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The Assessment of the EU(28) Member States Innovation Potential Related to Entrepreneurship: The Influence of Cross-Border Activity and R&D Expenditure

Beata Sofrankova[1]*, Erika Onuferova[1], Dana Kiselakova[1], Veronika Cabinova[1]

[1]Deparment of Finance, University of Presov in Presov, Faculty of Management, Slovakia

***Corresponding Author:** Ing. Beata Sofrankova, PhD., Assistant to the Head of the Department of Finance, Faculty of Management, University of Presov in Presov, Slovakia.*

ABSTRACT

Innovation leading to increased productivity is the fundamental source of increasing wealth in an economy. Hence, the innovation is the most important factor for countries that guarantees employment growth, sustainable growth, social welfare and the quality of life. It´s obvious, that firms and entrepreneurs are at the centre of the innovation process and any innovation leads to a new product or service with an impact on long-term economic growth. The main aim of this paper was to examine the impact of the cross-border activity (representing by the indicators as high-tech exports, exports and imports) and gross domestic expenditure on R&D on the EU(28) countries' innovation potential (using Global Innovation Index) over the years 2011 – 2018 in the context of global enterprise development. We obtained secondary data by processing databases such as Eurostat, the World Bank and the annual GII reports. To reveal the relations between the dependent variable (Global Innovation Index) and independent variables (high-tech exports, R&D expenditure, import and export), the regression analysis was applied. Based on the results of the regression analysis, we conclude, that there is a statistically significant relationship between the innovation potential of EU (28) countries, cross-border activity and R&D expenditure. A stronger impact on innovation was confirmed in the case of R&D expenditure (0.6845 on average) and high-tech exports (0.4655 on average). In line with the findings, we recommend to improve business initiatives in the high-tech manufacturing process to increase cross-border productivity, as well as, continually increasing R&D expenditure, which will have an important impact on the innovation potential of companies and countries in Europe.

Keywords: *Global Innovation Index, R&D expenditure, Import, Export, High-tech exports, EU(28) countries*

INTRODUCTION

Innovative activity is an important source of competitiveness, economic growth, as well as the sustainable development of each country. At present, the factors of innovative potential are analyzed by research academics from the perspective of enterprise's innovativeness (micro scale) in relation to impact on the economy (macro scale). According to Galindo-Martin, Mendez-Picazo, Castano-Martinez (2019), economic growth is one the most relevant economic objectives for policy makers. In order to determine the variables that enhance such an objective it is important to consider entrepreneurial activity in relation to innovation activity. Malik (2020) presented that innovation is fundamental to the process of an economy's growth and is crucial for its survival in today's dynamic world. As reported by Nonaka et al. (2014), the whole process comes to replacing the obsolete solutions with solutions adapted to the knowledge-based economy as well as innovative economy that is one that is gaining advantage through innovation. Pukala, Sira, Vavrek (2018) claim that development of enterprises is often based on new and unique technologies and this is also reflected in gradually increasing expenditure aimed at stimulating the development of innovation and the effects of research and development work that contribute to creating novel solutions and increase the innovation level among enterprises. Authors Kaynak, Altuntas, Dereli (2017) agree that innovation is important for countries in the competitive global economy. It is one of the main criteria for countries to be superior, to remain competitive, and to produce high technology products. As well as, the increase in innovativeness is a priority for the EU which for years has been running a policy of supporting the development of innovations in member states (Eurostat 2018). Besides, as

reported by Chawla (2020), the economic growth and innovation potential of nations is strongly associated with rising R&D expenditures. The EU is aware of this and its current strategy, Europe 2020, states that 3% of GDP should be allocated to R&D by 2020 at the latest and this should boost innovation levels and make the EU a top global economic leader.

In accordance with above-mentioned claims concerning the growing importance of countries' innovation development, we focused on analyzing the interrelations between innovation potential of EU (28) member states (represented by Global innovation index), cross-border activity of enterprises (represented by indicators as exports, imports and high-tech exports), and R&D expenditure. Furthermore, we aimed to examining the development of all variables used within presented research over the years 2011-2018. An effort was to reveal the impact of innovation factors on enterprises development in global environment.

Global Approach to Countries´ Innovation Potential Assessment

In recent times, innovation and technological activities have been recognized as a major source of economic growth and have been prioritized in national policy with a greater attention. The advantage of innovation has become a critical determinant to achieve the higher growth rates of countries. As reported by Kowalska et al. (2018), the economic development of every country and its competitiveness on the world market is supported by the creation of innovation (knowledge-based economy), especially from an Industry 4.0 point of view. An almost unanimously accepted issue is that the path to competitiveness of economies, whose companies are exposed to international competition, goes through innovation. This enables companies to adapt quickly to the pace of the technological change, in order to increase competitiveness (Ciocanel, Pavelescu 2015). Authors Mihai, Titan (2014) perceive the innovation as an essential element to generate sustained economic growth. However, we cannot speak of innovation without a high level of education or a high standard of living. According to Yusr (2016), innovation plays a critical role in predicting the long-term survival of organizations, determining an organization's success and sustaining its global competitiveness, especially in an environment where technologies, competitive position and customer demands can change almost overnight, and where the life-cycle of products and services are becoming shorter. Belas et al. (2018) confirmed that innovations are an important part of business activities, because of their impact on financial performance of enterprises and it leads to achieving countries growing competitive environment. As reported by Anton, Bostan (2017), in the extant literature, there is a broad consensus on the positive relationship between entrepreneurial activity, on the one hand, and innovation, job creation, and economic development, on the other hand.

Since the 1980s, experts began to create concepts measuring the innovation performance of countries from global perspective. Many international institutions through reports provide valuable information concerning to the innovation development and competitiveness of countries to various subjects operating in the unstable economic environment in order to compare countries and recognize the future trends and challenges. In this context was launched the ***Global Innovation Index (GII)*** examining the innovation capacity of countries. On the basis of GII conceptual framework, each ranking reflects the relate positioning of particular economy or country, because every year the sample of economies are changed.

INSEAD launched a project in 2007 entitled "The Global Innovation Index (GII)" whose objective was to find the metrics and approaches that might be better to measure the development of innovation in society and across the border (Khalid, Zhiying 2015). As reported by Dutta, Benavente (2011), the project was suggested with a goal to better capture the richness of innovation in society and exceed traditional innovatory measures (such as the number of PhD students, the number of published research articles, patents or the amount of R&D expenditures atc.). In general, the GIIassesses the country by exploiting its innovative potential, it means how the countries are able to fulfill their potential.

The GII relies on two main sub-indices: The *Innovation Input Sub-Index* and the *Innovation Output Sub-Index*. Each of them consists of pillars made up of three other sub-pillars. Overall, the GII indicator examines 81 partial indicators. Four basic values (scores) are quantified (Dutta et al. 2019):

1. *Innovation Input Sub-Index*– representing five input pillars capture elements of the national economy that enable the

implementation of innovative activities (54 indicators).

- *1st Pillar: Institutions*
- *2nd Pillar: Human capital and research*
- *3rdPillar: Infrastructure*
- *4st Pillar: Market sophistication*
- *5th Pillar: Business sophistication*

2. *Innovation Output Sub-Index– innovation outputs are the results of innovative activities within the economy and although the Output Sub-Index includes only two pillars (27 indicators), it has the same weight in calculating the overall GII score.*
   - *6th Pillar: Knowledge and technology*
   - *7th Pillar: Creative outputs*
3. *The overall GII score– is the simple average of both sub-indices.*
4. *The Innovation Efficiency Ratio– is the ratio of the Output Sub-Index to the Input Sub-Index and indicates how much innovation output a given country is getting for its inputs.*

As reported by Dutta et al. (2019), all available official data needed for index construction are obtained from international organizations as the World Bank, the United Nations Educational, Scientific and Cultural Organization, the World Intellectual Property Organization, the International Energy Agency, the International Telecommunications Union as well as other private organizations.

The Research Linkage of the Innovation to Cross-Border Activities and R&D Expenditure

During the last two decades, a vast literature has addressed the issue of innovation and their impact on cross-border activities of countries. Today when globalization process is increasing, innovation enable to achieve positional advantages and better economic outcomes (Hasanov, Abada, Aktamov 2015). In this respect, innovation can constitute one of the main channels fueling a firm's entry in foreign markets (Lo Turco, Maggioni 2014). Tuhin (2016) emphasized that firm innovation and export behavior are mutually driven processes. As reported by Andrijauskiene, Dumciuviene (2019), a remarkable increase in the attention devoted to national innovative capacity (NIC) has been noticed over the last decades. An investigation of 28 European Union member states in the period of 2007-2017 shows that the international transmission of knowledge through import spillovers has a positive effect on trademark applications and exports of high-tech products. Authors Chen, Zhang, Zheng (2017) also investigated the relationship between imports and innovation. They constructed a theoretical model in which imports stimulate innovation through cost-reducing knowledge spillovers. High-tech firms tended to experience greater increases in innovation intensity, as do private firms. The issue of cross-border activities in connection to innovation level was analysed also by Pirja (2016). In order to compare the relations, they have with each other, author studied their effect in the innovation and other factors (productivity and technology) related to the total economic situation. The research of authors Li, Millman, Chi (2011) was focused on examining how innovation and exports at the firm-level give impact on their technology imports. Results suggested that innovation is significantly positively associated with its technology imports.

As reported by Pelikanova (2019), sustainable development cannot be achieved in highly competitive global society without innovations. Undoubtedly, innovation is indispensable and needs to be financed. To make an initial step to address this issue, authors investigated what fraction of GDP goes towards R&D, expressed by GERD, and what is the GERD trend in the EU and selected EU member states. The presented study revealed that the 3% threshold is not met in the larger part of the EU and the differences between EU member states regarding innovations can still grow. According to Li (2017), enterprises are lack of the enthusiasm of R&D investment. Public R&D subsidies may reduce the cost of R&D investment and promote R&D investment of enterprises. However public R&D also has the extrusive effect to the R&D investment of enterprises. Research paper presented evidence on the effects of public R&D subsidies on the R&D investment of technological innovation enterprises. The results showed that public R&D subsidies can stimulate the R&D investment of enterprises. There also exist different effects of public R&D subsidies between different scales, proportion of state-owned shares and managerial ownership of enterprises. Akcali & Sismanoglu (2015) stated that international competition and sustainable growth have increased the

importance of Research and Development (R&D) expenditure. So for this, a good R&D level is required for whole countries. The increase of the R&D level forms a basis for the innovation to move. The main scope of their study was to investigate the relationship between R&D corresponding with innovation and economic growth and to analyze their relative influence on some developing and developed countries in the world.

DATA AND METHODOLOGY

The main aim of this paper was to examine the impact of the cross-border activity (representing by the indicators as exports, imports and high-tech exports) and gross domestic expenditure on R&D (GERD)on the EU(28) countries' innovation potential (by means of Global Innovation Index) over the years 2011 – 2018 in the context of global enterprise development.

Moreover, this article is focused on the development analysis of EU (28) countries in the context of global innovation potential (represented by GII indicator), cross-border activities (represented by export and import indicators), high-tech exports (represented by high technology products) and R&D expenditure. The briefly description of selected variables is given in the following Table 1.

Table1. *List of variables examined in the analysis*

Variable	Description	Unit of measure
Global Innovation Index (GII)	The GII relies on two main sub-indices: The Innovation Input Sub-Index and the Innovation Output Sub-Index. Overall, the GII indicator examines 81 partial indicators.	score
High-tech Export (HTE)	The data shows the share of exports of all high technology products in total exports.	% of exports
Export of Goods and Services (EXP)	Exports of goods and services consist of transactions in goods and services (sales, barter, and gifts) from residents to non-residents.	at current prices in million EUR
Import of Goods and Services (IMP)	Imports of goods and services consist of transactions in goods and services (purchases, barter, and gifts) from non-residents to residents.	at current prices in million EUR
Gross domestic expenditure on R&D (GERD)	Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications	% of GDP

Source: *Authors' processing*

The analyses of the EU (28) countries' innovation position were performed on the basis of secondary data drawn and subsequently processed from the annual reports that are the result of a collaboration between the Cornell University, INSEAD, and the World Intellectual Property Organization (Dutta, et al. 2019). Furthermore, the other needed secondary data concerning the cross-border activities, were retrieved from the Eurostat (2019) database. The information about government expenditure on R&D was retrieved from the World Bank (2019) database.

In accordance to the above-mentioned theoretical approaches and the main aim of this research paper, the following hypotheses were set:

Hypotheses 1 (H1): *There is a statistically significant relation between the assessment of global innovation potential (GII) and exports activity within the EU(28) countries.*

Hypotheses 2 (H2): *There is a statistically significant relation between the assessment of global innovation potential (GII) and imports activity within the EU(28) countries.*

Hypotheses 3 (H3): *There is a statistically significant relation between the assessment of global innovation potential (GII) and R&D expenditure within the EU(28) countries.*

For the purposes of meeting the goals of presented study, we performed regression analysis presenting one of the multidimensional statistical methods. The role of regression analysis when examining statistical dependence of Y on X is to find a suitable mathematical model (function) in which the idea of this dependence is expressed. This model was adapted to investigate the relationship among

one dependent variable (GII indicator) and independent variables (import, export and high-tech export). For analyzing the relationship among variables, a linear regression model was used. The linear relation is a mathematical relationship that can be expressed by the regression model (Hendl 2015):

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_n x_n + \varepsilon_i \quad i = 1,2,\ldots, n$$

where y_i- i^{th} *value of variable Y in the basic file,*
x_n- i^{th} *value of the variable X in the basic file,*
$ß_0$- *intersection of the y-axis with the regression line,*
ε_i- i^{th} *random error of variable,*
$ß_n$- *regression coefficient in the basic file.*

To process the above-mentioned data, the STATISTICA software (13th edition) was utilized.

Empirical Results

At first step, the research was targeted to describing the results of performed analysis focused at examining the average values of the selected variables (global innovation index, export, import, high-tech exports and R&D expenditure) over the year 2011 to 2018 within EU(28) member states. An ambition was to compare individual countries, to identify not/leading countries, as well as assess the level of innovation potential, cross-border activity and government expenditure on R&D within EU countries.

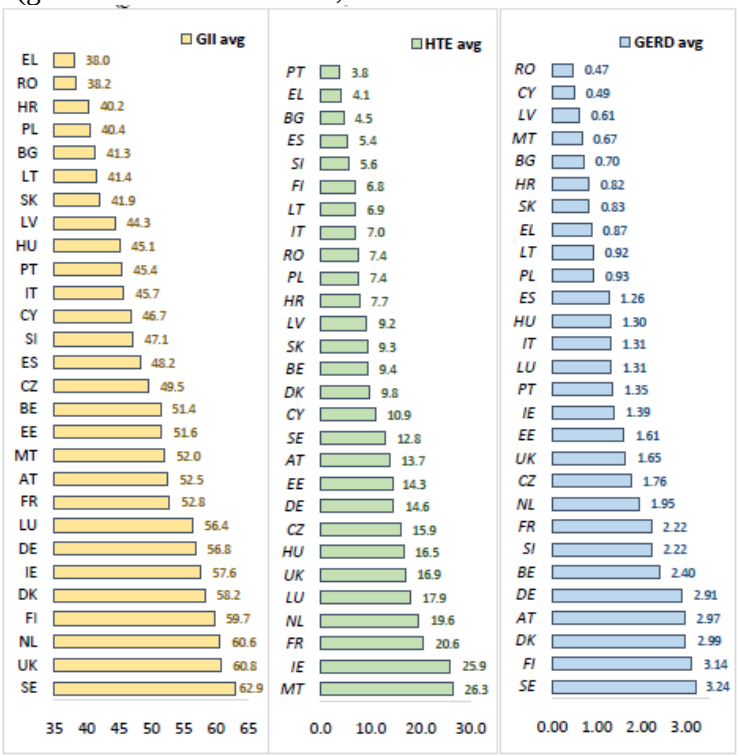


Figure1. *The comparison of the average GII, HTE and GERD within the EU(28) (2011-2018)Source: authors' processing*

The Analysis of the Global Innovation Index (GII)

The following part was devoted to the analysis of innovation potential of EU(28) member countries represented by GII indicator. The comparison of average values of GII scores is presented in the previous Figure 1. To begin with, it is important to emphasize that the innovation potential of countries is quantified through scores ranging from 0 to 100. Over the reporting period, the innovation potential of EU(28) countries achieved range of values at level 24.9 points on average. Moreover, the standard deviation was quantified at level 7.51, kurtosis at level -1.16 and skewness at level 0.17. Sweden achieved the best innovation performance (62.9) and this country was indicated for the leader country of EU during the period analyzed. In contrast, the lowest GII score was reached by Greece (38.0). When comparing the innovation average scores of

countries, we can state that only 3 European countries (Sweden, United Kingdom and Netherlands) achieved the level of innovation over 60 points, while 2 countries (Greece, Romania) had not even achieved a score of 40 points.

High-Tech Exports (HTE)

In the next section, we pay attention to analysis of the selected determinant of innovation potential, namely the indicator of high-tech exports. In the previousFigure 1 we presented the average values of this indicator over the monitored period in order to compare individual EU(28) countries.

The second indicator that was the object of the realized analysis is called high-tech exports. In this case, it is necessary to state that this indicator is express as share of high technology products on overall exports of country (in %). The results of the analysis showed that Malta was indicated as the country with the highest share (26.3%), while Portugal achieved the lowest share (3.8%).It follows that the share was in the range of 22.6 %. Furthermore, based on descriptive statistics analysis we identified the standard deviation of values at level 6.31, kurtosis at level -0.06 and skewness at level 0.81. Looking at the results, we also found that only 3 countries (Malta, Ireland, France) within EU achieved a share of high-tech products on exports at level more than 20 %, while up 3 countries (Bulgaria, Greece, Portugal) achieved share below 5 %.

Gross Domestic Expenditure on R&D (GERD)

The development analysis concludes with an evaluation of R&D expenditure (GERD). In the previous Figure 1, we presented the average values of this indicator over the monitored years within EU(28) member states.

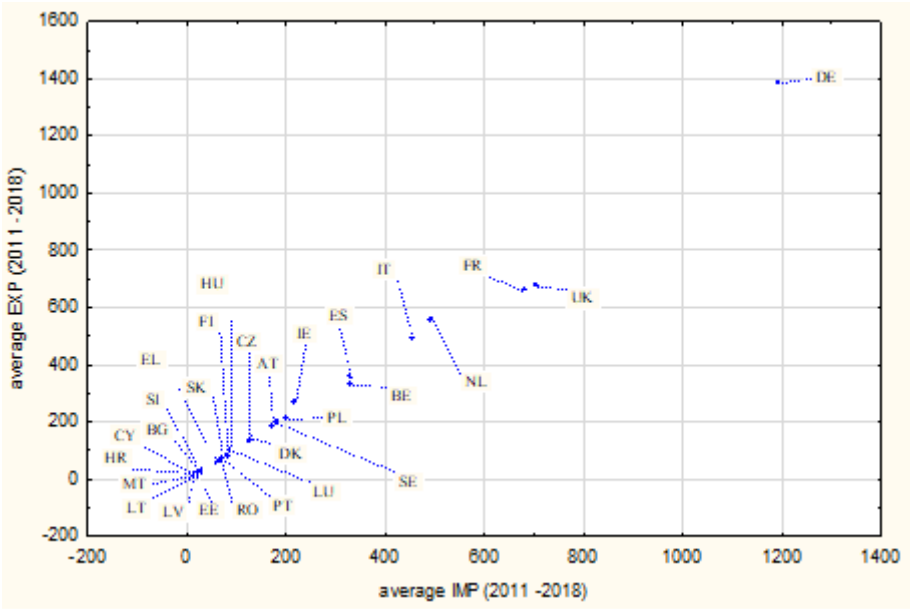
Based on founded results, we can state that government expenditure on R&D (as % of GDP) varied within individuals EU countries. The R&D expenditure ranged from 0.38 % to 3.71 %. Accord to Europe 2020 strategy, 3 % of GDP should be allocated to R&D. This condition was fulfilled only by two countries - Sweden and Finland. Both countries spent on R&D 3.18 % of GDP on average and were ranked to the European leaders in this area. Furthermore, up to 16 countries invested more than 1 % of GDP on R&D. On the other hand, to the worst-performed countries in this sphere were belonged Cyprus and Romania (R&D 0.48 % on average). Moreover, findings showed that the government expenditure on R&D within EU member states achieved value at 1.58 %. This result not comply the goals of EU and it is important to pay more attention to solving this problem. However, looking at the development analysis, we can claim that in recent two years was indicated growing trend, so it is positively.

Exports (EXP) and Imports (IMP)

In assessing cross-border activity, at first we focused on exports data analysis of the EU(28) countries over the period of 2011-2018 on average. Based on the results, we came to the following findings. Germany was indicated as the unequivocal EU leader (the only one country of EU that achieved export above EUR 1,000,000 million). The second rank was held by United Kingdom, however this country reached about half lower value of exports. On the other hand, the lowest export value was achieved in the case of Cyprus and Malta. The gap between the country with the highest and lowest export activity was considerable, range at level EUR 1,372,896 million. In connection to the above-mentioned results, we can state that similar findings were revealed for import activity too. The lowest import values were found for Malta and Cyprus again. In comparison, Germany achieved almost 100 times higher import values over the analyzed period on average and ranked 1st position in this ranking. In accordance with presented findings, we can conclude that range of imports values between the best and the worst country achieved EUR 1,178,956 million.

In accordance with the above analyses, we also focused on the assessing the individual EU countries (28) in terms of overall cross-border activity. However, in this case, the aim was to compare countries with regard to the achieved values of import and export all at once. In our opinion, this assessment of cross-border activities is most effective as it captures both aspects of the international activities of countries. The resulting average values of above-mentioned indicators in absolute values are presented in the following two-dimensional Figure 2 (in EUR billion). We can see that Germany achieved significantly better results than the rest of the European countries during the analyzed period. France and the UK also performed very well, taking both indicators into account. For the period under review, among the European countries belonging to the average

were included Czech Republic, Luxembourg and Hungary. The group of the least performing countries in view of export and import consisted of Bulgaria, Cyprus, Croatia, Malta, Latvia, Lithuania and Estonia on average from 2011 to 2018.



Source: *Authors' processing*

Figure2. *The cross-border efficiency ratio of the EU(28) countries (on average of 2011-2018)*

Within the export and import evaluating process, it is essential to monitor the ratio of the two variables, not only to analyze the indicators themselves. For this reason, we have decided to examine the relations between these indicators and so to compare the effectiveness of each EU country (28) with a view to better identifying their impact on innovation potential in the next part of the research. Based on assessing the cross-border activity efficiency ratio within EU(28) countries we founded the interesting results. Out of the total number of countries, up to 20 countries achieved the favorable value of the efficiency indicator (higher exports than imports). The remaining 8 countries (Portugal, Croatia, Finland, Latvia, France, United Kingdom, Romania and Greece) reached the values below 1, but at the same time, the indicator range above the level of 0.9, which can be assessed positively. The best results were recorded in the case of Ireland with an efficiency ratio at the level of 1.24. On the opposite, Greece achieved the lowest share of exports to imports (0.93).

Results of Regression Analysis

The next part of this study was devoted to the investigation of the selected independent variables impact (HTE, R&D, IMP and EXP) on dependent variable (GII) using the regression analysis. We decided to create three regression models in order to examining the impact of export and import on the innovation potential of countries separately, as well as, to consider the influence of R&D government expenditure. The high-tech exports indicator, as a key determinant of innovation activities (we are coming out of theoretical research), was included as a factor into all regression models. In the following tables we provided the regression analysis results.

Table2. *Result of regression analysis among the GII, HTE and GERD indicators*

	Regression Summary for Dependent Variable: **$GII_{2011-2018}$** R= .8470; R^2= .7175; Adjusted R^2= .7149; F(2.221)=280.61; p<0.0000; Std. Error of estimate: 0.5339					
	b*	Std. Err.	b	Std. Err.	t(221)	p-value
Intercept			0.0000	0.0357	0.0000	1.0000
$HTE_{2011-2018}$	0.4727	0.0360	**0.4727**	0.0360	13.1266	0.0000
$GERD_{2011-2018}$	0.6485	0.0360	**0.6485**	0.0360	18.0075	0.0000

Source: *Processing of Authors*

In the first part of statistical research, we analyzed the impact of HTE and GERD indicators on innovation development. With regard to Fisher's test criterion at the selected significance level α = 5% (p = 0.0000), we can state that created linear regression equation (Table 4) is appropriate. The coefficient of determination (R^2), which explains the variability of the dependent variable (GII), achieved value 71.75%. As in the previous regression analysis, in this case also the regression equation confirmed the statistically significant impact of both independent variables on GII indicator (p=0.0000). When comparing independent variables, we can state that a higher impact on GII was revealed in the case of the GERD indicator (0.6485).

Table3. *Result of regression analysis among the GII, HTE and IMP indicators*

	Regression Summary for Dependent Variable: **$GII_{2011-2018}$** R= .6261; R^2= .3921; Adjusted R^2= .3866; F(2.221)=71.261; p<0.0000; Std. Error of estimate: 0.7832					
	b*	Std. Err.	b	Std. Err.	t(221)	p-value
Intercept			0.0000	0.0523	0.0000	1.0000
$HTE_{2011 - 2018}$	0.4659	0.0545	**0.4659**	0.0545	8.5482	0.0000
$IMP_{2011 - 2018}$	0.3103	0.0545	**0.3103**	0.0545	5.6928	0.0000

Source: *processing of authors*

The analysis of the appropriateness of the created regression analysis (Table 1) showed that the second linear regression equation is appropriate with regard to Fisher's test criterion at the selected significance level α = 5% (p = 0.0000). The coefficient of determination (R^2), which explains the variability of the dependent variable (GII), achieved value 39.21%. Moreover, the regression equation confirmed that both independent variables are statistically significant and to determine the score of GII indicator (p=0.0000). While the causal relationship is not strong, but it should be emphasized that this quantification suggests only one unit to change of the HTE and IMP variables. When comparing independent variables, we can state that a higher impact on GII was revealed in the case of the HTE indicator (0.4659).

Table4. *Result of regression analysis among the GII, HTE and EXP indicators*

	Regression Summary for Dependent Variable: **$GII_{2011-2018}$** R= .6266; R^2= .3926; Adjusted R^2= .3871; F(2.221)=71.430; p<0.0000; Std. Error of estimate: 0.7829					
	b*	Std. Err.	b	Std. Err.	t(221)	p-value
Intercept			0.0000	0.0523	0.0000	1.0000
$HTE_{2011 - 2018}$	0.4652	0.0545	**0.4652**	0.0545	8.5356	0.0000
$EXP_{2011 - 2018}$	0.3114	0.0545	**0.3114**	0.0545	5.7134	0.0000

Source: *processing of authors*

In the case of the last regression analysis, we detected the following findings. The linear regression equation is appropriate with regard to Fisher's test criterion at the selected significance level α = 5% (p = 0.0000). The coefficient of determination (R^2), which explains the variability of the dependent variable (GII), achieved value 39.26%. Moreover, the regression equation confirmed that both independent variables (exports and high-tech exports) significantly determined the score of GII indicator (p=0.0000). In comparison of independent variables within this regression model, we found that variable HTE have more significant impact (again) on GII indicator (0.4652). Based on performed analysis, we also revealed that correlation coefficient of above-mentioned variables ranged at level 0.6266.

CONCLUSION

The presented article was devoted to the development analysis of EU (28) countries in the context of global innovation potential, cross-border activities and R&D government expenditures over the period of 2011-2018 in effort to reveal the interdependencies among variables. The main aim was to examine the influence of innovation determinants on nations´ innovation development in linkage to entrepreneurship environment.

At first, attention was paid to development analysis of individual variables entering to our research. The EU countries (28) were gradually analyzed in terms of innovation potential, exports, imports and high-tech exports based on the achieved average values over the years 2011-2018.Taking into account the overall results, we can state that Germany, the United Kingdom, France and Netherlands ranked among the best performing countries. By contrast, Greece, Cyprus, Malta and Bulgaria achieved the lowest levels of innovation and cross-border activities. Also, Germany has been identified as the leader in cross-border activities, and as only one EU country recorded export and import values above EUR 1 billion. To the positive facts belong also that up to 20 countries achieved the favorable value of the cross-border efficiency ratio and the remaining 8 countries (Portugal, Croatia, Finland, Latvia, France, United Kingdom, Romania and Greece) reached the level of the indicator above of 0.9, which can be assessed positively. The analysis of government expenditure on R&D (GERD) revealed the following findings. In terms of Europe 2020 strategy, 3 % of GDP should be allocated to R&D, but this goals was fulfilled only by two countries (Sweden and Finland). Both countries spent on R&D 3.18 % of GDP on average and were ranked to the European leaders in this area. On the opposite, Cyprus and Romania belonged to the worst-performed countries in the area of government expenditures (R&D 0.48 % on average).

Based on the performed research analysis over the period of2011-2018 within EU(28) countries, we can draw the following four conclusions:

1. Analysis results confirmed a medium-strong impact of cross-border activity (export and import) and R&D expenditure (GERD) on the innovation level of countries.
2. In the case of regression models examining cross-border activity was revealed the more significant impact of high-tech exports on innovations (on average 0.4655).
3. In the case of regression model examining government expenditure was revealed the more significant impact of GERD on innovations (on average 0.6485).
4. Based on correlation and regression analysis results, we can state that all hypotheses were confirmed ($p<0.0000$), so there is a statistically significant relation between innovation potential of the EU (28) member countries, cross- border activity and R&D expenditure.

In line with the performed analyses, it is necessary to point the research limitations. To the main limitations of presented paper belongs the validity of study findings. In view of the economic disparities and different political interventions of the individual countries in this sphere, it's difficult to generalize research findings for all EU. For this reason, the regression models should be suggested for every country separately. Furthermore, we consider the assessment of the European countries' innovation potential via the cross-border activity and government expenditure as insufficient. Therefore, for future research, we recommend including other global determinants influencing innovation level of enterprises, as well as, to investigate concrete factors of countries innovation potential.

In the international environment, we can observe that global competition is intensifying, and Europe needs to deepen its innovation to compete on a market increasingly defined by new technologies. Within discussion section we compared our results to others. As reported by Sipa et al. (2016), what is of particular importance in this field is the European cohesion policy, which enabled the former Eastern Bloc countries to successfully implement a number of changes, some of which entailed increasing their innovation level. Within research, authors identified the similarities and differences between selected innovation factors of the Visegrad Group economies, focusing on R&D expenditure, R&D employment, and public access to the Internet. Based on results, they also confirmed the strong relationship between R&D expenditure, the number of patent applications submitted to the EPO and innovation potential. The paper of Palangkaraya (2012) investigated the direction of causality between export and import market participation and innovation using firm level data. The paper revealed a statistically and economically significant positive correlation between export and innovation.

On the basis of theoretical review and research findings, we come to the conclusion that our results were confirmed by other research papers. In accordance with study results, we recommend improving the business initiatives for creating high-tech products in linkage to increase of cross-border country productivity, as these drivers have a significant impact on improving

innovation potential of firms, as well as countries. Furthermore, the policymakers should pay more attention to solving the government expenditure issue related to the Europe 2020 strategy (at least 3% of GDP).

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