

# The innovation gap between the new members of the European Union and the average level of EU innovation

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## Summary

In the modern world innovation is considered as one of the most important factors determining the rate of economic growth and the level of economic prosperity. The factors determining its development are today research and development activity (R&D), innovative activity and human capital.

The aim of the paper is to assess the results of analysis aimed at estimating an innovation gap between new members of the European Union (Countries that joined the European Union in 2004 and later) and the average level of innovation of the EU in the years 2004–2022. The paper is an introduction to further research including an analysis of the innovative capacity and innovative position of the surveyed countries, as well as an analysis of their innovative effectiveness with more in-depth exploration of the reasons for the convergence/divergence in innovation performance. The paper formulates the research thesis that assumes that the new member states of the EU did not catch up with an innovation gap in relation to the EU average in the years 2004–2022. The results of the analysis confirm this thesis for all countries except Estonia and Cyprus. The comparison is based on the Summary Innovation Index (SII), which was developed by the European Commission within the European Innovation Scoreboard (EIS). The paper reviewed

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the literature on the innovation gap. Descriptive analysis, statistical data analysis and comparative analysis methods were applied along with statistical data from the European Innovation Scoreboard in the period 2004–2022.

**Keywords:** innovation, innovation gap, European Innovation Scoreboard (EIS), Summary Innovation Index

**JEL:** O30, O31, O33, O43

## Introduction

Numerous facts in the modern world indicate that in order to understand the economic and social phenomena currently taking place in the global economy, one should assume that economic development is increasingly dependent on knowledge and innovation. The factors determining its development are: research and development activity (R&D), innovative activity and human capital. Innovation is considered as one of the most important factors determining the rate of economic growth and the level of economic prosperity. Awareness of the key role of knowledge and innovation in the development of the modern economy has increased the importance of simulating innovative processes in the economic policy of both highly developed countries as well as countries catching up with the leaders.

The aim of the paper is to present the results of analysis aimed at estimating an innovation gap between new members of the European Union and the average level of innovation of the EU in the years 2004–2022. The paper is an introduction to further research including an analysis of the innovative capacity and innovative position of the surveyed countries, as well as an analysis of their innovative effectiveness with more in-depth exploration of the reasons for the convergence/divergence in innovation performance. The paper formulates the research thesis that assumes that the new member states of the EU did not catch up with an innovation gap in relation to the EU average in the years 2004–2022. The results of the analysis confirm this thesis for all countries except Estonia and Cyprus. The comparison is based on the Summary Innovation Index (SII), which was developed by the European Commission within the European Innovation Scoreboard (EIS). The paper reviewed the literature on the innovation gap. Descriptive analysis, statistical data analysis and comparative analysis methods were applied along with statistical data from the European Innovation Scoreboard in the period 2004–2022.

## The concept of the innovation gap – the literature review

The innovation gap is a characteristic that is common to all contemporary developed economies. The concept of the innovation gap is variously interpreted in the economic literature. Kubiela defines the innovation gap as differences in the level of technological advancement between countries and proposes several methods to measure its size. He observes that it can be measured by the distance between the level of technological activity of a country and the countries at the technological frontier, calculated either as a ratio of the number of patents per capita or the share of research expenditure in value-added or national income (Kubiela 2009, p. 137). The literature review also shows indirect measures such as the share of high-tech products in exports in relation to a similar indicator for the technology frontier, the relation of the productivity of a given branch of the country to the country on the verge of technological frontier or, in aggregate terms, the relationship between GDP per capita and the corresponding indicator of the technological frontier (Kubiela 2009, p. 137). The last two approaches identify the technological gap with a productivity gap or income gap. The global technological frontier shall be deemed as the GDP level, which can be achieved by using the given inputs of capital and labor, and the best possible technologies (Growiec 2012). This level of GDP is now achieved by the U.S. economy, in which, as stressed by Kubiela, the distribution of specialization (between Pavitt's four sectors) is the standard for a technology leader. The highest competitive advantages are demonstrated by the science-based sector, followed by the specialized supplier sectors; the scale-intensive and traditional ones are characterized by negative indices of the comparative advantage, of which the traditional is the lowest on the scale of advantages of the U.S. economy (Kubiela 2009, p. 153).

In the literature, there is also the concept of the innovation gap, understood as the distance between individual economies and the so-called modern technological frontier. It is identified with the last stage of the socio-economic development of economies, i.e., the emergence of a knowledge-based economy (Zacher 2007, p. 530; Pawlik 2014, pp. 68–69, *National Systems of Innovation* 1992, pp. 25–36). To investigate this approach to the innovation gap, one should use a point of reference, which involves the initial conditions of building a knowledge-based economy, as formulated by Kleer (Kleer 2009): (a) the economy must achieve a sufficiently high level of income (about \$20,000 per capita), and the structure of GDP should be characterized by a high share of services in GDP – 70% or more; (b) society should be characterized by a high level of education, in which secondary education is widespread, and higher education covers at least half of the economically active population; (c) there should be a high share of expenditure on R&D (it is generally recognized that the size of the required outlays is about 3% of GDP); (d) the innovation of the economy manifests itself in minimizing

regulations and supporting innovative projects, not only in purely economic areas, but also in high expenditure of the public sector on research that directly and indirectly promotes development; (e) the economy and society are involved in the exterior exchange, which concerns not only the exchange of goods and services, but also the circulation of ideas (for which the information revolution has created enormous opportunities); (f) the modern public sector needs to be a mixed model, and not purely liberal.

It should be noted there are quite general definitions of the innovation gap in the literature, e.g. Kowalski states that the innovation gap is a broader concept, encompassing also non-technological innovation, such as process, and organizational or social innovation (Kowalski 2020, pp. 19–68). According to Djella and Gallouj „the innovation gap reflects the difference between the reality of innovation produced in an economy and what traditional innovation indicators (R&D, patents) capture (Djella, Gallouj 2015, pp. 1–4). The United Nations defines the innovation gap as the distance between those who have access to technologies and know how to use them effectively, and those who are not able to do it (Kraciuk 2006, p. 13). The innovation gap can be considered from the perspective of creating new technology in the home country, as well as from the perspective of its transfer from other countries and effectively adapting it to the needs and capabilities of the nation.

In summary, it can be stated that measuring the innovation gap means estimating the distance between a given country’s economy and the most developed economies of Europe and the world, known today as knowledge-based economies, in many areas, e.g., in the sphere of innovation, education, and institutional system. Estimating the innovation gap is possible by comparing synthetic measures of innovation, e.g., the *Summary Innovation Index* developed by the European Commission, the *Global Innovation Index* developed by Cornell University (*The Global Competitiveness Report 2018–2019; Annual Report 2021–2022*) in cooperation with the World Intellectual Property Organization (Weresa 2014, p. 64; Mielcarek 2013), or indicators that describe the advancement of the knowledge-based economy, e.g., the *Knowledge Index* and the *Knowledge Economy Index*, derived from the *Knowledge Assessment Methodology*.

## Research method

Innovation measurements are made based on various methods and measures. One of such methods is the *European Innovation Scoreboard*, developed by the European Commission. *The European Innovation Scoreboard* has been published since 2000, and it is an attempt to estimate the achievements of innovative European economies based on the SII. It is estimated using weighted values of normalized data, with the highest value of the indicator in the examined group of countries

equaling 1 and the lowest value equaling 0. Based on this indicator, four groups of EU economies that show different levels of innovativeness can be distinguished: *innovation leaders* – which present the highest level of innovation of the economy, *strong innovators*, *moderate innovators*, and *emerging innovators* (*European Innovation Scoreboard 2022*).

This paper presents an attempt to estimate the innovation gap based on the indicator that shows the difference between the level of the SII for a given country and the average value of this index for the European Union. The indicator of the innovation gap defined in this way takes the following form (Weresa 2014, p. 64):

$$L_{pt} = \frac{SII_{pt}}{SII_{UE_t}}, \quad (1)$$

where:

$L_{pt}$  – is the innovation gap index for a given country in relation to the EU average in year t;

$SII_{pt}$  – the Summary Innovation Index for a given country in year t;

$SII_{UE_t}$  – the average Summary Innovation Index for the EU in year t.

The value of the innovation gap index exceeding 1 means that the analyzed country presents a higher level of innovation than the EU average, while a value lower than 1 indicates the innovation gap exists between a given country and the EU average.

In order to assess the changes in the level of the innovation gap over time, a formula presenting the difference between the innovation gap index ( $L_{pt}$ ) in a given year and the value of this index for the previous year should be used. It is written as follows (Weresa 2014, p.64):

$$D_{pt_1} = \left[ \frac{SII_{pt_1}}{SII_{uet_1}} \right] - \left[ \frac{SII_{pt}}{SII_{uet}} \right], \quad (2)$$

where:

$D_{pt_1}$  – is an index of changes in the level of the innovation gap between a given country and the EU average in year  $t_1$  compared to year t;

$SII_{pt}$  – the Summary Innovation Index for a given country in year t;

$SII_{uet}$  – the average Summary Innovation Index for the EU in year t;

$SII_{pt_1}$  – the Summary Innovation Index for a given country in year  $t_1$ ;

$SII_{uet_1}$  – the average Summary Innovation Index for the EU in year  $t_1$ .

The index of the change in the innovation gap level ( $D_{pt_1}$ ) takes values from -1 to +1. Negative values indicate an increase in the innovation gap between a given country and the EU average, while positive ones indicate a decrease. Nevertheless, it should be emphasized that the analyzed index only indicates the direction

of changes, but it does not allow us to determine whether the distance shortens, or the previously gained advantage is gradually being lost (Weresa 2014, p. 65). Therefore, it is necessary to analyze the index of changes in the level of innovation gap ( $D_{pt1}$ ) in relation to the index of the innovation gap ( $L_{pt}$ ).

## Results and discussion

The following part discusses the empirical data on the level of innovation in the new EU member states in the years 2004–2022. Table 1 shows the values of the Summary Innovation Index for the new EU members and the average value for 28 EU countries in the years 2004–2022.

**Table 1.** The Summary Innovation Index for the new member states of the EU and the average value for 28 EU countries in the years 2004–2022

	Summary Innovation Index									
	2004	2010	2015	2016	2017	2018	2019	2020	2021	2022
EU28 average	0,45	0,533	0,493	0,495	0,501	0,512	0,514	0,533	0,539	0,542
Bulgaria	0,21	0,216	0,238	0,244	0,239	0,241	0,239	0,229	0,230	0,245
Czechia	0,33	0,4	0,404	0,409	0,417	0,416	0,428	0,443	0,444	0,502
Estonia	0,34	0,492	0,422	0,391	0,405	0,474	0,488	0,553	0,585	0,542
Croatia	0,23	0,281	0,284	0,291	0,291	0,3	0,306	0,34	0,35	0,36
Latvia	0,16	0,213	0,252	0,268	0,272	0,275	0,267	0,279	0,279	0,275
Lithuania	0,24	0,258	0,356	0,37	0,376	0,415	0,414	0,413	0,422	0,454
Hungary	0,25	0,333	0,343	0,345	0,344	0,354	0,34	0,352	0,364	0,378
Poland	0,21	0,304	0,272	0,28	0,29	0,288	0,294	0,296	0,307	0,328
Romania	0,15	0,259	0,176	0,175	0,17	0,159	0,166	0,189	0,191	0,177
Slovenia	0,34	0,499	0,497	0,492	0,495	0,476	0,461	0,473	0,492	0,507
Slovakia	0,22	0,322	0,326	0,319	0,336	0,332	0,333	0,326	0,326	0,349
Malta	0,27	0,351	0,426	0,434	0,447	0,471	0,487	0,534	0,482	0,459
Cyprus	0,29	0,495	0,392	0,395	0,411	0,43	0,415	0,537	0,55	0,579

Source: *European Innovation Scoreboard 2005, Comparative Analysis of Innovation Performance*, European Commission [https://www.astrid-online.it/static/upload/protected/Euro/European-Innovation-Scorebord-12\\_01\\_.pdf](https://www.astrid-online.it/static/upload/protected/Euro/European-Innovation-Scorebord-12_01_.pdf); *European Innovation Scoreboard 2007, Comparative Analysis of Innovation Performance*, European Commission, [http://aei.pitt.edu/46016/1/innovation\\_scoreboard\\_2007.pdf](http://aei.pitt.edu/46016/1/innovation_scoreboard_2007.pdf); *European Innovation Scoreboard (EIS) 2009*, European Commission, [http://aei.pitt.edu/46018/1/innovation\\_scoreboard\\_2009.pdf](http://aei.pitt.edu/46018/1/innovation_scoreboard_2009.pdf); *European Innovation Scoreboard 2011*, European Commission, <https://op.europa.eu/en/publication-detail/-/publication/705c770c-68f7-4f-90-ac2b-618cc6cc8ed7>; *European Innovation Scoreboard 2015*, European Commission, <https://op.europa.eu/en/publication-detail/-/publication/b00c3803-a940-11e5-b528-01aa75ed71a1>; *European Innovation Scoreboard 2019, Methodology Report*, European Commission, <https://www.insme.org/the-european-innovation-scoreboard-2019/>; *European Innovation Scoreboard 2019*, European Commission, [https://www.eustat.eu/elements/ele0016800/european-innovation-scoreboard/in-f0016823\\_c.pdf](https://www.eustat.eu/elements/ele0016800/european-innovation-scoreboard/in-f0016823_c.pdf) (access: 23 December 2022)

Table 2 shows the values of the innovation gap index for the new EU member states in relation to the EU average ( $L_{pt}$ ), and the index of changes in the level of the innovation gap between a given country and the EU average ( $D_{pt_1}$ ) in the years 2004–2022.

**Table 2.** The innovation gap index for the new member states of the EU in relation to the EU average ( $L_{pt}$ ), and the index of changes in the level of the innovation gap between the new member states of the EU and the EU average ( $D_{pt_1}$ ) between 2004 and 2022

		2004	2010	2015	2016	2017	2018	2019	2020	2021	2022
Bulgaria	$L_{pt}$	0,46	0,405	0,482	0,492	0,477	0,47	0,454	0,429	0,426	0,452
	$D_{pt}$	-0,008									
Czechia	$L_{pt}$	0,73	0,75	0,819	0,826	0,832	0,812	0,835	0,831	0,823	0,926
	$D_{pt}$	0,196									
Estonia	$L_{pt}$	0,75	0,923	0,855	0,798	0,808	0,925	0,949	1	1,085	1
	$D_{pt}$	0,25									
Croatia	$L_{pt}$	0,511	0,527	0,576	0,587	0,58	0,585	0,595	0,63	0,649	0,667
	$D_{pt}$	0,156									
Latvia	$L_{pt}$	0,355	0,399	0,511	0,541	0,542	0,537	0,519	0,523	0,523	0,599
	$D_{pt}$	0,244									
Lithuania	$L_{pt}$	0,533	0,484	0,722	0,747	0,75	0,81	0,805	0,774	0,766	0,837
	$D_{pt}$	-0,45									
Hungary	$L_{pt}$	0,555	0,624	0,695	0,696	0,686	0,691	0,661	0,66	0,675	0,697
	$D_{pt}$	0,142									
Poland	$L_{pt}$	0,466	0,57	0,548	0,565	0,578	0,562	0,571	0,555	0,569	0,605
	$D_{pt}$	0,139									
Romania	$L_{pt}$	0,333	0,485	0,356	0,353	0,339	0,31	0,322	0,354	0,354	0,326
	$D_{pt}$	-0,007									
Slovenia	$L_{pt}$	0,755	0,909	1	0,993	0,988	0,929	0,896	0,887	0,912	0,935
	$D_{pt}$	0,18									
Slovakia	$L_{pt}$	0,488	0,559	0,661	0,644	0,67	0,648	0,647	0,611	0,604	0,643
	$D_{pt}$	0,155									
Malta	$L_{pt}$	0,6	0,658	0,864	0,876	0,892	0,919	0,947	1	0,894	0,846
	$D_{pt}$	0,246									
Cyprus	$L_{pt}$	0,64	0,928	0,795	0,797	0,82	0,839	0,807	1,007	1,02	1,068
	$D_{pt}$	0,428									

$D_{pt}$  is compared to 2004.

Source: own calculations based on the data from Table 1.

Based on the data presented in Table 2, it can be concluded that most of the new EU member states showed an innovation gap compared to the average level of innovation of the economy in the European Union in the entire analyzed period; these were: Bulgaria, Croatia, Lithuania, Latvia, Poland, the Czech Republic, Hungary, Romania and Slovakia. Only Estonia, Slovenia, Malta and Cyprus in several years recorded the level of innovation of the economy corresponding to

the EU average or slightly exceeded this level. Slovenia reached the level of the EU average in 2015, in the following years it showed an innovation gap. Estonia reached the level of the EU average in 2020 and 2022 and slightly exceeded it in 2021. Malta reached this level in 2020. Cyprus, on the other hand, exceeded the average level of innovation of the EU economy in 2020, 2021 and 2022. As for Poland, it should be noted that in the years 2004–2021 the level of innovation of its economy oscillated around 50 percent of the EU average, in 2022 it exceeded 60 percent of the EU average.

On the basis of the  $D_{pt}$  indicator describing the direction of change in the innovation gap, it can be concluded that most of the new EU member states have reduced the innovation distance compared to the EU average in the years 2004–2022 – this distance has decreased to the greatest extent in the case of Cyprus, Malta and Latvia. Poland was also included in this group of countries, but the decrease in its innovation gap was insignificant ( $D_{pt} = 0.139$ ).

The obtained results confirm the conclusions formulated in the European Innovation Scoreboard 2022 (*European Innovation Scoreboard 2022; European innovation performance continues to improve in spite of challenges; These are the top 5 most innovative countries in the European Union*). In this ranking, the EU countries as in the previous years were divided into four groups according to the level of innovation of the economies: (a) innovation leaders – the results of innovation of the economy above 125 percent of the EU average, (b) strong innovators – the results in the range of 101-125 percent, (c) moderate innovators – the range: 70–100 percent, (d) emerging innovators – below 70 percent of the EU average. According to the EIS 2022 ranking, groups of EU countries with similar results are geographically concentrated – innovation leaders and strong innovators are mainly found in Northern and Western Europe, so these are the countries of the so-called “old” EU, while the majority of moderate innovators and emerging innovators are located in Southern and Eastern Europe, so they are mostly new EU member states. In the EIS 2022 ranking, among the new EU members, only Cyprus in 2022 was included in the group of strong innovators. The group of moderate innovators, which achieve the results of innovation of economies at the level of 80–100 percent of the EU average, includes Estonia, Slovenia, the Czech Republic, Malta and Lithuania. The group of emerging innovators includes: Hungary, Croatia, Slovakia, Poland, Latvia, Bulgaria and Romania.

## Conclusions

The results of the study presented in the article confirm the research thesis formulated in the introduction in relation to all new EU member states, except for Estonia and Cyprus. Thus, in 2022, most of the new EU members, apart from Estonia

and Cyprus, have not caught up with the innovation gap and show the innovation gap in relation to the EU average. In 2022 Estonia reached the average level of innovation of the EU economy, Cyprus slightly exceeded this level.

Based on the results of the study presented in the article, as well as the conclusions of the EIS 2022, it can be concluded that most of the new EU member states, have not caught up with the innovation gap 18 years after accession to the EU and still show the innovation gap compared to the EU average. It is therefore necessary for these countries to redefine the innovation policy and intensify their efforts to increase the innovation of their economies, e.g. as part of the activities provided for in the latest documents and programs of the European Union, i.e. the European Green Deal, which is a plan to build a sustainable EU economy, the “digital compass”, setting the direction of Europe’s digital transformation, or the research and development funding program “Horizon Europe 2021–2027” (*Closing the EU’s innovation gap: Member states must get more involved*, pp. 1–2; *Theme report on innovation, technologies and data. Towards the achievement of SDG 7 and net-zero emission*, pp. 19–20 ).

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## Streszczenie

### Luka innowacyjna nowych krajów członkowskich Unii Europejskiej

Innowacyjność jest uznawana we współczesnym świecie za jeden z najważniejszych czynników determinujących tempo wzrostu gospodarczego i poziom dobrobytu ekonomicznego. Czynnikiem determinującym rozwój są dziś działalność badawczo-rozwojowa (B+R), działalność innowacyjna oraz kapitał ludzki. Celem artykułu jest ocena wyników analizy mającej na celu oszacowanie luki innowacyjnej pomiędzy nowymi członkami Unii Europejskiej a średnim poziomem innowacyjności UE w latach 2004–2022. Artykuł formułuje tezę badawczą, która zakłada, że nowe kraje członkowskie UE nie nadrobiły luki innowacyjnej w stosunku do średniej unijnej w latach 2004–2022. Wyniki analizy potwierdzają tę tezę dla wszystkich krajów z wyjątkiem Estonii i Cypru. Porównanie opiera się na Sumary Innovation Index (SII), który został opracowany przez Komisję Europejską w ramach *European Innovation Scoreboard* (EIS). W artykule dokonano przeglądu literatury dotyczącej luki innowacyjnej. Zastosowano metody analizy opisowej, statystycznej analizy danych oraz analizy porównawczej. Wykorzystano dane statystyczne z *European Innovation Scoreboard* w latach 2004–2022.

**Słowa kluczowe:** innowacyjność, luka innowacyjna, Europejska Tablica Innowacyjności, sumaryczny wskaźnik innowacyjności