ORIGINAL ARTICLE

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The evaluation of competitive position of EU-28 economies with using global multi-criteria indices

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Abstract

Research background: Under the current conditions of increasing competitiveness and interdependence, national economies are more influenced by the global business environment and its development. Constantly changing economic, social, political aspects, and many other factors, cause the differences in the global competitiveness of economies, so the economies are forced to analyze their competitive level more complexly. Despite that, there is a lack of research studies analyzing the international competitiveness of EU–28 economies from the point of view various multi-criteria indices.

Purpose of the article: The paper investigates the relations between the Global Competitiveness Index (GCI) and other selected multi-criteria indices, namely the Global Innovation Index (GII),

the Doing Business Index (DBI), the Economic Freedom Index (EFI) and the Corruption Perceptions Index (CPI) in the case of EU–28 economies.

Methods: In order to investigate the relations between the global competitiveness and selected multi-criteria indices affecting the EU–28 economies, the multiple linear regression analyses were applied. The multiple regression model was quantified for every single year, as well as, the regression model using the average score of all analyzed indices. The secondary data concerning the scores of individual indices were collected based on annually published online reports over the period of 2014–2018.

Findings & Value added: The research confirmed that there is a statistically significant dependence between the global competitiveness, corruption and the level of innovation potential within the EU–28 economies. Besides, we identified the worst results in the context of competitiveness evaluation especially in the area of corruption and innovation activities. In this regard, the issue of insufficient innovation development and inappropriate corruption perception is considered to be key determinants influencing the assessment of the global competitiveness of the EU–28 member states. In our opinion, to improve the competitiveness of these countries, targeted activities should be implemented in the frame of national competitive strategies, programs, and policies.

Introduction

The issue of competitiveness is an important aspect in the global economic environment. In today's constantly changing world, companies as well as whole economies face new challenges that require them to be more flexible and effective (Dobrovic *et al.,* 2019; Bacik *et al.,* 2019). By the influence of globalization, there is an increasing intensity of the competition of economies in international markets, so national economies are forced to be as competitive as possible. The business environment is evolving faster with increasing time and it constantly comes to social, technological and other changes. Thus, it is important to react to these changes promptly and, ideally, predict them (Gallo & Tomčíková, 2019). According to Ivanova *et al.* (2015), competitiveness represents one of the alternative performance economic indicators which allows for monitoring of all important factors that affect not only economic performance, but also many social aspects and social maturity of the country. Every year, many international organizations, international research institutes or foundations compile multi-criteria evaluations of competitiveness indicators which lead to the compilation of worldwide rankings where countries defend not only their overall position, but also position in selected areas. There are many internationally well-recognized annual rankings on the competitiveness of countries focused on different areas of economy evaluation.

The main aim of paper is to reveal the relations between the GCI and other selected multi-criteria indices, namely GII, DBI, EFI and CPI within the EU–28 member states over the analysed years 2014–2018 by means of multiple linear regression analyses. Based on the results, we have focused

on identifying key determinants (in terms of multi-criteria indices) that affects the global competitiveness of the EU–28 member states.

The research paper is organized into the following sections. First, we conducted the literature review related to global competitiveness, innovation development, business environment, economic freedom and corruption perception. In the next part, the methodology and data were introduced briefly. The following empirical section was focused on meeting the stated aim of paper. The last section summarized the main findings and pointed to the most significant issues in the area of the EU countries' development.

Literature review

The most extended ranking that is published by the World Economic Forum and presented in the Global Competitiveness Rankings is the Global Competitiveness Index (GCI). Many authors are focused on the overall GCI score evaluation, on the analysis of individual factors and growth indicators in order to suggest recommendations to improve the current competitive position of countries. For example, Roy (2018) examined the impact of basic requirements, efficiency enhancers, innovation and sophistication factors (categorized as three sub-indexes) on the GCI. The competitiveness of nations is a complex issue, so the indexes' methodology trying to capture its essence is crucial. For this reason, Dudas and Cibula (2018) focused on the new GCI methodology changes within the annual report 2018. The authors studied whether the new methodology is able to capture better the real competitiveness of nations operating in an exceedingly complex global economy. Petrarca and Terzi (2018) presented an alternative method to compute the GCI by means of a partial least squares path model. Using the GCI, through a regression analysis on a dataset made by 140 countries, Di Fatta *et al.* (2018) analyzed the relationships among public-sector performance, ethics and corruption. The results revealed a correlation between government efficiency and ethics. These findings could be an inspiration for government workers and managers in order to establish an ethical culture leading to public performance growth. In this regard, Mishchuk *et al.* (2018) emphasize the importance of the state regulation of distribution processes directed towards achieving positive social and economic consequences. Based on the GCI score of 41 European countries and using the various statistical methods, Bucher (2018) evaluated the contribution of each factor to the GCI and examined interconnections to other indexes. The analysis revealed the specifics of the existing regional socioeconomic differentiation compared to averaged European data. According to the author's

opinion, these characteristics should be considered when building the national competitive strategy of each state of the region. The study revealed also a high correlation between a country's rating for the GCI and the Human Development Index (HDI), the Gross Domestic Product per capita (GDP), the level of gender inequality and the competitiveness of the tourism industry.

In today's economic climate, innovation activities are considered to be major drivers of economic growth. Not only advanced economies, but also developing nations are finding that innovation is one of the main drivers of growth. INSEAD launched the Global Innovation Index (GII) with a relatively simple goal of discovering, creating and developing approaches and metrics to better capture the richness of innovation in society. In this context, Oveshnikova *et al.* (2019) analyzed dynamics and perspectives of the high-tech innovation markets development within the selected countries. The authors determined the problems of the existing system of high-tech business functioning by applying the GII. The present state of competitiveness along with other economic issues in a number of EU countries was investigated by Dobrovic *et al.* (2018). The research objective of this paper was to analyze the relation between innovation and competitiveness. Heterogeneous results were produced in terms of the full integration of these economies into the framework of competitiveness stated in the Europe 2020 strategy. Using the GII, Jankowska *et al.* (2017) described what can be understood by the term 'innovation', and they also explained how national innovation systems may transform innovation inputs into innovation outputs. Analysis of comparative innovative advantages was performed by Vlasova *et al.* (2017). The research paper explored the potential of the complex international index for identifying, assessing and comparing the strengths and weaknesses of progress in science, technology and innovation. In the process of increasing innovation level, knowledge workers play an important role. In the global perspective, countries are competing to grow better talent; attract the talent they need; and retain those workers who contribute to competitiveness, innovation, and growth. In this context, Alexy *et al.* (2018) studied creative capacity of 28 European countries. The authors constructed a creativity index based on the 3Ts concept of talent, technology and tolerance as the key components of the creativity. The creativity index was compared to World Happiness Index (WHI), GDP per capita and Human Development Index (HDI). Using cross-sectional analyses, a relatively strong correlation was revealed among above mentioned indices, and it was also confirmed that the creative capacity is clustered geographically.

Company performance is an integral part of macroeconomic perspective on country competitiveness and, as reported by Belas *et al.* (2017); Kljucnikov *et al.* (2016), the growth of entrepreneurial activities is a major issue on which the sustainability of future growth depends. According to Kot (2018), the sector of small and medium-sized enterprises (SMEs) plays a key role in the economies of all of the countries in the world. These entities constitute the basis for the development of the national and global economies. In a contemporary complex and competitive business environment, the adaptation of appropriate strategies is a particularly important effort to furthering the development of companies. Each economy has its own specific business environment, which is influenced by a wide range of factors, and there is a constant debate about how the business environment should be assessed (Lietuvniké *et al.,* 2018; Komarova *et al.,* 2018). In this regard, the World Bank Group created the Doing Business Index (DBI) to report aspects of entrepreneurship business regulation. On the basis of DBI analysis, Tan *et al.* (2018) suggested a new framework of index that encompasses indicators capturing attractiveness to investors, business friendliness and competitive policies. Findings confirmed that eliminating the barriers of doing business is a pre-requisite to enhance both domestic and foreign investments, as well as competitiveness of country. In this regard, Morkūnas *et al.* (2018) state that too high government involvement into the matters of their countries' particular economic sector may bring adverse effects. Across the globe, Hossain *et al.* (2018) focused on investigating the impact of Ease of Doing Business on foreign direct investment (FDI), as important factor of competitiveness. According to Ani (2015), economic activity requires a streamlined regulatory environment and effectual policies. Using the multiple regression, the study was focused on the analysis of Ease of Doing Business effect to economic growth of the selected economies.

In a market-oriented economy, the goal of many governments is to ensure the economic freedom, in order to achieve better level of competitiveness. Economic freedom allows to develop sustainable prosperity and competitive of country, as well as to increase economy growth. The aim of economic freedom is not simply the absence of government coercion or constraints, but rather the creation and maintenance of a mutual sense of liberty for all. In this context, the Heritage Foundation suggested the Index of Economic Freedom (EFI). As reported by Stefko *et al.* (2018), the role of the state is to financially and legally support public organizations and to ensure the mutual cooperation in different above-mentioned areas. The issue of economic freedom was addressed by Akin *et al.* (2014). Using the panel data analysis method, the authors investigated the relationship be-

tween economic growth and economic freedom using the EFI and its sub-components on the sample of 94 different countries belonging to five different income groups. Finally, a statistically significant positive relationship was proved. The research paper of Mushtaq and Ali Khan (2018) analyzed the effect of EFI on the sustainable development of countries represented by the Sustainable Development Index (SDI). The data observed was categorized into economic, society and environment dimensions and the results indicated the EFI's a positive impact on sustainable development competitiveness of nations. Macroeconomic perspective for economic freedom was quantified by Yevdokimov *et al.* (2018). Authors analyzed the role and influence of economic freedom measured by EFI on macroeconomic stability and democracy. The findings revealed a positive and statistically significant impact of economic freedom on the macroeconomic stability of countries leading to economic growth, employment, financial development, and increasing global competitiveness.

According to many experts, corruption is considered as a major bottleneck for economic development. However, empirical research on corruption was limited because it was difficult to measure actual levels of corruption. This problem was resolved by Transparency International, which created product called Corruption Perceptions Index (CPI). Zouaoui *et al.* (2017) investigated the CPI development in the case of all countries included in the rankings for the period of 2000–2014. Using a hierarchical classification method, the authors grouped the countries into high, medium and low corrupt countries and then they analyzed the volatility of perception of corruption among the same group and the different groups. Another view for corruption's perception was provided by Ngoc *et al.* (2018), who applied spatial regression in combination with dynamic panel data and investigated how CPI impacts the choice of FDI location within the selected host country. As reported by Ficeac (2013), nevertheless, there are still many occurrences of government officers abusing their offices to do an act of corruption.

Research methodology

As reported by Abrham and Herget (2013), approaches of the above-discussed measures of competitiveness differ from one another according to the number and type of selected indicators, weights allocated to them or other particular approaches for their evaluation. Some institutions are focused on the institutional quality and the role of government in the country, while others put emphasis on the technological aspects of competitive ad-

vantage. This problem was very well-discussed in the research study presented by Balcerzak and Pietrzak (2016). The authors concentrated on the problem of quality of institutions in the European Union countries in the context of their compatibility with the global knowledge-based economy. The aim was to evaluate the progress in the process of regulation reforms. Another group of institutions prefer multi-criteria evaluation based on many different indicators grouped into various areas.

The main aim of paper is to reveal the relations between the GCI and other selected multi-criteria indices, namely GII, DBI, EFI and CPI. To perform the analysis, we choose the aggregation of EU–28 countries.

For this paper, our research question (RQ) can be formulated as follows:

RQ: *Is there a statistically significant relation between the GCI and other multi-criteria indices GII, DBI, EFI and CPI within the EU-28 countries which reveals the impact of different economic areas on global competitiveness development?*

The data relating to individual indices was collected on the basis of annually published online reports and available dataset over the period of 2014–2018 (5 years). As the following research part is focused on deeper analysis of the selected five multi-criteria indices, a brief overview of their structure and research orientation is given in Table 1.

In order to compare data, we had to make some adjustments. The score ranges of individual indices are different, so data comparisons were not possible and appropriate. For this reason, we decided to transform the original GCI scores by a simple adjustment to a score moving in the same range (in this case is a range from 0 to 100), as follows:

$$I_{adjusted\ index} = (I_{basic\ index} / 7) * 100 \qquad (1)$$

To investigate the relations between the selected independent variable Y (GCI) and other dependent variables X_1(GII), X_2(DBI), X_3(EFI) and X_4(CPI), we have applied a multiple linear regression model in the in the following form:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + \eta, \qquad (2)$$

where b_0, b_1, b_2, b_3, b_4 are structural parameters of the model and η is the random component.

To process the above mentioned data, the STATISTICA software (13th ed.) was used.

Results

The following empirical part of research is focused on describing the results of analyses carried out in an effort to reveal the relations between the GCI and other selected international indices (GII, DBI, EFI, CPI) within the EU–28 member states over the period of 2014–2018.

Firstly, in order to obtain a general overview of the development as well as actual situation of the above mentioned indices, the attention was focused on their average (overall) score within the individual EU–28 countries. Based on the results and compiled ratings over the 5 years monitored, we have analyzed the average score of EU–28 member states as a whole, the V4 countries (the Czech Republic, the Slovak Republic, Poland, Hungary) and Slovakia. Besides assessing their positions, overall scores and score ranges, we have also identified the best and the worst evaluated country within the individual indices (see Table 2). Brief comments concerning the assessment of individual indices over the years 2014–2018 are presented in the text below, starting with the most common one, the GCI.

The average GCI score of EU–28 countries (68.94) ranged from the minimum value of 58.29 recorded by Greece, up to the maximum value of 80.33, unsurprisingly recorded in the case of Germany. During the years 2014–2018, Slovakia's GCI score was below the average level achieved by EU–28 countries as well as V4 countries (64.16), thereby Slovakia reached the 24th position. Over the analysed period, the average GII score (within the all countries evaluated) reached the lowest values in comparison with other multi-criteria indices. Based on the comparative analysis of the GII across the EU–28 countries, we can conclude that the lowest value was achieved by Romania (38.20), vice-versa, the highest score was recorded by Sweden (63.04). When evaluating the V4 countries, the GII score reached the level of 44.34, which was essentially lower then score compared to EU–28 member states (49.76). Slovakia's GII score (42.58) belonged to the worst one, so country ranked 22nd within the all European countries.

When evaluating the average scores of DBI, it can be seen that countries achieved the highest values at all, with one exception of maximum score reached (also) by Denmark (84.44). On the other side, Malta was identified as a country with the lowest achieved score (64.20). For this index, even the lowest score range was recorded (20.25). The average DBI score within the all EU–28 countries recorded the level of 75.49, whereas, the situation in V4 countries was very similar. Only in this case Slovakia was able to attain score higher than V4 countries, which indicates its relatively attractive business environment (17th position within the European countries).

The assessment of countries analysed on the basis of EFI was very similar as in the case of GCI score analysis. Within the all EU–28 countries, the highest average score was identified for Estonia (77.56), on the contrary, Greece reached the lowest value (55.04). The EU–28 countries as a whole obtained the average level of 69.29 and V4 countries recorded even lower EFI score (68.53). Unsurprisingly, Slovakia fluctuated below the level of above mentioned aggregations and ranked 22th on average.

In the context of CPI, it is important to emphasise that lower CPI value indicates a higher level of corruption. Thus, countries with the value of 100 are characterized as countries with the lowest level of corruption, and vice-versa. By comparing the individual countries, the average score of EU–28 member states was indicated at the level of 64.74, the V4 countries reached the most significant difference (54.00). This result expresses that the issue of abuse of power for private gain in the public sector is a serious problem. It is necessary to emphasise that for this index, even the highest score range was recorded (47.80). The maximum CPI score was achieved by Denmark (89.80), vice-versa, the minimum score was identified by Bulgaria (42.00). Over the 2014–2018, Slovakia's CPI was recorded at the average value of 50.40 (22th position in European rankings).

In order to achieve the main aim of this paper, we have focused on the analysis of causal relations among variables on the basis of the regression analysis. The regression analysis is targeted to maximize the output (*dependent*) variable (Y). In this case, the output variable is represented by the average value of GCI score in the case of EU–28 member states as a whole. Input (*independent*) variables (X) are represented by individual indices GII, DBI, EFI and CPI. The purpose was to quantify the impact of selected indices (their overall score) on the total GCI score and to find out what changes of indices leads to the increase/decrease of the GCI score. Within the EU-28 countries, the regression analysis was performed for each monitored year from 2014 to 2018 (separately).

Based on the countries' score in the case of all analysed indices, the first regression equation per year 2014 was quantified. The results of the statistical output of the estimated variables for the GCI are presented in Table 3.

The results of regression analysis confirmed the direct proportional relations among the GII score, CPI score and the overall GCI score. It means that an increase in the value of any of these 2 indices caused an increase in the total score of GCI in 2014. In the case of other indices, the statistically significant relationship was not confirmed. The determination factor (R^2) reached the value of 0.8921, which means that our model explained up to 89.21 % of variability. Based on the results, it is obvious that the impact of independent variables varies. The regression analysis indicated that increas-

ing the value of the GII score by one unit will cause an increase in the overall GCI score by 0.4350 points and increasing the value of the CPI score by one unit will cause an increase of GCI score by 0.1819 points. In the previous analysis (see Table 2), we found out that GII and CPI indices reached the lowest score compared to all other selected indices. Based on the results, we can consider GII and CPI as key determinants of global competitiveness of EU–28 member states.

In order to examine the relations among GCI score and other selected indices in the case of year 2015, the attention was paid to compile the second regression equation. Table 4 provides the statistical results of the estimated variables.

The second regression analysis statistically confirmed direct relations among the GII score, CPI score and the GCI score. The created model explained about 89.57% of variability, as the determination factor (R^2) achieved the value of 0.8957. Therefore, we can state that the significant determinant values were different, again. The regression results indicated that increasing the value of the GII score by one unit will cause an increase in the value of the GCI score by 0.4374 points. Otherwise, in the case of CPI, a statistical dependency on the GCI score at the level of 0.1907 was confirmed. Statistically significant interdependency for other indices was not confirmed. Taking into account the regression findings and previous analysis, we can conclude that GII and CPI indices represented key factors in the process of increasing the global competitiveness of EU member states.

In the following partial analysis, we have focused on creating the third regression equation per year 2016. The statistical output of the estimated variables for the GCI indicator is presented in Table 5.

In accordance with regression analysis, we can state that in direct proportional dependencies among the GII score, CPI score and the overall GCI score was confirmed. These results expressed that an increase of GII and CPI scores will lead to an increase in the total score of GCI. The statistically significant relationship was not confirmed for other indices. The determination factor (R^2) reached the value of 0.8765, which means that our model explained up to 87.65% of variability. The impact of independent variables differs again. The regression equation showed that increasing the value of the GII score by one unit will cause an increase in the overall GCI score by 0.3800 points and increasing the value of the CPI score by one unit will cause an increase of GCI score by 0.2591 points. Based on these findings, we come to an identical conclusion as in the previous partial analyses.

Additional analysis was dedicated to quantifying the regression equation in the context of selected indices score. In this case, we have focused on revealing the dependencies among variables per year 2017. The results of the estimated variables are presented in Table 6.

Based on the results achieved in year 2017, we can state that regression analysis confirmed the direct proportional dependencies among the GCI score and two independent variables (CPI and GII). The analysis confirmed the identical findings. An increase in the score of the above-mentioned indices will lead to an increase in the total score of GCI. The statistically significant relationship was not confirmed for other indices. The determination factor (R^2) reached 0.9179, which means that the compiled model explained up to 91.79% of variability. In this regard, it is obvious that the impact of independent variables was different. The regression analysis indicated that increasing the value of the CPI score by one unit will cause an increase of the GCI score by 0.2138 points and increasing the value of the GII score by one unit will cause an increase of GCI score by 0.4967 points.

In the last part of this section, we have also aimed at revealing the dependencies among GCI, GII, CPI, DBI and EFI score. In this case, the analysis was realized per year 2018. Table 7 provides the statistical output of the estimated variables for the GCI indicator.

Results of the regression analysis per year 2018 revealed that among the GCI indicator, as dependent variable, and GII and CPI indices there is a significant relation. The statistically significant interdependencies were not confirmed for other indices. The direct proportional dependencies mean that an increase in the score of GII and GCI indices will cause an increase the total value of indices. The determination factor (R^2) is 0.9248, so this model explains up to 92.48 % of variability. As the independent variables presents, the impact of indices varies. The regression analysis indicates that increasing the value of the GII score by one unit will cause an increase the GCI indicator by 0.5533 points and increasing the value of the CPI indicator by one unit will cause an increase of GCI value by 0.2031 points.

In the last part of the performed analysis, we formulated the regression model using the average score of all analysed indices. Table 8 provides the statistical results of the estimated variables for GCI indicator. Based on the composed regression equation, the statistical relations of GCI indicator, GII and CPI indices was confirmed. Our model explains 91.36% of variability, as the determination factor (R^2) reached the value of 0.9136. Furthermore, the regression analysis did not confirm the statistically significant relations for the other indices. The independent variables values showed that an increase of the CPI score by one unit will cause an increase in the overall GCI value by 0.2034 points and increasing the value of the GII score by

one unit will cause an increase of GCI value by 0.4753 points. Based on these results, we revealed the identical findings compared to every partial analysis. So, in order to increase the global competitiveness within the all EU member countries, it is necessary to focus on increasing the GII and CPI scores.

Discussion

The stage of country development in accordance with the Global Competitiveness Index was analysed by Kharlamova *et al.* (2013). The authors were dedicated to monitor the correlation between the competitiveness level and the factors that can potentially increase/decrease competitive advantages of a state. A similar approach within competitiveness assessment was applied by Vevere *et al.* (2017). The authors conducted a comparative analysis of the Baltic countries compared to average of the European Union by using the KOF Index of Globalization, the Corruption Perception Index, the Global Competitiveness Index and the Global Innovation Index. The results confirmed a significant impact of innovations on the global development of competitiveness.

As reported by Rusu and Dornean (2019), to increase the competitiveness, a country has to outperform its competitors in terms of research and innovation, entrepreneurship, competition, and education. In their study, the authors aimed to test the relationship between the quality of entrepreneurial activity and the economic competitiveness for the European Union countries by using panel data estimation techniques over the period 2011–2017. The results obtained confirmed that business, macroeconomic environment and the quality of entrepreneurship are significant determinants of economic competitiveness of the EU countries. The empirical research presented by Chapcakova *et al.* (2019) was also devoted to the global competitiveness issue. The contribution focused on quantification of the selected macroeconomic impacts on the national competitiveness assessment of countries in the European Economic Area (EEA). In terms of the indices assessing the competitiveness of countries analysed, the authors selected the Index of Economic Freedom (EFI), the World Competitiveness Scoreboard (WCS) and the Global Competitiveness Index (GCI). In each of the panel tests performed, the existence of certain differences between the European and the regional level was confirmed. Moreover, the authors revealed a directly proportional dependence between the competitiveness of the economy and the year-on-year GDP growth rate, as well as economic freedom. Rusu & Roman (2018) provided other similar research in the context of global

competitiveness evaluation. The main aim of paper was to analyse the key economic factors influencing the competitiveness of Central and Eastern European countries. The research was carried out on a sample of ten countries (Bulgaria, the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovenia and Slovakia) over the period 2004–2016. An econometric analysis on panel data was used, considering as a dependent variable the competitiveness of a country quantified by the Global Competitiveness Index. As independent variables, a set of seven macroeconomic and business environment indicators was taken into account. The results distinguished important differences between countries, but also some resemblance. Despite this fact, the significant impact of all indicators on the national competitiveness level was confirmed.

In order to compare and discuss the obtained results with other empirical researches, the following part briefly summarizes the paper's main findings. To reveal the relations among individual indices, we have applied a multiple regression model for every single year (5 years at all) and came to the following conclusions:

- in all regression analyses performed, statistically significant relations were confirmed between the GCI and two indices, namely GII and CPI;
- the year-on-year comparison indicated a gradual increase in the regression constant b_0, which is related to the gradual increase of the GCI average score; the highest year-on-year increase was recorded in 2016 (0.46%) and the lowest in 2018 (0.17%);
- when evaluating the interannual development of regression coefficient (b_1) for GII and CPI, it is evident that GII achieved higher regression coefficient (0.4753 on average) compared to the regression coefficient for the CPI (0.2034 on average) in every year analyzed;
- overall, the year-on-year GII regression coefficient was increasing with one exception in 2016, when its minimum value reached the level of 0.3800; in this context, GII coefficient ranged from 0.4350 recorded in 2014 up to the maximum value of 0.5533 recorded in 2018;
- in the case of the CPI, the regression coefficient also recorded an increasing trend from 2014 (0.1819) to 2016 (0.2591); however, the coefficient gradually declined to 0.2031 (2018).

The findings confirmed that the global competitiveness by means of the GCI indicator is significantly related to the level of innovation potential and corruption in EU member states as a whole. The global competitiveness growth of European countries was influenced mainly by innovation development represented by the GII indicator. Over the analysed period, the average GII score of EU–28 countries achieved the value of 49.76 (from maximum score 100). According to results achieved, the best average score

was recorded by Sweden (63.04), vice-versa, the lowest one by Romania (38.20). The second identified important factor affecting the global competitiveness of countries was the perception of corruption measured by the CPI. Within EU member states, the average score of CPI achieved the value of 64.76. The highest score was recorded in the case of Denmark (89.8), compared to Bulgaria which recorded the lowest score at all (42.0). In this regard, the results revealed the high range score of CPI at the level of 47.80 pointing to significant differences in perceptions of corruption among all European countries. A considerably lower score (24.84) was recorded in the case of innovation assessment. Insufficient GII scores achieved by EU-28 countries pointed to actual problems in the area of innovation development over the past decades.

As a result of this research study, the issue of innovation development and corruption perception is considered to be key determinants influencing the assessment of global competitiveness of the EU–28 economies. It is necessary to emphasize that our results and findings are close to many above-mentioned research studies highlighting the essential importance of innovation activities and the quality of business and political environment in process of increasing national and regional competitiveness.

Conclusions

In the past few decades, the issue of countries' competitiveness assessment has intensified mainly by influence of globalization. In this regard, many international organizations are concerned with their evaluation by using various multi-criteria indices which allow evaluate the economic development of countries from different perspectives (the level of globalization and innovation, economic and business conditions, human development, etc.).

The level of competitiveness of countries is affected by many factors and determinants. In this paper, we focused on revealing the relations between the GCI and other selected multi-criteria indices that are used to evaluate the level of innovations (GII), business environment (DBI), economic freedom (EFI) and perception of corruption (CPI) for the period of 2014–2018. These indices were used for the analysis of various competitiveness aspects within the EU member states.

Based on obtained findings, the summary results of the article can be formulated in the following points. Almost in all analyzed years, we confirmed a significantly positive impact of innovation activities and perception of corruption on increasing the competitiveness of EU–28 member states. The gradual increase of the GCI average score was also identified,

which indicates the improving level of global competitiveness of analyzed countries. The regression coefficients of innovation achieved higher values in every single year, so it can be concluded that innovation are the most important factor influencing competitiveness. Besides, it is necessary to state that in case of innovation and corruption issues, the worst overall scores were detected.

Countries' innovation strategies must coordinate disparate policies toward scientific research, technology commercialization, information technology (IT) investments, education and skills development, tax, trade, government procurement, and regulatory policies in an integrated fashion that drives economic growth. Ultimately, countries' innovation policies aim to explicitly link science, technology, and innovation with economic and employment growth, effectively creating a game plan for how they can compete and win in innovation-based economic activity. Furthermore, in the corruption area, effective law enforcement is essential to ensure the corrupt are punished and break the cycle of impunity. So, it is important to end immunity of policymakers. As another example, reforms focusing on improving financial management and strengthening the role of auditing agencies are of high importance. The special institutions also have an important role, as they contribute to the detection of corruption, reduce leakages of funds and improve quantity and quality of public services. Furthermore, the major financial centers urgently need to put in place ways to stop their banks and cooperating offshore financial centers from absorbing illicit flows of money.

Of course, this research paper contains several limitations. Because of inconsistent available data, the analysed period was quite short. Moreover, relatively simple methods of analyses have been applied. In the context of the Fourth Industrial Revolution (4IR), further research will be focused on deeper analyses of GCI 4.0 as it emphasizes the role of drivers of long-term growth of competitiveness, e.g. human capital, innovation-innovation capability, technology-new information and communication technologies and resilience.

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Annex

Table 1. Brief structure overview of the analysed indices

Index	Area of interest	Brief index structure and orientation
GCI	global competitiveness, productivity and economic growth	The overall GCI score is composed of twelve general pillars that are on the basis of their content and M. Porter's theory integrated into three main subindexes containing the following pillars: − *1st Subindex* – Basic requirements (1st – 4th pillar*),* − *2nd Subindex* – Efficiency enhancers (5th – 10th pillar*),* − *3rd Subindex* – Innovation and sophistication factors (11th – 12th pillar*).*
GII	innovation, research activities, knowledge and technology	The final GII score is the simple average of two main sub-indices: − *Innovation Input Subindex* – represented by 1st – 5th input pillar capturing the elements of national economy that enable the implementation of innovative activities. − *Innovation Output Subindex* – consists of 6th – 7th pillar, which are considered to be the results of innovative activities within the economy and they have the same weight in calculating the overall GII score.
DBI	macroeconomic stability, business environment and regulation	The methodology of DBI calculates the percentile for the individual indicators of the economy. The overall DBI is calculated on the basis of 11 different indicator sets (dimensions), whereas the first ten DBI dimensions (*Starting a business, Dealing with construction permits, Getting electricity, Registering property, Getting credit, Protecting minority investors, Paying taxes, Trading across borders, Enforcing contracts, Resolving insolvency*) are included in the DBI score and the last dimension (*Labor Market Measures)* only provides information on the state and development in this area.
EFI	sense of liberty, property rights, economic and personal freedom	The overall EFI score consist of twelve aspects (components) of economic freedom that covers own formulas and methodology used to compute the overall score which is grouped into four broad categories: − *1st Category* – Rule of law (1st– 3rd component), − *2ndCategory* – Government size (4th – 6th component), − *3rdCategory* – Regulatory efficiency (7th – 9th component), − *4thCategory* – Market openness (10th – 12th component).
CPI	public sector corruption	The composite CPI is based on the hundreds specific question used to collect data capturing the nine aspects of corruption (*Bribery, Diversion of public funds, Prevalence of officials using public office for private gain*, *Ability of governments to contain corruption and enforce effective mechanisms*, *Red tape and excessive bureaucratic burden,* etc.) and country's rank indicates its position relative to the other countries included in the index.

Source: Sala-i-Martín *et al.* (2017); Dutta *et al*. (2018); World Bank Group (2019); Miller *et al.* (2018); Rubio *et al.* (2018).

Table 2. Average values analysis (out) of the analysed indices

	Ø GCI	Ø GII	Ø DBI	Ø EFI	Ø CPI
EU–28	68.98	49.76	75.49	69.29	64.74
V4	64.16	44.36	74.56	68.53	54.00
SR	61.84	42.58	74.63	66.24	50.40
Maximum score *(Country)*	80.33 *(Germany)*	63.04 *(Sweden)*	84.44 *(Denmark)*	77.56 *(Estonia)*	89.80 *(Denmark)*
Minimum score *(Country)*	58.29 *(Greece)*	38.20 *(Romania)*	64.20 *(Malta)*	55.04 *(Greece)*	42.00 *(Bulgaria)*

Table 3. The statistical output of the estimated variables for GCI score in 2014

Variable	estimate	Std. err. of b	t-Statistic	p-value
Intercept	**21.48548**	**8.718024**	**2.464490**	**0.021618***
GII_{2014}	**0.435010**	**0.140331**	**3.099898**	**0.005049***
DBI_{2014}	0.181872	0.124722	1.458218	0.158302
EFI_{2014}	-0.006681	0.144379	-0.046262	0.963501
CPI_{2014}	**0.181915**	**0.076552**	**2.376255**	**0.026198***

Table 4. The statistical output of the estimated variables for GCI score in 2015

Variable	estimate	Std. err. of b	t-Statistic	p-value
Intercept	17.70560	9.256228	1.912831	0.068301
GII_{2015}	**0.437402**	**0.136458**	**3.205349**	**0.003928***
DBI_{2015}	0.138433	0.133009	1.040793	0.308789
EFI_{2015}	0.076331	0.124816	0.611506	0.546862
CPI_{2015}	**0.190655**	**0.072939**	**2.613776**	**0.015523***

Table 5. The statistical output of the estimated variables for GCI score in 2016

Variable	estimate	Std. err. of b	t-Statistic	p-value
Intercept	**26.60686**	**10.69407**	**2.488000**	**0.020530***
GII$_{2016}$	**0.380016**	**0.15831**	**2.400340**	**0.024867***
DBI$_{2016}$	0.022441	0.15737	0.142594	0.887852
EFI$_{2016}$	0.064122	0.13387	0.478994	0.636465
CPI$_{2016}$	**0.259083**	**0.08708**	**2.975187**	**0.006773***

Table 6. The statistical output of the estimated variables for GCI score in 2017

Variable	estimate	Std. err. of b	t-Statistic	p-value
Intercept	**24.07518**	**8.277321**	**2.908571**	**0.007912***
GII$_{2017}$	**0.496742**	**0.130617**	**3.803031**	**0.000916***
DBI$_{2017}$	0.058881	0.122385	0.481083	0.635003
EFI$_{2017}$	0.027413	0.095630	0.286661	0.776939
CPI$_{2017}$	**0.213793**	**0.074999**	**2.850617**	**0.009050***

Table 7. The statistical output of the estimated variables for GCI score in 2018

Variable	estimate	Std. err. of b	t-Statistic	p-value
Intercept	**30.02860**	**8.283900**	**3.62494**	**0.001421***
GII$_{2018}$	**0.553274**	**0.120714**	**4.58329**	**0.000132***
DBI$_{2018}$	0.173822	0.117553	1.47862	0.152807
EFI$_{2018}$	-0.168201	0.093870	-1.79179	0.086334
CPI$_{2018}$	**0.203112**	**0.071451**	**2.84268**	**0.009218***

Table 8. The statistical output of the estimated variables for GCI score on average for period of 2014–2018

Variable	estimate	Std. err. of b	t-Statistic	p-value
Intercept	**23.51489**	**8.542282**	**2.752764**	**0.011332***
GII$_{\varnothing2014-2018}$	**0.475303**	**0.136004**	**3.494733**	**0.001953***
DBI$_{\varnothing2014-2018}$	0.110554	0.125959	0.877643	0.389214
EFI$_{\varnothing2014-2018}$	0.004371	0.112319	0.038879	0.969323
CPI$_{\varnothing2014-2018}$	**0.203382**	**0.075650**	**2.688389**	**0.013120***