THE IMPACT OF INNOVATION PERFORMANCE ON THE COMPETITIVENESS OF THE VISEGRAD 4 COUNTRIES

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Abstract

The economic development of world economies accompanied by their growing openness and stronger integration processes put pressure on mutual confrontation of their economic power based on its determinant sources. International comparison requires determining a complex of factors that affect the success of developed economies; factors that, given their multiplier effects, influence the social productivity of labor in a country and create a competitive advantage in an international comparison. A key factor of the states' increasing competitiveness is assumed to be the innovation performance of enterprises, which is projected through innovative business processes into the innovation performance of the economy as a whole. This paper determines the impact of their innovation performance on their international competitiveness position observed by the Global Economic Forum based on the Global Competitiveness Index (GCI). To assess the impact, the following economic-statistical methods were used: comparative and correlation analyses and logical deduction. Data from the World Economic Forum (WEF), European Innovation Scoreboard (EIS), and Eurostat database were used to process the assessment. The results of the research have led to the conclusion that the Visegrad 4 (V4) countries as transition economies in terms of their economic development are quite similar, but in the ranking of global competitiveness, their position varies depending on the innovative performance. The Czech economy is the best performing of the four, while the worst indicators are attributed to the economies of Slovakia and Hungary. The economy of Poland has a relatively balanced development. The results of these analyses have led to the creation of a discussion platform focused on the evaluation of the innovation potential status and its determinants in Slovakia, with the aim of pointing out critical areas in the country's competitiveness growth on an international scale.

Key words: competitiveness, innovations, innovation performance, Visegrad 4 countries
JEL Classification: E20, O31, O32,

1. INTRODUCTION

In today's globalized world, there is an ongoing process of division of labor and changes in labor (Balcerzak, 2016; Peleckis, 2016; Sinicakova & Gavurova, 2017; Ribau et al., 2017), creating an even wider scope for exchange processes and the competitiveness of subjects on the domestic market, but especially on foreign markets.

In recent decades, competitiveness has become one of the most widely used terms in the process of national and regional politics. Despite the professionals' and the scientific community's growing interest in this matter, a unanimous definition of competitiveness has not been established in

either the scientific or expert literature. This is mainly because of the strong heterogeneity of its measuring processes, as well as other factors involved. These factors are determined mainly by their system complexity, as well as geographical limitations that evaluate the extensive causalities among the elements of the system – enterprises, regions, countries, etc. (Gavurova et al., 2016).

It is not possible to increase the competitiveness of an economy at the macroeconomic level without the participation of the business sphere. Only firms can be the creators of new forms of competitive advantages; governments can create a business environment for the development of companies (Soltes & Gavurova, 2015). The productivity of a country's economy is determined by the productivity of enterprises operating in it; the competitive economy can only be created by businesses being able to compete (Virglerova et al., 2006; Vojtovic, 2016; Gedek et al., 2017, Dudda et al., 2017). At the corporate level, significant factors for increasing competitiveness are as follows: increasing labor productivity by applying modern management and marketing methods, applying the latest science and technology achievements in manufacturing and service delivery, the ability to implement innovation in a proper timeframe, and better work organization. (Grenčíková & Španková, 2016; Giedraitis et al., 2017; Hilkevics & Hilkevica, 2017).

The current level of economic development requires that, in an effort to increase their competitiveness, individual EU countries focus on the qualitative factors (Kordoš, 2016). In the European Economic Area, there is a group of transitive economies which, regarding the competitiveness construction, are moving to the qualitative factors, reflecting their economic and political development (Androniceanu & Popescu, 2017). At the European level, the internationalization process could be an important driver for economic, political, social and cultural development, and it has many implications in the competitiveness field (Dima & Vasilache, 2016).

V4 countries being represented by economies with strong fundamentals, relatively diversified structures and growing economic activity, but with a different degree of economic openness. The Polish economy is the least open economy. Slovakia, the Czech Republic and Hungary are among the most open economies in Europe, and therefore they are highly sensitive to external environment development (Pavelková et al., 2017). Speaking about the national efforts to increase the competitiveness of the whole economy, it is logical that promoting the competitiveness of domestic enterprises in these countries should be a key aspect of their economic policy.

This paper examines and quantifies the dependence of the V4 countries' overall competitiveness level on innovation factors. Its structure is as follows: the introductory theoretical part provides an overview of the issue of innovativeness and the significance of the Global Competitiveness Index in evaluating the countries' competitiveness and their international benchmarking. The structure of the index enables the clarification of basic causalities of the measured competitiveness components, its extension into various types of policies, as well as modification options. The analytical part deals with set targets and the chosen methodology, as well as the justified database. Upon evaluation of the results, a discussion platform was created to address the controversy of Slovakia's unfavorable, lowest position within the V4 countries, on the scale of competitiveness in terms of innovation activities.

2. THEORETICAL BACKGROUND

Competitiveness is a market's attribute by which a country is able, in terms of free market conditions, to produce products and provide services being reviewed by international markets, while maintaining and expanding real incomes and improving living conditions of people in the long run. According to the OECD (2017), the term competitiveness means the ability of companies and industries, regions, nations and multinational units to generate relatively high income levels from production factors, but also their use at a sustainable level in the current competitive environment. Most often, the competitiveness is assessed at company level. Competitiveness is a basic condition for the existence of an enterprise and is realized as the ability to maintain and expand the assets of business owners. In this sense, the competitiveness of an enterprise is a matter of strategic importance and therefore it is an issue for the top management of a company. Global institutions and organizations dealing with competitiveness evaluate it and compile competitiveness rankings of economies or businesses, they define this category for their needs and compile criteria and methods for competitiveness measuring.

Many research studies deal with measuring competitiveness from different perspectives (e.g. Simionescu et al., 2017; Bánociová & Martinková, 2017; Simionescu, 2016; Calabrese et al., 2013; Vigoda-Gadot et al., 2008). A number of them assess competitiveness of countries in relation to selected aspects, where research confrontational and interpretational lines play an interesting role. E.g. Odehnal et al. (2012) measure the competitiveness of Ukraine regions. For the purpose of their analyses, they chose several socioeconomic indicators from various industries. They used factor analysis and its results to arrive at the conclusion that out of four analyzed entry variables, one explained nearly half of the data source. Further, the following factors were analyzed: economic development factor, industry development factor, migration and employment rate factor, job market factor, and development factor. In their research, Önsel et al. (2008) examine the competitiveness of countries, while declaring the fact that the gross domestic product as an indicator has many limitations in terms of a correct grouping of countries via cluster analysis. 178 criteria were set within 11 sections, while three main indicators were measured: the so-called macroeconomic index, index of public institutions, and technological index. The results of their analysis are clusters of countries based on their level of competitiveness and a draft list of criteria for further analysis conducted by applying neural networks. The final country groups reflect the most commonly used indicator which is the gross domestic product.

Ülengin et al. (2002) assess competitiveness based on the evaluation of the World Competitiveness Index by the International Institute for Management Development. One of its components is gross domestic product. When examining the research variables in more detail, it is apparent that a number of explanatory parameters significantly correlate with the given evaluation of the researched country, which can have a negative effect on outcomes and strongly limit the quality of the analysis' interpretations.

The research by Rozmahel et al. (2014) has a significantly different research character when measuring competitiveness. Emphasis is put on the evaluation of the European Union member countries' infrastructure. The authors of the research primarily focus on EU's new members,

even though the analysis is performed using the data of all member countries, or potential future members in the given time period. The research implies that disparities between countries are gradually eliminated over time.

There are studies that investigated the differences between countries in terms of innovation performance and competitiveness. Şener & Sarıdoğan (2011) tried to investigate the effects of science-technology-innovation oriented global competitiveness strategies and transmission mechanism on the economic growth for the high income OECD countries. Their results were that those countries that have science-technology-innovation based economic policies and strategies have great superiority and sustainable competitive advantage in not only global competitiveness but also economic growth and development leading to wealth and welfare of the country. Cvetanovic et al. (2014) studied the relationship between the global innovation index and the global competitiveness index in Western Balkan countries and a group of six selected EU countries. Based on correlation and cluster analysis, they found no statistically significant effect (linear correlation) of the global innovation index (GII) on the global competitiveness index (GCI) at the Western Balkan countries. On the other hand, they proved the existence of a statistically significant impact of the GII on the GCI. Carayannis & Grigoroudis (2014), using multiobjective mathematical programming and trend and gap analyses, found no significant gaps among innovation, productivity, and competitiveness, although several variations may be found for particular countries. Hudec & Prochádzková (2015) carried out a study in Visegrad countries and regions focusing on innovation performance and efficiency. Based on their research, the country factor does not hold much importance in that issue.

Many international institutions examine the evaluation of countries' competitiveness, its determinants, as well as the countries' rankings. Their aim is to use the analyses and evaluations to promote the platform for creating effective policies in the area of competitiveness development, while eliminating territorial disparities and discrepancies. Information from these evaluations can serve as a valuable basis for conducting complementary analyses within individual countries, with the aim of discovering their competitive potential and mainly possibilities for its growth. This creates a basis for various internal evaluation systems within the countries which will reflect the discovered facts and push for changes in partial policies regarding e.g. innovation development, elimination of economic disparities among regions, support of the SME segment development, support of the qualification population structure reflecting changes on the job market, etc.

The World Economic Forum (2016) claims that national competitiveness is determined as the ability of national economy to execute the sustained level and quality of life. Every year the WEF evaluates and publishes the information on global competitiveness; the measurement index consists of a number of factors that support the competitiveness of a country's economy. The World Economic Forum (2016) defines competitiveness as a "set of institutions, policies, and factors determining the level of country's productivity. The productivity level then determines the sustainable level of prosperity that can be achieved by the economy.

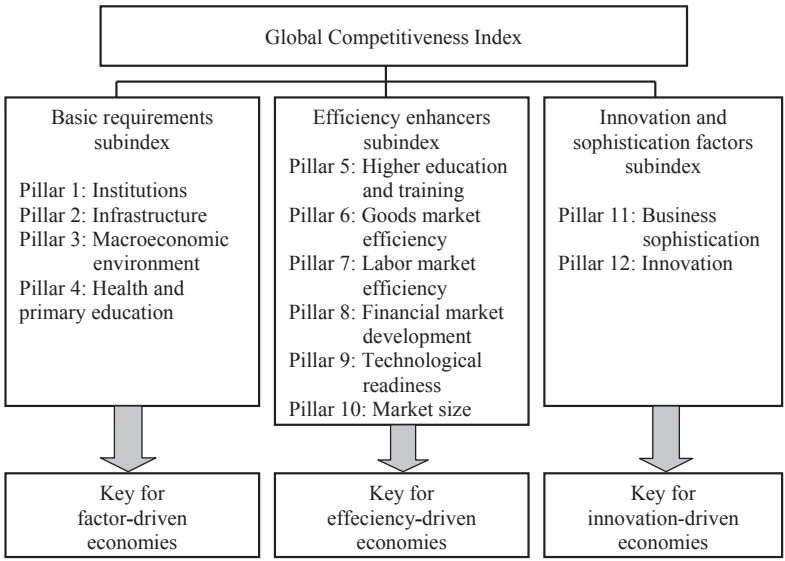


Fig. 1 – The Global Competitiveness Index structure. Source: authors' elaboration by the World Economic Forum (2011-2016)

As the name of the next indicator indicates, the Global Competitiveness Index (GCI) is geared to explore the ability of an economy to compete in international competition. Since 2004, it has been shown by the World Economic Forum (WEF). Previously, the Growth Competitiveness Index (GCI) and the Concurrent Competitiveness Index (CCI) have been reported. In 2007, the methodology for calculating the Global Competitiveness Index was changed and to evaluate the year-to-year changes, the past results were recalculated by a new methodology.

GCI consists of 12 pillars of competitiveness which are classified into three sub-indices based on whether their growth is based on the factors of production, efficiency, and innovation (Figure 1). Each of these pillars consists of 7-20 other sub-indicators. Some sub-indicators are evaluated on the basis of available statistical data; others are the result of the global Executive Opinion Survey.

According to the obtained results, the rated states are classified into three development stages and two "inter-levels", as the criterion is GDP per capita and the primary products export share of total export. In the first development stage - economies driven by production factors, there are classified countries of whose GDP per capita is less than 2000 USD and the primary products export share in total export is over 70%. The sub-indexes weight in proportion of 65:35:5 is applied for the countries in the first development stage. The second stage - economies driven by efficiency – there are states whose GDP per capita is in the range of 3000-8999 USD, as the sub-indexes weights are in the proportion of 40:50:10. The third stage - the economy driven by innovation – there are states with a GDP per capita of more than 17000 USD and sub-indexes weights are 20:50:30.

By calculating the GCI, it is very important to know the development stage in which the country is located so the scales can be set for the individual sub-indices. The countries are classified into individual stages based on GDP per capita, the specific stages are in Table no. 1. Individual scales are defined as essential requirements, factors determining efficiency, and factors of innovation and sophistication.

Tab. 1 – Sub index weights and income thresholds for development stages. Source: World Economic Forum (2016)

Stages and criteria for countries	Stage 1: Factor-driven	Transition from stage 1 to stage 2	Stage 2: Efficiency driven	Transition from stage 2 to stage 3	Stage 3: Innovation driven
GDR per capita US$ thresholds	< 2 000	2 000 – 2 999	3 000 – 8 999	9 000 – 17 000	> 17 000
Weight for basic requirements	60%	40-60%	40%	20-40%	20%
Weight for efficiency enhancers	35%	35-50%	50%	50%	50%
Weight for innovation and sophistications factors	5%	5-10%	10%	10-30%	30%

Innovation performance is essential for an economy to be strong, competitive and resource efficient on the world markets (Kaynak et al., 2017). Innovation performance is highly dependent on the economic agents´ expectations regarding future economic situation on domestic and international markets (Tomaszewski & Swiadek, 2017).

According to Tidd et al. (2007), innovation contributes to achieving a competitive advantage in several aspects. The most important characteristics of innovations include: A strong relationship between market performance and new products. New products help maintain market shares and improve profitability. Growth also by means of non-price factors (design, quality, individualization, etc.). Ability to substitute outdated products (shortening product lifecycles). Innovation of processes that lead to production time shortening and speed up new product development in comparison to competitors. Habánik et al. (2016) claim that industrial clusters are important for the development of innovation activities and competitiveness of the companies. Unlike traditional industrial innovation clusters represent a system of close relationships not only between companies, their suppliers and customers, but also to institutions of knowledge, including research centers, universities, scientific research institutes, etc. As a generator of new knowledge and innovation, they provide a high level of competitiveness (Balcerzak & Pietrzak, 2016). Because the research part of the study evaluates the results of countries in the 11th and 12th pillars

of global competitiveness, a brief characteristic is included based on WEF.

The final pillar of competitiveness focuses on innovation. Innovation is particularly important for economies as they approach the frontiers of knowledge, and the possibility of generating more value by merely integrating and adapting exogenous technologies tends to disappear. In these economies, firms must design and develop cutting-edge products and processes to maintain a competitive edge and move toward even higher value-added activities which could also focus on solving social issues (Hadad, 2015). This progression requires an environment that is conducive to innovative activity and supported by both the public and the private sectors. In particular, it means sufficient investment in research and development (R&D), especially by the private sector; the presence of high-quality scientific research institutions that can generate the basic knowledge needed to build the new technologies; extensive collaboration in research and technological developments between universities and industry; and the protection of intellectual property.

Business sophistication concerns two elements that are intricately linked: the quality of a country's overall business networks and the quality of individual firms' operations and strategies. These factors are especially important for countries at an advanced stage of development when, to a large extent, the more basic sources of productivity improvements have been exhausted. The quality of a country's business networks and supporting industries, as measured by the quantity and quality of local suppliers and the extent of their interaction, is important for a variety of reasons. When companies and suppliers from a particular sector are interconnected in geographically proximate groups called clusters, efficiency is heightened, greater opportunities for innovation in processes and products are created, and barriers to entry for new firms are reduced.

3. THE RESEARCH OBJECTIVE, METHODOLOGY AND DATA

The aim of this paper is to determine the impact of their innovation performance on international competitiveness position pursued by the Global Economic Forum based on the synoptic of Global Competitiveness Index (GCI). Innovation and sophisticated business processes are two sub-indicators that support competitiveness based on qualitative factors; their assessment is based on hard statistical data.

The basic method is a comparative analysis to compare the overall competitiveness of V4 countries and the results of these countries in innovative performance and business processes sophistication. By means of statistical methods (correlation analysis), the impact of GCI indexes (sub-index of Innovations and Sophisticated Factors) will be examined to assess the V4 countries in terms of Global Competitiveness ranking. The baseline data to assess the issue is retrieved from the World Economic Forum database, the Eurostat database, and the European Innovation Scoreboard, EIS (European Commission).

The functionality degree between two variables is expressed by correlation (correlation coefficient). For the numerical expression of the functionality degree between two characters the Pearson's correlation coefficient – r, or Spearman's coefficient of sequence correlation – R are most commonly used. Coefficients require correlated selections to have at least approximately normal distribution and selection ranges $n \approx 30$.

Correlation coefficients can be verified by a significance test. The test answers the question whether the results being obtained can be generalized to the entire base file. Thus, if between X and Y there is in general a statistically significant functionality. The hypothesis H0 on the observed signs independence is rejected in favor of an alternative hypothesis if p value < α (0,05).

The correlation analysis was used to assess the impact of V4 innovation performance shown in the 11th and 12th pillars of Global Competitiveness Index on their overall ranking in the Competitiveness Ranking (GCI).

Setting of hypotheses

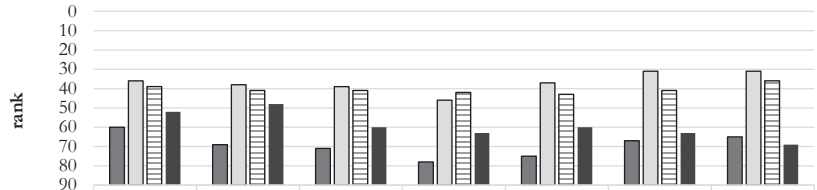
> Hypothesis 1: We assume that in the observed time series there is a statistically significant functionality between the V4 countries ranking compiled by the Innovation and Business sophistication sub-index and the overall V4 countries ranking in GCI.

Since changes in the ranking of non-V4 countries can also have the influence on correlation in ranking of countries by the Innovation and Sophistication indexes and overall ranking in the GCI chart, it has been decided to set a second hypothesis that verifies the correlation between the absolute values of the Innovation and Sophistication Indexes and the overall Competitiveness Index of V4 countries in GCI ranking.

> Hypothesis 2: We assume that during the observed time series, there is statistically a significant functionality between the Innovation and Business sophistication subindex values and the overall Competitiveness Index values in GCI of V4countries.

4. RESULTS AND DISCUSSIONS

Figure 2 shows the evolution of V4 countries in the GCI since 2010. As it can be seen from the graph, Poland was keeping the most stable position in the reviewed period. Since 2010, Slovak Republic has continued to decline in ranking until 2013-2014, in the next two years, there was increasing tendency and a shift in ranking to the level being closed to the position in 2010-2011, and in the last year of ranking it was at the 65th place in the GCI. The chart shows that Czech Republic is a leader among the countries of Visegrad group, it has a balanced trend in positions in 2016 and 2017, occupying the 31st place in the total ranking of countries. Poland's trend is similar to the one of Czech Republic; Poland has lagged behind in the last two years, ranking at the 36th (2016) and the 41st (2015) places. In this assessment Hungary shows a negative development, its ranking in the reviewed period was tumbling down 17 places from 52 to 69.



	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
SR	60	69	71	78	75	67	65
CR	36	38	39	46	37	31	31
Poland	39	41	41	42	43	41	36
Hungary	52	48	60	63	60	63	69

Fig. 2 – The V4 countries ranking development in the GCR (2010-2017). Source: own processing by the World Economic Forum (2011-2016)

Figure 3 shows the score development values of V4 countries in the observed period. Compared to the previous chart, it is apparent that the change in the Slovak Republic's score was not as dramatic as the fall in ranking, being affected by the change in the ranking of other countries; based on the obtained score value SR got before Hungary. If the score values in the periods of 2010-2011 and 2016-2017 are compared, Czech Republic as the only country has increased its score value by the 0.18 percentage point. Of the other 3 countries being under review, Hungary tumbled down by 0.8 percentage point to the 69th place in GCI. Poland has a very balanced development, its score in the last reviewed period has been slightly improved, it is located behind the Czech Republic within the rated countries, but before Slovakia and Hungary.

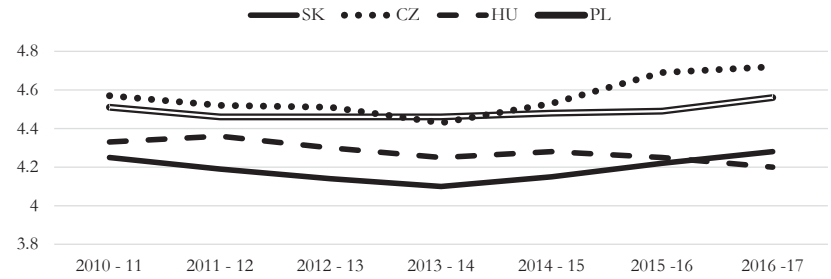
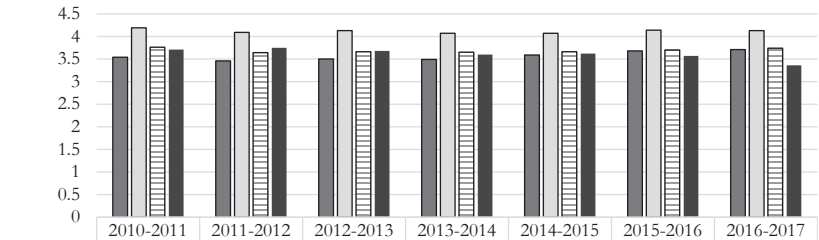


Fig. 3 – The V4 countries GCI Score development (2010-2017). Source: own processing by the World Economic Forum (2011-2016)

It is important to remember that the twelve rated pillars do not affect the competitiveness independently but are mutually complementary. Bad results in one pillar often have a negative impact on other areas. So the result in the score or in the competitiveness ranking list is a complex result. For the V4 countries, results in the subindex of Innovation and Sophistication of Business Processes are important for competitiveness, these countries are at the stage of transition to the economy driven by

innovation, and in their evaluation this subindex is of a relatively high weight (see the Table 1). The V4 countries ranking by subindex Innovations and sophistication factors are shown in Figure 4.



	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
SR	3.54	3.46	3.5	3.49	3.59	3.68	3.71
CR	4.19	4.09	4.13	4.07	4.07	4.14	4.13
Poland	3.76	3.64	3.66	3.65	3.66	3.7	3.74
Hungary	3.71	3.75	3.68	3.6	3.62	3.57	3.36

Fig. 4 – The Comparison of V4 Countries' Success in subindex Innovations and Sophistication factors, in 2016. Source: own processing by the World Economic Forum (2011-2016)

Based on the WEF assessment (Figure 4), the Czech Republic shows the highest values in the subindex Innovations and Sophistication factors, but shows a slight deterioration from 4.19 to 4.13 compared to the base year. As regards the development trend, Slovakia shows a slightly increasing trend and Poland shows a balanced development. The trend decline in the reviewed period was reflected in Hungary, as it worsened from 3.71 to 3.36 from the beginning of the reference period.

A slightly more optimistic view on the country' s innovation potential is provided by the Global Innovation Index where the Slovak Republic is placed in the transition area between the first and second quadrant of countries with the most innovation activity, the V4 countries belong to the group "moderate innovator" with a low value summary innovation index, while innovation leaders are Switzerland, Sweden, Denmark, Finland, Germany, Netherlands, and the United Kingdom.

The innovation potential affects fundamentally the competitiveness of a country. According to the WEF methodology, none of the V4 countries are in the third stage of the three-level Porter model. The SR is in a transition between the 2nd and 3rd stages, i.e. in the transition from the industrial to a post-industrial economy. Regarding the competitiveness assessment, the higher index values of 11th and 12th pillars are important for the shift to a post-industrial economy. In the next part, the V4 countries' rating in the 11th and 12th pillars on their overall competitiveness within the GCI will be examined.

Verifying the H1 hypothesis, the dependence between the formal quality features was examined, namely the innovation factor and business sophistication, and the overall GCI ranking of V4 countries in the monitored period (from 2010 to 2017). The selection consisted of 7 ranges in each of the four countries, i.e. n = 28. The files had an approximately normal distribution.

Tab. 2 – Ranking of V4 countries according to the monitored indexes. Source: own processing by World Economic Forum (2011-2016)

Country	Year	Innovation and Sophistication factors ranking	GCI Overall Index Score ranking
Slovak Republic	2016/2017	57	65
	2015/2016	59	67
	2014/2015	73	75
	2013/2014	77	78
	2012/2013	74	71
	2011/2012	70	69
	2010/2011	63	60
Czech Republic	2016/2017	35	31
	2015/2016	32	31
	2014/2015	36	37
	2013/2014	36	46
	2012/2013	32	39
	2011/2012	32	38
	2010/2011	30	36
Poland	2016/2017	55	36
	2015/2016	57	41
	2014/2015	63	43
	2013/2014	65	42
	2012/2013	61	41
	2011/2012	57	41
	2010/2011	50	39
Hungary	2016/2017	97	69
	2015/2016	69	63
	2014/2015	67	60
	2013/2014	71	63
	2012/2013	58	60
	2011/2012	52	48
	2010/2011	51	52
Shapiro-Wilk's test p-value		0.122	0.023

In the first step, functionality was assessed, a degree of matching between the innovation sub-index and enterprise sophistication rankings and the overall ranking in GCI. Since the value of

sequence correlation coefficient R = 0.84, there is a high linkage degree between the innovation and sophistication index rankings and the overall score ranking. This positive functionality can be seen in the following chart, where along with the one ranking, the second ranking is increasing as well, with axis x - V4 countries ranking in Innovation and sophistication of enterprises index, axis y - V4 countries ranking in the overall GCI index.

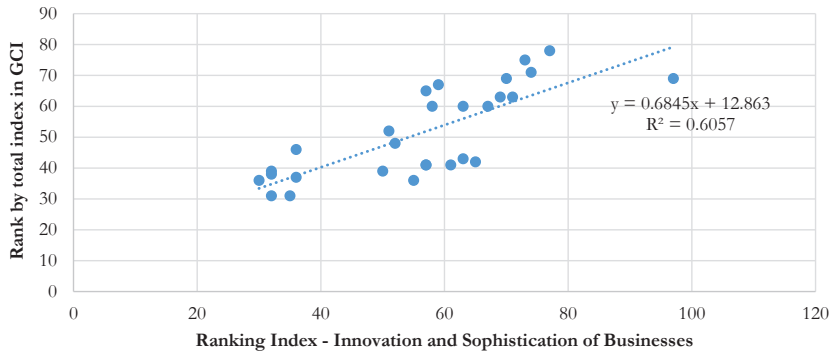


Fig. 5 – Overall ranking and innovation ranking correlation for V4 countries. Source: own processing, program statistics

For the H1 exact verification, there is still an unanswered question if the observed linkage degree could be generalized to the whole basic set, i.e. if there is a statistically significant functionality between these rankings. At the significance level $\alpha = 0.05$ we tested, by means of the sequence correlation coefficient significance test, the H0 hypothesis on the observed characteristics independence, compared to the alternative hypothesis H1, that there is a statistically significant functionality between the X and Y rankings, where X means the Innovations and processes sophistication ranking, and the Y means the Overall GCI ranking.

Since the value p ($2.26.10^{-8}$) < α (0,05) hypothesis H0 has been rejected in favor of the alternative hypothesis H1 and it can be said that the correlation is statistically significant. Hypothesis H1 has been confirmed.

In H2, the functionality between the values of Innovation and Sophistication index of V4 countries in the period of 2010-2017 and the values of the GCI total score index was examined. The selection consisted of a total of 7 values (seven years) of each V4 country, i.e. n = 28. Since the files had an approximately normal distribution and a relatively large range, to make a comparison, the Pearson's correlation coefficient has been used.

Tab. 3 – Indexes values of Innovation and Sophistication Factors of V4 countries and Overall Index scores in GCI countries of V4 countries. Source: own processing based on World Economic Forum (2011-2016)

Country	Year	Subindex Innovation and sophistication factors score	Overall Index score in GCI
Slovak Republic	2017/2016	3.71	4.28
	2016/2015	3.68	4.22
	2015/2014	3.59	4.15
	2014/2013	3.49	4.10
	2013/2012	3.50	4.14
	2012/2011	3.46	4.19
	2011/2010	3.54	4.25
Czech Republic	2017/2016	4.13	4.72
	2016/2015	4.14	4.69
	2015/2014	4.07	4.53
	2014/2013	4.07	4.43
	2013/2012	4.13	4.51
	2012/2011	4.09	4.52
	2011/2010	4.19	4.57
Poland	2017/2016	3.74	4.56
	2016/2015	3.70	4.49
	2015/2014	3.66	4.48
	2014/2013	3.65	4.46
	2013/2012	3.66	4.46
	2012/2011	3.64	4.46
	2011/2010	3.76	4.51
Hungary	2017/2016	3.36	4.20
	2016/2015	3.57	4.25
	2015/2014	3.62	4.28
	2014/2013	3.60	4.25
	2013/2012	3.68	4.30
	2012/2011	3.75	4.36
	2011/2010	3.71	4.33
Shapiro-Wilk's test p-value		0.004	0.296

In the first step, the following are assessed: the functionality, the degree of matching between the Innovation and sophistication factors index and the overall GCI index for the particular

country and year. Thecorrelation coefficient r = 0.797 reflects a high degree of linkage between the value of the Enterprise Innovation and Sophistication Score and the overall score of the country in GCI. This positive functionality can also be observed in the following graph, where along with the index of Enterprise Innovation and Sophistication – axis x, the overall GCI index is also increasing – axis y.

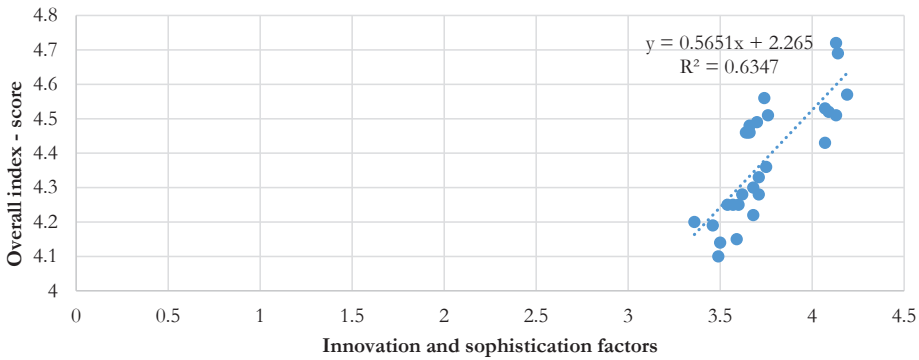


Fig.6 – Correlation of the GCI overall score and the Enterprise Innovation and Sophistication Score of V4. Source: own processing

For the exact verification of H2, it is still necessary to determine whether the observed linkage degree can be generalized to the whole basic set, i.e., if there is a statistically significant functionality between the indexes being compared. At the significance level $\alpha = 0.05$, by means of a correlation coefficient significance test, we tested the H0 hypothesis on observed characteristics' independency, compared to the alternative H2 hypothesis that there is a statistically significant functionality between the index of Innovation and sophistication factors - axis x and the overall GCI index score – axis y.

Since $p = (3.94.10\text{-}7) < \alpha\ (0{,}05)$, the H0 hypothesis is rejected in favor of the alternative hypothesis H2, and the correlation is statistically significant. The H2 hypothesis has been confirmed.

Generally speaking, in V4 countries, the Innovation and Sophistication index value is increasing along with the overall GCI index value of these countries. This, however, does not exclude the possibility that there is a significant linear functionality among the other indexes being observed and the overall score.

The research results confirm that Slovakia's results on the scale of global competitiveness measured in relation to the country's innovative performance are the worst among the V4 countries. This is related to the state of the economy in a post-crisis era, while in order to increase the competitiveness level on the international scale, it is important to intensively search for possibilities to broaden innovation and innovative processes in the Slovak economy. This is possible in a number of areas. Improving the quality of the business environment is a dominant possibility. The state has to set up adequate tools for supporting innovation, establish fiscal measures to support businesses in investing into research and innovation, etc. It is also important to connect

the academic and the business field, to strengthen the education system and the development of human resources, etc.

In the past years, a stronger relationship has been developed between the business field and the research institutions that are responsible for supporting the transfer of new technologies and the implementation of new know-how in the business field, while active feedback can increase the quality of research and development management in the country. This relationship, however, is still insufficient in terms of the value of innovation development indicators. The state must show interest in the progress of research and development and search for adequate options of creating conditions for the development of an innovative environment in the field of research and innovation, innovative products, processes, know-how, and the use of the most up-to-date information and communication technologies. The situation in the field of innovation in Slovak companies varies.

The development process management strategy is only flexible in innovative enterprises. Meanwhile, other businesses also have to adapt to quickly changing conditions and react to external and internal inputs. In terms of innovation management and innovation politics development and support that aim at increasing the country's competitiveness, it is important to devise an active innovation policy that would eliminate the fragmentation of competencies within the innovation system. The insufficient amount of explicit innovative tools creates a significant barrier in the innovation effectiveness of the country. Slovakia has long been declaring a low number of innovative tools compared to other European Union countries. The low innovativeness level in Slovak enterprises is mainly related to a lack of capital, insufficiently developed intercompany cooperation in the area of innovation, and a low level of innovativeness understanding as the determinant of their competitiveness.

Despite these negatives in the area of innovation development, Slovakia has a great potential to change this situation. It has a qualified workforce, the potential for an intensive international cooperation in the field of science and research, a broad use of information technologies, etc. In the field of innovation, it has established an extensive system of monitoring and the use of successful innovation practices, which have already proven effective in other EU countries. Slovakia has to modernize its innovation system and create an innovation policy in accordance with EU policies, which will provide desirable solutions to increase the country's innovativeness and hence its sustainability.

5. CONCLUSION

The competitiveness of the V4 countries is influenced by a wide range of economic, political and social factors. All of these countries have gained some specificities in their development, so it was interesting to compare the results of their competitive ability over the last period. As proven both by GCI position as well as in score values, the Czech Republic appears to be the most successful of these countries. A lower rating, but relatively balanced development is reported by Poland, followed by Hungary, and the worst results in both indicators have been shown by Slovakia. However, in the last reviewed period, Slovakia's rating improved so as to be on par with Hungary. To assess the countries' competitiveness results, the 11th and 12th pillars of competi-

tiveness have a considerable impact. By means of hypotheses, the extent of this impact has been assessed. Since both hypotheses showed statistically significant functionality, it can be said that the increased ranking in the overall GCI chart is affected by the ranking of V4 countries compiled according to the values within the innovation and enterprise sophistication indexes. Also, the value of innovation and business sophistication indexes is significantly affected by the value of the overall GCI index of the V4 countries. The causes of Slovakia's unfavorable position are related to the country's complex innovation politics, which has been affected by the processes set up as a solution for the post-crisis development in the country. In the future, Slovakia should focus on broadening the use of its innovative potential, especially by evaluating its level and relations within other sector policies. From the analytical point of view, it is important to map all innovation components and quantify their causal relations with outputs to main innovation metrics, which should serve as a platform for national and international benchmarking. Their significance lies in their implementation into the stabilization and regulatory mechanisms of the country's internal innovation politics.

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References

1. Androniceanu, A. & Popescu, C. R. (2017). An inclusive model for an effective development of the renewable energies public sector. *Administraie i Management Public,* 2017 (28), 81–96.

2. Balcerzak, A. P. (2016). Multiple-criteria Evaluation of Quality of Human Capital in the European Union Countries. *Economics and Sociology,* 9(2), 11–26.

3. Balcerzak, A. P. & Pietrzak, M. B. (2016). Quality of Institutions for Knowledgebased Economy within New Institutional Economics Framework. Multiple Criteria Decision Analysis for European Countries in the Years 2000–2013. *Economics and Sociology*, 9(4), 66–81.

4. Bánociová, A. & Martinková, S. (2017). Active Labour Market Policies of Selected European Countries and Their Competitiveness. *Journal of Competitiveness*, 9 (3), 5 – 21. https://doi/10.7441/joc.2017.03.01.

5. Calabrese, A., Campisi, D., Capece, G., Costa, R., & Di Pillo, F. (2013). Competiveness and Innovation in High-tech Companies: An Application to the Italian Biotech and Aerospace Industries. *International Journal of Engineering Business Management,* 5 (40). https://doi.org/10.5772/56755.

6. Carayannis, E., & Grigoroudis, E. (2014). Linking innovation, productivity, and competitiveness: implications for policy and practice. *The Journal of Technology Transfer*, 39(2), 199–218. https://doi.org/10.1007/s10961-012-9295-2.

7. Cvetanovic, S., Despotović, D., Mladenović, I., & Jovović, D. (2014). The analysis of innovation in Western Balkan countries in 2012. *Economic Research-Ekonomska Istraživanja,* 27(1), 830–846. https://doi.org/10.1080/1331677X.2014.974920.

8. Dima, M. A. & Vasilache, S. (2016). Trends in the internationalization of European

higher education in a convergence perspective. Management & Marketing. *Challenges for the Knowledge Society*, 11 (2), 449–457 https://doi/10.1515/mmcks2016-0008.

9. Dudda, J., Gasior, A., & Alebaite, I. (2017). Innovation of Polish Micro and Small Enterprises and Trade Credit. *Transformations in Business and Economics*. 16 (3), 89–109.

10. Gavurova, B., Vagasova, T., & Kovac, V. (2016). Competitiveness Assessment of Slovak Republic Regions. Proceedings Paper, Edited by: Krajicek, J; Nesleha, J; Urbanovsky, K. In: *13th International Scientific Conference of the European Financial Systems*, Brno, Czech Republic, Jun 27-28, 2016, 175–184.

11. Gedek , S., Misiak, T., & Mentel, G. (2017). Changes in GDP and the Employment and unemployment in the European Union. *Transformations in Business and Economics,* 16, (3C), 440–457.

12. Giedraitis, A., Stašys, R., & Skirpstaitė, R. (2017). Management team development opportunities: a case of Lithuanian furniture company. *Entrepreneurship and Sustainability Issues,* 5(2), 212–222. https://doi.org/10.9770/jesi.2017.5.2(4).

13. Grenčíková, A. & Španková, J. (2016). Labour migration trends in the Slovak Republic. *Economics & Sociology*, 9 (2), 158–167. https://doi/10.14254/2071- 789X.

14. Habánik, J., Kordoš, M., & Hošták, P. (2016). Competitiveness of Slovak economy and regional development policies. *Journal of International Studies*, 9 (1), 144–155.

15. Hadad, S. (2015). Analytic hierarchy process analysis for choosing a corporate social entrepreneurship strategy. *Management & Marketing*, 10(3), 185–207.

16. Hilkevics, S. & Hilkevica, G. (2017). New information technologies use for Latvian stock companies financial health evaluation. *Entrepreneurship and Sustainability Issues*, 5(2), 178–189. https://doi.org/10.9770/jesi.2017.5.2(1).

17. Hudec, O., & Prochádzková, M. (2015). Visegrad Countries and Regions: Innovation Performance and Efficiency. *Quality Innovation Prosperity*, 19(2), 55–64. https://doi.org/10.12776/qip.v19i2.593.

18. Kaynak, S., Altuntas, S., & Dereli, T. (2017). Comparing the innovation performance of EU candidate countries: an entropy-based TOPSIS approach. *Economic Research-Ekonomska Istrazivanja,* 30(1), 31–54, https://doi/10.1080/1331677X.2016.1265895.

19. Kordoš, M. (2016). Creative Industry Within the European Regional Policy -Effect and Benefits, Knowledge for Market Use 2016: Our Interconnected and Divided World. Olomouc: Palacky Univ, Dept Appl Econ, 199-207.

20. Odehnal, J., Sedlačík, M., & Michálek, J. (2012). A Competitiveness Evaluation of the Ukrainian Regions – Empirical Study. *Inžinerinė ekonomika – Engineering Economics,* 23 (4), 406–413. https://doi/10.5755/j01.ee.23.4.1296.

21. OECD (2017). *Global Economic Outlook*. Retrieved from http://www.oecd.org/eco/ outlook/sources-and-methods.html.

22. Önsel, S., Ülengin, F., Ulusoy, G., Aktaş, E., Kabak, Ö., & İlker Topcu, Y. (2008). A new perspective on the competitiveness of nations. *Socio-Economic Planning Sciences*, 42 (4), 221–246. https://doi/10.1016/j.seps.2007.11.001.

23. Pavelková, D., Sopoligová, M., & Bednář, P. (2017). Impact of cluster policies on structure and management of cluster organisations in Czechia and Slovakia. *Administratie si Management Public*, 2017 (29), 6–26.

24. Peleckis, K. (2016). International business negotiation strategies based on bargaining power assessment: the case of attracting investments. *Journal of Business Economics and Management*, 17(6), 882–900.

25. Ribau, C. P., Moreira, A. C., & Raposo, M. (2017). SMEs innovation capabilities and export performance: an entrepreneurial orientation view. *Journal of Business Economics and Management*, 18(5), 920–934.

26. Rozmahel, P., Issever Grochová, L., & Litzman, M. (2014). Evaluation of Competitiveness in the European Union: Alternative Perspectives. Procedia Economics and Finance, 12–17th International Conference Enterprise and Competitive Environment 2014, 575–581.

27. Şener, S., & Sarıdoğan, E. (2011). The Effects Of Science-Technology-Innovation On Competitiveness And Economic Growth. *Procedia - Social and Behavioral Sciences*, 24, 815–828. https://doi.org/10.1016/J.SBSPRO.2011.09.127.

28. Simionescu, M., Lazányi, K., Sopková, G., Dobeš, K., & Balcerzak, A. P. (2017). Determinants of Economic Growth in V4 Countries and Romania. *Journal of Competitiveness*, 9 (1), 103–116. https://doi.org/10.7441/joc.2017.01.07.

29. Simionescu, M. (2016). Competitiveness and Economic Growth in Romanian Regions. *Journal of Competitiveness,* 8(4), 46–60. https://doi.org/10.7441/joc.2016.04.03.

30. Sinicakova, M. & Gavurova, B. (2017). Single Monetary Policy Versus Macroeconomic Fundamentals in Slovakia. *Ekonomicky casopis*, 65(2), 158–172.

31. Soltes, V. & Gavurova, B. (2015). Modification of Performance Measurement System in the Intentions of Globalization Trends. *Polish Journal of Management Studies*, 11(2), 160–170.

32. Tidd, J. et al. (2007). *Řízení inovací. Zavádění technologických, tržních a organizačních změn*. Brno: Computer press.

33. Tomaszewski, M., & Swiadek, A. (2017). The impact of the economic conditions on the innovation activity of the companies from selected Balkan states. *Economic Research-Ekonomska Istrazivanja,* 30(1), 1896–1913, https://doi.org/10.1080/1331677X.2017.1398099.

34. Ülengin, F., Ülengin, B., & Önsel, S. (2002). A power-based measurement approach to specify macroeconomic competitiveness of countries. *Socio-Economic Planning Sciences*, 36 (3), 203–226.

35. Vigoda-Gadot, E., Shoham, A., Schwabsky, N., & Ruvio, A. (2008). Public sector innovation for Europe: a multinational eight-country exploration of citizens' perspectives. *Public Administration*, 86(2), 307–329. https://doi.org/10.1111/j.1467-9299.2008.00731.x.

36. Virglerova, Z., Dobes, K., & Vojtovic, S. (2016). The Perception of the States Influence on its Business Environment in the SMEs from Czech Republic. *Administratie si Management Public,* 14 (26), 78–96.

37. Vojtovic, S. (2016). The Impact of The Structural Funds on Competitiveness of Small and Medium-Sized Enterprises. *Journal of Competitiveness*, 8(4), 30–45. https://doi.org/10.7441/joc.2016.04.02.

38. World Economic Forum (2016). The Global Competitiveness Report 2016-2017. Retrieved from https://www.weforum.org/reports/the-global-competitiveness-report-2016-2017-1.pdf.

39. World Economic Forum (2015). The Global Competitiveness Report 2015-2016. Retrieved from https://www.weforum.org/reports/global-competitiveness-report-2015.

40. World Economic Forum (2014). The Global Competitiveness Report 2014-2016. Retrieved from https://www.weforum.org/reports/global-competitiveness-report-2014.

41. World Economic Forum (2013). The Global Competitiveness Report 2015-2016. Retrieved from http://reports.weforum.org/the-global-competitiveness-report-2013-2014/.

42. World Economic Forum (2012). The Global Competitiveness Report 2011-2012. Retrieved from http://www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf.

43. World Economic Forum (2011). The Global Competitiveness Report 2010-2011. Retrieved from https://www.weforum.org/reports/global-competitiveness-report-2010-2011.pdf.

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