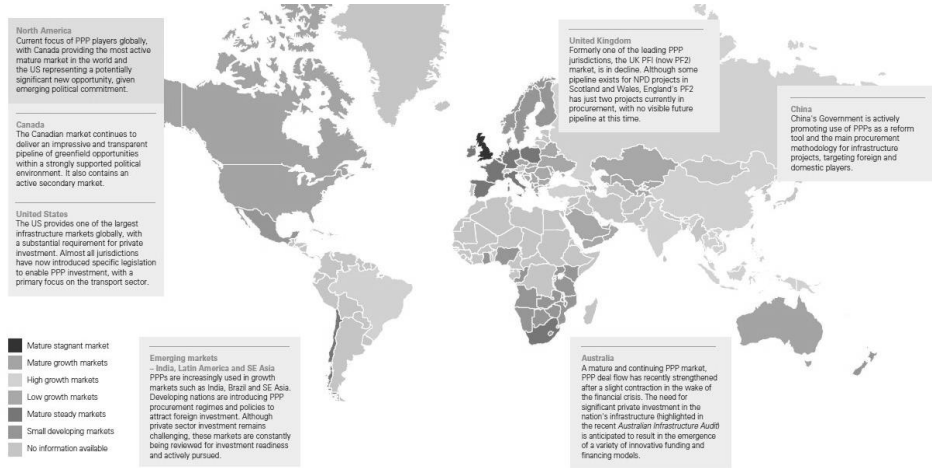
Fig. 1 World PPP market
Source: KPMG Public-private partnership 2015. p. 8

Some regions of the world participate more in the private investment in infrastructure and some less. On the following figure 2, levels of each region will be presented from 2010 to 2019. For instance, the region of East Asia and Pacific recorded an increase for eight years and from 2017. show a slight decline, although from that year they accounted for the most investments. In the first half of 2019, they are still dominating global investment and represent around 40% of the private participation in infrastructure. Latin America and the Caribbean dominated the market for most years as can be seen in figure 2. Now they show almost double the investment in 2019 than in 2018, rising from 17 to 32% (World Bank Group, 2020c). Investments in South-East Asia continue to grow and are slightly bigger than last year. Other regions, Sub-Saharan Africa, Europe and Central Asia and the Middle East and North Africa all record a decline compared to last year's results.
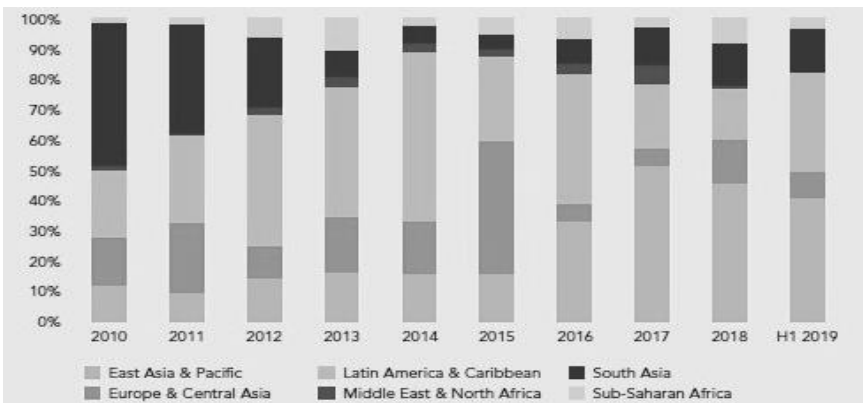
Fig. 2 Geographical structure of Infrastructure investments
Source: WB group H1 2019 Private participation in Infrastructure. 2020c. p. 7

Analysed from the country perspective, there is a huge inequality, namely five countries represent around ¾ of the whole market in the first half of 2019. China is the leading country as expected, considering its size and the number of residents, followed by Brazil, India, Russia and the Philippines (World Bank Group, 2020c).

3.2. Sectoral structure of PPP

According to the report of Private Participation in Infrastructure (PPI) of World Bank Group, total private investment in low and middle-income countries was US$49.8 billion across 175 projects in 38 countries in the first half of 2019. Half of the year showed an increase of 14% over the last year period and 18% over the five-year average for that period. Most of the investment was concentrated in five countries: China, Brazil, India, the Russian Federation and the Philippines. Regarding the sectors, transport sector was more invested in than the energy sector, water sector was lower than in 2018. and ICT sector investment declined. As it can be seen in the next figure 3 energy and transport sector occupy the most in Emerging and developing economies (EMDE). In 2019 private investments in the transport sector represent more than half of all. The water sector is slowly growing and being more invested in than ICT (World Bank Group, 2020c).
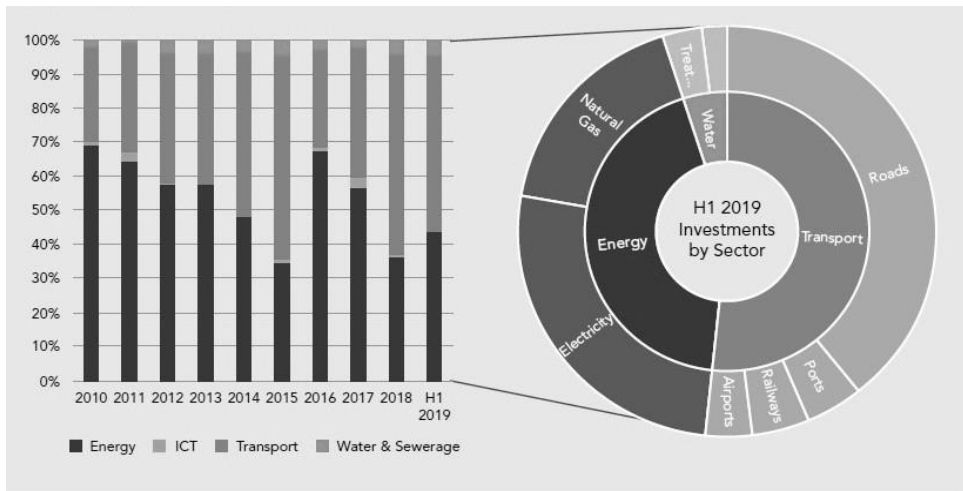
Fig. 3 Sector structure of EMDEs 2010-2019
Source: WB group H1 2019 Private participation in Infrastructure. 2020c. p. 14

If sectors are seen from a country perspective, transport sector recorded the biggest investments in China, India and Russia. Energy sector recorded the lowest amount in the last five years. This is due to the steep decline of solar projects in China. As the main country, China is appearing again in the water and sewerage sector, next to Brazil and Vietnam. This sector recorded a decrease compared to last year (World Bank Group, 2020c). According to the IMF categorisation by criterion GDP per capita, countries could be divided into developed and developing. Namely developed countries have GDP per capita higher than 25.000 US dollars while developing have between 2.500 and 25.000 US dollars.
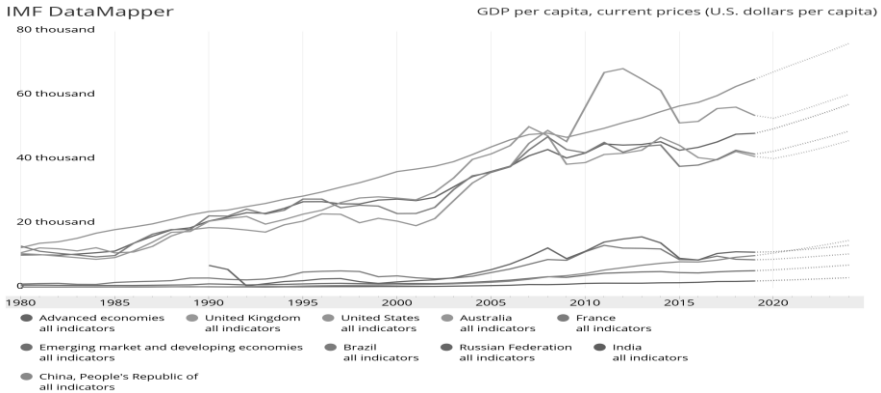
Fig. 4 Developed and developing countries GDP per capita
Source: IMF. World Economic Outlook. 2020.

In the following chapters, developed countries that implement PPP in their economies, UK, USA, Australia and France will be presented next to developing countries from BRIC group: Brazil, Russian Federation, India and China. These countries and their GDP per capita could be seen in figure 4 above. The United States of America has the highest, while India has the lowest score. China and the Russian Federation record higher scores than Brazil and India, but they are still far from the 25.000 US dollar border of highly developed countries. The United States and Australia have higher scores in their group than the United Kingdom and France, which has the lowest score in the developed group (IMF, 2020).

3.3. Sectoral structure of PPP in developed countries

The history of PPP started in the United Kingdom a few centuries ago, and then in its modern form from the 1990s until the World financial crisis in 2007 it recorded constant growth as can be seen on the figure 5. United Kingdom has special forms of PPP called Private financial initiative (PFI) and private financing (PF2). A number of these projects grew consistently with their capital value.
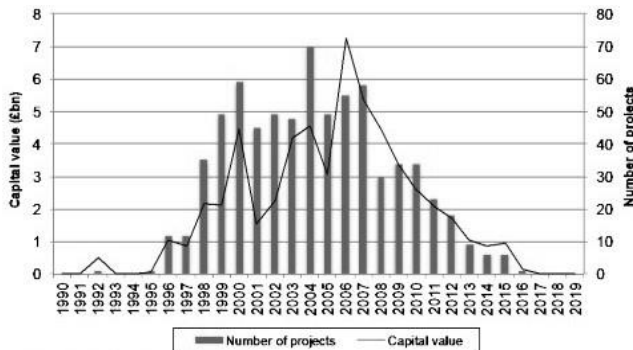
Fig. 5 PFI and PF2 projects in the UK – number and capital value
Source: HM Treasury. 2019. p.6

At the time of the global financial crisis, a drastic fall in both the number and the value followed, slightly recovering in 2009 and 2010 before facing another steep decline almost until today. The decline was partially due to the saturation of the market and exhausting the possible projects. Structure of the ongoing projects also changed, as now the dominant sector is health and insurance, by capital value, which can be noted in the next figure 6.
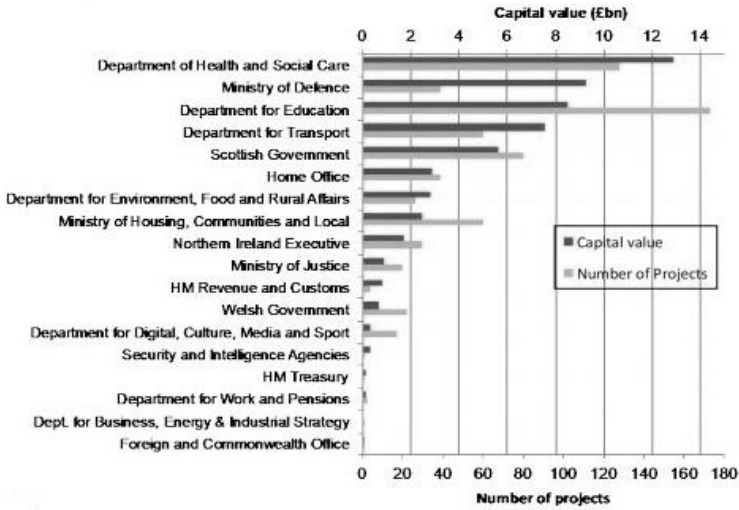
Fig. 6 Current PFI and PF2 projects by department
Source: HM Treasury. 2019. p.6

Department for Education has the highest number of projects while being in third place by the value of the projects. Defence sector and transport department closely follow. Some other social infrastructure sectors such as department for environment, food and rural affairs and Ministry of housing, communities and local appear on the list, indicating a shift from purely economic investment in PPP projects to social.

The United States of America showed a decline as the whole global market during the world economic crisis, but afterwards, it recorded fast growth. In 2019 PPP market has more than quadrupled with 83.3 billion while in 2018 it amounted to 19.5 and in 2017 19.7 billion dollars (infraPPP, 2020b). From the structure perspective as can be seen in figure 7, the biggest number of projects and the value is seen in the transport sector, followed by social and health, water and waste, and telecom, while energy sector comes in last.
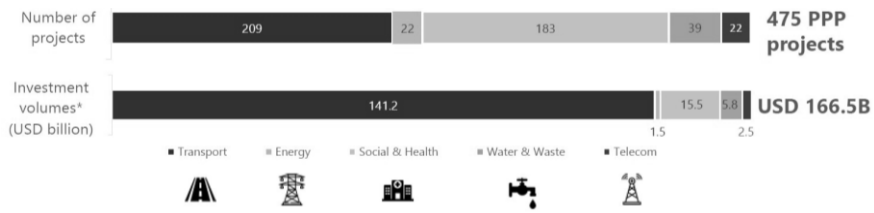
Fig. 7 USA PPP market
Source: infraPPP Reports. USA PPP market. 2020b.

Australia as a mature PPP market and a developed economy presents a stable investment market for the private sector. It has a particularly good regulatory framework and a strong base of PPP projects. In 2019 it recorded 69 billion US dollars of investment after 27.7 billion in 2018 and 2.3 billion in 2017 (infraPPP, 2020a).

Fig. 8 Australian PPP market
Source: infraPPP Reports. Australia PPP market. 2020a.

From the sector point of view, transport leads with more than half of the number of projects and almost 90% of the value of all PPP projects. Social and Health is the next sector by the number of projects, while Water and Waste have the least number of projects and capital value, as indicated in figure 8. (infraPPP, 2020a).

France represents one of the cradles of public-private partnership, especially the concession type. It is considered to be one of the most developed countries in the world and a mature PPP market. From the database of the European PPP Expertise Centre (EPEC), it could be seen that the highest value of all sectors belongs to transport, followed by Telecom, Education, and other social infrastructure.
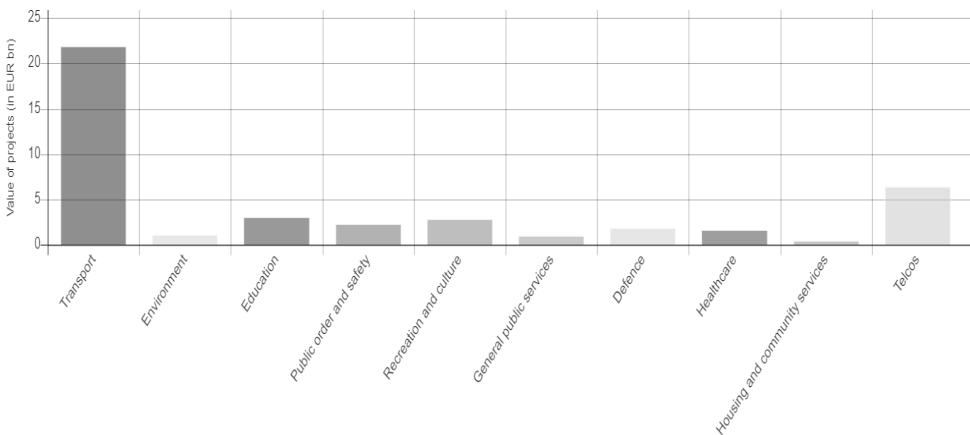
Fig. 9 France PPP project value
Source: EPEC, https://data.eib.org/epec

The number of projects shows almost equal amount of transport and education sector, followed by recreation and culture, public order and safety and other social infrastructure (EPEC, 2020). France being the least developed in this group still has the most investments and highest number of projects in the economic infrastructure sector.

Transport: 45   Environment: 11   Education: 43   Public order and safety: 15
Recreation and culture: 29   General public services: 5   Defence: 5   Healthcare: 19
Housing and community services: 7   Telcos: 19
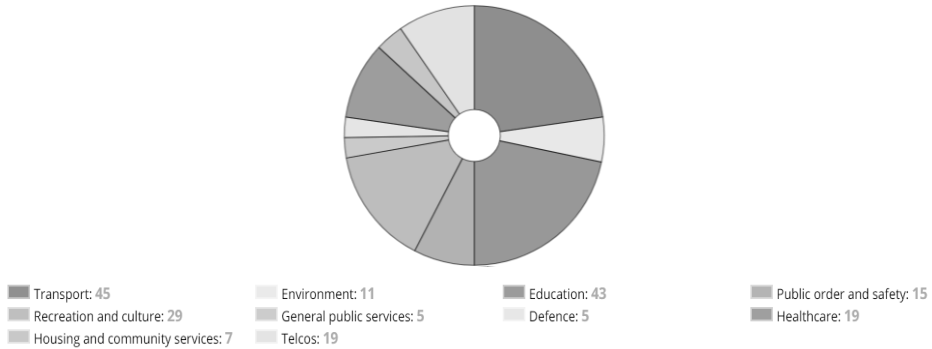
Fig. 10 France PPP sectoral structure
Source: EPEC, https://data.eib.org/epec

3.4. Sectoral structure of PPP in developing countries

In recent history, these countries have been recognized as rising and developing economies, which led them to form an informal BRIC group. The acronym is formed from the names of the countries that make up the group: Brazil, Russia, India and China. These countries are also advanced in implementing public-private partnership projects. Presented data is from the Private Participation in Infrastructure database from World Bank Group as it represents universal methodology and it is quite difficult to acquire national data let alone make it comparable. Data is recorded from 2018 to 2019, in order to be comparable to the data of developed countries presented in the former chapter.

Brazil presents the most developed economy in Latin America and one of the biggest PPP markets. Most projects relate to economic infrastructure, providing electricity, natural gas, collection and transport, and some of them belong to social infrastructure providing ICT and water and sewage as shown in figure 11. In the last year, 60 projects reached financial closure with the total amount of 18.628 billion dollars (World Bank Group, 2020a).

Fig. 11 Brazil PPP market in 2018
Source: https://ppi.worldbank.org/en/snapshots/country/brazil
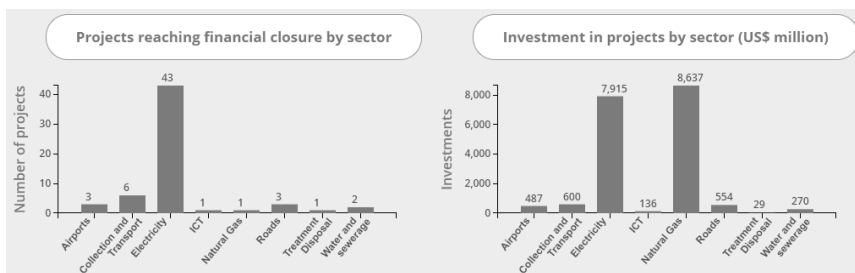
The most valuable project was an investment in natural gas and a lot of investments in electricity. Brazil also recorded high infrastructure investment in 2014 and 2016 while hosting world football championship and summer Olympic games.

Russian Federation is still in development considering public-private partnership, it is fine-tuning its laws and regulations, but many regional PPP projects and the need for building infrastructure positively affect the development of the concept. There are many risks tied with this concept, considering that financial market and laws and regulations are not well developed in Russia. On the other hand, these projects can stimulate technology and management innovations, improve service quality and bring many more benefits (Maslova, & Yushkov, 2017). During the past year, Russia recorded 17 projects that reached financial closure with 7.2 billion dollars in total investment (World Bank Group, 2020e). Most of the projects were from the economic infrastructure, encompassing electricity, collection and transport, ports, roads, airports, as can be seen in figure 12.

Fig. 12 Russia PPP market in 2018
Source: https://ppi.worldbank.org/en/snapshots/country/russian-federation
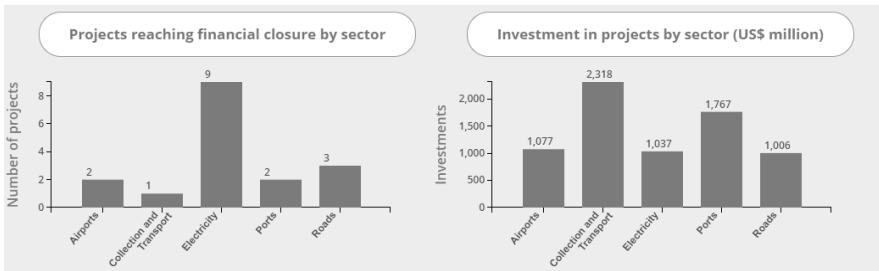
Russia has a lot of improvements to incorporate in order to implement more PPP projects from the number point and by the investment amount. While improving the scores it is also advancing in economic growth and development.

India is one of the nations with the biggest population in the world and pursuing fast economic growth. That is putting a lot of pressure on its already limited infrastructure. Government is searching for a way to finance the infrastructure without making a lot of investments and going into debt. Public-private partnership comes as almost an ideal solution for this problem. A lot of work on the policy and transparency is much needed for the concept to work adequately (Kutumbale & Telang, 2014). In the last year, from 2018 to 2019 India has had 83 projects which reached financial closure with the total investment of 15.549 billion US dollars (World Bank Group, 2020d).
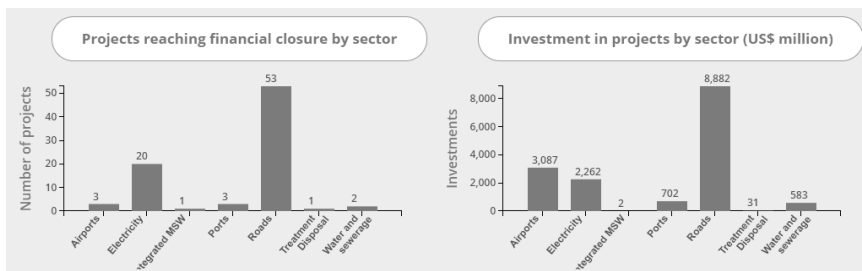
Fig. 13 India PPP market in 2018
Source: https://ppi.worldbank.org/en/snapshots/country/india

As it can be noticed from the Figure 13 above, almost all of the projects are from economic infrastructure including dominantly roads, electricity, airports, ports, and only a few of them belong to social infrastructure from treatment disposal, integrated municipal solid waste and water and sewage sectors.

China has a similar position as India regarding the number of residents and a limited infrastructure; government budget is under pressure due to increased economic development and overloading of urban areas. In the case of China, private part of the investment in many cases is a government-owned company, and very rarely a truly private one or a foreign company (Ke et al., 2014).

Fig. 14 China PPP market in 2018
Source: https://ppi.worldbank.org/en/snapshots/country/china
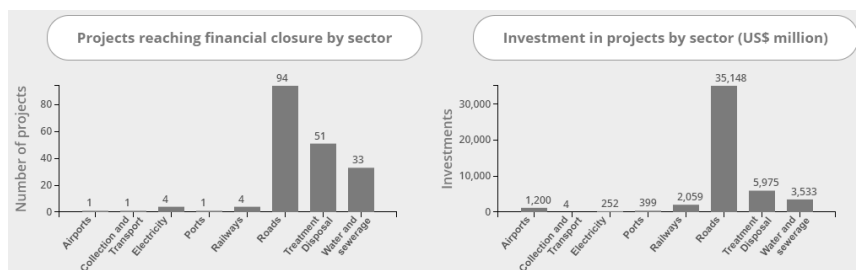
Figure 14 shows that most projects as in the whole group of developing countries occupy economic infrastructure: roads, electricity, airports, although here a substantial part goes to social infrastructure including disposal treatment and water and sewage. China has implemented a total of 189 projects from 2018 to 2019 with a total value of 48.57 billion US dollars (World Bank Group, 2020b). This country is working on updating its legal framework and regulations to be ready to attract more private partners and also working on changing the attitude of the public towards private capital participation in infrastructure projects.

4. CONCLUSION

From the presented data several conclusions could be drawn out and help to decide on the hypothesis set in the Methodology and data analysis part. Developed economies, analysed in this paper, have a lot more projects, and their higher total value than developing ones considering that they are smaller countries from the population and country size point of view. Projects implemented in the developing countries tend to be more turned towards building social infrastructure including sectors like health and social care, education, defence, water and waste, informational and communicational technology and similar. This could be explained in two ways. One is that these economies have a higher level of development and consequently already built strong economic infrastructure, including roads, airports, energy sectors, while another is that they have been implementing public-private partnership for a longer period and have used it in the beginning for building economic infrastructure and now they have switched to social as the need for the economic one has been satisfied. This confirms the first hypothesis that developed countries have more

projects that are in the category of social infrastructure and developing ones have more in the economic infrastructure part.

The second hypothesis that stated that developed countries have more micro and developing more macro projects could not be confirmed nor rejected from the available data. Namely, both types of analysed countries implement micro and macro projects, so projects of the big value and long duration could be found both in developing and in developed countries. This also stands for micro-projects which could be found in all analysed countries. It could be said that the second hypothesis is being rejected based on available and analysed data and countries.

The third hypothesis could not be confirmed as advanced technology is being used throughout all of PPP projects, as one of the main purposes to implement the partnership is being the transfer of technology from the private entity to the public one.

The fourth hypothesis implied that developed countries have a bigger number of small projects while developing countries have larger infrastructure projects. Set like this it could be partly confirmed and partly rejected. Developed countries implement a larger number of PPP projects and that part can be confirmed, while on the other hand they also have large infrastructure projects bringing to the conclusion that second part of the hypothesis stating that developing countries have larger infrastructure projects can be rejected.

The public-private partnership serves as a tool to promote and catalyse the growth and the development of an economy, enabling developing countries by undertaking proper actions to converge towards developed ones and even overtake them.

REFERENCES

Busler, M. (2014). The role of properly structured public-private partnerships in promoting economic development. *World Journal of Entrepreneurship, Management and Sustainable Development, 10*(2), 90-97. https://doi.org/10.1108/WJEMSD-07-2013-0039

Chou, J.-S., & Pramudawardhani, D. (2015). Cross-country comparisons of key drivers, critical success factors and risk allocation for public-private partnership projects. *International Journal of Project Management, 33*(5), 1136-1150. https://doi.org/10.1016/j.ijproman.2014.12.003

European PPP Expertise Centre - EPEC. (2020). *France PPP value of the project and sectoral structure*. Retrieved from: https://data.eib.org/epec Accessed on: 20.02.2020.

Grimsey, D., & Lewis, M. K. (2004). *Public-Private Partnerships – the worldwide revolution in Infrastructure Provision and Project Finance*. UK: Edward Elgar Publishing Limited.

HM Treasury. (2019). *Private Finance Initiative and Private Finance 2 projects: 2018 summary data*. Retrieved from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/805117/PFI_and_PF2_FINAL_PDF1.pdf Accessed on: 20.02.2020.

IMF. (2020). *GDP per capita, current prices*. Retrieved from: https://www.imf.org/external/datamapper/NGDPDPC@WEO/ADVEC/GBR/USA/AUS/FRA/OEMDC/BRA/RUS/IND/CHN?year=2020 Accessed on: 20.02.2020.

infraPPP Reports. (2020a). *Australia PPP market*. Retrieved from: https://www.infrapppworld.com/country-reports/australia-ppp-market-2020 Accessed on: 20.02.2020.

infraPPP Reports. (2020b). *USA PPP market*. Retrieved from: https://www.infrapppworld.com/country-reports/usa-ppp-market-2020 Accessed on: 20.02.2020.

Kahyaoğullari, B. (2013). *Public-Private Partnerships in Developing and Developed Countries: The UK And Turkish Cases*. Retrieved from: https://www.semanticscholar.org/paper/Public-Private-Partnerships-In-Developing-And-The-Kahyao%C4%9Fullar%C4%B1/e4add75e29f69c27d739498d1129b1d3c36d58c9#citing-papers

Ke, Y., Jefferies, M. Shrestha, A., & Jin, X.-H. (2014). Public-Private Partnership in China: Where to From Here. *Organization, technology & management in construction, 6*(3), 1156-1162. https://doi.org/10.5592/otmcj.2014.3.10

KPMG. (2015). *Public-Private Partnership: Emerging global trends and the implications for future infrastructure development in Australia.* Retrieved from: https://assets.kpmg/content/dam/kpmg/pdf/2015/06/public-private-partnerships-june-2015.pdf

Kutumbale, V., & Telang, V. P. (2014). PUBLIC-PRIVATE PARTNERSHIPS IN INDIA (An Overview of Current Scenario). Retrieved from: https://www.researchgate.net/publication/281024752_PUBLIC_PRIVATE_PARTNERSHIPS_IN_INDIA_An_Overview_of_Current_Scenario/citations

Maslova, S., & Yushkov, A. (2017). PPP Development in Russia: Overview of Current Trends and Transport Case Studies. Retrieved from: https://www.researchgate.net/publication/320592263_PPP_Development_in_Russia_Overview_of_Current_Trends_and_Transport_Case_Studies

Mitchell-Weaver, C., & Manning, B. (1991). Public-Private Partnerships in Third World Development: A Conceptual Review. *Studies in Comparative International Development, 26*(4), 45-67.

Osei-Kyei, R., & Chan, A. (2017). Implementation constraints in Public-Private Partnership: Empirical comparison between developing and developed countries. *Journal of Facilities Management, 15*(1), 90-106. https://doi.org/10.1108/JFM-07-2016-0032

Prats, J., Demaestri, E., & Chiara, J. (2018). *Analytical Description and Comparative Analysis of National and International Databases*. Institutions for Development Sector. Discussion paper nº IDB-DP-585. Inter-American Development Bank.

Rakić, B., & Rađenović, T. (2011). Public-private partnerships as an instrument of new public management. *Facta Universitatis, Series: Economics and Organization, 8*(2), 207 – 220.

Rakić, B. (2011). *Javno privatno partnerstvo: mogućnosti i ograničenja [Public-Private Partnership: Possibilities and Limitations].* Niš: Ekonomski fakultet.

Sredojević, S. (2010). *Javno privatno partnerstvo. [Public-private partnership].* Beograd: Arhipelag, Institut Ekonomskih nauka.

World Bank Group. (2020a). *Brazil PPP market in 2018.* Retrieved from: https://ppi.worldbank.org/en/snapshots/country/brazil Accessed on: 25.02.2020.

World Bank Group. (2020b). *China PPP market in 2018.* Retrieved from: https://ppi.worldbank.org/en/snapshots/country/china Accessed on: 25.02.2020.

World Bank Group. (2020c). *H1 2019 Private Participation in Infrastructure.* Retrieved from: https://ppi.worldbank.org/content/dam/PPI/documents/H12019_PPI-report_small.pdf Accessed on: 25.02.2020.

World Bank Group. (2020d). *India PPP market 2018.* Retrieved from: https://ppi.worldbank.org/en/snapshots/country/india Accessed on: 25.02.2020.

World Bank Group. (2020e). *Russia PPP market in 2018.* Retrieved from: https://ppi.worldbank.org/en/snapshots/country/russian-federation Accessed on: 25.02.2020.

KOMPARATIVNA ANALIZA
SEKTORSKE STRUKTURE PROJEKATA JPP
U RAZVIJENIM ZEMLJAMA I ZEMLJAMA U RAZVOJU

Cilj ovog rada je analiza vrsta projekata javno-privatnog partnerstva (JPP) i njihove sektorske strukture u razvijenim i zemljama u razvoju. To će biti postignuto uporednom analizom osam zemalja koje pripadaju kategorijama razvijenih i zemalja u razvoju i pored toga implementiraju brojne projekte JPP-a. Rezultati analize pokazuju da razvijene zemlje odabrane za ovu analizu realizuju više projekata i beleže višu ukupnu vrednost projekata. Njihovi projekti su raznovrsniji i osim ekonomske infrastrukture obuhvataju i socijalnu infrastrukturu koja ima veći broj projekata, a u nekim razvijenim zemljama i višu vrednost od sektora ekonomske infrastrukture. Između grupa i sektora postoje određena preklapanja, jer to nije strogo pravilo koje bi se moglo primeniti na sve zemlje, jer je svaka ekonomija pojedinačan i poseban slučaj. Kako adekvatna struktura JPP-a vodi ekonomskom rastu i razvoju nacionalne ekonomije, preporučuje se prilagođavanje institucionalnog okvira, zakona i propisa o JPP, privlačenje više privatnog kapitala, razvoj osnovne ekonomske infrastrukture i uz njegovu pomoć nastojanje da se struktura projekta JPP zemalja u razvoju približi strukturi razvijenih zemalja. Cilj je prvenstveno dostići adekvatno razvijenu ekonomsku infrastrukturu, a zatim više ulagati u projekte socijalne infrastrukture koji mogu povećati nivo društvenog blagostanja.

Ključne reči: *javno-privatno partnerstvo, sektorska struktura, razvijene zemlje, zemlje u razvoju*

Contents