

Regional innovation systems of Ukraine in EU coordinates: Transformational challenges and vectors of convergence

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The purpose of the article is to conduct a comprehensive comparative analysis of the regional innovation systems of Ukraine and the EU based on the adaptation of the European Regional Innovation Scoreboard methodology, taking into account the specifics of national official statistics to identify key gaps, competitive advantages, and vulnerabilities of Ukrainian regions in the context of European integration.

The methodology is based on the European Regional Innovation Scoreboard (EU-RIS) and European Innovation Scoreboard (EIS) approaches, adapted to Ukraine's conditions and official statistics requirements. The spatial framework is aligned with NUTS-UA standards. To overcome wartime statistical limitations, proxy indicators, bibliometric analysis of Scopus databases, and a combined method for allocating patent and licensing activity (UANIPO, EUIPO) by region were applied.

The results reveal a deep structural gap between the regional innovation ecosystems of Ukraine and the EU across virtually all parameters. In particular, the study identifies the dominance of inertial budget-centrism, the persistence of a «closed innovation» model, and a low level of business sector activity in R&D, commercialization, and international patenting (PCT, EUIPO) against the backdrop of a high level of digitalization in certain regions.

The originality of the study lies in the development of an adapted methodological toolkit for benchmarking regional innovation systems under conditions of limited official national statistics and martial law, which enabled a detailed comparison of Ukrainian Oblasts with European regions.

The practical value of the results lies in their potential use by state authorities and local self-government bodies to improve public innovation policy, implement smart specialization strategies, overcome digital and technological disparities, and accelerate the integration of domestic businesses into European research spaces.

Keywords: regional innovation systems, innovations, regions of Ukraine, European Union, Regional Innovation Scoreboard, European integration, innovation development, local statistics.

Introduction. Today, Ukraine's economy is developing under unprecedented security challenges and the intensification of European integration processes. The restructuring of regional and global value chains and gradual entry into highly competitive European markets require the search for tools and sources to ensure high growth dynamics and modernization of the national economy. Sustainable economic growth is increasingly linked to the ability of regional economies to innovate and undergo structural transformation, enabling adaptation to a dynamic and increasingly competitive environment. This necessitates the formation of effective ecosystems that foster innovation activity, research and development, and entrepreneurship development (European Commission, 2026).

Innovation development plays a crucial role in the process of approximation to the European Union (hereinafter referred to as the EU), particularly under Chapter 25 «Science and Research» of the EU *acquis*, which is a component of Ukraine's EU accession negotiations. According to the European Commission Report on Ukraine of November 4, 2025, the country demonstrated good progress (scoring 4 out of 5) with a generally moderate level of preparedness (Directorate-General for Enlargement and Eastern Neighbourhood, 2025). This was facilitated by the adoption of a number of regulatory legal acts and policy documents, in particular: the Law of Ukraine No. 3791-IX on supporting scientific work in higher education institutions (Verkhovna Rada of Ukraine, 2024), the new Methodology for State Certification of Scientific Institutions (Ministry of Education and Science of Ukraine, 2024), the Digital Development Strategy for Innovation Activity until 2030 (Cabinet of Ministers of Ukraine, 2024), as well as the launch of the Roadmap for Integration into the European Research Area for 2025-2027 (Ministry of Education and Science

of Ukraine, 2025), aimed at combining the domestic innovation ecosystem with EU resources. According to the Report on the Implementation of the Association Agreement for 2025, progress in the fields of science, technology, innovation, and digital integration rose to 74% (Government Office for Coordination of European and Euro-Atlantic Integration, 2026).

At the same time, a number of practical problems remain: interaction between science and business is insufficient, and the share of R&D expenditures (with a slight increase from 0.33% of GDP in 2022 to 0.37% in 2024) remains extremely low. According to the European Innovation Scoreboard 2025 (EIS) (European Commission, 2025a), Ukraine belongs to the group of emerging innovators, yet the gap with the EU average has widened (the index decreased from 32.5% in 2024 to 29% in 2025).

To bridge this gap and modernize the economy, a key guideline for Ukrainian regions is the EU innovation policy aimed at strengthening positions in global science, stimulating industrial innovations, and commercializing technological breakthroughs (Richard-Romei & Ploeger, 2026). At the present stage, the core components and tools of this policy include the «Innovation Union» concept and analytical scoreboards (the introduction of the European Innovation Scoreboard and the Regional Innovation Scoreboard to monitor the single European innovation market); the Horizon Europe program (with its second strategic plan for 2025-2027, outlining priorities for green and digital transitions and building a resilient, inclusive economy); Cohesion Policy (financial support for regional innovation and research within the 2021-2027 programs with a budget of about EUR 56.6 billion); as well as the European Institute of Innovation and Technology as an entity that drives innovation through the integration of business, education, and research.

As Ukraine consistently moves along the path of European integration, carrying out a systematic comparative assessment of the regional innovation systems of Ukraine and the EU acquires special strategic importance. European standards, metrics, and tools must become the primary guideline for transforming public policy in the field of innovation activity. Such benchmarking makes it possible not only to objectively measure the existing gap, but also to identify key growth points, adapt advanced EU practices to Ukrainian realities, and ensure effective convergence of economies at the regional level.

To conduct such an assessment, the methodology of the Regional Innovation Scoreboard (European Commission, 2025b) (EU-RIS) was taken as a basis and adapted to the development features of Ukraine's regional innovation systems, taking into account the specifics of the organization and functioning of official statistics in Ukraine.

Literature Review. The theoretical foundations of research on regional innovation systems (RIS) were formed on the basis of the national innovation system concept presented in the works of C. Freeman and B.-A. Lundvall. Their approaches are complementary: C. Freeman considered innovations primarily at the macro level in the context of international trade and economic development, whereas B.-A. Lundvall focused on the micro level, emphasizing the «producer-user» interaction as a driver of innovation (Lundvall, 2016). The further development of the systemic approach to innovation was driven by increased attention to the territorial specificity of innovation processes, the role of knowledge, the institutional environment, and interaction among participants in innovation activity. An important theoretical foundation for the regional approach was formed, in particular, by A. Marshall's studies on the localization of economic activity and agglomeration effects, while the conceptual framework of RIS was further developed in the works of P. Cooke and other scholars who viewed the region as a space for the interaction of enterprises, research and educational institutions, government bodies, and other institutions involved in the creation, dissemination, and use of knowledge (Pino & Ortega, 2018).

In modern research, RIS are viewed as multidimensional systems whose functioning is associated with the ability of regions to undergo structural and technological transformation, build competitive advantages, and ensure long-term economic development. Significant attention is paid to spatial interaction, institutional capacity, and the nature of relationships among key participants in the innovation process. Such interaction creates prerequisites for knowledge exchange, joint innovation production, and the enhancement of regional competitiveness (Leydesdorff & Porto-Gomez, 2019; Uribe-Gymez et al., 2019). At the same time, external network ties expand the opportunities of regions for accessing knowledge and attracting resources and competencies that are not always available within a specific territory. This is of particular importance for peripheral and cross-border territories, where spatial remoteness and institutional barriers can limit access to innovation resources. Studies of cross-border RIS emphasize the role of cognitive and institutional proximity, universities, and network interaction in ensuring inter-territorial technology transfer (van den Broek et al., 2019; Cappellano & Rizzo, 2019). Empirical studies of peripheral territories also demonstrate that resource constraints and significant spatial distances can complicate the formation of stable regional innovation networks (Jauhiainen & Moilanen, 2012).

The multidimensionality of the RIS concept is systematized, in particular, in a study by C. Fernandes, L. Farinha, J. Ferreira, B. Asheim, and R. Rutten (Fernandes, Farinha, Ferreira, Asheim, & Rutten, 2021), who, based on bibliometric and co-citation analysis, identified four interrelated directions of its research: regional knowledge systems, institutional systems, regional research and development systems, and regional network systems. This systematization demonstrates a shift from considering individual characteristics of innovation development to a comprehensive interpretation of RIS as a set of interrelated knowledge, institutional, research, and network components. At the same time, the issue of RIS assessment remains debatable (Doloreux & Parto, 2005).

A logical continuation of such research was the creation of comprehensive assessment systems, among which a leading place is occupied by the EU- RIS. The EU-RIS assessment system is based on the logic of the EIS; however, due to the limitations of regional data, it covers 23 of the 32 EIS indicators (European Commission, 2025c). In the 2025 edition, the EU-RIS covers 241 regions (NUTS 2) in 22 EU member states, as well as in Norway, Serbia, Switzerland, and the United Kingdom (five smaller countries are included at the national level). The construction of a composite index makes it possible to conduct interregional comparisons taking into account the specifics of regional data.

In the Ukrainian scientific space, the issues of RIS formation and assessment are explored in the works of T. Yarema (Yarema, 2022), Yu. Klius and V. Syvochka (Klius&Syvochka,2023). Significant attention is paid to the analysis of regional innovation ecosystems, innovation infrastructure, and smart specialization as tools for developing the innovation potential of territories (Shvets, 2022; Matrunchyk, 2023; Rohoza et al., 2025). The interaction of key RIS participants (universities, business, and the state) is studied separately, particularly in the context of developing innovation clusters (Mann & Borovko, 2025). In the context of Ukraine's European integration, attention is also focused on the integration of Ukrainian regions into European innovation ecosystems and the development of interregional innovation cooperation (Bilous, 2026).

At the same time, an analysis of scientific literature demonstrates that domestic research is mainly focused on individual components of regional innovation development – innovation potential, infrastructure, ecosystems, smart specialization, and specific aspects of stakeholder interaction. An unresolved part of the general problem is the lack of a holistic methodological toolkit for assessing RIS that would combine the conceptual logic of the EU-RIS methodology with the capabilities

and limitations of national official statistics. This significantly constrains the possibilities for systematic benchmarking of Ukraine's regions and the objective identification of their competitive advantages and vulnerabilities in the European context. Therefore, an adapted methodology for the comparative analysis of RIS requires scientific rethinking and further development to ensure the comparability of Ukrainian regions with European ones in the context of European integration.

Methodology. The theoretical and methodological foundation of the comparative assessment is provided by European tools for measuring innovation development. In accordance with the EIS methodology, the assessment of innovation performance is carried out through the prism of four main components (framework conditions, investments, innovation activities, and impacts) and 12 innovation dimensions (European Commission, 2025a).

The spatial framework of the comparative analysis in Ukraine was harmonized with European standards due to the introduction, as of January 1, 2025, of the statistical classification of territorial units of Ukraine (NUTS-UA), approved by Order of the State Statistics Service of Ukraine No. 189 dated July 18, 2024 (State Statistics Service of Ukraine, 2024). The classification was developed in accordance with Regulation (EC) No. 1059/2003 and received a positive assessment from Eurostat:

- NUTS-UA1: 8 territorial units formed by combining regions (population threshold ranging from 3 to 7 million people);
- NUTS-UA2: 27 administrative units «regions» (population threshold ranging from 800 thousand to 3 million people);
- NUTS-UA3: 138 administrative units «districts» (population threshold ranging from 150 to 800 thousand people), with the cities of Kyiv and Sevastopol classified simultaneously as both NUTS-UA2 and NUTS-UA3 levels.

To carry out a comparative assessment of RIS development in EU countries and Ukraine, the RIS-2025 methodology was adapted to the specific features of Ukraine's RIS, taking into account the specifics of the functioning of official statistics under wartime conditions. The system of indicators is either completely analogous to the EU-RIS indicators or contains well-founded proxy indicators in cases of statistical discrepancies (while conceptually characterizing the same aspects of innovation activity).

For each indicator, a reference year is determined – the year for which data are available in at least 75% of the regions. Due to the specifics of the functioning of the national statistical system under wartime conditions, the reference year typically lags 1-2 years behind the research period; in particular, for the gross regional product (GRP) indicator, 2021 has been defined as the reference year.

Due to the absence of official statistical reporting in certain areas, custom methodological tools for data collection and processing were developed. In particular, to assess scientific productivity, the indicator of the number of publications in Scopus database journals per 1,000 population was used. Information was collected via the Scopus platform interface using search queries for the period 2018-2024 (publication year filter: PUBYEAR > 2017 AND PUBYEAR < 2025). The obtained results provide representative estimates of the publication activity of Ukraine's Oblasts and reflect the territorial distribution of scientific output on a regional basis.

Data collection regarding the number of applications for inventions, utility models, trademarks, and industrial designs was carried out based on official reporting from the Ukrainian National Office for Intellectual Property and Innovations (UANIPIO) and information obtained upon an official request (Ukrainian National Office for Intellectual Property and Innovations, 2025) combined with the analysis of international registries. In particular, the regional distribution of applications under the Patent Cooperation Treaty (PCT) procedure is based directly on UANIPIO

data, whereas a combined approach was applied to calculate the corresponding indicators for trademarks and industrial designs (under the EUIPO procedure). At the first stage, based on official EUIPO (European Union Intellectual Property Office) reports, the TOP-25 key Ukrainian applicant-owners were identified. At the second stage, using an advanced search in the EUIPO eSearch plus database, UANIPIO's special information system, and the OpenDataBot open data service by the legal registration place of enterprises, their territorial distribution across the regions of Ukraine was carried out. This approach made it possible to determine the specific weight of each region in the total volume of applications submitted by Ukrainian residents to EUIPO and ensured the completeness of the assessment of the patent-licensing component of regional innovation systems. In addition, the obtained results create an analytical foundation for assessing the innovation activity of regions not only at the national level, but also internationally.

Table 1

System of adapted indicators for assessing the regional innovation systems of Ukraine

Indicator name
FRAMEWORK CONDITIONS
1.1.1. Share of the population aged 25 and older with at least a first (bachelor's) level of higher education (basic higher education), % of the total population of the respective age group
1.1.2. Average duration of education for individuals aged 25 and older, years
1.2.1. Number of publications published in Scopus database journals per 1,000 population
1.3.1. Share of households with home internet access (connection type – fixed broadband connection), percentage of the total number of households in the respective group
INVESTMENTS
2.1.1. Share of research and development expenditures in the government and higher education sectors, percentage of GRP
2.2.1. Share of research and development expenditures in the business enterprise sector, percentage of GRP
2.2.2. Enterprise innovation expenditures not related to R&D, percentage of the volume of products sold by enterprises
2.2.3. Enterprise innovation expenditures per employee at innovation-active enterprises, thousand UAH
2.3.1. Share of enterprises purchasing cloud computing services in the total number of enterprises, %
2.3.2. Share of employed population in the information and communication sector, percentage of the total number of employed in the economy, %
INNOVATION ACTIVITIES
3.1.1. Share of enterprises that introduced new or significantly improved products (goods, services), percentage of the total number of enterprises
3.1.2. Share of enterprises that implemented innovation processes, percentage of the total number of enterprises
3.2.1. Share of innovation-active enterprises engaged in innovation cooperation, percentage of the total number of enterprises
3.3.1. Number of patent and utility model applications from domestic applicants under the national procedure per million UAH of GRP
3.3.2. Number of trademark applications from domestic applicants per million UAH of GRP
3.3.3. Number of industrial design applications from domestic applicants per million UAH of GRP
IMPACTS
4.1.1. Share of realized innovative products (new to the market and new to the enterprise) of enterprises, percentage of the total volume of products sold by enterprises
4.1.2. Share of employed workers at innovation-active enterprises of the respective type of economic activity, %
4.2.1. Share of medium- and high-tech product exports in the total volume of exports, percentage
4.3.1. Emissions of PM2.5 from stationary sources per 1,000 population, in tons
4.3.2. Labor productivity, UAH per hour

The general list of adapted indicators for assessing RIS is given in Table 1.

To calculate indicators 2.2.2, 2.2.3, 3.1.1, 3.1.2, 3.2.1, 4.1.1, and 4.1.2, all enterprises were taken into account, whereas in the EU, only small and medium-sized enterprises (SMEs) were included. Such methodological discrepancies are due to the lack of disaggregated regional-level data in official Ukrainian statistics for the SME sector across a number of indicators, specifically: the volume of innovation expenditures not related to R&D; specific innovation expenditures per employee; the number of SMEs implementing product and business process innovations; data on the engagement of innovation-active SMEs in cooperation with other counterparties; the sales volumes of products new to the market or the firm; as well as the overall employment level in innovative enterprises of the SME sector.

The purpose of the article is to conduct a comparative analysis of the regional innovation systems of Ukraine and the EU based on the adaptation of the RIS methodology, taking into account the specifics of national official statistics, as well as to identify key gaps, competitive advantages, and vulnerabilities of Ukrainian regions in the context of European integration.

Results. The current transformation of Ukraine's RIS is taking place under unprecedented external challenges, which requires a rethinking of strategic development guidelines in the context of European integration. A comparative analysis of key indicators within the «Ukraine – EU» coordinate system allows for the identification of differences in the architecture of innovation processes and the determination of vectors for convergence. At the same time, the use of the macro-level is necessary to synthesize a large array of data from over 240 European regions and identify general trends, which is complemented by a detailed regional level to identify local asymmetries and growth points.

Models of Research and Development Financing. A fundamental difference between the RIS of Ukraine and the EU is the model of financial support for scientific activities. In European practice, business acts as the main driver of innovation, accounting for about 66% of all R&D expenditure, whereas Ukraine exhibits an inertial «budget-centric» model, where the main burden falls on the public and higher education sectors. An analysis of the share of expenditures on research and development in the public and higher education sectors (% of GRP) for the period 2018-2024 indicates a gradual decrease in funding levels. The average indicator for Ukraine demonstrated a downward trend from 0.196% in 2018 to 0.148% in 2024. For comparison, in the EU, it averages about 0.76%, which is 4.3 times higher than the Ukrainian level (State Statistics Service of Ukraine, 2026a; European Commission, 2025d).

There is a deficit of resource support for academic science, which limits the potential for generating new knowledge. Regional analysis reveals an excessive concentration of scientific potential: Kyiv is the leader (0.459%), which is 2.5 times higher than the average, while Kharkivska Oblast (0.424%) remains a powerful hub due to the concentration of higher education institutions. However, in most other Oblasts, the indicators are critically low (below 0.05% or 0.01%), indicating an actual lack of science funding in the regions. The most pronounced asymmetry lies in R&D financing by the business sector; specifically, the investment intensity of European business in research is approximately seven times higher than the corresponding Ukrainian indicator. In Ukraine, the share of business sector expenditures on R&D has decreased to 0.21% of GRP, while in most regions private investment in research remains minimal, contrasting with the industrially developed regions of Germany, where this indicator reaches 7% of GRP.

Digital Infrastructure and Regional Convergence. In 2021, fixed broadband household coverage in Ukraine reached 82.1%, bringing the country close to the EU average (90%). Ukraine demonstrated higher growth dynamics compared to the European market, with the mass deployment of modern fiber-optic lines being a

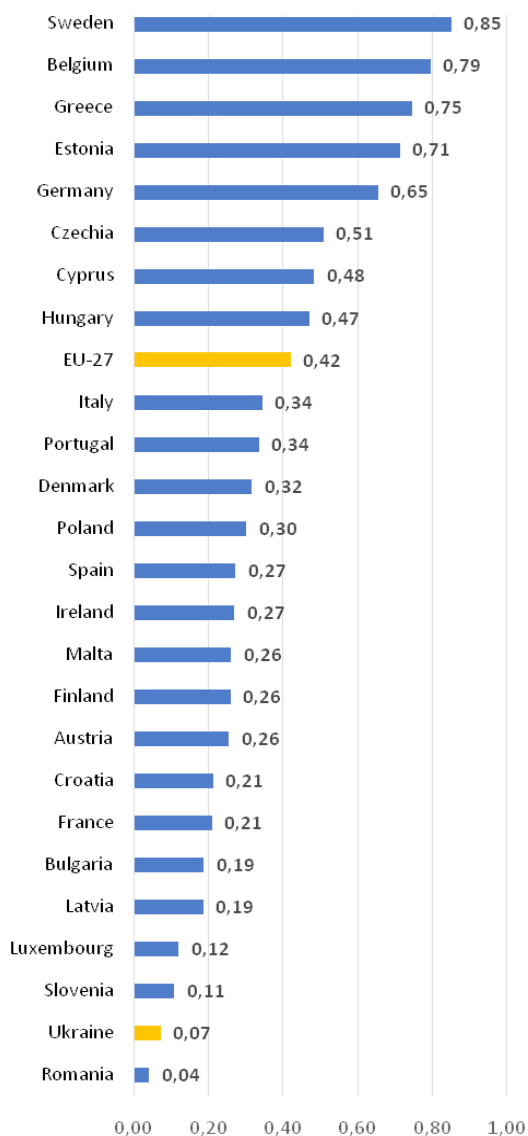


Fig. 1. Innovation expenditures of small and medium-sized enterprises in 2022, non-R&D related, as a percentage of the volume of products sold by such enterprises (for Ukraine – of all enterprises)

Source: Compiled by the authors based on the data of European Commission (2025d), State Statistics Service of Ukraine (2026b).

qualitative advantage. A comparison of individual Ukrainian regions with the EU in the pre-war period made it possible to identify a group of leaders, which included Luhanska Oblast (96.3%) and Chernivetska Oblast (95.6%), matching the level of the Netherlands (98%) and outperforming Germany and Belgium. The city of Kyiv (92.2%) demonstrated a standard level for major European metropolises such as Berlin or Prague.

The conducted analysis highlights the deepening of interregional disparities in Ukraine: the lowest indicators were recorded in Chernihivska Oblast (65.7%)

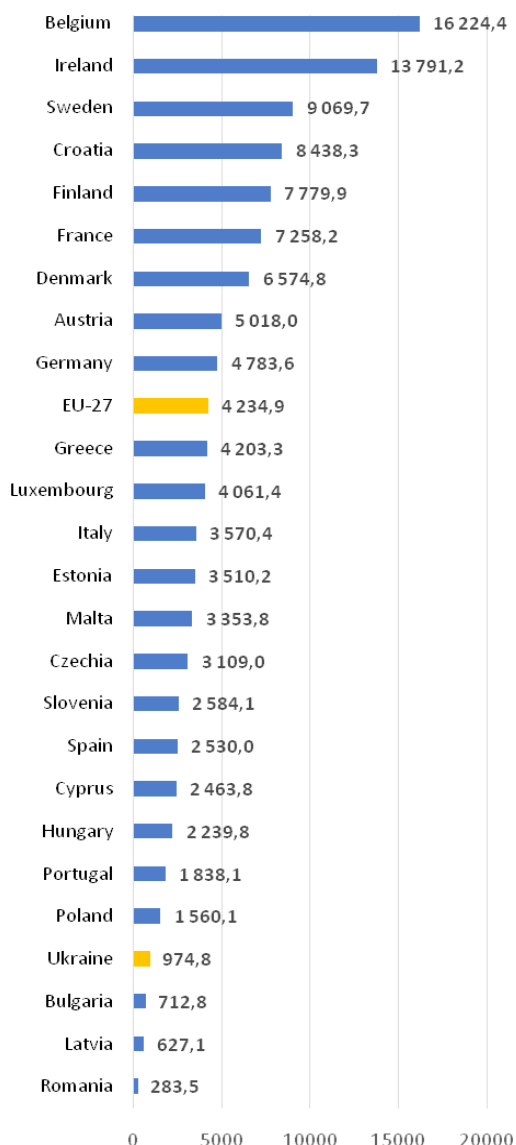


Fig. 2. Innovation expenditures of small and medium-sized enterprises in 2022, per employee at innovation-active small and medium-sized enterprises (for Ukraine – of all enterprises)

and Rivnenska Oblast (66.0%). Unlike the EU, where Cohesion policy is aimed at the convergence of rural areas, development in Ukraine followed a spontaneous market model. This led to the formation of an «island» model of digitalization – the concentration of technological progress in points with high competition, accompanied by the deceleration of processes in regions with complex logistics.

Innovation Expenditures and Technological Equipment of Workplaces. An analysis of non-R&D innovation expenditures for the period 2018-2024 reveals the structural specificity of the Ukrainian economy. In the EU in 2024, small and medium-sized enterprises (SMEs) play a crucial role in ensuring innovation activity, with the R&D expenditure indicator in this sector standing at 0.42%. In Ukraine, the corresponding indicator was only 0.088%, which is 4.7 times lower than the EU level. Average expenditures per employee in Ukraine in 2024 amounted to EUR 974.76, which is 4.3 times less than the average SME indicator in the EU (EUR 4,334.88) (see Fig. 1-2).

Since the data for Ukraine and its regions cover all enterprises, the real gap in the investment capabilities of Ukrainian small businesses is even more significant. Ukraine exhibits substantial interregional differentiation in the distribution of investment resources: Khmelnytska (EUR 2,700.29) and Chernihivska (EUR 2,429.42) Oblasts approach the level of Spanish SMEs (EUR 2,529.96), whereas in Lvivska Oblast, expenditures amount to only EUR 267.83 per employee. The overall low investment intensity in Ukraine, comparable to the figures of Bulgaria (EUR 712.83) and Latvia (EUR 627.07), confirms the orientation of domestic businesses toward labor-intensive processes instead of the technological re-equipment of labor. SMEs in neighboring Poland spend 1.6 times more than the average indicator for Ukraine's entire corporate sector. This vividly highlights the systemic deficit of investment in modernization, as even small businesses in Poland technologically outperform the general level of the Ukrainian economy (European Commission, 2025d).

Human Capital and ICT Employment. As of 2023, the average ICT employment rate in the EU-27 is 4.80%, whereas in Ukraine it was 1.85% in 2021. This means that the intensity of involving the population in the ICT sector in Ukraine is 2.6 times lower than in Europe, where the leaders are Sweden (8.70%) and Finland (7.60%). Ukraine lags behind even the countries with the lowest share of ICT employment in the EU, such as Greece (2.40%) and Romania (2.60%).

Regional breakdown reveals an uneven distribution of specialists: Kyiv (6.65%) is the only region that meets European standards, approaching the level of Estonia. However, Kyiv still lags behind Prague (12.09%), Bratislava (11.06%), and Warsaw (10.55%), which have almost twice the concentration of personnel. In most other Ukrainian Oblasts, the indicator is below 1% (Zakarpatska – 0.62%, Ivano-Frankivska – 0.66%), whereas in the EU, even in agricultural regions, the share of ICT employment is typically not lower than 1%. Even industrial regions of Poland, such as Silesia (3.85%), have a significantly higher share of ICT personnel than Kharkivska or Dnipropetrovska Oblasts (European Commission, 2025d).

Diffusion of Product and Process Innovations in the Business Sector. A comparative analysis of the share of enterprises that introduced new or significantly improved products (goods, services) indicates a significant lag of Ukraine behind EU countries in terms of innovation activity. While the average indicator for the SME sector in the EU in 2022 is 26.43%, in Ukraine the corresponding indicator is only 0.45%. This gap means that the innovative renewal of product lines in European small businesses occurs almost 60 times more intensively. Even compared to countries with the lowest indicators, such as Poland (10.53%) and Romania (6.82%), Ukrainian enterprises are characterized by an extremely low capacity for commercialization and launching new products onto the market. At the same time, the experience of small economies, such as Luxembourg (26.06%) and Latvia

(17.16%), confirms that the scale of the domestic market is not a decisive factor in innovation dynamics (State Statistics Service of Ukraine, 2026b; European Commission, 2025d).

At the regional level, the gap is even more critical: while in EU regions the share of innovation-active enterprises typically ranges between 15-45%, in Ukrainian Oblasts this indicator does not even reach 1.1%. In particular, domestic leaders – Ternopil'ska (1.08%) and Vinnytska (0.91%) Oblasts – lag behind even those European regions with the lowest values, such as Sud-Vest Oltenia in Romania (1.58%) or the Masovian Voivodeship in Poland (4.35%). Such a discrepancy indicates not just low dynamics, but the institutional underdevelopment of innovation processes as a systemic phenomenon at the level of Ukraine's regional economies.

An even more pronounced asymmetry is observed in the sphere of process innovations, which form the basis of technological modernization. The average level of their implementation in EU countries in 2022 reaches 41.56%, whereas in Ukraine it is only 0.72%. Leading countries, particularly Greece (61.17%) and Belgium (60.50%), demonstrate a development model in which the modernization of production and management processes is a prerequisite for maintaining competitiveness (European Commission, 2025d). In Ukraine, however, process innovations are sporadic, which hinders the pace of technological renewal in the industrial sector and perpetuates the problem of their low productivity. Similar trends are observed at the regional level, where the majority of EU regions hold a multiple advantage over Ukrainian regions.

Institutional Interaction and the «Closed Innovation» Model. An analysis of the share of innovation-active enterprises engaged in innovation cooperation reveals even greater differences between EU countries and Ukraine. The average level of SME engagement in innovation cooperation in EU countries in 2022 is 12.43%, whereas in Ukraine it is only 0.19%. Even in comparison with neighboring Poland (7.08%) and Hungary (9.36%), domestic business entities exhibit a significantly lower level of institutional interaction. This confirms the dominance of the «closed innovation» model, in which the development of new solutions is carried out primarily by enterprises using their own resources, without involving research institutions, professional associations, or other market participants.

At the regional level, the situation is characterized by fragmentation and weak integration into international innovation networks: the indicators of leaders (Ternopil'ska – 0.49%, Mykolayiv'ska – 0.41%) remain dozens of times lower than the values of neighboring EU regions. In particular, the Podkarpackie Voivodeship demonstrates almost a hundred times higher intensity of innovation links than the adjacent Lviv'ska Oblast (0.12%). In leading European innovation regions, such as Stockholm (32.92%) or Helsinki-Uusimaa (26.92%), every third SME operates in partnership, which promotes intensive knowledge and technology exchange. The low partnership activity, even in powerful scientific centers including the city of Kyiv (0.27%), becomes a major barrier to technology transfer. Knowledge remains localized within individual companies, which makes it impossible to generate a synergistic effect for regional economies and hinders the formation of innovation clusters.

International Legal Protection of Enterprises' Intellectual Property. A comparative analysis of the number of patent and utility model applications under the Patent Cooperation Treaty (PCT) per EUR 1 million of GRP demonstrates a significant gap between Ukraine and EU countries. While the average indicator in the EU in 2018-2021 was 3.26-3.53 units per EUR 1 million of GRP, in Ukraine it ranged from $1,84 \cdot 10^{-5}$ – $3,54 \cdot 10^{-5}$ units per EUR 1 million of GRP. Even EU countries with the lowest indicators, notably Romania (0.15 units per EUR 1 million of GRP), Bulgaria (0.40 units per EUR 1 million of GRP), and Croatia (0.44 units per EUR 1 million of GRP), exhibit results exceeding those of Ukraine by a thousand times.

At the same time, the leading EU countries (Sweden (8.22 units per EUR 1 million of GRP), Finland (7.56 units per EUR 1 million of GRP), and Switzerland (7.10 units per EUR 1 million of GRP)) shape innovation-driven economic models where international patenting serves as a systemic element of knowledge commercialization (European Commission, 2025d).

Regional analysis confirms that in the EU, patent activity is of a cluster-based yet mass character: in the region of North Brabant (Netherlands), the indicator reaches 15.5-16.9 units per EUR 1 million of GRP, in Sydsverige Sweden – up to 14.03 units per EUR 1 million of GRP, and in Stockholm – 11.70 units per EUR 1 million of GRP, whereas even in the least active regions of Romania (Sud-Vest Oltenia – 0.016-0.046 units per EUR 1 million of GRP, Sud-Est – 0.036-0.059 units per EUR 1 million of GRP) and Greece (Dytiki Makedonia – 0.025 units per EUR 1 million of GRP), the indicators exceed those of Ukraine. In Ukraine, however, international patenting under the PCT procedure is localized in character and is effectively limited to a few regions (Kharkivska, Kyivska, Lvivska, and Dnipropetrovska Oblasts, as well as the city of Kyiv), while in most regions it is practically non-existent.

Integration into the European Intellectual Property Market (EUIPO). The average indicator of trademark registration in the EU in 2021 was 7.40 units per EUR 1 million of GRP, whereas in Ukraine it was only 0.0013 units per EUR 1 million of GRP, which indicates a lag of more than 5,000 times. A similar situation is observed regarding industrial designs: 3.97 units per EUR 1 million of GRP in the EU versus $4,14 \cdot 10^{-5}$ units per EUR 1 million of GRP in Ukraine, creating a gap of more than 90,000 times.

In EU countries, the active use of EUIPO tools is an established practice. In particular, the intensity of trademark registration in Malta reaches 48.19 units per EUR 1 million of GRP, in Cyprus – 42.81 units per EUR 1 million of GRP, and in Estonia – 23.03 units per EUR 1 million of GRP. Even in Central and Eastern European countries (Poland – 6.02 units per EUR 1 million of GRP; Romania – 3.00 units per EUR 1 million of GRP), the indicators remain consistently high. In the field of industrial designs, the leaders are Austria (7.56 units per EUR 1 million of GRP), Denmark (7.57 units per EUR 1 million of GRP), and Poland (5.56 units per EUR 1 million of GRP), reflecting the active use of design as an instrument of competitive differentiation (European Commission, 2025d).

Market Performance of Innovation Commercialization. The average indicator of the share of realized innovative products (new to the market and to the enterprise) in 2022 for SMEs in EU countries is 8.67%, whereas in Ukraine it is only 0.43%, which creates a gap of more than 20 times and indicates a low capability of Ukrainian enterprises to transform innovative developments into market outcomes. Even in EU countries with relatively low values of this indicator, notably Poland (2.19%) and Malta (2.24%), the level of commercialization exceeds the Ukrainian one by 5 times, whereas in leading countries (Denmark (24.15%), Greece (16.15%), and Portugal (15.60%)) it is higher by tens of times (see Fig. 3).

At the regional level in the EU, the share of innovative products in SME sales reaches 25-34% (Panonska Hrvatska – 33.93%; Northern and Western Ireland – 25.37%), whereas in Ukraine, even in the leading regions (Dnipropetrovska – 3.65%; Khmelnytska – 2.4%), it remains several times lower. At the same time, certain Oblasts demonstrate indicator values comparable to or even higher than those of individual regions in Central and Eastern Europe, indicating the presence of local potential for integration into the European innovation space.

The efficiency of the economy's technological renewal directly depends on the volume of human capital involved in the creation and implementation of new products and processes. In 2022, the employment rate in innovation-active enterprises in Ukraine was 24.8%, which is more than twice lower than the average indicator of

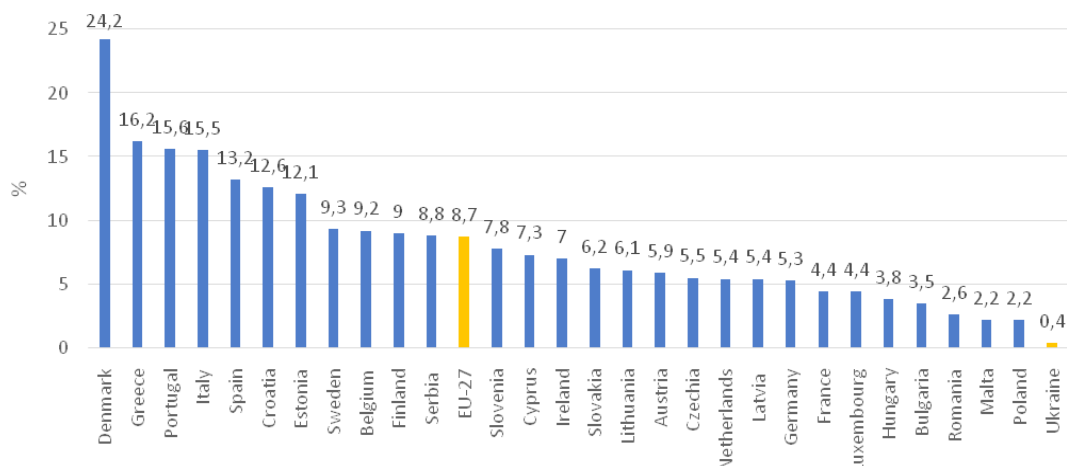


Fig. 3. Share of realized innovative products (new-to-market and new-to-firm) of small and medium-sized enterprises in 2022, percentage of total SME sales volume

Source: Compiled by the authors based on the data of European Commission (2025d), State Statistics Service of Ukraine (2026b).

EU countries in the SME sector (57.93%) and indicates insufficient involvement of human resource potential in innovation activity. The leaders in this indicator are Belgium (75.76%), Germany (71.29%), and Italy (69.78%), which confirms the high innovation intensity of their labor markets. Ukraine's employment level in the innovation sector is lower than that of most EU countries, yet it exceeds the corresponding indicator of Romania (10.05%) and approaches the value of Bulgaria (34.31%) (European Commission, 2025d).

At the regional level, the gap in the innovation intensity of labor is even more pronounced: while in the Vlaams Gewest of Belgium this indicator reaches 80.17%, in Ukraine's leading industrial Oblasts it remains twice as low (Zaporizhshka – 45.9%, Dnipropetrovska – 31.8%). Particularly noticeable is the lag of border regions behind adjacent EU territories: Zakarpatska (24.1%) and Lvivska (28.7%) Oblasts significantly trail Eastern Slovakia (35.5%) and the Podkarpackie Voivodeship (47.8%), which indicates a low intensity of personnel involvement in value-added creation compared to closest neighbors.

A comprehensive comparative analysis demonstrates a deep systemic gap between the regional innovation systems of Ukraine and the EU across virtually all key parameters – from funding models and institutional interaction to the market performance of commercialization and international patenting. The Ukrainian RIS model exhibits traits of budget-centrism, fragmentation, and «closed innovations», complicated by the destructive consequences of war and deindustrialization. At the same time, the presence of local growth points and individual regional leaders approaching European indicators in terms of digitalization or certain productivity parameters confirms the existence of internal potential for gradual convergence. Overcoming the identified imbalances requires targeted state policy in the field of innovation activity, the stimulation of private investments in modernization, the strengthening of links between science and business, and the harmonization of Ukrainian innovation indicators with European standards.

Discussion. The obtained results complement and expand the modern theoretical foundations of RIS research, building upon the classical approaches of C. Freeman regarding the macro-level analysis of innovations and B. –A. Lundvall concerning the micro-dynamics of user-producer interaction (Lundvall, 2016). At the same time, the conducted study develops the ideas of P. Cooke and other

scholars regarding the region as a space of institutional interaction, confirming the conceptual propositions on the multidimensionality of RIS highlighted in the works of C. Fernandes and co-authors through four key components – knowledge, institutional, research, and network components (Fernandes et al., 2020). Unlike the works of domestic researchers (Yarema, 2022; Klius, Syvochka, 2023), who primarily focus on individual ecosystem elements or smart specialization (Shvets, 2022; Matrunchyk, 2023), the proposed comprehensive benchmarking bridges the methodological gap regarding the operationalization of RIS under the constraints of national statistics by adapting it to the European RIS 2025 standards (European Commission, 2025c).

The comparison of empirical data with existing scientific studies has made it possible to identify both common patterns and distinctive characteristics. As in the countries of Eastern and Central Europe, Ukraine exhibits a clear spatial polarization and concentration of scientific and technological potential around metropolitan and major educational centers. However, the fundamental difference is the dominance of an inertial budget-centric financing model versus a market-oriented European business segment, which confirms the conclusions regarding the critical vulnerability of peripheral territories and the limitation of sustainable regional networks pointed out by researchers of cross-border and peripheral RIS (Jauhainen & Moilanen, 2012; van den Broek et al., 2020). The obtained results also demonstrate a significant scientific contribution in the form of the documented «digital saturation» paradox: despite high indicators of fixed broadband access in certain regions, an extremely low diffusion of process and product innovations is recorded. This clearly indicates the weak absorptive capacity of the economy, a deficit of institutional proximity between the academic environment and business, and the absence of effective channels for knowledge commercialization in the absence of full-fledged network interaction based on «Triple Helix» models.

Conclusions. As a result of the conducted study, a comprehensive assessment and comparative benchmarking of the regional innovation systems of Ukraine and the EU were carried out based on the adapted RIS 2025 methodology. The obtained findings indicate that Ukraine's regional innovation ecosystems are in a state of deep structural transformation caused by the cumulative impact of wartime challenges and European integration commitments. The main destructive factors identified are the excessive concentration of scientific potential in individual centers, the persistence of the «closed innovation» model, and low innovation activity. Unlike the European model, where small businesses ensure technology diffusion, the Ukrainian landscape is characterized by inertial budget-centrism and weak commercialization of academic developments.

To mitigate the identified disparities and ensure convergence with the European space, it is necessary to intensify the commercialization of scientific achievements through the introduction of regional innovation vouchers and tax incentives for enterprises investing in joint projects with academic institutions. To overcome digital and technological asymmetry, it is envisaged to implement targeted subventions in regions with low connectivity access (in particular, Chernihivska, Rivnenska, and Zhytomyrska Oblasts) to eliminate the threefold lag in cloud services, as well as to develop regional technology transfer centers and digital hubs providing targeted automation grants for SMEs.

The intensification of innovation processes requires a systemic transition from spot subsidization to the support of network structures, the development of horizontal linkages according to the «business – science – government» model (Triple Helix), and the scaling of ICT employment beyond the capital through regional educational hubs. In addition, priority steps include the expansion of financial compensation and support programs for the registration of trademarks and industrial designs in European institutions (EUIPO, PCT), the development of a network of Technology

and Innovation Support Centers (TISC), as well as the intensification of the participation of scientific institutions in international research programs.

Overall, state regional policy should shift its focus toward the implementation of smart specialization strategies, which will help overcome existing structural gaps, strengthen the synergistic effect of regional ecosystems, and ensure an effective transition from an inertial scenario to the dynamic integration of domestic business into European value chains and the European Research Area.

Prospects for Further Research. A critical analysis of the results demonstrates the need for further study of the EU's experience regarding the effectiveness of its instruments and mechanisms for stimulating innovation development in order to justify the possibilities of transferring them into the practical dimension of Ukraine's state regional policy. Given the identified significant innovation gap, a priority direction for future research should be the development of applied recommendations for implementing leading European practices to overcome inertial budget-centrism, intensify the commercialization of scientific developments, and accelerate the convergence of domestic regional innovation systems for their full integration into the European Research Area.

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Причула Х. М., Калат Я. Я., Цока К.-В., Захарчук Є. В. Регіональні інноваційні системи України в координатах ЄС: трансформаційні виклики та вектори конвергенції

Метою статті є здійснення комплексного порівняльного аналізу регіональних інноваційних систем України та ЄС на основі адаптації європейської методології Регіонального інноваційного табло (Regional Innovation Scoreboard, RIS) з огляду на специфіку національної офіційної статистики для ідентифікації ключових розривів, конкурентних переваг і вразливостей українських регіонів в умовах євроінтеграції.

Методологія базується на європейських підходах RIS та European Innovation Scoreboard (EIS), адаптованих до умов України та вимог офіційної статистики. Просторову основу узгоджено зі стандартами NUTS-UA. Задля подолання статистичних обмежень воєнного часу використано проксі-показники, бібліометричний аналіз баз даних Scopus, а також комбінований метод розподілу патентно-ліцензійної активності (UKPHOIBI, EUIPO) за регіонами.

Результати засвідчують глибокий структурний розрив між регіональними інноваційними екосистемами України та ЄС практично за всіма параметрами. Зокрема, виявлено домінування інерційної бюджетоцентричності, збереження моделі «закритих інновацій», а також критично низьку активність підприємницького сектору у сфері НДДКР, комерціалізації та міжнародного патентування (PCT, EUIPO) на фоні високого рівня цифрового зв'язку в окремих регіонах.

Оригінальність дослідження полягає в розробленні адаптованого методичного інструментарію бенчмаркінгу RIS в умовах обмеженості офіційної національної статистики та воєнного стану, що дало змогу вперше здійснити детальну зіставність українських областей із європейськими регіонами.

Практична цінність результатів полягає у можливості використання їх органами державної влади та місцевого самоврядування для коригування регіональної інноваційної політики, імплементації стратегій смарт-спеціалізації, подолання цифрових і технологічних диспропорцій та прискорення інтеграції вітчизняного бізнесу в європейські дослідницькі простори.

Ключові слова: регіональні інноваційні системи, інновації, регіони України, Європейський Союз, Регіональне інноваційне табло, євроінтеграція, інноваційний розвиток, місцева статистика.

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