# CORRELATION BETWEEN INNOVATION CAPACITY AND ECONOMIC DEVELOPMENT IN THE EUROPEAN UNION

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**Abstract.** The economic productivity of the Member States and regions of the European Union (EU-27) as well as its spatial disparities are a highly current topic of regional economic analyses. In terms of economic and social conditions, the EU-27 Member States are highly polarised, which can be defined as a clear factor of deep-rooted structural inequalities. These disparities can be interpreted in a number of aspects, of which the study focuses on the links between innovation capacity and economic performance. After analysing the relevant databases, it can be concluded that the degree of innovation capacity plays a key role in long-term productivity growth and in promoting competitiveness. It can be concluded that one of the most important resources and capital raising forces of the different space units lies in knowledge-based or innovation-driven economic processes. In this context, the link between innovation and the economic development of territorial units has been highlighted by various growth theories for decades, which shows that the economic development of the coming decades will be based on the capacity of innovation and the preservation of knowledge-based competitiveness. The statistical analysis reveals the spatially homogeneous, developed areas that are functioning as economic-innovation centres of EU-27, although in the regions of the Member States that joined the European Union in the 21st century, most of them are peripheral, thus showing the existence of significant territorial disparities on the European scale.

**Keywords:** innovation capacity, economic development, knowledge-based competitiveness, regional inequalities.

## Introduction

The European Union (EU-27) is extremely diverse and heterogeneous, characterised not only by cultural and historical differences between the 27 Member States, but also by territorial disparities that are still significant today. These differences are apparent in several factors, including economic development and innovation capacity, the level of infrastructure, education, and health services. In this context, one of the EU's key objectives is to promote territorial cohesion, and to achieve this, it is essential to identify and understand the existing disparities. However, disparities are not only observed within countries but also across borders and have hardly decreased at regional level over the last two decades [1]. At the same time, it should be noted that, in EU-27 as a whole, public attention to territorial disparities has increased. Since inequalities are constantly increasing, with the result that territorial policy is becoming increasingly important. This general trend is also noticeable and visible today, as the enlargements of the European Union in several stages after 2004 have brought the issue of territorial disparities into increasing focus, the laws of which are explained in more detail in theories of growth [2; 3].

The subject of inequalities is further deepened by the fact that the economic decline of former industrial centres, the depopulation of rural areas and the concentrated development of large cities and their suburbs are all prominent determinants of territorial inequalities [4; 5]. The more developed regions often have better infrastructure, a more highly skilled workforce, and a more attractive business environment [6]. At national level, significant progress has been achieved, with the EU's 9th Cohesion Report detailing, among other things, the convergence of Member States that joined after 2004 with the EU average: GDP per capita has increased from 52% to almost 80% of the EU average, and unemployment has fallen from 13% to 4%, reducing the gap with the rest of EU by half [7]. However, it is not only economic performance or labour market trends that influence the relative development and innovation capacity of nation states. Innovation plays a key role in promoting long-term productivity growth and competitiveness, and it can be described as one of the most important resources and capital attracting forces of different regions in the knowledge-based or innovation-driven economy. Various growth theories have been highlighting the link between innovation and the economic development of territorial units for decades, and it can be stated that the EU's economic development in the next decades will be based on the ability to innovation and to maintain knowledge-based competitiveness [8; 9].

The international scientific literature identifies several crucial factors that have a significant impact on innovation capacity and thus on economic development [10-15]:

- Human capital: Highly skilled workforce, especially in science, technology, engineering, and mathematics (STEM), and the digital skills of the population are key factors for innovation capacity and economic competitiveness. Persistent asymmetries in digital skills and access to digital technologies across EU regions are a major barrier to the spread of innovation;
- Economic structure: Regions concentrating on high-tech or knowledge-intensive industries tend to have higher innovation capacity and economic growth compared to regions relying on traditional low value-added sectors;
- Infrastructure: Advanced physical infrastructure (e.g. transport networks) and digital infrastructure (e.g. broadband internet capacity) are essential for knowledge diffusion and innovation;
- R&D investment: Regions with a stronger knowledge base and higher levels of R&D investment have higher innovation capacity and economic performance;
- Connecting to global supply chains: Regions that are well connected to external knowledge networks and integrated into global supply chains tend to have better access to new ideas and technologies, which increases their innovation capacity.

All of this indicates that there is a significant correlation between innovation capacity and economic performance, and that several other factors also have a strong influence on innovation-led development. The territorial aspects of these processes clearly demonstrate that the existing territorial disparities in the EU, both in terms of innovation capacity and economic development, are the result of a complex interaction of a number of related factors. Over the past two decades or so, regional disparities in EU have been significantly influenced by the relationship between innovation capacity and economic development, while today there are increasingly emerging development priorities related to sustainability or energy management [16]. In addition, there has been a general improvement in innovation performance at EU level, and some economic convergence in the Member States that joined the EU in 2004, significant regional differences in both innovation and economic development remain. Therefore, tackling territorial disparities in the EU requires targeted interventions to improve and to strengthen innovation ecosystem.

The long-term aim of our research (for which this manuscript contains the introductory ideas) is to identify the links between economic development and innovation capacity, with a particular focus on industrial, technical and energy supply developments, and to formulate technical recommendations that are also closely linked to the development of the EU-27 Member States and the diffusion of smart technologies.

## Materials and methods

In the study, we used the European Innovation Scoreboard (EIS) and GDP per capita (in PPS) values for the period 2017-2023. [17; 18]. We chose these two dates (2017, 2023) for the comparative analysis because EIS data are available from 2017. The annual European Innovation Scoreboard (EIS) provides a comparative assessment of the research and innovation performance of EU Member States and selected third countries, and the relative strengths and weaknesses of their research and innovation systems. It helps countries assess areas in which they need to concentrate their efforts in order to boost their innovation performance. The EIS 2023 is the third edition based on the new measurement framework introduced in 2021. It 2023 covers all EU Member States, 11 other European countries, and, at a less detailed level, 11 global competitors. The EIS measurement framework distinguishes 12 dimensions of innovation, with a total of 32 indicators [19]:

1. Human resources: New doctorate graduates in science, technology, engineering, and mathematics (STEM) per 1000 population aged 25-34, Percentage population aged 25-34 having completed tertiary education, Percentage population aged 25-64 participating in lifelong learning;
2. Attractive research systems: International scientific co-publications per million population, Scientific publications among the top 10% most cited publications worldwide as percentage of total scientific publications of the country, Foreign doctorate students as a percentage of all doctorate students;
3. Digitalisation: Broadband penetration, Individuals who have above basic overall digital skills (% share);

4. Finance and support: R&D expenditure in the public sector (percentage of GDP), Venture capital expenditures (percentage of GDP), Direct government funding and government tax support for business R&D (percentage of GDP);
5. Firm investments: R&D expenditure in the business sector (percentage of GDP), Non-R&D innovation expenditures (percentage of turnover), Innovation expenditures per person employed in innovation-active enterprises;
6. Use of information technologies: Enterprises providing training to develop or upgrade ICT skills of their personnel, ICT specialists (as a percentage of total employment);
7. Innovators: SMEs with product innovations (percentage of SMEs), SMEs with business process innovations (percentage of SMEs);
8. Linkages: Innovative SMEs collaborating with others (percentage of SMEs, Public-private co-publications per million population, Job-to-job mobility of Human Resources in Science & Technology;
9. Intellectual assets: PCT patent applications per billion GDP (in PPS), Trademark applications per billion GDP (in PPS), Design applications per billion GDP (in PPS);
10. Employment impacts: Employment in knowledge-intensive activities (percentage of total employment), Employment in innovative enterprises;
11. Sales impacts: Exports of medium and high technology products as a share of total product exports, Knowledge-intensive services exports as percentage of total services exports, Sales of new-to-market and new-to-enterprise innovations as percentage of turnover;
12. Environmental sustainability: Resource productivity, Air emissions by fine particulate matter (PM2.5) in industry, Development of environment-related technologies, percentage of all technologies.

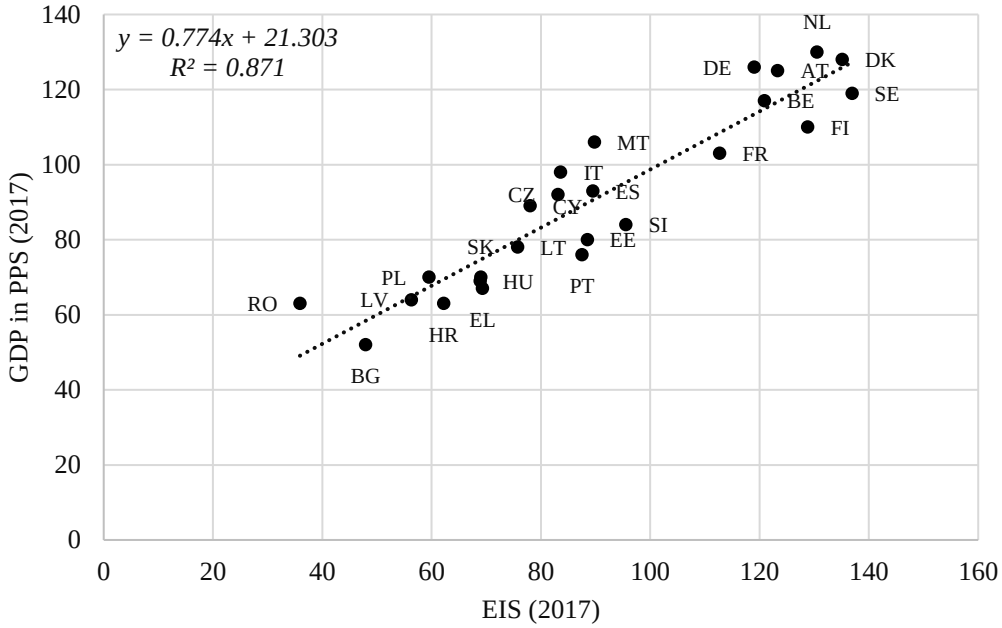
By this statistical analysis, our aim is to show the correlation between innovation performance (EIS) and economic development (GDP) in the EU Member States, which may provide a basis for further research in this perspective.

**Results and discussion**

The relationship between innovation capacity (EIS) and economic development is complex. The two indicators do not always show a significant correlation, especially at the regional (NUTS-2 or NUTS-3) level, as the relationship between innovation and economic growth varies from country to country and from region to region, depending on the specific circumstances [20]. In this chapter of the manuscript, the focus is on the correlation between innovation capacity and economic development for the EU-27 Member States. It is necessary to mention here the hypothesis of our research that the EIS values per country show a strong positive correlation with the economic performance (GDP in PPS) values between 2017 and 2023, indicating significant differences between the EU Member States. From 2017 onwards, the EIS classifies the 27 EU Member States into 4 categories, with the values for 2023 as follows:

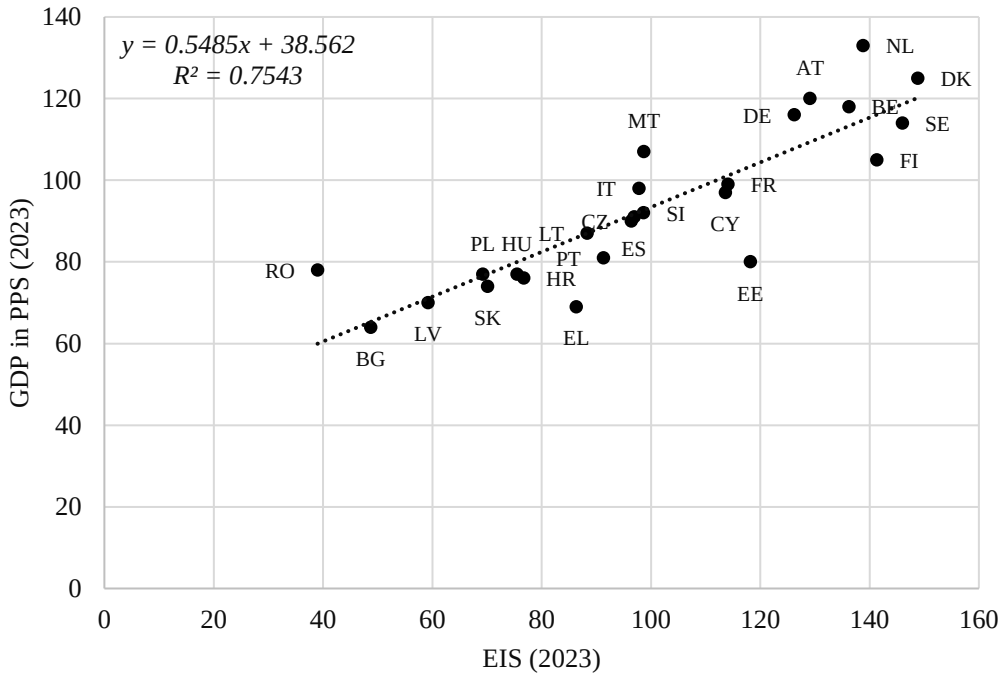
1. Innovation Leaders (Innovation score greater than 125% of the EU average): Denmark, Sweden, Finland, Netherlands;
2. Strong Innovators (Innovation score between 100% and 125% of the EU average): Belgium, Austria, Germany, Luxembourg, Ireland, Estonia, France, Cyprus;
3. Moderate Innovators (Innovation score between 70% and 100% of the EU average): Malta, Slovenia, Italy, Spain, Czechia, Portugal, Lithuania, Greece, Croatia;
4. Emerging Innovators (Innovation score below 70% of the EU average): Hungary, Slovakia, Poland, Latvia, Bulgaria, Romania.

However, the period 2017-2023 has brought a series of challenges and changes to the European Union. Economic development in the period 2017-2023 was significantly affected by the pandemic COVID-19, which caused a marked downturn in all Member States in 2020. The pace of recovery was uneven, and the outbreak of the war in Ukraine in 2022 and the resulting energy crisis posed new economic challenges. It can thus be seen that there has continued to be a significant gap in economic development between the EU's Northern and Western Member States and Southern and Central-eastern Europe in recent years.




*Note (1):* Excluding Ireland (IE) and Luxembourg (LU) data due to exceptionally high GDP levels.
*Note (2):* Abbreviations of country names: BE: Belgium, BG: Bulgaria, CZ: Czechia, DK: Denmark, DE: Germany, EE: Estonia, EL: Greece, ES: Spain, FR: France, HR: Croatia, IT: Italy, CY: Cyprus, LV: Latvia, LT: Lithuania, HU: Hungary, MT: Malta, NL: Netherlands, AT: Austria, PL: Poland, PT: Portugal, RO: Romania, SI: Slovenia, SK: Slovakia, FI: Finland, SE: Sweden.

Fig. 1. **Correlation between innovation capacity (EIS) and economic performance (GDP in PPS) in EU Member States, 2017**




*Note (1):* Excluding Ireland (IE) and Luxembourg (LU) data due to exceptionally high GDP levels.
*Note (2):* The abbreviations of the country names are given below Fig. 1.

Fig. 2. **Correlation between innovation capacity (EIS) and economic performance (GDP in PPS) in EU Member States, 2023**

The countries with the highest economic development (GDP in PPS) over the period are Luxembourg, Ireland, the Netherlands, Denmark, Sweden, Belgium, Austria, and Germany. These countries typically have higher value-added industries and a developed services sector, giving them a significant competitive advantage over other Member States (the most developed countries Ireland and Luxembourg are not included in the analysis as they are outliers in the measure of economic development, which has a high bias). In contrast, the less developed Member States are the Central and Eastern European countries such as Bulgaria, Romania, Croatia, Hungary, Slovakia, and Poland. Although these countries have shown significant economic catching-up in recent years, with GDP growth rates often above the EU average, their economic development is still lower than in Western Member States.

The correlation analysis shows that there is a strong correlation between economic development and innovation capacity in the EU at the level of nation states (linear regression in 2017 is 0.871 and 0.754 in 2023). Countries with higher economic development also have stronger innovation capacities, as they can devote more resources to R&D investment, education, and the creation of a business environment. However, Ireland, for example, with its high level of economic development, is only in the middle of the EIS ranking, mainly because its economic growth is highly dependent on multinational companies and their productivity. In contrast, some less economically developed countries, such as Estonia, show significant progress in terms of innovation capacity, indicating that they have a strong innovation performance relative to their economic development and can serve as an example for other less developed Member States.

Overall, innovation capacity contributes to economic growth, improving competitiveness and creating higher value-added jobs. In addition, the data show that many countries have made significant efforts to increase R&D investment, develop the innovation ecosystem and thus increase innovation capacity, but that over the period 2017-2023, the gaps in innovation performance between EU Member States, especially in the Central and Eastern European region, have been slowly narrowing.

## Conclusions

1. The statistical analysis reveals the spatially homogeneous, developed nation states (e.g. Denmark, Sweden, Finland, Netherlands) that are functioning as economic-innovation centres of the EU-27, although the Member States that joined the European Union in the 21st century, most of them are peripheral, thus showing the existence of significant territorial disparities on a European scale.
2. We believe that the objective should be to reduce the EU's economic dependency, especially in terms of energy supply, which can reduce vulnerability to external externalities, thus helping create stable economic structures and increase innovation capacity. In addition, accelerating investment in digital, innovative developments will not only improve sustainability but also create new economic opportunities and areas for innovation.
3. Based on the data, they highlight the need for a more efficient allocation of the EU structural and investment funds, where the aim should be to harness the economic and innovation potential of less developed countries and regions. In our opinion, particular emphasis should be placed on supporting innovative enterprises and developing human capital, which will help catch up lagging regions in the future.
4. In addition, we believe that closer coordination of national economic policies and stronger strategic planning at the EU level are essential to achieve these goals - reducing territorial disparities, reducing economic dependency, and exploiting innovation potential - more effectively.

## Acknowledgements

Supported by the EKÖP-MATE/2024/25/D university research scholarship Programme of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

## Author contributions

Conceptualization, B.L., T.Cs. and J.K.; Data collection and Methodology, B.L.; Formal analysis, T.Cs. and J.K.; Investigation, B.L. and J.K.; Writing-review and editing, T.Cs. and J.K.; Visualization, B.L. All authors have read and agreed to the published version of the manuscript.

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