



## The impact of the innovative performance of the country on its economic development

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**Abstract:** Innovations are a way how to improve the quality of life, support sustainable solutions, attract talent, increase competitiveness, or increase GDP. The aim of the article is to verify the dependence of GDP per capita on the innovation performance of the country by the regression and correlation analysis. The secondary data contained in the European Innovation Scoreboard 2023 (for the innovation performance) and the related EUROSTAT datasets within the EU countries (for the level of countries' wealth) were used. According to the results, there is a significant interdependence between innovation performance of the country and its wealth. There have not been many empirical studies realized in Slovakia yet. The author herself dealt with the evaluation of the innovation performance of the SR in her previous studies. Her motivation is to use quantitative method to analyse this issue in a more detail.

**Keywords:** innovations, economic development, regression analysis

**JEL classification:** O11, O30

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## Vpliv inovativne uspešnosti države na njen gospodarski razvoj

**Povzetek:** Inovacije so način, kako izboljšati kakovost življenja, podpirati trajnostne rešitve, privabljati talente, povečevati konkurenčnost ali povečevati bruto domači proizvod (BDP). Cilj članka je preveriti odvisnost BDP-ja na prebivalca od inovacijske uspešnosti države s pomočjo regresijske in korelacijske analize. Uporabljeni so bili sekundarni podatki iz Evropskega indeksa inovacij za leto 2023 (za inovacijsko uspešnost) ter povezani podatki EUROSTAT-a znotraj držav EU (za raven bogastva držav). Po ugotovljenih rezultatih obstaja pomembna medsebojna odvisnost med inovacijsko uspešnostjo države in njenim bogastvom. V Slovaški doslej ni bilo veliko empiričnih študij. Avtorica se je že v prejšnjih raziskavah ukvarjala z ocenjevanjem inovacijske uspešnosti SR. Njena motivacija je uporaba kvantitativne metode za bolj podrobno analizo tega problema.

**Ključne besede:** inovacije, gospodarski razvoj, regresijska analiza

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## 1 INTRODUCTION

Advantages of innovative activity include, among others, that they are an important source of competitiveness and economic growth. Countries where many innovations are created and applied are more competitive and it is expected that their higher innovation performance leads to higher wealth of the country. However, the innovation performance varies among individual the EU countries, and so the wealth of the countries.

In this regard, it makes sense to measure the country's innovation performance and compare it either with a defined group of countries (in the case of Slovakia, these are V4 countries, Central and Eastern European countries, EU countries, etc.), or from a global perspective.

There are several ways how to measure and evaluate the innovation performance of a country. In this article, the Summary Innovation Index (SII), a tool used for analyzing the innovative ability of European countries, is used. The SII is a composite indicator, so - called performance score calculated from the indicators in the European Innovations Scoreboard (EIS). The latest edition of the European Innovation Scoreboard 2023 distinguishes between four main types of activities with 12 innovation dimensions, capturing in total 32 indicators (Table 1). Each group and all indicators have the same weight.

Table 1. The EIS 2023: indicators

FRAMEWORK CONDITIONS	INNOVATION ACTIVITIES
Human resources	Innovators
1.1.1 New doctorate graduates (in STEM)	3.1.1 SMEs with product innovations
1.1.2 Population aged 25-34 with tertiary education	3.1.2 SMEs with business process innovations
1.1.3 Lifelong learning	
Attractive research systems	Linkages
1.2.1 International scientific co-publications	3.2.1 Innovative SMEs collaborating with others
1.2.2 Top 10% most cited publications	3.2.2 Public-private co-publications
1.2.3 Foreign doctorate students	3.2.3 Job-to-job mobility of Human Resources in Science & Technology
Digitalisation	Intellectual assets
1.3.1 Broadband penetration	3.3.1 PCT patent applications
	3.3.2 Trademark applications
1.3.2 Individuals who have above basic overall digital skills	3.3.3 Design applications
INVESTMENTS	IMPACTS
Finance and support	Employment impacts

2.1.1 R&D expenditure in the public sector	4.1.1 Employment in knowledge-intensive activities
2.1.2 Venture capital expenditures	4.1.2 Employment in innovative enterprises
2.1.3 Direct government funding and government tax	Sales impacts
Firm investments	4.2.1 Medium and high-tech product exports
2.2.1 R&D expenditure in the business sector	4.2.2 Knowledge-intensive services exports
2.2.2 Non-R&D innovation expenditures	4.2.3 Sales of product innovations
2.2.3 Innovation expenditures per person employed in	Environmental sustainability
Use of information technologies	4.3.1 Resource productivity
2.3.1 Enterprises providing training to develop or upgrade ICT skills of their personnel	4.3.2 Air emissions by fine particulates PM2.5 in industry
2.3.2 Employed ICT specialists	4.3.3 Development of environment - related technologies

Source: own compilation according to the EIS 2023

Figure 1 depicts that the best-placed country in the EIS 2023 is Denmark, which has overtaken Sweden. Sweden has held the leading position for several years. Other leaders in innovation are the countries of Finland, the Netherlands and Belgium (in the shades of dark green). Austria, Germany, Luxembourg, Ireland, Cyprus, France are "strong innovators" (in the shades of light green) and Estonia, Slovenia, Czech Republic, Italy, Spain, Malta, Portugal, Lithuania, Greece and Hungary are considered to be "moderate innovators" (in the shades of yellow). Croatia, Poland, Latvia, Bulgaria and Romania together with Slovakia belong to the group of "emerging innovators" (in the shades of orange).

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*\*Another well - known way to measure and evaluate the innovation performance of the country is the Global Innovation Index.*

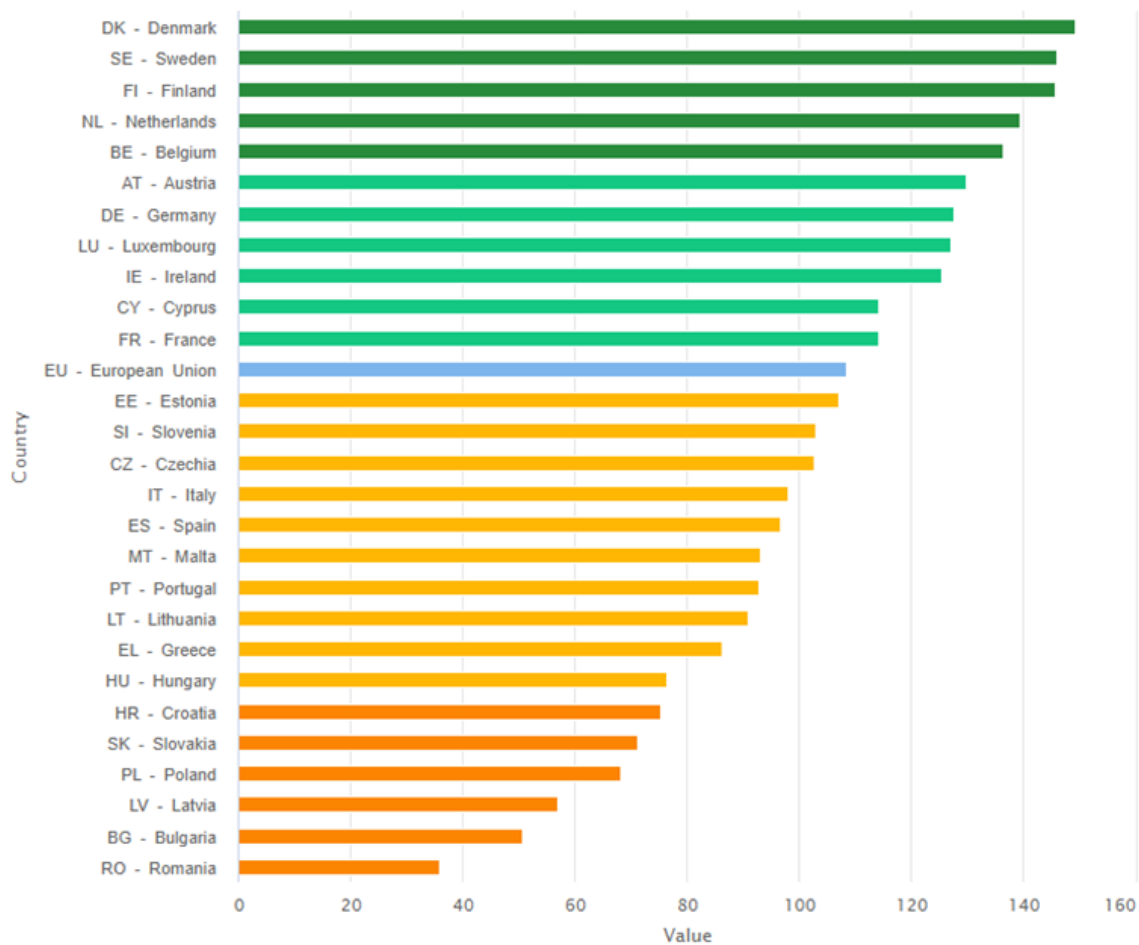


Figure 1. Score of the SII for EU countries  
Source: EC (2023)

In the survey, we used GDP per capita as an indicator of the countries' wealth especially for its comparability between individual countries and the uniform methodology of its measurement.

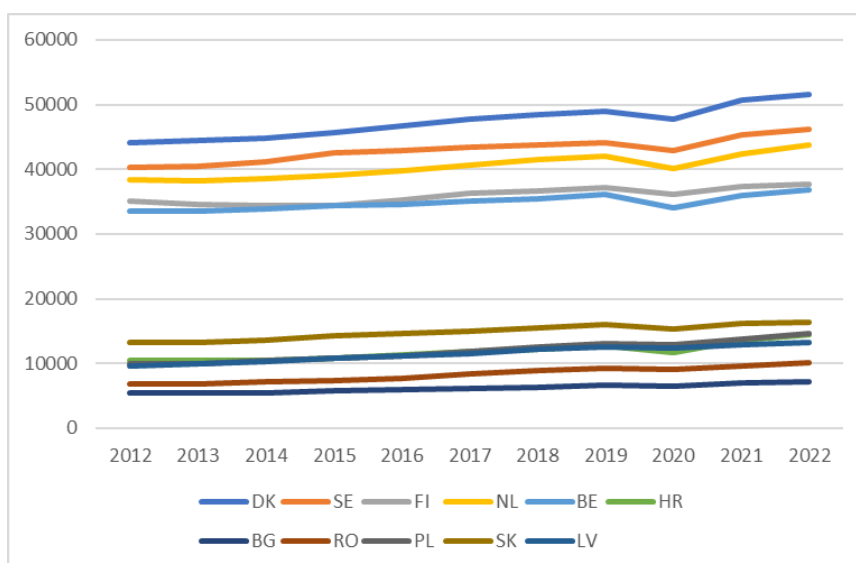


Figure 2. GDP per capita in selected EU countries in 2021 - 2022  
Source: EUROSTAT (2023)

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Following Figure 1, Figure 2 shows the development of GDP per capita of the largest and smallest innovators in the period 2012 - 2022. As we can see on the graph, the innovation leaders are also one of the wealthiest countries in the EU and the least innovative countries are one of the poorest countries in the EU. It indicates that countries with higher innovation scores tend to achieve higher GDP per capita.

The regression analysis was applied to examine a possible relationship between two variables. We assume that the value of the dependent variable (Y - GDP per capita) is affected by a change in the value of an independent variable (X - innovation performance).

We have documented a significant interdependence between the innovation performance of the country and countries' wealth.

## 2 LITERATURE OVERVIEW

The effort to strengthen innovation activity, whether of companies or countries in general, is often met with an interest in examining the relationship between innovation performance and macroeconomic variables. Special attention is paid to the dependence between innovation performance and economic growth. The economic growth theories indicate that there are three factors influencing GDP growth: capital increase, investments and increase of the workforce through population growth. Modern economic theories consider new technologies and knowledge to be the main source of economic growth (Solow's neoclassical growth model, Barro's and Romer's model). The representative of the endogenous growth theory Romer (1993), suggested that poor countries should adopt the technologies of better developed countries for faster economic growth. Fagerberg (2010) states that the ability of a poor country to catch up with the rich is a result of capital accumulation, as well as its ability to generate innovations. In an environment of constantly changing technologies, the country's long-term sustainable growth will increasingly depend on the country's research and development and innovation potential. Endo and Ikeda (2021) focused in their research on ways how the wealthy countries are reaching the already mentioned sustainable development. Similarly, Misankova and Chlebikova (2013) state that innovations play necessary part in continued economic growth.

There have not been many empirical studies realized in Slovakia yet. Fabova and Janakova (2015) stated that low innovation performance of the SR is the reason for its low competitiveness. Ivanová and Masárová (2018) evaluated the innovation performance of regions of the Visegrad Group with an emphasis on human capital. Janoskova and Kral (2019) analyzed the impact of the SII indicators in terms of the total value of the SII using samples from the V4 countries. Kučera and Fil'a (2022) proved a significant interdependence between R&D expenditure, innovation performance and level of economic development of the EU countries.

The author herself dealt with the evaluation of the innovation performance of the SR in her previous studies (2018, 2021). Her motivation is to use quantitative method to analyze this issue in a more detail and to verify the relationship of the innovation performance of the country with selected variable.

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### 3 METHODOLOGY

To verify the dependence of GDP per capita on the innovation performance of the country, a hypothesis was set and verified through regression analysis (Figure 3).

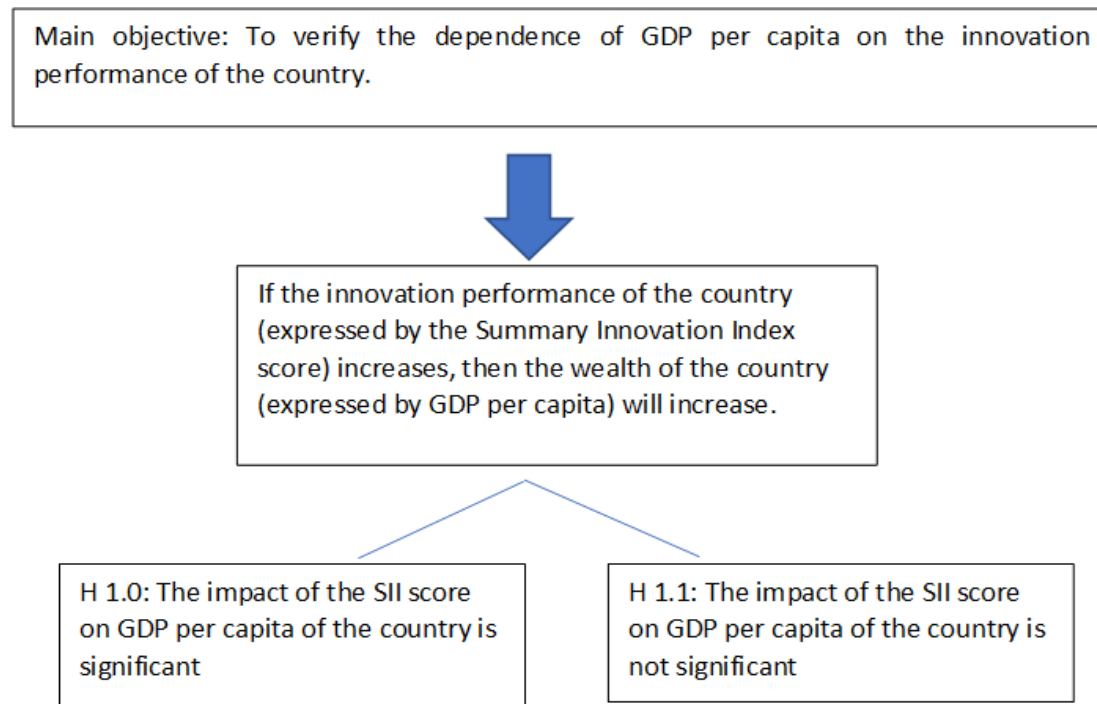


Figure 3. Aim and hypothesis  
Source: own processing

Data on the innovation performance (the SII) were collected on the basis of annual reports published by the European Commission: The European Innovation Scoreboard. Collecting data on economic growth (GDP per capita) were taken from the EUROSTAT datasets [https://ec.europa.eu/eurostat/databrowser/view/sdg\\_08\\_10/default/table](https://ec.europa.eu/eurostat/databrowser/view/sdg_08_10/default/table)

For the purposes of the research, GDP per capita was used to measure the countries' wealth. The fact we did not take into account other factors such as the quality of the environment, length of working time etc., can be understood as the limitation of the research. However, the growth of GDP depends on technological progress, which is not possible without innovation. Similarly, we did not monitor the contribution of individual components of innovation or their number, but we survey the overall innovation performance of the countries.

## 4 RESULTS AND DISCUSSION

To analyze the dependence between the level of innovation performance and GDP per capita we applied regression analysis.

After the initial analysis through visual assessment using X to Y depending chart, we chose a suitable mathematical function of which the curve best reflects the relationship between observed variables. Considering the nature of the data applied, an exponential function has been used. Table 2 contains the result of the regression analysis.

Table 2. The regression analysis output: the innovation performance and wealth of the countries

<i>Regression Statistics</i>	
Multiple R	0,877424
R Square	0,769873
Adjusted R Square	0,760668
Standard Error	0,126461
Observations	27

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	1,337542837	1,337543	83,63572	1,89E-09
Residual	25	0,399812083	0,015992		
Total	26	1,73735492			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
Intercept	3,637395	0,08579322	42,39723	8,26E-25	3,4607	3,814089	3,4607	3,814089
X Variable 1	0,007357	0,000804495	9,145257	1,89E-09	0,0057	0,009014	0,0057	0,009014

Source: own research

Since significance F - F test for statistical significance of the model is at 1,89E-09, which is considerably less than 0,05, we accept the hypothesis of the model significance. The exponential model used to analyze the dependence between the level of innovation performance and GDP per capita has proved to be statistically significant (Table 3).

Table 3. Summary of correlation and regression analysis output

hypothesis	Confirmation/refusal	Multiple R	R - square	Significance F
H1	YES	0,88	0,77	1,89E-0,9
H1.0	YES			
H1.1	NO			

Source: own research

Graphic processing of the regression analysis is included in Figure 4.

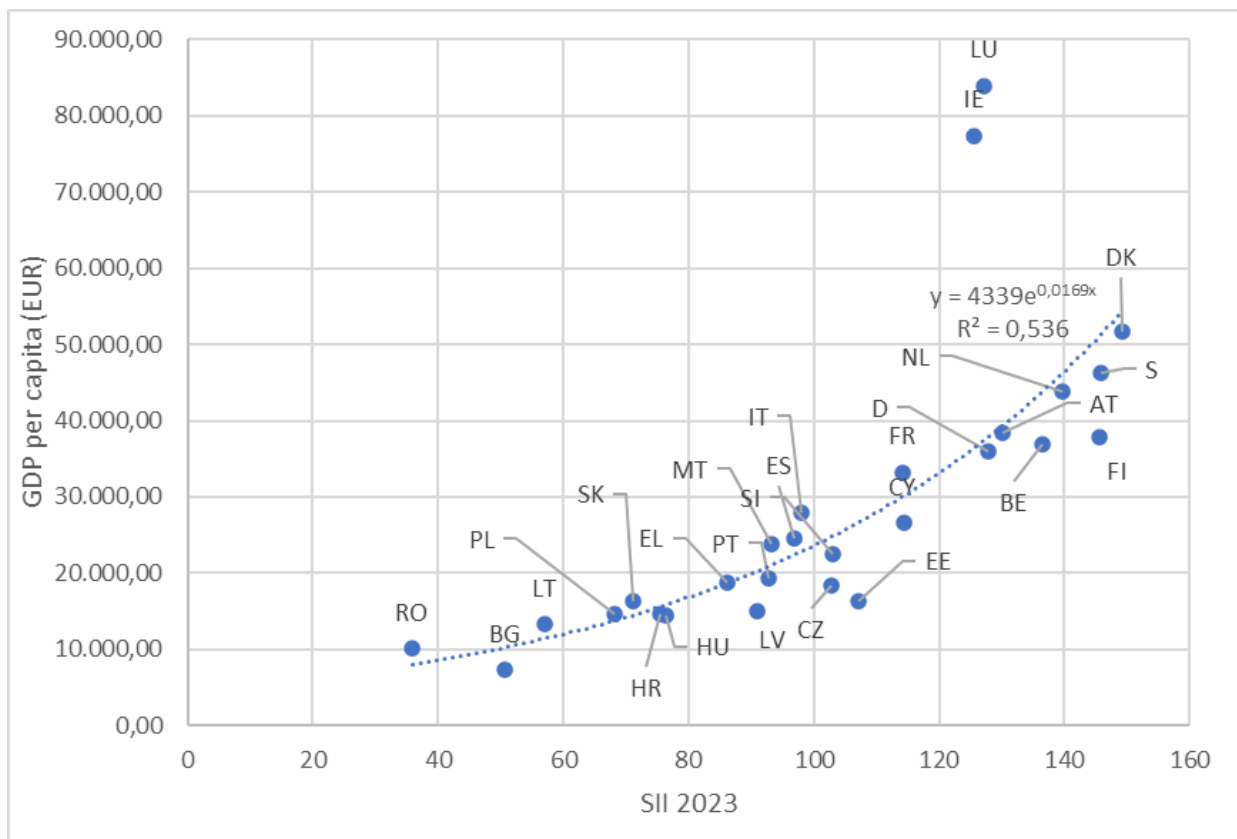


Figure 4. The relationship between the innovation performance of EU countries and the performance of the economy

Source: own compilation according to the EIS 2023 and EUROSTAT (2023)

Note: Sweden S, Austria AT, Belgium BE, Germany D, Finland FI, Denmark DK, Netherlands NL, France FR, Slovenia SI, Czechia CZ, Estonia EE, Portugal PT, Hungary HU, Italy IT, Greece EL, Poland PL, Spain ES, Ireland IE, Croatia HR, Lithuania LV, Luxembourg LU, Slovakia SK, Cyprus CY, Bulgaria BG, Latvia LT, Malta MT, Romania RO

Based on Figure 4, we can state that significantly better innovation scores are achieved by countries with a higher level of GDP per capita. Maintaining a higher level of innovative activity supports the growth of their economic performance, which in turn enables them to support the development of innovations, either in the form of an increase in research and development expenditures or by improving the competitive environment, etc. This creates a positive circle of growth. However, it is important to emphasize that in this case the largest economies of the European Union in terms of GDP per capita may not be the best leaders in the field of innovation. For example, Luxembourg, with the largest GDP per capita among the EU countries, achieves a lower innovation activity score than Sweden, Denmark or Finland. On the contrary, Slovakia lags behind countries with a relatively similar value of GDP per capita such as Lithuania, Estonia or the Czech Republic in the field of innovation activity.

The innovativeness of companies and countries depends on a whole range of technological, organizational and marketing innovations. The degree of innovativeness of the countries is also reflected in the structure of its exports. It can be assumed that countries with a low degree of innovativeness export mainly raw materials and semi-finished products, while countries with advanced innovation systems export mainly sophisticated goods and services.



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All European countries are aware of the importance of innovation in increasing the competitiveness of their economies. Considerations about competitiveness are intensified mostly when developed countries feel the threat of losing their markets or when the results of the world economy deteriorate. The innovative performance of the economy is largely conditioned by the effective functioning of the entire system of support for the creation and application of innovations.

## 5 CONCLUSIONS

Innovations are referred to as the driving force of economic development. The article focused on the relationship between innovation performance and wealth of the country. We used the Summary Innovation Index to measure and evaluate the innovation performance of the country. We indicated that the innovation leaders are also one of the wealthiest countries in the EU. Following this, we set the hypothesis that a higher innovation performance leads to higher wealth of the country. The analytical tools used include the regression analysis. For the purposes of the research, GDP per capita was used to measure the countries' wealth. The fact we did not take into account other factors such as the quality of the environment, length of working time etc., can be understood as the limitation of the research. However, the growth of GDP depends on technological progress, which is not possible without innovation. Similarly, we did not monitor the contribution of individual components of innovation or their number, but we survey the overall innovation performance of the countries. We have documented a significant interdependence between the innovation performance of the country and countries' wealth. However, there are some exceptions and it suggests that the innovativeness of companies and countries depends on a whole range of technological, organizational and marketing innovations. Regarding this, a multiple regression could be used in the future research.

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