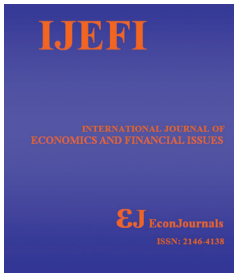

**International Journal of Economics and Financial Issues**

ISSN: 2146-4138

available at http: www.econjournals.com

**International Journal of Economics and Financial Issues, 2025, 15(5), 55-64.**

# Innovation Ecosystem Finance and Social Resilience in Central-Eastern Europe: A Bucharest Nine Perspective

**Volodymyr Tokar[1]*, Dmytro Tyshchenko[1], Anna Mishchenko[1], Tamara Franchuk[2], Vladyslav Tipanov[3]**

[1]State University of Trade and Economics, Kyiv, Ukraine, [2]National Academy of Statistics, Accounting and Audit, Kyiv, Ukraine, [3]Charitable Organization "Foundation Promoting Social and Economic Development of Kyiv Region", Kyiv, Ukraine.
*Email: v.tokar@knute.edu.ua

**Received:** 29 March 2025 **Accepted:** 11 July 2025 **DOI:** https://doi.org/10.32479/ijefi.20041

**ABSTRACT**

This article explores the relationship between innovation ecosystem finance and social resilience in Central-Eastern Europe, focusing on the Bucharest Nine (B9) countries. The scientific problem addressed is the limited integration of financial innovation metrics into resilience assessments, particularly in post-socialist EU states. The study aims to evaluate how R&D investment influences national capacities to adapt to and recover from systemic crises. A mixed-methods approach is employed, combining quantitative analysis of financial indicators – R&D expenditure per capita, per employed person, and per R&D personnel – with a newly constructed Integral Social Resilience Index based on economic, political, social, and ecological dimensions. Data were sourced from Eurostat, the World Bank, and other reputable institutions. The findings reveal significant disparities within the B9: Estonia and Czechia lead in both innovation finance and resilience, while Romania and Bulgaria lag behind. The results demonstrate that high R&D investment aligns with stronger societal resilience, though institutional and governance factors mediate this relationship. Limitations include reliance on available quantitative data, lack of qualitative governance indicators, and limited generalizability beyond the B9. These constraints may be addressed through future multi-scalar and longitudinal studies. The study offers practical insights for policymakers aiming to align innovation finance with resilience-building and contributes a novel framework linking financial ecosystems to adaptive capacities.

**Keywords:** Innovation Ecosystem, Central-Eastern Europe, Bucharest Nine, Social Resilience, Regional Finance
**JEL Classifications:** E44, G20, O30, O38, R11

## 1. INTRODUCTION

In an era marked by recurring systemic crises—ranging from global pandemics and geopolitical instability to environmental disruptions—the concept of social resilience has gained renewed relevance in both policy and academic discourse. As countries seek sustainable development pathways, the ability to withstand and adapt to shocks is increasingly recognized as a strategic imperative. Social resilience, understood as the capacity of societies to maintain core functions and cohesion in the face of adversity, is deeply intertwined with institutional quality, economic inclusivity, ecological adaptability, and technological readiness.

Parallel to this growing emphasis on resilience, innovation ecosystems have emerged as central instruments for driving national competitiveness and regional integration within the European Union (EU). By fostering knowledge exchange, promoting research and development (R&D), and enabling technological breakthroughs, innovation ecosystems contribute not only to economic growth but also to the adaptive capacity of societies. Yet, in much of the academic literature, these two concepts – innovation and resilience – have been treated in isolation. While some studies focus on the structural and financial attributes of innovation systems, others examine the social or institutional underpinnings of resilience, often without integrating the two frameworks. This analytical disconnection is particularly

This Journal is licensed under a Creative Commons Attribution 4.0 International License

evident in research on Central-Eastern Europe (CEE), a region undergoing simultaneous processes of economic modernization, institutional transition, and social reconfiguration.

The Bucharest Nine (B9) – a group of NATO's eastern flank countries consisting of Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia – offer a compelling case for exploring the nexus between innovation finance and social resilience. These countries face common structural legacies of post-socialist transformation, yet differ markedly in their innovation capacities, governance architectures, and resilience outcomes. While several B9 members have made significant strides in R&D investment and digital infrastructure, others continue to struggle with underfunded innovation systems and institutional fragilities. The resulting disparities underscore the need for a comparative, empirically grounded framework that links innovation ecosystem finance with broader resilience metrics.

This article addresses this gap by developing and applying a novel analytical model that integrates financial indicators of innovation ecosystems with a multidimensional index of social resilience. By doing so, it seeks to identify patterns of alignment, mismatch, and divergence across the B9 region. Drawing on recent data from Eurostat, the European Commission, and global governance and sustainability indices, the study evaluates the financial capacity of innovation systems in each country and assesses how these correlates with national resilience performance. Special emphasis is placed on R&D expenditure per capita, per employed person, and per R&D personnel, as well as on threshold-based scoring of resilience indicators across economic, political, social, and ecological domains.

This study adopts a mixed-methods design, combining quantitative analysis with comparative assessment to investigate how innovation ecosystem finance influences social resilience across the Bucharest Nine (B9) countries in Central-Eastern Europe. The research methodology draws from multiple reputable data sources and builds an integrated analytical framework that links innovation financing indicators with a newly developed index of social resilience.

The core of the analysis is the construction of an Integral Social Resilience Index (ISRI), which captures the economic, political, social, and ecological capacities of the B9 states. Twenty indicators were selected based on their relevance to the conceptual dimensions of resilience, the availability of recent data, and their alignment with prior literature. The data were obtained from internationally recognized databases, including the United Nations, World Bank, Transparency International, Social Progress Index, Fund for Peace, World Economic Forum, FM Global, and the Yale Environmental Performance Index. Each indicator was evaluated against a predefined threshold, and a binary scoring system was applied, whereby a country received a score of one if it met or exceeded the threshold and zero if it did not. The ISRI for each country was calculated as the proportion of indicators for which the threshold was met, thereby enabling direct cross-national comparison.

The dataset integrates data primarily from 2022 and 2023, although some indicators reflect earlier years depending on availability. Manual data collection was complemented by validation checks to ensure consistency. Where data gaps existed, especially in the case of Ukraine, imputation techniques such as regional averaging or nearest-neighbor substitution were used to maintain analytical coherence.

In parallel, the study analyzed financial performance in innovation ecosystems using three indicators: R&D expenditure per capita, per employed person, and per R&D personnel. These indicators were derived from Eurostat and European Commission datasets and averaged over the 2015-2023 period to reveal structural trends. The financial metrics were then juxtaposed with ISRI scores to examine alignment or divergence between innovation investment and resilience outcomes.

A key methodological innovation of this study is the integration of financial indicators into a broader framework of social resilience, enabling the identification of gaps and synergies between innovation system financing and national adaptive capacities. This dual approach provides a novel empirical lens through which to evaluate the institutional readiness of Central-Eastern European countries to leverage innovation finance for societal resilience.

## 2. LITERATURE REVIEW

Social resilience has gained prominence as a multidimensional concept encompassing economic, political, social, and ecological capacities necessary to withstand and adapt to crises. Tokar and Shkuropadska integrate these domains by constructing a comprehensive index of social resilience for the Bucharest Nine (B9) countries and Ukraine. The authors highlight disparities among the B9 countries and Ukraine, identifying institutional trust, economic inclusivity, and climate adaptability as key resilience factors (Tokar and Shkuropadska, 2025). However, while the integral index is methodologically sound, the exclusion of qualitative insights (e.g., local governance practices or lived community experiences) may reduce the explanatory power of the model. Despite referencing innovation and digital transformation as future research avenues, the article does not empirically examine the role of innovation ecosystems or financial instruments in enhancing resilience.

Innovation parks are gaining strategic importance across the European Union as platforms that facilitate technological growth, economic resilience, and integration into global knowledge ecosystems. In their comparative analysis of EU member states, Tokar, Tyshchenko, Franchuk, Babenko, and Koval assess national readiness for innovation parks by applying a clustering methodology based on two indicators: Gross domestic expenditure on R&D (GERD) and the proportion of R&D personnel in the labor force (Tokar et al., 2025). This empirical model classifies countries into three distinct groups, revealing sharp disparities in innovation capacity and financial preparedness across the region. Nevertheless, the study's scope is confined to financial and labor metrics, excluding critical elements such as innovation policies, sectoral dynamics, and cross-sector collaboration. These omissions

limit its ability to capture the institutional, cultural, and governance factors that influence the long-term viability of innovation parks.

The concept of digital resilience is closely aligned with national innovation capacity, particularly in regions under geopolitical pressure. Shkuropadska, Tokar, Purdenko, Lotariev, and Savchuk provide a detailed quantitative and qualitative assessment of the digital resilience of the Bucharest Nine and Ukraine. They construct an integral index combining cybersecurity, infrastructure, and socio-economic indicators to evaluate countries' preparedness to handle digital disruptions. This approach captures both structural and strategic components of resilience, highlighting disparities among states based on digital quality of life, e-participation, ICT sector contribution, and cyber readiness (Shkuropadska et al., 2024). Although the model is robust in its construction and provides actionable insights for policy, its dependence on available datasets and binary normalization of indicators may oversimplify complex realities.

Filippetti et al. explore the connection between regional innovation performance and resilience in the European Union, analyzing patent and trademark data across NUTS2 regions during the 2008–2016 period. Their findings suggest that regions with stronger innovation ecosystems – characterized by accumulated learning capabilities and long-term innovation infrastructure – demonstrated higher resilience, particularly in maintaining employment during and after the global financial crisis. The authors frame innovation as a form of Schumpeterian "creative response," emphasizing that recovery and adaptability during systemic shocks are more likely in regions where robust innovation systems already exist (Filippetti et al., 2020). Although the analysis provides valuable insights into the regional dynamics of innovation and resilience, it is limited by its exclusion of financial indicators and lacks a direct evaluation of national-level innovation governance, which are essential dimensions for understanding ecosystem finance.

Bristow and Healy argue that regional economic resilience depends not only on innovation inputs like R&D but on adaptive capacity rooted in institutional strength and place-based knowledge. Innovation, in their view, is a socially embedded process that enables regions to adapt, renew, or transform in response to shocks, depending on their historical and governance contexts (Bristow and Healy, 2018). However, their framework is largely theoretical and lacks empirical indicators, limiting its application to financial or quantitative assessments of innovation ecosystems.

Takala, Tukiainen, Salminen and Sarkkinen highlight the growing importance of regional innovation ecosystems in implementing EU innovation policy, particularly through Smart Specialisation strategies. Their study underscores the need for ecosystem-specific assessments using diverse indicators and stakeholder-driven approaches like the Entrepreneurial Discovery Process. While innovation performance has improved across most EU regions, challenges remain in measuring and fostering innovation in institutionally weak areas with limited RDI activity (Takala et al., 2023). Their framework, developed in the context of the HGiE project, offers tools such as portfolio management to enhance open innovation practices, though its application is still evolving and context-dependent.

Ferreira, Fernandes, and Veiga explore how entrepreneurial ecosystems (EE) at different levels – macro (support institutions), meso (business and academic partners), and micro (firm-specific traits) – influence the internationalization performance of SMEs. Their research offers a dynamic, quantitative model, confirming that macro and meso-level EEs significantly enhance international performance, while micro-level factors show no such effect. Moreover, digital transformation technologies were found to negatively moderate the meso-level impact, suggesting that shared technological infrastructure may reduce individual firms' perceived technological advantages (Ferreira et al., 2023). The study fills gaps in existing literature by integrating digitalization and offering a multi-layered view of EEs, expanding beyond domestic-focused analyses and underscoring the importance of support agents, partnerships, and digital ecosystems in SME international growth.

Lee highlights that resilience plays a critical role in enabling innovation ecosystems to adapt to disruptions, sustain innovation outputs, and maintain competitiveness amid dynamic technological and market changes. Through a case study of TSMC in the semiconductor industry, the research demonstrates how resilience dimensions – such as adaptability, robustness, redundancy, integration, and anticipatory learning – enhance ecosystem governance and strategic adaptability (Lee, 2024). These capabilities are vital for innovation ecosystems to navigate external shocks, align diverse stakeholders, and ensure long-term sustainability and responsiveness in volatile environments.

Gautam and Gautam examine how startups strategically manage external resources across the creation, development, and market phases within innovation ecosystems. Their case-based study shows that startups leverage support from non-market actors (e.g., universities, incubators, mentors) and market-oriented stakeholders (e.g., investors, suppliers, accelerators) to bundle physical, social, financial, and human resources. This dynamic resource orchestration enhances innovation ambidexterity – balancing exploration and exploitation – throughout a startup's lifecycle (Gautam and Gautam, 2024). However, the findings are context-specific, with limited generalizability beyond developing economies.

Wen and Fang investigate how the structural configuration of regional co-patenting networks influences economic resilience, distinguishing between adaptation (returning to a pre-shock trajectory) and adaptability (establishing a new one). Their analysis of U.S. manufacturing sectors reveals that tightly connected (complete) networks enhance adaptation but limit adaptability, while loosely connected (coalitional) networks support adaptability at the expense of adaptation (Wen and Fang, 2024). This empirical evidence highlights a structural trade-off and offers practical guidance for designing innovation policies and allocating resources to balance short-term recovery and long-term transformation.

Bandera and Thomas (2018) explore the role of social capital within innovation ecosystems, particularly in startup survival. Their model distinguishes between merely having access to social

capital and actively leveraging it through collaboration with ecosystem agents such as universities, industries, and governments (Bandera and Thomas, 2018). Findings from the Kauffman Firm Survey reveal that startups utilizing social capital significantly outperform those that do not, though the availability of such capital does not guarantee its use. The study highlights the nuanced role of ecosystem density and actor engagement in promoting long-term firm performance.

Kubus, Mascareñas Pérez-Iñigo, and González Fernández examine the structure and evolution of innovation ecosystems within the banking and monetary sector, focusing on the balance between competitiveness and sustainability. Their analysis highlights that financial innovation ecosystems are increasingly shaped by technological change, regulatory transformation, and market expectations. The authors emphasize that successful ecosystems require coordination between public institutions, financial actors, and digital service providers (Kubus et al., 2019). However, the study also notes the risk of fragmentation and instability if innovation is driven purely by competitiveness without sustainable frameworks. Their findings underline the need for coherent governance mechanisms that integrate financial, technological, and regulatory components.

Abdi, Yazdani, and Najafi develop a comprehensive framework for innovation ecosystem resilience by synthesizing previous research on system, organizational, and innovation-specific resilience. Drawing from diverse models, they identify structural, strategic, cognitive, and behavioral dimensions as key to ecosystem sustainability during disruptions. Unlike earlier studies focused on isolated aspects, their meta-synthesis integrates insights from over 60 studies, leading to a validated factor model that captures both internal and external drivers of resilience (Abdi et al., 2024). While the framework is theoretically robust, its reliance on secondary sources and expert validation limits empirical generalizability across diverse regional or sectoral contexts.

Demirhan and Babacan (2016) analyze the impact of financing opportunities on innovation ecosystem components across 115 countries using panel data. Their study confirms that access to financial resources significantly boosts R&D spending and university-industry collaboration but has no measurable effect on a country's innovation capacity. They emphasize the role of financial markets and institutions in fostering innovation and competitiveness, while also highlighting the importance of research institution quality as a key enabler (Demirhan and Babacan, 2016). However, their findings suggest that financial availability alone does not translate into enhanced innovation capabilities unless other structural factors are in place.

Armstrong-Gibbs and Brown (2023) present an ethnographic case study of Baltic Creative CIC in Liverpool to explore the resilience and adaptability of a creative innovation ecosystem during the COVID-19 crisis. Their findings emphasize the strategic conversion of entrepreneurial capitals—economic, cultural, social, and symbolic—which enabled rapid organizational responses, tenant support, and sustained ecosystem cohesion. The study illustrates how embedded networks, inclusive governance, and proactive communication fortified the ecosystem against disruption (Armstrong-Gibbs and Brown, 2023). However, the analysis remains centered on intrapersonal capital conversion, suggesting a need for further investigation into interpersonal dynamics.

Xie, Liu, and Blanco develop an evaluation and forecasting model for the niche fitness of regional innovation ecosystems (RIEs) in China, grounded in ecological niche theory. Their findings show that overall RIE fitness remained low from 2010 to 2019 due to imbalanced regional development and lagging innovation infrastructure (Xie et al., 2023). To address this, they introduce an optimized grey forecasting model (FMCGM (1,1)) projecting gradual improvement in RIE fitness by 2025, with a shift from resource- and technology-driven models to more balanced ecosystem support. The study fills a methodological gap by linking ecological modeling to policy-oriented innovation governance.

Pilotti examines how European SMEs can support innovation ecosystems that foster prosperity and resilience, particularly in the post-COVID-19 context. The study argues that traditional industrial policies must shift toward place-based, evolutionary governance models that recognize the dynamic interplay between firms, institutions, and territorial contexts. Innovation ecosystems, in this view, are sustained not merely through technological capability but also through civic engagement, entrepreneurial learning, and adaptive local networks (Pilotti, 2020). The author emphasizes the importance of enabling environments that support experimentation, local co-creation, and open innovation. However, the article remains conceptual, with limited empirical validation across diverse European regions.

Czajkowska investigates the role of credit financing in supporting technological innovation among Polish micro, small, and medium-sized enterprises (MSMEs). The study highlights that traditional bank credit remains the most prevalent external funding source for innovation despite the emergence of alternative instruments. Through an analysis of Poland's Smart Growth Operational Programme and its sub-measure for technological innovation credit, the article underscores the critical importance of public incentives – like the technology bonus – in overcoming internal financial constraints (Czajkowska, 2019). However, complex application procedures and limited accessibility for smaller firms reduce the broader effectiveness of this support tool.

Zhang, Hu, and Zhou investigate how internal and external social capital within top management teams (TMT) drives business model innovation in business ecosystems. Their study of 168 Chinese firms shows that both forms of TMT social capital positively influence innovation, with internal social capital reinforcing external networks. Notably, the health of the business ecosystem moderates these effects – ecosystem productivity weakens, while niche creation strengthens, the impact of external social capital (Zhang et al., 2024). The study underscores the strategic importance of aligning social capital strategies with evolving ecosystem dynamics to enhance innovation outcomes.

Muldoon, Liguori, Solomon, and Bendickson examine how technological innovation transforms the boundaries and structure

of entrepreneurship ecosystems. Challenging the traditional view that ecosystems are geographically bounded, they argue for a relational perspective where value and legitimacy flow through diverse social exchanges, including digital platforms (Muldoon et al., 2023). Drawing on resource theory and social exchange models, the study highlights how technology enables decentralized, trust-based, and adaptive ecosystems that extend beyond physical space. Their findings underscore the need to reconceptualize entrepreneurial ecosystems as hybrid, dynamic environments shaped by both institutional and technological factors.

González Fernández, Kubus, and Mascareñas Pérez-Iñigo analyze the evolution of EU innovation policy through the lens of Horizon Europe, emphasizing a shift toward more inclusive and mission-oriented innovation ecosystems. They extend the traditional triple helix model to incorporate civil society and environmental concerns, framing innovation within a broader socioecological context (González Fernández et al., 2019). Their institutional mapping highlights structural imbalances, including fragmented governance, unequal access to R&I funding, and limited alignment between policy rhetoric and budgetary allocations. The study advocates for stronger coordination among actors and simplified regulatory frameworks to enhance ecosystem performance across EU member states.

Kaur, Ahmad, Hari, and Kattumuri examine the Fintech entrepreneurial ecosystem in India, focusing on how social and founder capital influence startup funding. Using firm-level data and econometric methods, the study finds that incubators and accelerators serve as strong social capital signals, significantly improving access to financing. Founders' networks and prior experience also positively affect funding outcomes (Kaur et al., 2024). The study highlights the importance of ecosystem-enabling institutions and the signaling power of non-financial attributes in resource-scarce environments, though its findings are context-specific to the Indian Fintech sector.

De Bernardi and Azucar (2020) present a detailed synthesis of the structure, dynamics, and boundaries of innovation and entrepreneurial ecosystems, emphasizing their role in fostering sustainability and value co-creation. They distinguish between innovation ecosystems—centered on technology and knowledge spillovers—and entrepreneurial ecosystems—focused on firm creation and stakeholder interaction. Their analysis highlights the complexity and heterogeneity of ecosystem actors, noting that no universal framework exists due to contextual variations (De Bernardi and Azucar, 2020). The study contributes a holistic approach linking ecosystem performance to collaborative networks, yet offers limited empirical validation across sectors beyond the food industry.

The literature reveals a strong but fragmented understanding of how innovation ecosystems contribute to regional development, yet limited attention is given to their financial foundations and role in fostering social resilience. Most studies treat these dimensions separately, lacking integrated regional perspectives. This article responds by examining how innovation ecosystem finance supports social resilience across the Bucharest Nine countries in Central-Eastern Europe.

## 3. METHODOLOGY

The methodology for this study revolves around assessing the readiness of EU member states to establish and operate innovation parks, using two key indicators: gross domestic expenditure on research and development (GERD) and the share of R&D personnel in the labor force. The data used in this analysis was sourced from Eurostat. Specifically, two databases were employed: Gross domestic expenditure on R&D (GERD): "Purchasing power standard (PPS) per inhabitant at constant 2005 prices" and "Share of R&D personnel and researchers in the total active population and employment by sector of performance and sex: Percentage of population in the labour force in full-time equivalent (FTE)" (Eurostat, 2024a; 2024b).

These databases were selected due to their comprehensive coverage and consistency in reporting across EU member states, making them ideal for cross-country comparison over the 2013-2022 period. Their standardization ensures that the comparisons and clustering performed in the analysis are based on uniform metrics, enhancing the reliability of the results.

To analyze the readiness of these countries for innovation parks, k-means clustering was utilized as the primary statistical method. This method is well-suited for grouping entities based on shared characteristics and has been used in several studies for similar purposes, such as revealing gender equality patterns in ICT education (Tokar et al., 2023a) and examining disparities in tax systems across European countries (Reiff et al., 2016b). Additionally, cluster analysis has proven effective in analyzing economic development and gender equality in EU countries (Tokar et al., 2023b, Vinska et al., 2021; 2024) and for studying economic trajectories in post-communist nations (Reiff et al., 2016a). These precedents underscore the utility of clustering techniques for identifying underlying patterns in multidimensional datasets.

For this study, k-means clustering allowed the grouping of EU countries based on their GERD and share of R&D personnel. The clustering helped identify groups of countries exhibiting similar trends in R&D investments and workforce allocation, both essential factors for determining their capacity to develop and sustain innovation parks. The approach provided meaningful insights into how countries compare and contrast in terms of their innovation readiness.

Data normalization was necessary prior to clustering, to ensure comparability across the two indicators, GERD and R&D personnel. Normalization adjusts for the differences in the units of measurement between these variables (PPS and percentage of labor force). Without normalization, the results would be biased toward the variable with the larger scale.

The number of clusters (k) was determined using the elbow method. This method identifies the optimal number of clusters by plotting the ratio of variance explained for each potential number

of clusters and selecting the "elbow" point, where adding more clusters does not substantially improve the explained variance. In this study, three clusters were chosen based on the elbow method, capturing 92.17% of the variance in the data.

After determining the number of clusters, the k-means clustering algorithm was applied. This algorithm begins by initializing k cluster centers randomly and assigning each country to the nearest center based on the Euclidean distance. The cluster centers are then recalculated as the average of all points within the cluster, and the process repeats until the sum of squared errors (SSE) within the clusters is minimized. The final clusters represent countries with similar patterns in their R&D investments and workforce structure. The free and open-source tools, including R (version 4.2.1) and Python, were used to perform this analysis ensuring that the study's methodology is reproducible by other researchers.

## 4. RESULTS

Table 1 indicates that all countries within the Bucharest Nine (B9) group – comprising Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia – have demonstrated an overall upward trend in R&D expenditure per capita between 2015 and 2023. However, the levels of investment and the pace of growth vary considerably within the group. Notably, within the broader classification of EU member-states, all of these countries are categorized as Emerging Innovators, reflecting their lower-than-average performance in innovation-related financial indicators. Czechia emerges as the strongest performer in the group, with R&D per capita increasing from €310 in 2015 to €534 in 2023, and a group-leading average of €401. Estonia also demonstrates steady and significant growth, from €230 to €514, resulting in an average of €340. These two countries show the most consistent commitment to expanding their innovation financing. Poland and Lithuania reveal moderate yet positive trends. Poland's investment nearly triples – from €114 to €312 – while Lithuania increases from €134 to €270. Their respective averages of €186 and €183 suggest improving efforts to strengthen national innovation systems, though they remain far below the EU average.

At the lower end of the spectrum, Bulgaria and Romania consistently underperform. Bulgaria's spending increases modestly from €62 to €116, while Romania records the lowest values throughout the period, rising only from €40 to €88. Their average R&D per capita – €77 and €56 – highlights ongoing structural limitations in innovation investment. Hungary, Latvia, and Slovakia represent an intermediate cluster within the B9. Although they display growth (e.g., Hungary from €154 to €287), their averages remain well below the group's leaders, indicating uneven policy effectiveness or fiscal constraints.

Table 2 presents the evolution of R&D expenditure per employed person across the Bucharest Nine (B9) countries from 2015 to 2023. All of these countries, classified by the EU as Emerging Innovators, show measurable growth in this indicator, although disparities in performance persist within the group. Czechia maintains its leading position in this category, with R&D investment increasing from €663 to €1,194 over the period, resulting in the highest group average of €848. Estonia also shows a solid upward trajectory, rising from €499 to €1,088, with an average of €727. These results reflect relatively successful policy frameworks for integrating R&D into labor productivity strategies.

Poland and Hungary also exhibit continuous growth, reaching €699 and €604 in 2023, respectively. Their averages of €430 (Poland) and €461 (Hungary) place them in the group's middle tier. Lithuania and Slovakia follow closely behind, with 2023 values of €570 and €504 and moderate average levels. At the lower end, Romania and Bulgaria remain the least advanced. Romania's average expenditure is only €144, with the lowest starting and ending values in the group. Bulgaria shows limited growth, rising from €148 to €266 and averaging €178. Latvia also demonstrates constrained progress, with an average of €247. The overall trend within the B9 reveals gradual increases in R&D spending per employed person, yet the internal variance suggests unequal progress. While some countries demonstrate steady commitment, others lag behind, highlighting the continued need for region-specific innovation financing reforms and workforce-linked investment strategies to foster convergence.

Table 3 provides data on R&D expenditure per R&D personnel across the Bucharest Nine (B9) countries from 2015 to 2023. This indicator reflects the financial intensity of R&D activity as measured by spending per researcher and technician. Among the EU classifications, eight countries remain categorized as Emerging Innovators, while Estonia stands out as a Moderate Innovator within this metric. Estonia is the top performer in the group, with spending per R&D personnel reaching €87,718 in 2023 and averaging €71,568 over the 9-year period. This marks a consistent

**Table 1: Classification of Bucharest Nine Countries by research and development expenditure per capita (euros, market prices, 2015-2023)**

| Country | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Average | Group |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bulgaria | 62 | 54 | 57 | 64 | 78 | 80 | 84 | 100 | 116 | 77 | Emerging Innovator |
| Czechia | 310 | 281 | 327 | 381 | 413 | 409 | 452 | 504 | 534 | 401 | Emerging Innovator |
| Estonia | 230 | 206 | 231 | 277 | 342 | 363 | 414 | 482 | 514 | 340 | Emerging Innovator |
| Hungary | 154 | 141 | 171 | 211 | 222 | 227 | 262 | 245 | 287 | 213 | Emerging Innovator |
| Latvia | 77 | 56 | 71 | 96 | 102 | 117 | 132 | 155 | 174 | 109 | Emerging Innovator |
| Lithuania | 134 | 113 | 134 | 152 | 173 | 200 | 222 | 250 | 270 | 183 | Emerging Innovator |
| Poland | 114 | 108 | 127 | 158 | 186 | 196 | 224 | 252 | 312 | 186 | Emerging Innovator |
| Romania | 40 | 42 | 49 | 53 | 54 | 53 | 60 | 68 | 88 | 56 | Emerging Innovator |
| Slovakia | 170 | 119 | 137 | 138 | 142 | 154 | 169 | 198 | 236 | 162 | Emerging Innovator |

Source: Elaborated by the authors based on (European Commission, 2024, Eurostat, 2025b; 2025c)

**Table 2: Classification of Bucharest Nine Countries by research and development expenditure per employed person (euros, market prices, 2015-2023)**

| Country | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Average | Group |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bulgaria | 148 | 129 | 128 | 141 | 177 | 189 | 198 | 228 | 266 | 178 | Emerging Innovator |
| Czechia | 663 | 592 | 679 | 783 | 850 | 848 | 941 | 1086 | 1194 | 848 | Emerging Innovator |
| Estonia | 499 | 447 | 492 | 588 | 724 | 786 | 901 | 1020 | 1088 | 727 | Emerging Innovator |
| Hungary | 353 | 312 | 373 | 454 | 476 | 492 | 563 | 518 | 604 | 461 | Emerging Innovator |
| Latvia | 176 | 129 | 161 | 214 | 226 | 263 | 304 | 351 | 395 | 247 | Emerging Innovator |
| Lithuania | 300 | 249 | 294 | 325 | 371 | 436 | 479 | 526 | 570 | 395 | Emerging Innovator |
| Poland | 281 | 264 | 306 | 378 | 433 | 447 | 497 | 569 | 699 | 430 | Emerging Innovator |
| Romania | 108 | 112 | 126 | 136 | 138 | 135 | 149 | 169 | 223 | 144 | Emerging Innovator |
| Slovakia | 375 | 255 | 292 | 289 | 297 | 328 | 365 | 422 | 504 | 347 | Emerging Innovator |

Source: Elaborated by the authors based on (European Commission, 2024, Eurostat, 2025a; 2025b; 2025c)

**Table 3: Classification of Bucharest Nine Countries by research and development expenditure per employed person (euros, market prices, 2015-2023)**

| Country | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Average | Group |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bulgaria | 21491 | 16516 | 18065 | 17628 | 20635 | 21673 | 23284 | 25061 | 30928 | 21698 | Emerging Innovator |
| Czechia | 51793 | 46966 | 51048 | 55166 | 56312 | 54711 | 58083 | 64621 | 70227 | 56548 | Emerging Innovator |
| Estonia | 58055 | 51346 | 54047 | 63276 | 75451 | 81056 | 87471 | 85689 | 87718 | 71568 | Moderate Innovator |
| Hungary | 44187 | 40470 | 43315 | 39169 | 39341 | 38743 | 43296 | 39246 | 48356 | 41791 | Emerging Innovator |
| Latvia | 30395 | 23905 | 28327 | 34567 | 35372 | 36977 | 38515 | 46188 | 54816 | 36563 | Emerging Innovator |
| Lithuania | 40601 | 32779 | 35802 | 38288 | 40324 | 43641 | 45606 | 48276 | 58135 | 42606 | Emerging Innovator |
| Poland | 43189 | 39368 | 35581 | 38547 | 44597 | 43430 | 46407 | 50388 | 60802 | 44701 | Emerging Innovator |
| Romania | 27595 | 27920 | 31520 | 34000 | 35464 | 32865 | 35554 | 39217 | 50653 | 34976 | Emerging Innovator |
| Slovakia | 59497 | 40423 | 42882 | 39584 | 39100 | 40052 | 43931 | 49100 | 56680 | 45694 | Emerging Innovator |

Source: Elaborated by the authors based on (European Commission, 2024, Eurostat, 2025a; 2025b; 2025c; 2025d)

**Table 4: Financial indicators of innovation ecosystems in the Bucharest Nine (2015-2023 averages)**

| Country | R&D per capita (€) | R&D per employed person (€) | R&D per R&D personnel (€) | Innovation group |
|---|---|---|---|---|
| Czechia | 401 | 848 | 56,548 | Emerging Innovator |
| Estonia | 340 | 727 | 71,568 | Moderate Innovator |
| Hungary | 213 | 461 | 41,791 | Emerging Innovator |
| Latvia | 109 | 247 | 36,563 | Emerging Innovator |
| Lithuania | 183 | 395 | 42,606 | Emerging Innovator |
| Poland | 186 | 430 | 44,701 | Emerging Innovator |
| Romania | 56 | 144 | 34,976 | Emerging Innovator |
| Slovakia | 162 | 347 | 45,694 | Emerging Innovator |
| Bulgaria | 77 | 178 | 21,698 | Emerging Innovator |

Source: Elaborated by the authors based on (European Commission, 2024, Eurostat, 2025a; 2025b; 2025c; 2025d)

and robust upward trajectory, underpinned by significant national investment efforts.

Czechia follows with an average of €56,548 and a steady increase in values, culminating at €70,227 in 2023. Poland, Slovakia, and Lithuania also show positive trends, each reaching above €56,000 by 2023, although starting from considerably lower baselines. Their respective averages – €44,701, €45,694, and €42,606 – indicate stable, if moderate, improvements. Latvia, Hungary, and Romania continue to lag, despite measurable growth over time. Latvia and Romania remain at the bottom of the group, with average values of €36,563 and €34,976, respectively. Bulgaria demonstrates the weakest performance, despite its 2023 value of €30,928 being the highest in its series, with an overall average of just €21,698. Overall, Table 3 suggests a general upward trend in R&D investment per researcher in the Bucharest Nine, though substantial internal disparities persist. The results reflect a shared challenge of underfunding human capital in innovation systems. Bridging these gaps remains crucial for achieving strategic autonomy and boosting regional research productivity.

Table 4 provides a comparative overview of innovation financing performance within the Bucharest Nine countries. Czechia and Estonia lead the group across all indicators, demonstrating robust, sustained investment in innovation per capita, per employed person, and per R&D personnel. Estonia is particularly notable for its high spending per researcher, placing it in the Moderate Innovator category, while all other B9 countries remain categorized as Emerging Innovators. Poland, Lithuania, and Slovakia represent a moderate cluster with growing but still limited R&D financing capacity. In contrast, Romania and Bulgaria show consistently low values across all metrics, highlighting critical weaknesses in innovation ecosystem development. This distribution underlines the disparities in national innovation policies and capacities across Central and Eastern Europe.

Table 5 examines how R&D performance aligns with social resilience across the Bucharest Nine countries. Estonia and Czechia demonstrate the most effective alignment, combining high innovation investment with sufficient social resilience scores.

**Table 5: Social resilience and innovation alignment in the Bucharest Nine**

| Country | R&D performance tier | Social Resilience Index | Social resilience category | Alignment assessment |
|---|---|---|---|---|
| Estonia | High (esp. R&D per personnel) | 0.85 | Sufficient | Positive synergy |
| Czechia | High (all three indicators) | 0.75 | Sufficient | Aligned |
| Poland | Moderate | 0.75 | Sufficient | Improving |
| Lithuania | Moderate | 0.80 | Sufficient | Converging |
| Latvia | Low–Moderate | 0.80 | Sufficient | Strengthening |
| Slovakia | Low–Moderate | 0.75 | Sufficient | Strengthening |
| Hungary | Moderate | 0.70 | Medium | Mismatch |
| Romania | Low | 0.65 | Medium | Structural gap |
| Bulgaria | Very Low | 0.75 | Sufficient | Contradiction |

Source: Elaborated by the authors based on (European Commission, 2024; Eurostat, 2025a; 2025b; 2025c; 2025d; Tokar et al., 2025)

**Table 6: Mapping innovation finance to resilience outcomes in the Bucharest Nine**

| Innovation Investment→Social Resilience ↓ | Low R&D investment | Moderate R&D investment | High R&D investment |
|---|---|---|---|
| Sufficient Resilience | Bulgaria, Latvia | Lithuania, Poland, Slovakia | Estonia, Czechia |
| Medium Resilience | Romania | Hungary | – |

Source: Elaborated by the authors

Countries like Poland, Lithuania, Latvia, and Slovakia occupy a middle space, where growing innovation investment corresponds with relatively high resilience, suggesting positive development trajectories. Hungary presents a policy mismatch: moderate R&D performance is paired with lower resilience. Romania and Bulgaria reflect deeper systemic issues, with limited innovation funding and weak or misaligned resilience levels. These findings point to the uneven integration of financial and social strategies across the region.

Table 6 presents a matrix showing the interaction between innovation investment levels and social resilience outcomes in the Bucharest Nine countries. Estonia and Czechia occupy the most favorable quadrant, combining high innovation spending with strong resilience indicators. Lithuania, Poland, and Slovakia form a middle group where resilience is improving alongside moderate financial support for R&D. Latvia and Bulgaria display relatively high resilience despite limited innovation funding, potentially indicating the influence of non-financial resilience factors. Hungary and Romania show either stagnating or weak outcomes, with moderate or low R&D investments failing to translate into corresponding resilience. This matrix helps to illustrate strategic gaps and potential alignment pathways in national innovation and resilience policies.

The results highlight both progress and persistent asymmetries in the development of innovation ecosystems across Bucharest Nine. While countries like Czechia and Estonia emerge as frontrunners with consistent investment and alignment between innovation finance and social resilience, others such as Romania and Bulgaria reveal critical gaps that may hinder sustainable development. The interplay between financial input into R&D and societal adaptive capacity underscores the necessity of integrated policy approaches that go beyond fiscal allocations alone. Achieving regional convergence will require targeted reforms that enhance human capital, institutional coordination, and the absorption capacity of innovation systems – especially in countries where resilience is not yet supported by adequate financial infrastructures. The diversity of trajectories within the B9 illustrates the broader challenges facing Central-Eastern Europe in leveraging innovation for strategic autonomy and inclusive growth.

## 5. DISCUSSION

The findings of this study align with and extend previous research on the relationship between innovation ecosystems and resilience, particularly in under-researched Central-Eastern European (CEE) contexts. The observed upward trends in R&D investment across all Bucharest Nine (B9) countries reinforce the broader conclusion made by Filippetti et al. (2020), who demonstrated that robust innovation ecosystems contribute to regional economic resilience during systemic shocks. Our results suggest that Czechia and Estonia are beginning to build such ecosystems, showing not only sustained financial commitment but also a positive correlation with social resilience indicators. This echoes Filippetti et al.'s notion of "creative response", where accumulated innovation capacity enhances recovery potential.

The study also supports Bristow and Healy's (2018) argument that regional resilience depends on adaptive institutional frameworks, though our findings indicate that financial investment alone is insufficient. For example, Bulgaria and Romania remain at the lower end of both R&D investment and resilience, highlighting the need for integrated policy strategies that bridge innovation financing with governance capacity and civic trust. These results also resonate with Demirhan and Babacan (2016), who found that financial access boosts innovation inputs, but institutional and research quality are necessary to translate resources into capacity.

The divergence among B9 countries mirrors the structural gaps observed by Tokar et al. (2025) in their clustering of EU countries based on GERD and R&D personnel metrics. However, unlike their focus on innovation park readiness, this study connects these financial indicators directly to social resilience outcomes, offering a more comprehensive perspective. The misalignment seen in Hungary—where moderate R&D funding coincides with lower resilience – parallels Wen and Fang's (Wen and Fang, 2024) structural trade-off theory: innovation networks may be financially sufficient but lack the adaptive architecture necessary for sustained transformation.

Moreover, the results validate insights from Tokar and Shkuropadska (2025), who emphasized that social resilience

in CEE countries depends on both economic inclusivity and institutional strength. Yet while their model was primarily descriptive, the present research introduces a financial dimension, demonstrating how innovation investment can act as a lever for resilience, provided that it is distributed strategically and not just concentrated in a few high-performing states.

This study also extends the frameworks of Takala et al. (2023) and Abdi et al. (2024) by offering empirical support for ecosystem-based policy design in institutionally weak areas. The disparities in financial indicators and their inconsistent translation into resilience outcomes underscore the need for entrepreneurial discovery processes and multi-actor coordination to improve governance in innovation ecosystems.

Nevertheless, several limitations should be noted. Firstly, the analysis is based solely on quantitative indicators available through Eurostat, which may omit relevant qualitative dimensions such as policy effectiveness, regulatory quality, or stakeholder engagement. This could explain anomalies such as Latvia's relatively strong resilience despite lower innovation financing. Secondly, the resilience index used builds on existing literature but lacks disaggregated subcomponents, limiting its diagnostic precision. Thirdly, this study does not consider external shocks – such as the COVID-19 pandemic or geopolitical tensions – as explicit variables, which may have influenced national investment capacities and social cohesion in divergent ways. Finally, while this research covers nine countries, broader generalizability is limited by regional heterogeneity and may not apply to Western or Southern EU member states.

Despite these limitations, the study contributes a novel synthesis of innovation ecosystem finance and social resilience, demonstrating their interdependence in a region undergoing institutional transition and economic modernization. It offers a foundation for future comparative studies and regional policy design aiming to strengthen the adaptive and transformative capacities of innovation systems in post-socialist contexts.

## 6. CONCLUSION

This study examined the interplay between innovation ecosystem finance and social resilience across the Bucharest Nine (B9) countries—Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia—by analyzing financial indicators of innovation (R&D per capita, per employed person, and per R&D personnel) alongside national resilience metrics. The results reveal a shared upward trajectory in R&D investment over the 2015–2023 period, albeit with marked disparities in levels and impact across the group. Estonia and Czechia emerge as clear leaders, combining strong innovation investment with high social resilience scores, while countries such as Romania and Bulgaria continue to lag in both domains, reflecting structural weaknesses in their innovation ecosystems and policy frameworks.

The value-added of this research lies in its integrated approach—bridging financial analysis with resilience outcomes in a comparative regional context. While most prior studies examine innovation ecosystems and resilience separately, this article explicitly maps how financial support for innovation correlates with national capacities to adapt to and recover from crises. The construction of comparative tables and alignment matrices offers a practical tool for identifying strategic gaps, synergies, and mismatches in national innovation-resilience dynamics.

In terms of policy implications, the findings underscore the urgent need for differentiated, context-sensitive innovation policies across the B9 region. High-performing countries should continue reinforcing their ecosystems through smart specialization and talent retention, while lower-performing states require foundational reforms – enhanced public investment, institutional strengthening, and capacity-building for governance and research. Cross-national collaboration through EU-level funding mechanisms (e.g., Horizon Europe, Recovery and Resilience Facility) should prioritize knowledge and infrastructure transfer to support innovation convergence within Central-Eastern Europe.

Future research should extend this work by incorporating qualitative dimensions such as innovation culture, stakeholder cooperation, and local governance effectiveness. Additionally, examining the role of digital transformation, sectoral innovation niches, and crisis-specific adaptive responses (e.g., during the COVID-19 pandemic or energy crises) could offer further insights. Longitudinal studies tracking post-2023 developments and integrating micro-level data from firms and research institutions would also enrich our understanding of how financial ecosystems translate into resilient outcomes across multi-scalar systems.

## REFERENCES

Abdi, S., Yazdani, M., Najafi, E. (2024), Comprehensive framework of influential factors on innovation ecosystem resilience: Using meta-synthesis and structural equation modelling. International Journal of Engineering, Transactions B: Applications, 37(2), 323-340.

Armstrong-Gibbs, F., Brown, J. (2023), The resilience and adaptability of an innovative ecosystem of creative entrepreneurs during crisis times: Baltic Creative CIC - a case study. In: Hill, I., Elias, S.R.S.T.A., Jones, P., Dobson, S., editors. Creative (and Cultural) Industry Entrepreneurship in the 21st Century. Vol. 18A. United Kingdom: Emerald Group Publishing. p105-120.

Bandera, C., Thomas, E.F. (2018), The role of innovation ecosystems and social capital in startup survival. IEEE Transactions on Engineering Management, 66(99), 542-551.

Bristow, G., Healy, A., 2018. Innovation and regional economic resilience: An exploratory analysis. Annals of Regional Science, 60(2), 265-284.

Czajkowska, A. (2019), The role of financing innovative technological investments with credit for technological innovations. Ekonomia i Prawo, Economics and Law, 18(4), 413-423.

De Bernardi, P., Azucar, D. (2020), Innovation and entrepreneurial ecosystems: Structure, boundaries, and dynamics. In: De Bernardi, P., Azucar, D., editors. Innovation in Food Ecosystems: Entrepreneurship for a Sustainable Future. Berlin: Springer. p73-102.

Demirhan, D., Babacan, Ö. (2016), The role of financing in innovation ecosystems: A panel data analysis. Ege Stratejik Araştırmalar Dergisi, 7, 93-110.

European Commission. (2025), European Innovation Scoreboard 2024. Available from: https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_

en [Last accessed on 2025 Mar 20].
Eurostat. (2025a), Employment and Activity by Sex and Age - Annual Data. Available from: https://ec.europa.eu/eurostat/databrowser/view/lfsi_emp_a/default/table?lang=en [Last accessed on 2025 Mar 20].
Eurostat. (2025b), Gross Domestic Product at Market Prices. Available from: https://ec.europa.eu/eurostat/databrowser/view/tec00001/default/table?lang=en [Last accessed on 2025 Mar 20].
Eurostat. (2025c), Research and Development Expenditure, by Sectors of Performance. Available from: https://ec.europa.eu/eurostat/databrowser/view/tsc00001/default/table?lang=en&category=t_scitech.t_rd [Last accessed on 2025 Mar 20].
Eurostat. (2025d), Research and Development Personnel, by Sectors of Performance. Available from: https://ec.europa.eu/eurostat/databrowser/view/tsc00002/default/table?lang=en&category=t_scitech.t_rd [Last accessed on 2025 Mar 20].
Ferreira, J.J.M., Fernandes, C.I., Veiga, P.M. (2023), The role of entrepreneurial ecosystems in the SME internationalization. Journal of Business Research, 157, 113603.
Filippetti, A., Gkotsis, P., Vezzani, A., Zinilli, A. (2020), Are innovative regions more resilient? Evidence from Europe in 2008-2016. Economia Politica, 37, 807-832.
Gautam, P.K., Gautam, S. (2024), Navigating the startup innovation ecosystem: Strategies for effective external resource management. The Batuk: A Peer Reviewed Journal of Interdisciplinary Studies, 10(2), 55-71.
González Fernández, S., Kubus, R., Mascareñas Pérez-Iñigo, J. (2019), Innovation ecosystems in the EU: Policy evolution and Horizon Europe proposal case study (the actors' perspective). Sustainability, 11(17), 4735.
Kaur, M., Ahmad, W., Hari, K.S., Kattumuri, R. (2024), FinTech entrepreneurial ecosystem in India: Role of incubators and accelerators. Global Finance Journal, 60, 100933.
Kubus, R., Mascareñas Pérez-Iñigo, J., González Fernández, S. (2019), Innovation ecosystems in banking and monetary sector: Competitiveness versus sustainability. Mercados y Negocios, 41(1), 19-44.
Lee, P.C. (2024), Strategic Integration of Resilience in Innovation Ecosystems. New York: SSRN.
Muldoon, J., Liguori, E.W., Solomon, S., Bendickson, J. (2023), Technological innovation and the expansion of entrepreneurship ecosystems. Review of Managerial Science, 17(6), 1789-1808.
Pilotti, L. (2020), SME in Europe towards local industrial policy able to sustain innovation ecosystems to redesign and reinforce prosperity and resilience in post-COVID-19: Some brief comments. Journal of US-China Public Administration, 17(6), 239-257.
Reiff, M., Tokar, V. (2016a), Post-communist financial and economic development: Cluster analysis of selected countries. Economic Annals XXI, 161(9-10), 12-17.
Reiff, M., Furková, A., Tokar, V. (2016b), The interplay of European countries' tax systems: A spatial autocorrelation and cluster analysis. Journal of Applied Economic Sciences, 11(6), 1103-1113.
Shkuropadska, D., Tokar, V., Purdenko, O., Lotariev, A., Savchuk, K. (2024), Digital resilience of the Bucharest Nine and Ukraine. International Journal of Economics and Financial Issues, 15(1), 24-31.
Takala, M., Tukiainen, T., Salminen, V., Sarkkinen, J. (2023), Impacts and indicators of regional innovation ecosystems supporting sustainable development. Human Factors, Business Management and Society, 97, 40-49.
Tokar, V., Shkuropadska, D. (2025), Social resilience in central-eastern Europe: Comparing Bucharest nine and Ukraine. Periodica Polytechnica Social and Management Sciences. doi: 10.3311/PPso.37037
Tokar, V., Tyshchenko, D., Franchuk, T., Babenko, A., Koval, I. (2025), Assessing EU member states' readiness for innovation parks: Financial and R and D perspectives. International Journal of Economics and Financial Issues, 15(3), 311-319.
Vinska, O., Tokar, V. (2021), Cluster analysis of the European Union gender equality and economic development. Business Management and Economics Engineering, 19(2), 373-388.
Vinska, O., Tokar, V., Novak, N. (2024), Female empowerment in business: Clustering EU member states and candidate countries. In R. Khamis Hamdan, A. Hamdan, B. Alareeni, & R. E. Khoury (Eds.), Information and communication technology in technical and vocational education and training for sustainable and equal opportunity (Vol. 38, pp. 91–104). Springer. doi: 10.1007/978-981-99-6909-8_8
Wen, Y., Fang, L. (2024), How does innovation-collaboration network structure influence regional economic resilience? Economic Development Quarterly, 38(4), 271-287.
Xie, X., Liu, X., Blanco, C. (2023), Evaluating and forecasting the niche fitness of regional innovation ecosystems: A comparative evaluation of different optimized grey models. Technological Forecasting and Social Change, 191, 122473.
Zhang, S., Hu, B., Zhou, M. (2024), Top management team social capital and business model innovation: Moderating role of business ecosystem health. European Journal of Innovation Management. doi: 10.1108/EJIM-11-2023-0954