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Mapping Innovativeness: The Evidence from the European Union Countries

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Abstract:

Purpose: *It is widely accepted that a country's innovativeness plays a crucial role in driving economic growth and development, improving competitiveness, and creating new opportunities for individuals and businesses. Innovative countries are better able to adapt to changing market conditions and technological advances, giving them a competitive advantage in global markets. This study aims to provide a comprehensive overview of the innovation levels of the 27 EU countries.*
Design/Methodology/Approach: *The innovativeness of the countries under examination was assessed using four selected indicators (RandD expenditure, RandD personnel and researchers, patent applications to the European Patent Office, and exports of high technology products) through two quantitative methods (composite measure and Data Envelopment Analysis).*
Findings: *According to this dual approach, the top innovators among the 27 EU countries are Luxembourg, the Netherlands, and Ireland. These countries demonstrate significant innovation potential and high efficiency in translating pro-innovation inputs into actual innovations. Conversely, Poland, Slovakia, Lithuania, Croatia, and Greece are identified as having the lowest levels of innovativeness in the EU.*
Practical Implications: *The findings of this study can be utilized to identify the strengths and weaknesses of EU countries and guide policies aimed at supporting innovation performance.*
Originality/Value: *The study complements the existing knowledge in the literature with evidence-based discussion on innovation leaders and laggards within the European Union, thereby contributing valuable knowledge to the field of innovation policy and strategy.*

Key Words: *Innovation, efficiency, EU states, DEA.*

JEL Classification: *C61, O30, P30.*

Paper Type: *Research article.*

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1. Introduction

Innovation plays a crucial role in driving economic growth and development, improving competitiveness, and creating new opportunities for individuals and businesses. Countries that are innovative can better adapt to changing market conditions and technological advances, which can help them gain a competitive edge in global markets.

Innovative countries tend to have higher levels of productivity, as they are able to produce more goods and services with the same amount of resources. This can lead to higher living standards and a better quality of life for citizens. Moreover, innovation can help address some of the world's most pressing challenges, such as climate change, health crises, and poverty. Innovative solutions can help reduce carbon emissions, develop new medicines and treatments, and create new jobs and industries.

Innovation involves utilizing new ideas that result in the creation of a new product, process, or service that is introduced into the market, putting it into practice, and using it in a way that leads to new products, services, or systems that add value or improve quality. Innovation also implies exploiting new technology and employing “out-of-the-box” thinking to generate new values and induce significant changes in society.

It is broadly accepted that innovativeness is an important factor for country’s development (Acs and Varga, 2002; Tang, 2006; Hasan and Tucci, 2010). Additionally, as Gossling and Rutten (2007) have shown, the relationship between innovation and economic welfare is interdependent — innovation creates wealth, and wealth is a precondition for innovation. All this encourages comparing countries according to their innovativeness.

The purpose of this study is to provide a comprehensive overview of the innovativeness of the 27 EU countries. The results can be used to identify strengths and weaknesses in EU countries, as well as to shape policies that support pro-innovative performance.

2. Literature Review

The recent literature is filled with studies that examine various aspects and perspectives of innovativeness at a country level. Many studies look at the relationship between economic and socio-cultural factors and a country's innovative potential or pro-innovation drivers. Understanding these relationships is important in selecting indicators for composite indices, such as the Global Innovation Index. For example, Filippetti and Guy (2016) studied the impact of internationalization (foreign direct investments) on innovation performance (patent applications) in 40 countries.

Other researchers like Genc *et al.* (2019), Elia *et al.* (2020), Leung and Sharma (2021), and Xiao and Sun (2022) also used internationalization in their studies. Internalization was combined with research and development (RandD) by Laurens *et al.* (2022) and Puertas *et al.* (2022). Savrul and Incekara (2015) focused on the effect of RandD intensity on innovation performance and found that positive environmental factors significantly influence a country's ability to turn innovation investments into performance.

Sipa *et al.* (2016) focused on the relationship between RandD expenditure, RandD employment, public access to the Internet, and the number of patent applications submitted to the EPO in the Visegrad Group Countries. Bednář and Halásková (2018) analyzed convergence or divergence related to innovation performance and RandD expenditures among Western European regions.

Hervás-Oliver *et al.* (2021) suggested that RandD-based innovation policies may not be the most effective in Europe, with collaboration and networks being more powerful drivers for regional innovation.

Kukharuk *et al.* (2017) explored the relationship between a country's economic development level and innovation activity, finding varying impacts across different regions. Raghupathi and Raghupathi (2017) examined OECD countries and found that countries with lower GDP rely on foreign collaboration for innovation.

Research on institutional quality by Bariş (2019) and cultural dimensions by Shkolnykova *et al.* (2022) also shed light on factors influencing innovation potential in countries. Murswieck *et al.* (2020) analyzed the relationship between cultural dimensions and innovation performance in EU countries. Vītola (2015) identified characteristics of innovation policy implementation at different government levels.

Other studies focused on innovation efficiency, with Hudec (2015) using DEA to assess Visegrad countries' performance and Despotovic *et al.* (2016) examining innovation determinants in European countries. Zhukovski and Gedranovich (2016) evaluated innovation activity in various economies, while Fang and Chiu (2017) studied innovation efficiency in China.

Brodny *et al.* (2023) evaluated the level of innovation in EU countries based on selected indicators, showing significant differences among countries. Kozuń-Cieślak and Murray Svidroňová (2017) analyzed the innovation performance of EU countries, highlighting the role of non-governmental organizations in promoting innovation. Kurkela *et al.* (2019) emphasized the importance of the third sector in innovation processes in Finnish municipalities.

Overall, many studies focus on innovation performance in developed countries, but there is still a gap in understanding innovation in post-communist countries. This research aims to identify low-performing countries and areas of inefficiency in transforming innovation inputs into outputs.

3. Empirical Framework and Methodology

3.1 Data

The most common indicators widely used as a proxy of innovative potential or performance are, RandD expenditures and employment, patent applications or exports of high technology (Bilbao-Osorio and Rodríguez-Pose, 2004; Bottazzi and Peri, 2003; Buesa *et al.*, 2010; Crosby, 2000; Durmaz, Yildiz, 2020; Hasan and Tucci, 2010; Hauser *et al.*, 2007; Moreno *et al.*, 2005; Sandu and Ciocanel, 2014; Siller *et al.*, 2014; Sterlacchini, 2008; Sternberg and Arndt, 2001; Thornhill, 2006).

The use of the RandD expenditure indicators as well as measures of human resources engaged in RandD does not require any special explanation, although it is worth noting that, in fact they are input factors, which show an innovative effort, and not necessarily reflect the success in innovative results.

Moreover these measures only imperfectly reflect innovation inputs because branches with less formal innovation processes such as service sectors may have little connection with RandD outlays, at least directly. Nevertheless, RandD effort is an important input into innovation processes in general (Freeman and Soete, 1997) and certainly important for industries with ample patenting.

Patents reflect an inventive activity. Measures based on patents’ statistics show the capacity to exploit knowledge and translate it into potential economic gains. However, there are some shortcomings in the usage of patents as an indicator of innovation.

Makkonen (2011) emphasizes that patents’ indicators measure the result of invention rather than innovation, not all firms make the effort to claim patents, certain sectors are poorly suitable for patent application, the range of patentable innovations constitutes only a sub-set of all research outcomes, not every registered patent is applied for and used, and the quality of individual patents varies widely – some inventions are extremely valuable, whereas others are of almost no commercial value.

In turn, measures showing trade in high-tech products partially eliminate the shortcomings of indicators based on patent statistics. The country's ability to compete in high-tech markets reflects its success in pro-innovation activities. High technology exports are a concept that refers to products with high innovation intensity, such as telecommunications products, products produced as a result of scientific research, aerospace, computers, pharmaceutical, electrical machinery, chemistry, electronics, etc. The innovation intensity is reflected in high technology exports and is its important factor.

Despite of critical remarks, patents, high-tech trade and RandD outlays are broadly used to measure country innovativeness. In this study, the innovativeness of EU Member States has been assessed using the following measures:

Indicator	Notation	Data scope and source
Total, all sectors RandD expenditure (PPS per inhabitant at constant 2005 prices)	RDexp	average of 2004 – 2021 Eurostat
Total, all sectors RandD personnel and researchers (% of total employment - numerator in full-time equivalent)	RDemp	average of 2004 – 2021 Eurostat
Patent applications to the European Patent Office (per million inhabitants)	EPapp	average of 2004 – 2021 Eurostat
Exports of high technology products (as a share of total exports)	HTexp	average of 2007-2021 Eurostat

The set of source data used to calculate the CII indicator has been presented in Table A1 in the Appendix.

3.2 Research Methodology

The innovation of the 27 EU Member States has been assessed by using two approaches based on quantitative methods.

In the first step, the country Composite Innovation Index (CII) was calculated. This approach is in line with the methodology used in the annual reports published by the European Commission in the European Innovation Scoreboards (EIS).

The composite innovation indexes presented in the EIS are calculated as the unweighted average of 32 sub-measures classified in four groups (i.e., framework conditions, investments, innovation activities and impacts). Among these 32 measures, there are both, pro-innovation outlays as well as innovative outputs/outcomes (for details see e.g., European Innovation Scoreboards, 2022).

In a very similar way, the innovation index at the country level is calculated by World Intellectual Property Organization and published in annual reports The Global Innovation Index (GII). The GII is computed by calculating the simple average of two composite sub-indices, namely Innovation Input Index and

Innovation Output Index, which include in total more than 80 individual indicators (for details see e.g., Global Innovation Index, 2022).

In this study has been used the similar methodology for calculating the composite measure of innovation as applied in the EIS and the GII, but based on a set of indicators reduced to four measures listed in the previous sub-section.

The composite CII indicator has been calculated as the unweighted average of the normalised scores of four measures, i.e. RDexp, RDemp, EPapp and THexp.

Because two of mentioned above indicators (EPapp and HTexp) showed raw data skewness exceeding 1, hance, they were transformed using a square root transformation with power N = 0.3 in order to achieve the skewness of the transformed data at about SK=0.5. Then data were normalized using the quotient transformation with the normalization base equal to the maximum value what finally gave values ranged in (0;1> (see Table A1).

According to the data prepared in this way countries have been ranked and classified to the following CII quartile (Q) based groups:

Innovation Leaders: CII≥Q3	ModerateInnovators: Q1≤CII≤Q2
Innovation Followers: Q2≤CII≤Q3	Modest Innovators: CII ≤ Q1

In the second step the country innovation efficiency has been computed by applying the Data Envelopment Analysis (DEA). This approach uses the concept of technical efficiency and can be brought down to the statement that the country is technically efficient if it is able to produce as much innovative outputs as it is possible from a given amount of pro-innovation inputs.

The DEA was introduced by Charnes, Cooper and Rhodes in 1978 (Charnes *et al.*, 1978), who on the work of Farrell (1957) proposed a basic DEA model – the radial CCR model (with assumption of constant returns to scale, CRS). The DEA CCR model was extended to account for technologies that show variable returns to scale (VRS) by Banker, Charnes and Cooper in 1984 (Banker *et al.*, 1984).

Generally speaking the DEA benchmarks analysed units (countries) only against the best ones which form the frontier of efficiency (productivity frontier). An object is recognized as 100% efficient (DEA score = 1) when comparisons with other units in a sample do not provide evidence of inefficiency in the use of any input or output. If any object is not at the frontier that means it is inefficient - its distance from the frontier determines the level of inefficiency and the DEA score < 1.

Over the years, the simple DEA models have been enriched by a number of modifications which enable users a better fit of the appropriate DEA variant to research specific needs.

In this study the super-efficiency and non-oriented slacks-based DEA model under the assumption of variable returns to scale (DEA SE-NO-SBM-V) will be applied (for mathematical foundations of the DEA see: Cooper *et al.*, 2007). The super-efficiency variant is identical to the standard approach, except that the DMU under evaluation is excluded from the reference set. Super-efficiency DEA models rank also efficient DMUs and efficiency scores may be greater than 1. The mathematical formulations of the DEA SE-NO-SBM-V variant is expressed as follows (Cheng, 2014; Tone, 2002):

$$\delta^{DEA-SE-NO-SBM} = \min \frac{1+\frac{1}{m}\sum_{i=1}^{m}\varphi_{io}}{1-\frac{1}{s}\sum_{r=1}^{s}\psi_{ro}}$$

subject to:

$$\sum_{j=1}^{n} x_{ij}\lambda_{jo} - x_{io}\varphi_{io} \leq x_{io}$$

$$\sum_{j=1}^{n} y_{rj}\lambda_{jo} - y_{ro}\psi_{ro} \geq y_{ro}$$

$$\varphi_{io};\ \psi_{ro};\ \lambda_{jo} \geq 0$$

$$i = 1,2,\dots,m;\ \ r = 1,2,\dots,s;\ \ j = 1,2,\dots,n$$

where:

$\delta^{DEA-SE-NO-SBM}$- efficiency score of DMU_O
x_{ij}- amount of the *i-th* input of DMU_j,
y_{rj}- amount of the *r-th* output of the DMU_j,
λ_{jo}- the intensity factor associated with DMU_j, and designated for the analysed DMU_O,
φ_{io}- indicates the required percentage reduction of the i-th input,
ψ_{ro}- indicates the required percentage increase of the r-th output.

The fundamental advantages of the DEA as the tool of technical efficiency assessment are as follows:

- it permits to create the models with many inputs and outputs (results), which are suitable perfectly for studying technical efficiency,
- it permits to use of the data with heterogeneous names (inputs and outputs can be expressed in different units of measure),

- it does not demand assumptions about the functional dependence between inputs and outputs,
- it does not demand the assignment of ranks (weight) to inputs and outputs,
- it makes possible to detect extreme values, which, in other methods, are invisible, on account of the fact of averaging of the data (instead of fitting regression curves to average values, DEA constructs the polyhedron based on extreme data),
- it distinguishes the *"best practice"* group, that is the group of entities with efficiency equal 100%,
- it permits to establish recommendations (based on leaders' solutions) for inefficient unites to improve their performance.

By all means, it should be remembered, that the DEA as every other quantitative method, has also its own limitations:

- it provides results in a form of relative efficiency of the given unite with relation to the studied group and there is no way to transform the relative DEA efficiency into the absolute measure of efficiency,
- it does not take into account the measurement error,
- it is very sensitive to the wrong data,
- even small changes concerning the selection of unites of the analyzed group (e.g. the change of their quantity) can have the meaningful influence on the final result of the research,
- it demands the preservation of the appropriate relation between the number of analyzed entities and the number of variables (inputs + outputs) used in the research.

The DEA SE-NO-SBM-V model in this research has been calculated using indicators prepared in the first step, namely: RDexp and RDemp as input measures EPapp and HTexp as outputs.

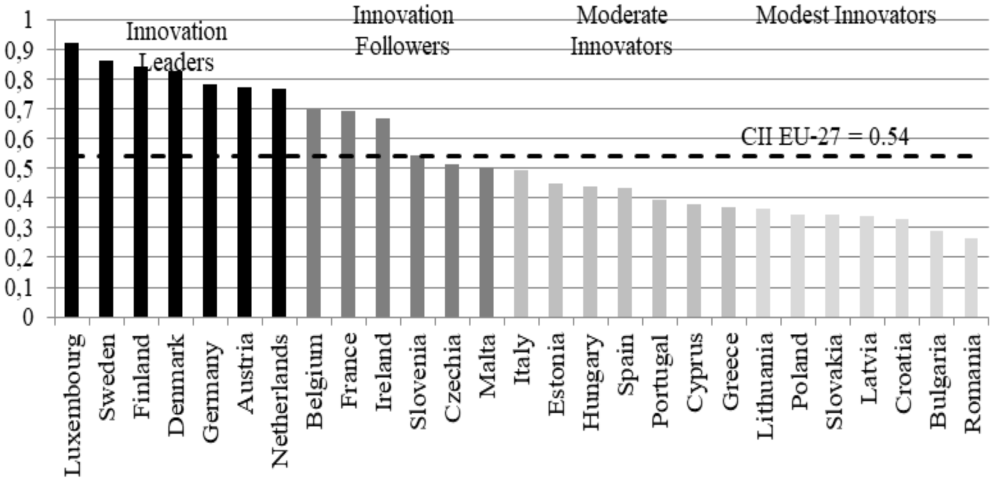
4. Study Results

4.1 Ranking of the EU States According to the Country Innovation Index (CII)

Figure 1 shows the ranking of 27 EU countries according to the Country Innovation Index. The CII scores range from 0.26 (Romania) up to 0.92 (Luxembourg) what means a medium diversity (CV=0,37). The average value of CII measure equals to AV = 0.54 and it is slightly higher than the median (Q2 = 0.49).

Eleven of seventeen countries that show the CII equal or lower than the average value are the post-communist EU members. Countries that received CII score higher than the upper quartile (Q3) are classified as Innovation Leaders. Their CII ranges from 0.73 up to 0.92. The Leaders' group includes, Luxembourg, Sweden, Finland, Denmark, Germany, Austria and the Netherlands.

Figure 1. *EU-27 ranking based on the Country Innovation Index*



Source: *Own work on the basis of Table A1.*

The next group - Innovation Followers – includes three countries who show the CII score significantly higher than the EU average (these are Belgium, France and Ireland) as well as those whose the CII is very close or even lower than the EU mean (Slovenia, the Czech Republic and Malta). These last three are, so called, "new" members who joined the EU in 2004.

The group of Moderate Innovators refers to countries whose CII indicators are included in the range from 68% to 91% of the EU average. Four "old" EU members, i.e. Italy, Spain, Portugal and Greece, belong to Moderate Innovators. This group covers also three "new" members, i.e. Estonia, Hungary and Cyprus.

The Modest Innovators group includes countries with the CII equal or lower than the first quartile (Q1 = 0.36). The tail of the ranking is formed by: Lithuania, Poland, Slovakia, Latvia Croatia, Bulgaria and Romania.

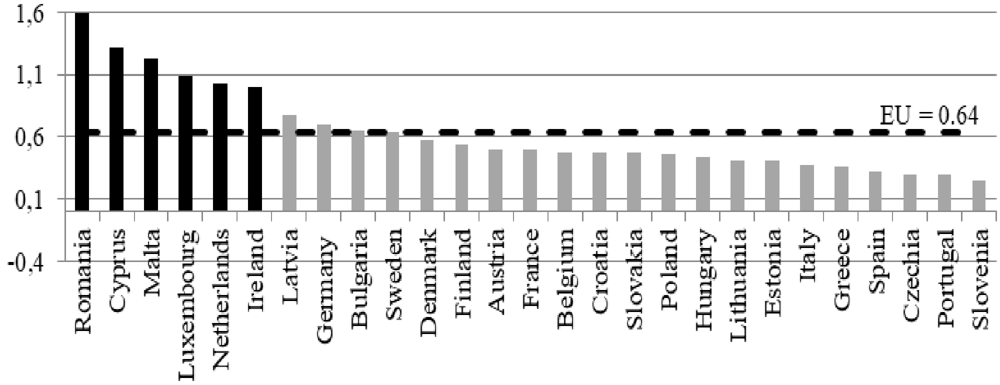
4.2 Ranking of the EU States According to the DEA Innovation Efficiency (DEA Scores)

The results of the DEA shows the success of the EU countries in transforming pro-innovative inputs expressed by RandD expenditure and RandD employment into innovative outputs embodied in patent applications and exports of high technology products. This approach delivers quite a new look at analyzed countries.

Figure 2 shows the ranking of 27 EU countries due to the innovation efficiency index expressed by DEA SE-NO-SBM-V scores (DEA scores). In the language of DEA interpretations, DEA scores show the relative technical efficiency of each country in the sample. According to the DEA computations there are six countries which are recognized as relatively efficient (with DEA score ≥1), i.e., Romania, Cyprus, Malta, Luxembourg, the Netherlands and Ireland. These countries are leaders due to transforming pro-innovative inputs into innovations. Other countries in the sample show inefficiency ranged from 22% for Latvia up to 76% for Slovenia.

The coefficient of variation of DEA scores equals to 0,55 which means rather strong diversity. In addition DEA scores show an asymmetry exhibited by a high right-skewness distribution (SK=1.31) what means that most countries are below average. The median value of DEA scores equals to 0.5 (France) and it is lower than the mean value (0.64).

Figure 2. *EU-27 ranking based on the DEA scores.*



Source: *Own work on the basis of Table A1.*

Among the thirteen countries showing the greatest inefficiency (DEA score below the median), eight are post-communist EU members (Croatia, Slovakia, Poland, Hungary, Lithuania, Estonia, the Czech Republic and Slovenia). It should also be noted that the group that shows DEA scores below the lower quartile (Q1=0.42) includes four "old" EU members, namely: Italy. Greece, Spain and Portugal.

4.3 Mapping the Innovativeness of the EU Countries – CII vs. DEA Scores

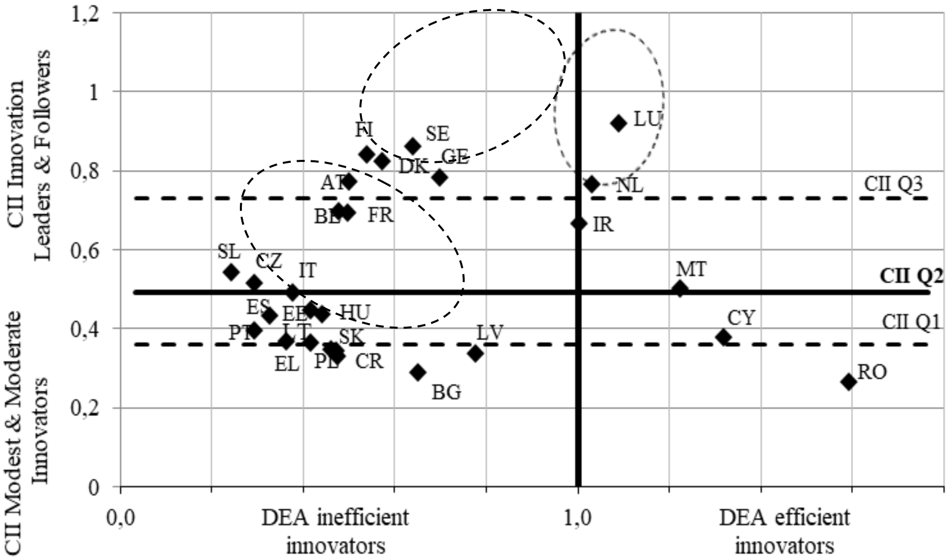
At the beginning it is worth emphasizing some general information comparing results obtained in the previous sub-sections.

Firstly, it should be noted that there is no correlation between CII and DEA measures (Pearson's coefficient equals to 0.05). Secondly, the diversity of countries in terms of the analyzed measures is greater when we take into account DEA efficiency scores (CV=055) than the overall innovation potential expressed by CII (CV=0.37). In addition, DEA scores show much greater right-side skewness (SK=1.31) than CII scores (SK=0.45).

This means that the vast majority of countries show lower indicators than the mean value, and this asymmetry in the case of the DEA approach is much stronger than for the CII approach.

Figure 3 shows the indicators for assessing the innovativeness of EU countries obtained by the two methods discussed in previous sub-sections. The Y-axis reflects the composite measure of innovation potential (CII scores), while the X-axis shows the technical efficiency in transforming pro-innovation inputs into innovative outputs (DEA scores).

Figure 3. *The EU -27 map of innovativeness*



Source: *Own work on the basis of Table A1.*

Such a graphical presentation of the CII and DEA measures allows to form a specific map of the innovativeness potential and efficiency of the EU countries.

The upper right area of the chart shows the leaders in both rankings. The undisputed winners are: Luxembourg and the Netherlands. Ireland and Malta also achieved very good results - the innovation potential of both countries was rated very high (Innovation Followers), and at the same time both have been included in a narrow group of DEA-efficient innovators.

In the lower right area there are countries that have been assessed as DEA-efficient, but at the same time show a lower innovation potential, these are Cyprus and Romania. Particular attention is paid to Romania, which among the entire analyzed group shows the highest DEA efficiency score and the lowest CII index. It can be said here that despite the fact that Romania is a relatively low developed country (expressed in GDP per capita) and it has very low pro-innovation outlays, it makes still excellent use of them.

All countries (except Ireland) assessed as DEA-efficient show the so-called over-efficiency, which is manifested by the DEA score > 1. These countries would retain the status of "efficient" (they would still form the efficiency frontier) even if there were changes in the level of inputs and outputs in them, in accordance with the projections presented in Table 1.

For example, Cyprus could maintain the DEA score = 1 even if its RandDemp increased by 62% and Htexp decreased by 21%. Interpretation for other countries are anallogical.

Table 1. *DEA input-output projection ensuring DEA score =1 (DEA efficient innovators)*

Country	DEA input-output projection (%)			
	RandDexp	RandDemp	EPapp	HTexp
Ireland	-56	-31	0	1
Cyprus	0	62	1	-21
Luxembourg	-19	-31	15	2
Malta	0	-36	13	23
Netherlands	-19	0	6	0
Romania	89	30	-112	0

Source: *Computed with Data Envelopment Analysis Software PIM version 3.2.*

In the upper left area there are countries that show high innovation potential expressed by the CII index, but at the same time they are DEA-ineffective. It is worth paying attention to the cluster of seven countries that belong to the most developed EU Member States. These countries could improve their relative efficiency by reducing inputs and improving outcomes as projected in Table 2. For example, Germany could reach the DEA efficiency frontier by reducing RandDexp and RandDexp by 41,3% and 7,3%, respectively and increasing HTexp by 17%. Recommendations for other countries should be interpreted in the same way.

Table 2. *DEA input-output projection ensuring DEA score =1 (CII Innovation Leaders and Followers)*

Country	DEA input-output projection (%)			
	RandDexp	RandDexp	EPapp	HTexp
Belgium	-55	-33	0	34
Denmark	-40	-29	0	29
Germany	-41	-7	0	17
France	-56	-39	0	10
Austria	-59	-29	0	23
Finland	-42	-32	0	35
Sweden	-46	-13	0	20

Source: *Computed with Data Envelopment Analysis Software PIM version 3.2.*

In the lower left area are the countries with the lowest scores in both CII and DEA scores. These are mostly post-communist EU member states and the least developed old members, which together with the three countries from the upper area form a distinct cluster. Bulgaria and Latvia are excluded from this cluster due to higher efficiency scores.

Table 3. *DEA input-output projection ensuring DEA score =1 (CII Modest and Moderate Innovators)*

Country	DEA input-output projection (%)			
	RandDexp	RandDexp	EPapp	HTexp
Bulgaria	0	-40	26	20
Czechia	-63	-61	57	0
Estonia	-49	-57	28	0
Greece	-26	-63	72	33
Spain	-58	-62	18	27
Croatia	-3	-44	109	14
Italy	-57	-56	0	32
Latvia	0	-38	5	4
Lithuania	-21	-57	80	16
Hungary	-34	-43	78	0
Poland	-20	-46	74	17
Portugal	-52	-63	55	34
Slovenia	-72	-74	0	25
Slovakia	-12	-46	93	11

Source: *Computed with Data Envelopment Analysis Software PIM version 3.2.*

The biggest losers of this study face the biggest challenges - to reach the DEA efficiency frontier they should both reduce inputs and increase outputs. For example, Poland needs decrease RandDexp and RandDexp by 20% and 46% as well as increase outputs: EPapp by 74% and HTexp by 17%. Most countries listed in Table 3 face similar challenges.

5. Conclusions

The results presented above demonstrate that the two approaches used in the study revealed two different aspects of innovation in the analyzed countries. Each methodological approach has its own strengths and weaknesses. The evaluation based on the composite indicator serves as a diagnosis of innovation potential, encompassing both innovation indicators and measures that are essential for innovation. However, this method lacks in assessing the productivity of resources utilized in pro-innovation activities of the country and tends to favor highly developed countries.

Conversely, the approach centered on evaluating a country's innovative effectiveness examines the correlation between pro-innovation spending and innovative outcomes, disregarding the fact that groundbreaking inventions sometimes require long-term, substantial investments (without a guaranteed success), such as basic research, which is a crucial component of the innovation process. Therefore, it is sensible to consider these two approaches as complementary.

Based on this dual approach, the undeniable leaders of innovation among the 27 EU countries are Luxembourg, the Netherlands, and Ireland. These countries exhibit significant innovation potential and exceptional efficiency in translating pro-innovation inputs into innovations. On the contrary, Poland, along with Slovakia, Lithuania, Croatia, and Greece, are the least successful in terms of innovativeness within the EU.

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Appendix:

Table A1. *Innovation indicators of 27 European Union countries*

EU country	EUROSTAT data				Normalized data*				CII score	DEA score
	RDexp	RDemp	EPapp	HTexp	RDexp N=1	RDemp N=1	EPapp N=0.3	HTexp N=0.3		
Belgium	683.43	1.487	181.59	9.91	0.68	0.72	0.67	0.73	**0.698**	**0.478**
Bulgaria	71.89	0.611	3.33	4.77	0.07	0.30	0.20	0.58	**0.288**	**0.651**
Czechia	342.72	1.162	14.96	16.31	0.34	0.56	0.32	0.84	**0.516**	**0.294**
Denmark	822.09	1.967	321.67	10.39	0.81	0.95	0.80	0.74	**0.825**	**0.573**
Germany	830.12	1.476	312.99	14.41	0.82	0.72	0.79	0.81	**0.785**	**0.698**

Estonia	234.96	0.848	24.79	12.31	0.23	0.41	0.37	0.77	**0.447**	**0.415**
Ireland	501.33	1.174	133.61	28.22	0.50	0.57	0.61	0.99	**0.668**	**1.003**
Greece	161.16	0.954	8.91	4.56	0.16	0.46	0.27	0.57	**0.367**	**0.364**
Spain	285.29	0.929	31.57	5.30	0.28	0.45	0.40	0.60	**0.433**	**0.326**
France	564.69	1.424	147.20	19.73	0.56	0.69	0.63	0.89	**0.693**	**0.498**
Croatia	122.17	0.637	4.68	7.61	0.12	0.31	0.22	0.67	**0.331**	**0.474**
Italy	299.84	1.056	70.19	6.97	0.30	0.51	0.50	0.65	**0.492**	**0.376**
Cyprus	118.77	0.354	54.51	11.67	0.12	0.17	0.47	0.76	**0.380**	**1.320**
Latvia	84.67	0.583	12.18	8.29	0.08	0.28	0.30	0.69	**0.338**	**0.777**
Lithuania	149.53	0.815	7.76	7.05	0.15	0.40	0.26	0.66	**0.365**	**0.415**
Luxembourg	801.34	2.031	687.57	20.62	0.79	0.98	1.00	0.90	**0.920**	**1.090**
Hungary	194.96	0.837	10.42	17.67	0.19	0.41	0.28	0.86	**0.437**	**0.440**
Malta	140.55	0.637	98.04	28.85	0.14	0.31	0.56	1.00	**0.501**	**1.223**
Netherlands	653.47	1.405	399.50	19.60	0.65	0.68	0.85	0.89	**0.767**	**1.029**
Austria	865.12	1.540	209.49	13.05	0.86	0.75	0.70	0.79	**0.773**	**0.500**
Poland	148.32	0.654	8.58	6.99	0.15	0.32	0.27	0.65	**0.346**	**0.462**
Portugal	249.08	0.960	12.66	4.37	0.25	0.47	0.30	0.57	**0.395**	**0.292**
Romania	50.19	0.373	1.41	7.59	0.05	0.18	0.16	0.67	**0.264**	**1.594**
Slovenia	429.13	1.360	55.30	5.75	0.42	0.66	0.47	0.62	**0.542**	**0.242**
Slovakia	134.47	0.650	6.14	8.25	0.13	0.31	0.24	0.69	**0.344**	**0.471**
Finland	871.44	2.063	330.28	8.87	0.86	1.00	0.80	0.70	**0.842**	**0.538**
Sweden	1010.72	1.710	365.45	12.96	1.00	0.83	0.83	0.79	**0.861**	**0.641**
MIN	50.19	0.35	1.41	4.37	0.05	0.17	0.16	0.57	**0.26**	**0.24**
MAX	1010.72	2.06	687.57	28.85	1.00	1.00	1.00	1.00	**0.92**	**1.59**
AV	400.79	1.10	130.18	11.93	0.40	0.53	0.49	0.74	**0.54**	**0.64**
SD	300.85	0.49	167.59	6.68	0.30	0.24	0.24	0.12	**0.20**	**0.35**
CV	0.75	0.44	1.29	0.56	0.75	0.44	0.49	0.16	**0.37**	**0.55**
SK	0.63	0.46	1.70	1.14	0.63	0.46	0.45	0.50	**0.45**	**1.31**
Q1	144.43	0.65	9.66	7.02	0.14	0.32	0.28	0.65	**0.37**	**0.42**
Q2	285.29	0.96	54.51	9.91	0.28	0.47	0.47	0.73	**0.49**	**0.50**
Q3	668.45	1.45	195.54	15.36	0.66	0.70	0.69	0.83	**0.73**	**0.74**

Notation: *MIN-minimum; MAX-maximum; AV-average; SD-standard deviation; CV-coefficient of variation; SK-skewness; Q1, Q2, Q3-quartils 1, 2, 3.*
** Data transformed using a square root transformation with power N and normalized using the quotient transformation with the normalization base equal to the maximum value.*
Source: *Own computations on the basis of Eurostat on line data. DEA scores computed with Data Envelopment Analysis Software PIM version 3.2.*