INNOVATION IN THE EUROPEAN UNION: DESCRIPTIVE ANALYSIS OF EMERGING INNOVATORS, WITH A FOCUS ON ROMANIA

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Abstract
Innovation plays a key role in driving economic growth, competitiveness, and social progress. The European Innovation Scoreboard (EIS) provides a comprehensive framework for assessing how countries advance in this area. This study examines the group of Emerging Innovators in 2025 — Bulgaria, Hungary, Latvia, Poland, Romania, and Slovakia — with particular attention to Romania. Within this group, Romania shows notable improvement over time, yet continues to face structural challenges that limit convergence with the EU average. Using the Summary Innovation Index (SII), performance changes, annual gaps, and Compound Annual Growth Rates (CAGR), we compare Romania's trajectory with that of Croatia and the EU27. The analysis highlights areas where Romania is catching up, as well as those where persistent weaknesses remain, offering a clearer picture of its position and progress within the European innovation landscape.

Keywords: innovation performance, Summary Innovation Index (SII), Emerging Innovators, Compound Annual Growth Rate (CAGR)

JEL Classification: M15

1. Introduction

Innovation is a central driver of growth, competitiveness, and societal development, and the European Innovation Scoreboard (EIS) [1] provides a valuable framework for assessing countries' progress.

This paper focuses on the Emerging Innovators group in 2025 [2] - Bulgaria, Hungary, Latvia, Poland, Romania, and Slovakia. Finally, our attention turns to Romania, whose

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innovation policies align with the European trend [3][4][5][6]. Within the Emerging Innovators' group, Romania stands out as a case of strong relative progress but persistent structural gaps [7][8][9][10]. By analyzing the evolution of the Summary Innovation Index (SII) [1], performance changes, annual gaps, and Compound Annual Growth Rates (CAGR) [11], with a particular comparison to Croatia and the EU27 average, we aim to highlight Romania's trajectory, strengths, and limitations.

In recent years, we have carried out a series of analyses on innovation at the EU level and we have highlighted the strong relationships between innovation and ICT. Given the complexity of the two entities, innovation and ICT, we employed a variety of indicators to capture their multiple dimensions. For ICT we have used:

- Network Readiness Index (NRI), originally part of the World Economic Forum's *Global Information Technology Report*, nowadays published by the Portulans Institute in partnership with the University of Oxford's Saïd Business School. The results of our research were published in [12][13].
- Human Resources in Science and Technology (HRST) Index published by Eurostat. The results of our research were published in [12][14].
- Gross Domestic Expenditure on R&D (GERD), both published by Eurostat. The results of our research were published in [14].
- ICT Development Index (IDI), a composite index calculated annually since 2009 by the International Telecommunication Union and published in the Measuring the Information Society Report (MISR). The results of our research were published in [15].

The stage of innovation across European countries has been captured through several indicators such are the Summary Innovation Index (SII) and Global Innovation Index (GII) [13][16]

In addition, in our work, we aimed to identify and analyze good practice models, such as Estonia [12], which has achieved outstanding results in innovation, or Bulgaria, an Emerging Innovator that has also recorded solid progress in innovation [14][17]. These examples may serve as valuable benchmarks for Romania in its efforts to improve its position within European innovation rankings.

2. The European Innovation Scoreboard (EIS)

The European Innovation Scoreboard (EIS) is a European Commission initiative that provides *"a comparative analysis of innovation performance of the European Union (EU), the 27 Member States, 12 neighboring European countries, and 11 global competitors"* [1]. The report is published annually and has now reached its 25th edition. It offers an overview of the state of innovation for the economies mentioned above.

Innovation performance is measured through a set of sub-indicators whose structure and calculation methods are subject to continuous refinement in order to better reflect the EU's evolving needs and priorities. The 2025 edition, once again redesigned compared to the 2021–2024 period, includes 32 indicators, divided into four main categories and 12 dimensions. Based on these 32 equally weighted indicators, a country-level composite index is calculated, known as the **Summary Innovation Index (SII)**.

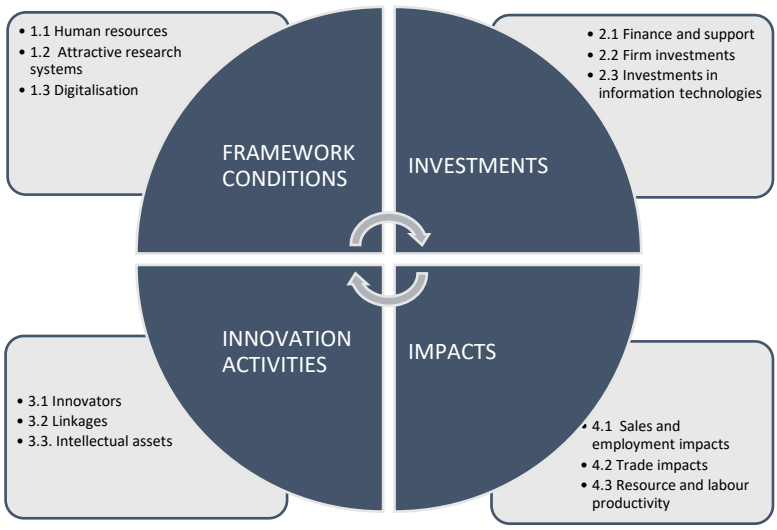
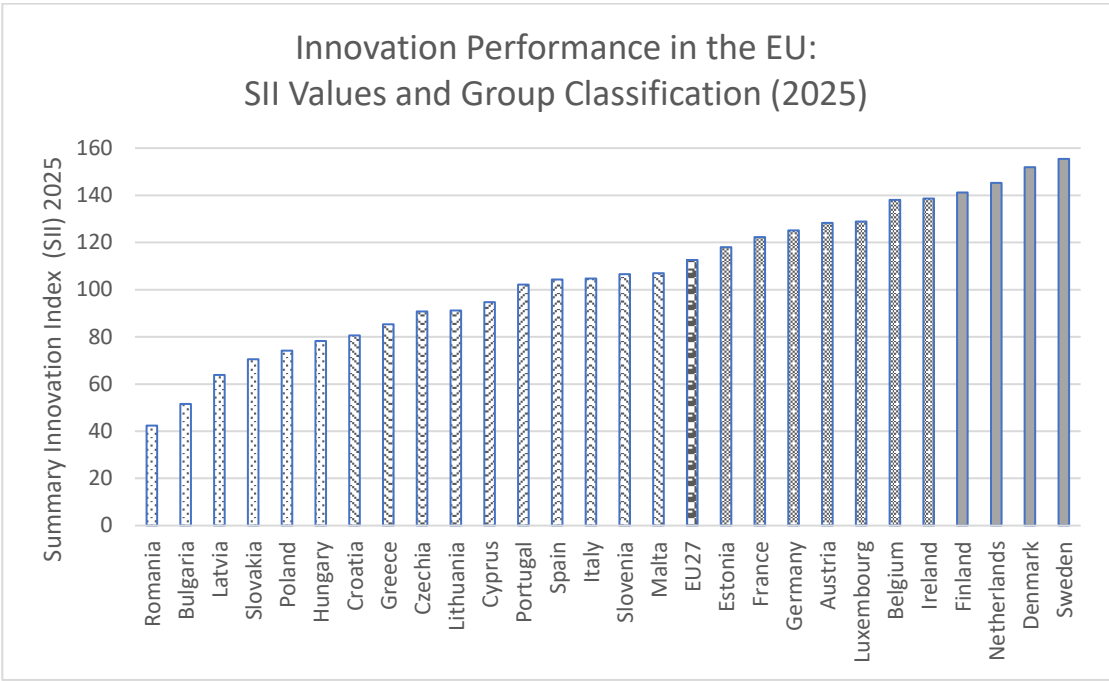


Figure 1. The structure of the Summary Innovation Index (SII) in 2025

(chart made with Ms. Excel, by authors)

Based on their SII in 2025, the EU27 Member States are categorised into four different groups:

- Innovation Leaders are Member States with performance above 125% of the EU average in 2025: Sweden, Denmark, the Netherlands and Finland.
- Strong Innovators are Member States with a performance between 100% and 125% of the EU average in 2025: Ireland, Belgium, Luxembourg, Austria, Germany, France, and Estonia.
- Moderate Innovators are Member States with performance between 70% and 100% of the EU average in 2025: Malta, Slovenia, Italy, Spain, Portugal, Cyprus, Lithuania, Czechia, Greece and Croatia.
- Emerging Innovators are Member States that have a performance level below 70% of the EU average in 2025: Hungary, Poland, Slovakia, Latvia, Bulgaria, and Romania.



Fiqure 2. Innovation Performance in the EU: SII Values and Group Classification (2025). The countries are ranked by order of performance, increasing, from left to right.

3. Innovation in the Emerging Innovators Group: descriptive analysis with focus on Romania, in the period 2018–2025

3.1. Materials and methods

For the materials and methodology, all tables, charts and graphics included in this paper were created by the authors using Microsoft Excel, with data sourced from the European Innovation Scoreboard (EIS) 2025, through the EIS Interactive Tool [1][2].

Data: SII values and 23 sub-indicators, for the 27 European Member States, in the period 2018-2025. According to [1]:

- the values are indexed to the EU27 in 2018;
- 0-values means that the country had the lowest performance for that indicator, or was identified as a negative outlier and rescaled to 0 during the rescaling phase.

In order to depict the evolution (growth or decline) of an indicator, we use the Compound Annual Growth Rate (CAGR) measure [11]. While annual fluctuations may occur, CAGR provides a synthetic indicator of long-term progress by smoothing out short-term variations. The CAGR for a country/economy is computed using the formula:

CAGR (t0, tn) = (V(tn) / V(t0))^(1/(number of periods)) - 1

For all indicators and sub-indicators, the analysis covers 2018–2025 (7 periods), except for the 'Innovators' sub-indicator (3.1), which spans 2021–2025 (4 periods).

The performance change over a period was computed with the formula:

Performance = Value_last_year - Value_initial_year

The annual performance change in year *i* is computed as the difference between the value in year *i* and the value in year *i–1*.

3.2. Comparative Analysis of Innovation Performance

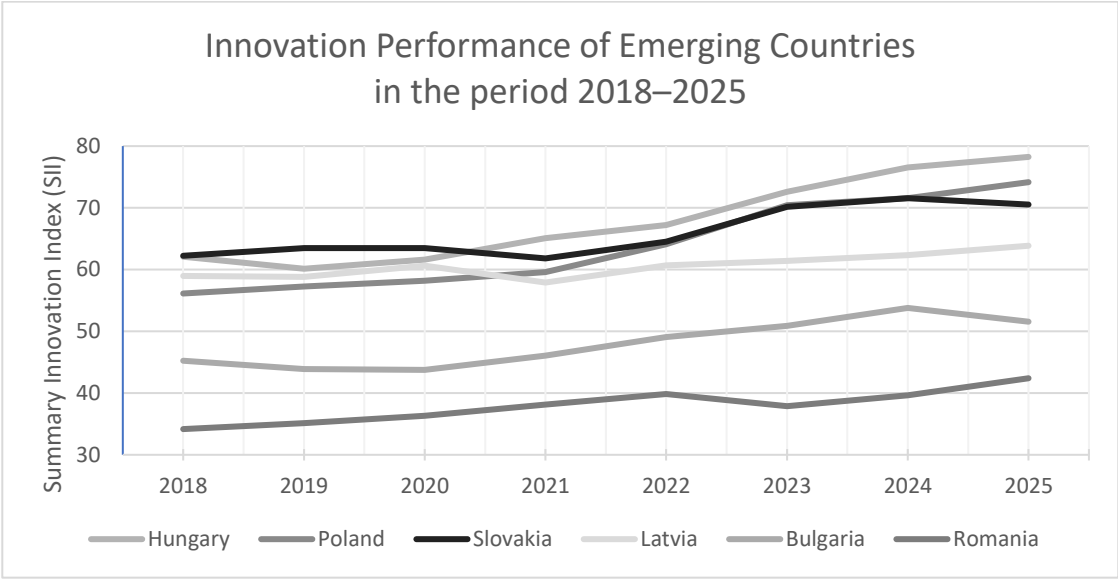
According to the European Innovation Scoreboard classifications in 2025, the Emerging Innovators are: Bulgaria, Hungary, Latvia, Poland, Romania, and Slovakia. Again, according the EIS 2025, these 6 countries have consistently been part of the Emerging Innovators group throughout the entire period covered by this analysis, 2018-2025.

Some other countries *graduated* to Moderate Innovators group: in 2018 Greece was classified as an Emerging Innovator; starting from 2019, it moved into the Moderate Innovators group and has remained there since. Similarly, Croatia was part of the Emerging group until 2022, but advanced to the Moderate Innovators group in 2023, where it has also remained. [1]

We have to mention that the previous two statements are based on the EIS 2025. Over time, indicators change, and values change also, yielding to changes in past classifications. For instance, in EIS 2024, Hungary and Croatia were at the limit between Moderate and Emerging Innovator, with Croatia classified as an Emerging Innovator, while Hungary as a Moderate Innovator. In EIS 2025, their rankings reversed.

In the next part of the analysis, we focus on the evolution of innovation among the Emerging Innovators, with particular attention to Romania in comparison with Croatia, which is considered a 'best-practice' case.

For the six Emerging Innovators, overall progress was observed over the 2018–2025 period. In the following study case, the countries are ordered by the 2025 innovation performance.



Fiqure 3. Innovation Performance of Emerging Countries in the period 2018–2025. The countries are ranked by their SII 2025 performance, with Hungary on the left as the most innovative within the group.

Romania shows steady advancement, except for the setback recorded in 2023. In terms of innovation, Romania occupies the most modest position, according to the country's profile published within EIS 2025. It performs at 37.7% of the EU27 average in 2025, while the Emerging Innovators group performs at 56.4% of EU27.

However, despite Romania's relatively low position, a remarkable progress can be observed in the current year: Romania recorded the best performance improvement in 2025 compared to the previous year, within its performance group, significantly higher than that of its Emerging Innovator peers and the overall EU27 average, as illustrated in the table below.

Table 1. Performance change for the Emerging Innovators

Measure	EU27	HU	PL	SK	LV	BG	RO
Performance Change 2025 vs 2018	12.59	16.18	18.04	8.30	4.90	6.32	8.23
Performance Change 2025 vs 2024	-0.44	1.71	2.58	-1.05	1.54	-2.23	2.73

Compound Annual Growth Rate	1.71	3.36	4.06	1.81	1.15	1.89	3.13

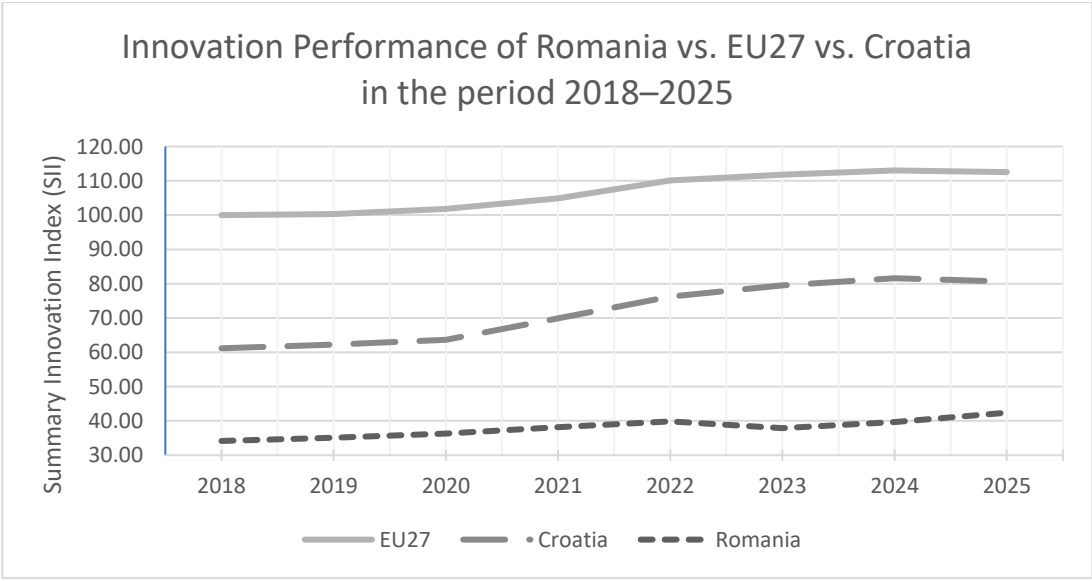
The Compound Annual Growth Rate (CAGR) also demonstrates Romania's progress over the past seven years, which is well above the EU27 average and places Romania in the top half of the Emerging Innovators group, alongside Poland and Hungary.

In fact, Romania recorded in 2025 the highest annual performance change across the entire period under analysis, of almost 3%, consolidating its position:

Table 2. Annual performance change for Romania in the period 2019-2025

2019	2020	2021	2022	2023	2024	2025
0.98	1.17	1.83	1.70	-1.95	1.77	**2.73**

In spite of Romania's progress over the past year, the gap between Romania and the EU27 continues to widen. In the next study case, we compared the evolution of Romania vs. EU27 vs. Croatia (the values are indexed to EU27 in 2018):



Fiqure 4. Innovation Performance of Romania vs. EU27 vs. Croatia in the period 2018–2025. The economies are ranked by their SII 2025 performance, with EU27 on the left as the most innovative.

Croatia experienced a significant increase in innovation performance between 2018 and 2025, reducing constantly the gap with the EU average and enabled the country to advance into the group of Moderate Innovators from Emerging in 2022.

Table 3. Annual innovation performance gap between Romania, the EU27 average, and Croatia in the period 2018–2025

	2018	2019	2020	2021	2022	2023	2024	2025	**Resolution**
Gap Romania vs. EU27	65.84	65.23	65.49	66.80	70.29	73.91	73.37	70.20	**diverged**
Gap Croatia vs. EU27	38.82	38.10	38.16	35.02	33.89	32.31	31.43	31.98	**converged**

In Romania's case, the gap with respect to EU27 increased from 65.84% in 2018 to 70.20% in 2025.

To capture the average yearly growth, we use the Compound Annual Growth Rate:

Table 4. The Compound Annual Growth Rate (CAGR) indicator for the 3 economies

Economy	EU27	Croatia	Romania
CAGR	1.71	4.02	3.13

Table 4 shows that both Croatia and Romania are well above the EU27 average: EU27 has grown, in average, with 1.71% yearly, while for Croatia and Romania the average yearly growth percentage is 4.02%, respectively 3.13%. However, in Romania's case, the relatively low starting values result in slow overall progress. Between 2018 and 2025, Romania's performance increased by only 8.23 points, compared with 12.59 points for the EU27 (see Table 1), thereby widening the gap between the two economies. (Both performance change values are reported relative to the same baseline: EU27 in 2018).

3.3. Decomposing Innovation: Sub-Pillar Analysis

As we observed above, although Romania has made substantial progress in recent years, the gap with the EU27 average and other countries remains concerning. In this section, we

aim to perform a structural analysis of innovation evolution, by examining the changes in sub-indicators for the three economies: Romania, the EU27, and Croatia.

Thus, we aim to identify which sub-indicators best explain the observed differences and which of them hold back Romania's transition.

To capture long-term performance dynamics, we computed the CAGR values for each of the three economies and for each of the 32 sub-pillars. The results are presented below.

Table 5. The Compound Annual Growth Rate (CAGR) and resolution for each innovation pillar for Romania, the EU27 average, and Croatia in the period 2018–2025

No	Indicator	CAGR Romania	CAGR EU27	CAGR Croatia	Romania vs. EU27	Romania vs. Croatia
	Summary Innovation Index (SII) 2025	3.13	1.71	4.02	+	-
1.1	Human resources	0.09	0.94	3.16	-	-
1.2	Attractive research systems	11.92	1.76	4.24	+	+
1.3	Digitalisation	5.79	5.26	2.63	+	+
2.1	Finance and support	-6.16	1.79	14.71	-	-
2.2	Firm investments	-0.53	0.16	3.97	-	-
2.3	Investments in information technologies	9.67	8.04	9.30	+	+
3.1	Innovators	-16.67	2.11	-1.16	-	-
3.2	Linkages	-5.81	4.48	5.91	-	-
3.3	Intellectual assets	1.96	-2.63	3.86	+	-
4.1	Sales and employment impacts	-3.66	0.21	1.20	-	-
4.2	Trade impacts	0.93	1.79	-0.38	-	+

4.3	Resource and labour productivity	7.96	1.79	4.53	+	+

The '+' symbol indicates an increase in innovation performance for Romania, while the '–' symbol denotes a decline.

As we can see in the table above, Romania have had a better progress rate than the average EU27, and lower than Croatia, at global innovation level. This evolution was largely analyzed in the previous section.

On sub-pillow level, compared with EU27 average and Croatia, the strengths of Romania are:

- Attractive research systems
- Digitalisation
- Investments in information technologies
- Resource and labour productivity

Among the weaknesses, we can list:

- Human resources
- Finance and support
- Firm investments
- Innovators
- Linkages
- Sales and employment impacts

While several strengths can be observed, structural weaknesses persist, limiting Romania's capacity to close the gap. Strengthening Romania's weaker sub-pillars through targeted measures is crucial.

4. Conclusions

Our analysis shows that Romania has achieved significant progress in innovation between 2018 and 2025, outperforming the EU27 average in terms of growth dynamics and positioning itself among the top Emerging Innovators alongside Poland and Hungary. However, due to its initially low baseline, Romania's absolute performance remains modest, and the gap with both the EU27 average and Croatia has widened. The sub-pillar analysis reveals important strengths - notably in research systems, digitalization, IT investments, and productivity - but also persistent weaknesses in human resources,

financing, firm investments, and innovation linkages. These structural challenges underline the need for targeted policy interventions to reinforce Romania's weaker dimensions and accelerate its convergence within the European innovation landscape.

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