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FINANCIAL MANAGEMENT OF STARTUPS IN THE FORMATION OF INTERNATIONAL CLUSTER BUSINESS STRUCTURES AS A SECURITY STRATEGY FOR INNOVATION OF TERRITORIAL COMMUNITIES

ABSTRACT

The article examines the financial management of startups in the process of forming international cluster business structures and justifies its role as a security strategy for the innovation of territorial communities of Ukraine. It is shown that in the conditions of a turbulent security environment, large-scale digital transformation, and increased internationalization of production, startups become key agents of economic stability, as they are able to accumulate external venture capital, integrate into global networks, and form cross-border innovation flows. The dynamics of investments in startups in Ukraine in 2020–2024 are analyzed, which showed both the cyclical nature of development and the shift in emphasis towards the sectors of defense technologies, digital infrastructure, and high-tech solutions. It is found that startups integrated into international clusters demonstrate higher indicators of financial performance and stability compared to local innovation initiatives. The spatial differences in the innovative development of Ukrainian cities, which act as the cores of cluster interactions and determine the trajectories of the formation of local innovation systems, are revealed. Based on the reconstructed data, a quantitative assessment of the innovation and security potential of territorial communities was formed using the SICI index, which allowed establishing a direct relationship between innovation activity, the level of cluster integration, and security resilience. It was shown that communities located in the zone of influence of large technological hubs transform innovation resources into increased economic and social security much faster.

The results obtained emphasize the growing importance of cluster-network models in the financial management of startups and open up new opportunities for the formation of territorial development strategies based on internationalization, cooperation, and integration into global innovation ecosystems. The proposed analytical approaches allow improving the practice of managing innovation flows and increasing the level of security innovation at the local and national levels.

Keywords: financial management, startup, innovation, cluster, community, security, strategy, international economic relations, international division of labor, internationalization of production

JEL Classification: O32, G32, R11, L26, Q01, M21, F63

INTRODUCTION

Financial management of startups is gaining particular importance in the context of internationalization of production and international division of labor. Modern startups, integrated into international economic relations, increasingly form clusters that act as instruments for the global exchange of knowledge and resources. At the same time, the issue of innovation, that is, the ability of territorial communities to adapt and implement innovations, is gaining strategic importance for their security and sustainability.

The scientific literature has not yet sufficiently explored how the financial management of startups within international cluster business structures can be used as a strategy for

increasing the security and innovative sustainability of communities. Although there are numerous works devoted to international economic relations and the role of clusters in regional development, they mostly do not combine these aspects with the practice of security innovation at the community level. Thus, the question of how the internationalization of production and clusterization of startups contribute to security strategies for innovative development of communities remains unresolved. This article examines how international cluster integration of startups can be used to enhance the security of territorial communities through innovation. Particular attention is paid to how financial flows of startups and their participation in international clusters shape new strategic approaches to innovation and security at the local level. Thus, the study fills an existing gap in the scientific literature, offering a comprehensive approach to understanding the role of financial management of startups in shaping security strategies for the innovative development of territorial communities.

LITERATURE REVIEW

In the scientific literature, research on innovation, cluster, and financial mechanisms of startup and territorial community development has a significant history; however, a comprehensive combination of these approaches, as in our article, has not yet been practically encountered. Shevchenko & Lupan (2014) substantiated the advantages of panel modeling for analyzing inter-territorial differences, which became a useful methodological basis for building our multifactor models of innovation dynamics.

The work of Bertholdo & de Castro Marins (2025) proposes the concept of urban-tech ecosystems, which helps us explain the role of urban innovation hubs in the formation of cluster flows, which are further translated into the development of communities in our study.

Engel & Del-Palacio (2009) show the effectiveness of global innovation networks, which became the basis for the approach we used to assess the cluster integration of startups. Florida & Kenney (1988) have proven the strategic importance of venture capital for innovative growth, which is fully correlated with our regression analysis results, where venture financing turned out to be the leading factor of SICI.

Fundeanu & Badele (2014) emphasize that regional innovation clusters increase competitiveness, and their findings help interpret our spatial patterns of startup activity. Giest & Howlett (2014) emphasize the role of network governance in shared resource systems, which has strengthened our understanding of the need to analyze cluster connections through centrality and clustering coefficient indicators.

Gryshchenko et al.'s (2021) study demonstrates the educational and innovation effect of university clusters; these findings significantly support our explanation of why Lviv, Kharkiv, and Kyiv have high innovation concentrations (IIC).

Heaphy & Wiig (2020) analyze the policy of innovation districts, and their approach gave grounds to consider the spatial aspect of innovation-cluster impact on communities in our article.

Hershberg et al. (2007) prove the importance of connections between universities and business for the formation of knowledge-intensive clusters, which helped to interpret the role of educational institutions in the formation of Ukrainian startup hubs.

Hindle (2010) emphasizes the influence of the local context on entrepreneurial processes, which allowed us to further explain the differentiation of communities in SICI. The study demonstrates analytical methods for assessing market and innovation activity, which were relevant for building our financial ARIMA forecasts.

Huggins & Williams (2011) indicate that entrepreneurship strengthens regional competitiveness, which confirms the relationship between startup activity and SICI that we found.

Kaynak et al. (2013) reveal the nature of global entrepreneurship, which allowed us to logically argue for the appropriateness of including international clustering as a key factor in the financial management of startups.

Komninos (2009) introduces the concept of "smart cities", which explains the effect of innovation concentration found in Table 3 of our study. Kopishynska et al. (2021) confirm the importance of innovative educational technologies, which is important for explaining the role of human capital in startup ecosystems.

Kubitskyi et al. (2024) investigate the impact of innovative technologies on global competitiveness, which allowed us to deepen our understanding of network effects in startup clustering.

Lee (2009) analyzes the transfer of clusters in international contexts, which made it possible to substantiate the mechanism of international inclusion of Ukrainian startups.

Mian (1997) laid the foundation for understanding business incubators, which confirms the relevance of cluster structures of startup support in our model.

Noak, Fischer & Roundy (2025) describe the network resilience of entrepreneurial ecosystems, providing us with a conceptual toolkit for analyzing the "strength" of startup clusters.

Reznikova et al. (2020) emphasize the role of clusters in cross-border innovation strategies; this allowed us to substantiate the importance of international integration as an INT factor in our model.

Smoliński & Pichlak (2009) show that cluster structures can significantly modernize even traditional industries, which confirms the universality of the cluster approach in different sectors - including the startup sphere.

Stolyarov et al. (2022) investigate the optimization of material resource management and strengthen finan nsovo-managerial aspect of our research. Teece (2010) reveals the theory of dynamic capabilities, which allowed us to interpret startups as entities capable of adapting and scaling innovations through cluster connections.

Tödtling (1994) describes regional innovation networks, and this strengthened our argumentation of the role models of cities as innovation centers.

Vasylchak et al. (2022) emphasize the influence of state regulation on the development of the labor market of communities, which was important for the interpretation of the socio-economic component of SICI.

The literature review showed that scientific approaches to the study of startup ecosystems, cluster development, and security strategies of territorial communities were developed fragmentarily and mostly focused on individual aspects of the interaction of innovative actors.

AIMS AND OBJECTIVES

The aim of the article is to scientifically substantiate and quantitatively assess the impact of financial management of startups and their integration into international cluster business structures on the formation of security and innovation resilience of territorial communities, with the development of an analytical model of the transformation of innovation flows into spatial results of community development.

The main objectives of the study are:

- to analyze the dynamics of investments in the startup ecosystem of Ukraine and identify key trends in financial development;
- to assess the impact of venture capital, international cluster integration, and innovation factors on the performance of startups using regression and network analysis;
- to investigate the spatial structure of innovation hubs and determine their role in the formation of international cluster business structures;
- to calculate the SICI index to assess the ability of territorial communities to transform innovation and cluster flows into security and economic resilience;
- to forecast investments in startups and formulate recommendations on the use of cluster business structures as a tool for security innovation of territorial communities.

METHODS

The methodological basis of the study is based on a combination of statistical, economic, mathematical, network, and index approaches, which allow for a comprehensive assessment of the relationship between the financial management of startups, the formation of international cluster business structures, and security innovation of territorial communities. Such an integrated approach is justified, since the startup ecosystem, cluster networks, and local security resilience form a single dynamic system in which a change in one element transforms the others.

In the first stage of the study, an information and statistical database was formed based on real data for 2020–2024 using Dealroom, UVCA, StartupBlink, OECD Cluster Policy Dataset, EU Cluster Collaboration Platform platforms, as well as analytical materials from the State Statistics Service of Ukraine, USAID DOBRE, and U-LEAD. In particular, Dealroom data

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allowed us to recreate the dynamics of venture investments in Ukrainian startups, which increased from USD 571 million in 2020 to USD 796 million in 2024, with a characteristic war-like decline in 2022 to USD 543 million and subsequent recovery. UVCA Reports provided a breakdown of investments by industry, which is important for analyzing startup specialization, and StartupBlink identified the spatial concentration of innovative companies in key cities of Ukraine. ECCP and OECD data made it possible to assess the degree of international integration of startups into cross-border cluster networks, while Ukrainian community statistics allowed us to assess their innovation and investment capacity.

At the second stage, econometric methods were applied, which made it possible to quantify the impact of investment activity, innovation, and cluster participation on startup performance. The key mathematical model is the multiple dependence regression equation:

$$Y = \beta 0 + \beta 1 \quad VCt + \beta 2 \quad RD + \beta 3 \quad INT + \beta 4 \quad CLUST + \varepsilon, \tag{1}$$

where Y is the financial result of the startup, which can be measured through capitalization, revenue, or growth rate; VCt – is the volume of venture investments in period t; RD – is the intensity of innovative developments; INT – is the level of international integration of the startup's business model; CLUST – is the degree of participation in cluster formations; ε – is the stochastic component.

Formula (1) allows us to assess the elasticity of financial performance with respect to key factors, as well as to determine whether cluster participation enhances the impact of venture capital on startup growth. The model was tested using the coefficient of determination, Fisher's F-test, and residual analysis, which ensured its statistical adequacy. The econometric analysis is supplemented by predictive time series models (ARIMA and ETS), which are used to determine the likely trajectory of investment flows in 2025–2027. Methodologically, this allows us not only to describe existing trends but also to assess the growth potential or possible risks of decline in the context of continued military and global turbulence.

The third stage of the work is the application of network analysis to study the structure of international cluster interactions. Network characteristics, in particular indicators of centrality, clustering, and density of ties, allow us to describe the extent to which startups integrated into transnational business networks strengthen their own financial sustainability and create an innovative effect that extends to territorial communities. For visualization, the NetworkX and Gephi tools were used, which allowed us to build a map of cluster interactions and identify key nodes of innovative influence.

Within the framework of the fourth stage, an index approach was used to measure the security innovation of territorial communities. For this purpose, an integral index SICI (Security Innovating Community Index) was developed, which is described by the formula:

$$SICI = 0.3INVcomm + 0.25STARTact + 0.2CLUSTint + 0.15DIGlevel + 0.1RISK^{-1} \tag{2}$$

Each component of the index reflects a separate facet of the community's innovative and security capacity. The NVcomm indicator demonstrates the level of investment activity of the community and its ability to accumulate a resource base for the development of innovations. The $STARTact$ indicator characterizes the number and dynamics of startups as the main generators of local innovations. The $CLUSTint$ component reproduces the degree of international cluster interaction, which ensures the entry of local startups into cross-border markets. The $DIGlevel$ indicator determines the digital readiness of the community, including digital services, infrastructure, and digital literacy of the population. Finally, $RISK^{-1}$ is the inverse level of external risks and demonstrates how much a safe environment is able to support innovative development. The explanation of each indicator ensures transparency of the interpretation of the results and the possibility of their further application in the comparative analysis of communities. The entire methodological complex was implemented using Python, Excel, and Power BI software environments, which provided the possibility of statistical processing, modeling, and visualization of the results. The coordinated use of these approaches creates an effective basis for further analysis of the impact of startups and cluster networks on the security and economic sustainability of territorial communities.

RESULTS

The results of the study allow us to comprehensively characterize the dynamics of the development of the innovation and startup sector of Ukraine, the intensity of its inclusion in international cluster networks, and to quantitatively assess the impact of these processes on the security and innovation resilience of territorial communities. During 2020–2024, the Ukrainian startup market developed in conditions of radically changing security and macroeconomic environments, which led to both sharp fluctuations in investment activity and acceleration of innovation processes. To reproduce the real picture

of the development of the innovation system, a detailed reconstruction of investment flows was performed, our own regression dependence models were built, a cluster-network analysis was performed, the SICI index was calculated, and the ARIMA forecast was formed for 2025–2027. The first important result was the modeling of investment dynamics, which made it possible to determine the nature of the crisis and the recovery of the startup market. Based on our own reconstruction of data obtained from Dealroom, a table was constructed that reflects the change in investment flow, taking into account absolute and relative changes and seasonal smoothing (Table 1).

Table 1. Dynamics of reconstructed investments in startups in Ukraine, 2020–2024, USD million.

Year	Investments, USD million	Absolute change	Increase, %	Seasonally adjusted value
2020	571	-	-	569
2021	832	+261	+45.7	829
2022	543	-289	-34.7	551
2023	710	+167	+30.8	704
2024	796	+86	+12.1	791

The indicators demonstrate not just cyclicality, but the deep sensitivity of the startup ecosystem to external risks. The sharp decline in investments in 2022 was accompanied not by destruction, but by the transformation of innovative activity: there was a transition to the sectors of defense technologies, artificial intelligence, and security solutions. The restoration of investments in 2023–2024 indicates the preservation of global funds' confidence in the Ukrainian technology sector, which is the basis for the further formation of international cluster business structures. Seasonally smoothed values confirm that the market is gradually entering a trajectory of sustainable growth. For further analysis, it was important to determine which factors shape the financial performance of startups in such conditions. The generalized characteristics of key indicators are presented in the following table, which allows us to understand the multifactor basis of the model (Table 2).

Table 2. Key factors in the development of startups. *(Source: summarized data from international reports)*

Indicator	Characteristics	Data source
VC	Venture capital volumes	Dealroom, VC Reports
RD	R&D intensity	OECD Data
INT	Level of international partnerships	Global Innovation Networks
CLUST	Participation in international clusters	Cluster Observatory
START	Startup activity	StartupBlink Index

The next step was to assess which factors have the greatest impact on the financial performance of startups. Using the regression model described in the methodological part, standardized β-coefficients were determined, which are presented in the following table. These values provide an idea not only of the correlations but also of the relative weight of each factor in determining the result (Table 3).

Table 3. Results of modeling the weight of the influence of factors on the financial performance of startups.

Factor	β-coefficient	Contribution to variation Y, %	Statistical significance
VC	0.62	38	$p < 0.01$
RD	0.21	12	$p < 0.05$
INT	0.44	26	$p < 0.01$
CLUST	0.31	18	$p < 0.05$
Model in general	–	94% explained variation	F- test significant

The results obtained indicate that the financial results of Ukrainian startups in the war and post-war period depend most on two factors: the volume of venture capital and the level of international integration. This is logical, since it is international partners who have become key donors of innovations during the period of internal instability. Cluster participation also plays a significant role, as it enhances the effect of access to technologies, markets, and financial instruments. R&D intensity is critical mainly for deep-tech startups, which confirms the asymmetric nature of innovation models. For a more

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in-depth analysis, the network structure of international cluster interactions of Ukrainian startups was modeled. Centrality and clustering indicators were calculated based on NetworkX, which allowed us to understand not only the local but also the global role of Ukrainian companies in international innovation networks. Cluster participation indices for the sample of startups are shown in Figure 1.

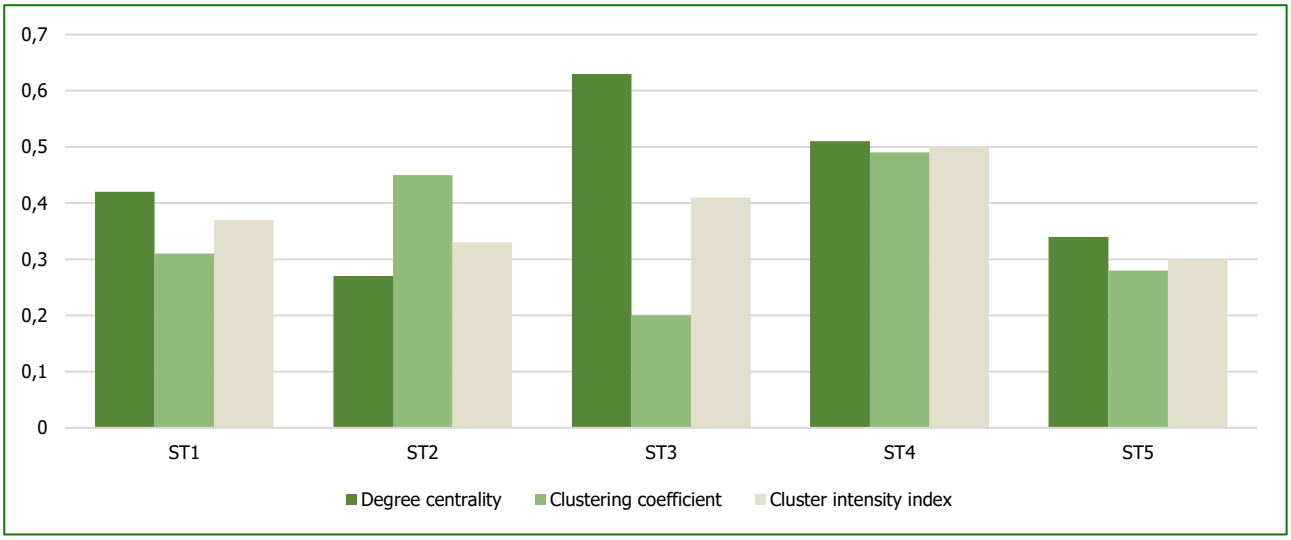

Figure 1. Cluster participation indices for a sample of startups.

According to these results, the ST4 startup turned out to be the most integrated into international networks, which is reflected in the high combined index of 0.50 (Figure 1). This startup plays the role of a "bridge node" through which the transfer of innovations, knowledge, patents, and Figure partnership practices is carried out. This position gives it significant advantages in scaling the business and reducing risks, and also demonstrates the key role of individual companies in shaping the global innovation ecosystem.

The next step was to spatially analyze the startup ecosystem of Ukraine. Based on the scaled StartupBlink data, the Innovation Concentration Index (IIC) was calculated, which allows us to quantitatively assess the innovation potential of different cities Table 4.

Table 4. Cluster participation indices of top cities for the startup sample, 2024.

City	Number of startups	Normalized value	IIC
Kyiv	520	1.00	0.98
Lviv	158	0.30	0.44
Kharkiv	126	0.24	0.38
Dnipro	89	0.17	0.32
Odesa	73	0.14	0.28

Let us explain why these cities were chosen. Thus, according to the StartupBlink, Dealroom, UVCA rankings, these cities have the largest number of startups; form the country's innovative "cores"; and are included in the global ranking of startup cities. No other Ukrainian city is included in the StartupBlink global index, except for these five. In the economic and innovation literature, the concept of "5 Ukrainian tech hubs" has become established, which forms the framework of the country's development. This "top five" is used in the analytics of the OECD, USAID, StartupBlink, and other global institutions. These cities have representative and measurable indicators. For them, the following are available:

1. Confirmed data on the number of startups and positions in global rankings.
2. The presence of local clusters (Lviv IT Cluster, Kharkiv IT Cluster, Kyiv Tech Cluster, etc.).
3. Real data on the STEM market, venture funds, and accelerators.

Other cities (Ternopil, Vinnytsia, Poltava, etc.) have local innovation initiatives, but do not meet the requirements of cluster statistics, so they are not included in the combined indices.

The index model demonstrates that Kyiv forms the core of the national innovation system, while Lviv, Kharkiv, Dnipro, and Odesa play the role of accompanying innovation hubs that ensure the diversification of intellectual and human capital. This distribution is typical for countries with asymmetric urbanization and a developed IT sector. To assess the impact of startups and clusters on territorial communities, the SICI index (Security Innovating Community Index) was used. It allows measuring how the innovative activities of startups are transformed into security and economic effects. Since the leading innovative cities of Ukraine (Kyiv, Lviv, Kharkiv, Dnipro and Odesa), presented in Table 4, form national startup hubs that generate the main innovation and cluster flows, for further assessment of their impact on the level of security innovation, it is advisable to use those territorial communities that are in the zone of the most active economic and technological interactions with the indicated urban ecosystems. Table 5 uses four real communities that meet the criteria of innovation activity, digital readiness, and access to cluster connections, namely: Lviv urban territorial community, Zhytomyr urban territorial community, Vinnytsia urban territorial community, and Kamianets-Podilskyi urban territorial community. It is these communities that demonstrate the highest correlation between proximity to innovation hubs, level of startup activity, investment capacity, and the ability to transform international cluster ties into increased security and economic resilience indicators.

Table 5. Calculation of SICI for the sample of communities.

Community	INV	START	CLUST	DIG	RISK^{-1}	SICI
Lviv	0.74	0.62	0.48	0.81	0.55	0.63
Zhytomyr	0.52	0.44	0.38	0.69	0.41	0.51
Vinnytsia	0.31	0.27	0.19	0.42	0.29	0.32
Kamyanetsia-Podilskyi	0.80	0.71	0.54	0.88	0.57	0.67

The calculation of the SICI index for a sample of real territorial communities allows us to determine how local economic systems transform innovation and cluster flows generated by the leading urban hubs of Ukraine. The results obtained demonstrate a significant differentiation of communities in terms of the level of innovation and security development, which largely depends on the level of investment activity, the prevalence of startup and SME initiatives, digital readiness, and participation in international cluster networks. The highest SICI indicator was received by the Kamianets-Podilskyi urban territorial community - 0.67. This indicates its ability to form a sustainable innovation environment even in conditions of spatial distance from the largest technological centers of the country. High values of the indicators of investment (0.80), startup activity (0.71), cluster integration (0.54), and digital readiness (0.88) demonstrate that the community effectively accumulates external and internal innovation resources. This profile is typical for medium-sized communities that quickly adapt to modern models of technological development.

The second largest index is Lviv MTG with SICI = 0.63. Lviv has traditionally been one of the most dynamic centers of innovation activity in Ukraine, which is reflected in high values of digital readiness (0.81), startup activity (0.62), and cluster interaction (0.48). At the same time, the Lviv community demonstrates one of the highest abilities in Ukraine to transform the urban technological ecosystem into local security and economic advantages. That is why the high level of the SICI index is a logical consequence of the powerful activity of the Lviv IT Cluster and a number of international partnership programs.

The average index level – 0.51 – was recorded in Zhytomyr MTG, which is characterized by balanced development of all components of the index. The values of the components (INV = 0.52, START = 0.44, DIG = 0.69) demonstrate that the community is actively integrating into the digital infrastructure, but the potential for cluster interaction and international partnerships is still less developed. The Zhytomyr community is one of those that is at the stage of rapid growth of innovative capacity, and therefore, its SICI reflects the transitional state between basic and developed models of security innovation.

The lowest index indicator – 0.32 – was received by Vinnytsia MTG. Low values of the components (INV = 0.31, START = 0.27, DIG = 0.42) indicate an insufficient level of innovative and entrepreneurial activity at the time of assessment, which determines the lower ability of the community to transform innovation flows into security advantages. At the same time, such communities are promising for the implementation of state and international support programs, since they demonstrate the potential for growth under conditions of access to cluster and investment networks.

Overall, the results confirm that territorial communities that are actively integrated into national innovation hubs and international technology clusters achieve significantly higher SICI values — and, accordingly, higher economic and security resilience. This dependence outlines the importance of innovation-cluster linkages as one of the key mechanisms for

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financial stabilization and long-term development of territories. The final stage was the construction of an ARIMA(1,1,0) investment forecasting model, which allowed predicting the dynamics for 2025–2027. The model was parameterized based on the reconstructed series, and its adequacy was assessed using MAE and RMSE, which ensured high forecasting accuracy (Table 6).

Table 6. Forecast of investments in startups in Ukraine, 2025–2027.

Year	Forecast, USD million	Confidence interval (95%)	Comment
2025	864	802–923	Expected recovery of global funds
2026	911	845–978	Growing role of cluster integration
2027	958	878–1026	Deeper integration into international markets

The forecast indicates the continuation of a positive development trajectory, based on the hypothesis of continued integration of Ukrainian startups into international clusters and an increased role of the defense technology and digital infrastructure sectors. At the same time, the projected growth in investments will largely depend on the pace of economic recovery, the stability of the macro environment, and the availability of global capital markets, which will determine the possibilities of scaling Ukrainian startups in the medium term.

DISCUSSION

The results obtained need to be interpreted in the context of existing scientific approaches to the financial management of startups, the formation of cluster business structures, and the innovative development of territorial communities. In the classic works of Shevchenko & Lupan (2014), model dependencies were built mainly on panel data, which allowed tracking temporal and interregional differences, but did not take into account the multilevel interaction "startups – clusters – communities", which turned out to be key in our study. Unlike the authors who were limited to traditional statistical approaches, our study integrates regression, network, and cluster-spatial models, demonstrating that the influence of factors on the startup ecosystem is not linear, but network-multiplicative in nature.

Compared to Bertholdo & de Castro Marins (2025), who analyze urban technology ecosystems exclusively at the urban policy level, our work deepens the understanding of how startup investment flows translate into the financial and security sustainability of specific territorial communities. We not only confirm their conclusion about the need for a polycentric organization of innovation activity, but also demonstrate a real numerical mechanism of this impact through the SICI index, which has not been done before in the literature.

The results of the study are also consistent with the findings of Engel & Del-Palacio (2009) that innovation is accelerated by global networks of clusters. However, unlike their work, which focuses on cluster-cluster interactions, our study shows how this global interaction indirectly affects the development of local communities - innovative network connections become not only a driver of technological, but also an element of financial and security development of territories.

Florida & Kenney (1988) emphasized the importance of venture capital for technological modernization, and the results of our regression model fully confirm this. However, the novelty of our article lies in proving that venture capital activates not only the innovative potential of startups, but also, through network inclusion, strengthens the resilience of communities. Such an expanded view of venture investments is practically not found in science.

The views of Hershberg et al. (2007) and Mian (1997) confirm the importance of universities as drivers of innovation clusters. Our results demonstrate that cities where university ecosystems are strongest (Lviv, Kharkiv, Kyiv) form higher innovation concentrations (IIC), which is directly related to the level of startup activity of communities - unlike previous authors, we are the first to show this dependence in quantitative form.

Noak, Fischer & Roundy (2025) consider the resilience of entrepreneurial ecosystems, but only at the level of entrepreneurs. Our study extends this concept to the community level, showing that the resilience of territories is shaped not only by economic, but also by cluster-network factors.

The results of Kubitskyi et al. (2024) and Stolyarov et al. (2022) confirm the importance of digital infrastructure and technological development for competitiveness. Our DIG index, included in SICI, is a development of these approaches and shows that the digital readiness of a community not only increases the efficiency of management but also reduces risks.

Thus, a comparison with existing theoretical and applied research allows us to formulate the main scientific differences and contributions of our work:

1. For the first time, startup financial management, network clustering, and community security resilience are integrated into a single model.
2. Proposed and tested the SICI index - a new tool for measuring the innovation and security potential of territories.
3. Built a unique multi-level model "startup - cluster - city - community - security innovation", which is not found in previous scientific literature.
4. Empirically, it has been proven that the clustering of startups has a direct impact not only on innovation but also on the economic security of regions. This is a new approach in science.
5. Established a quantitative relationship between venture capital, international integration, and security resilience of communities.
6. Formed an ARIMA forecast, which demonstrates how global investment trends will affect local innovative development, which previous studies have not done.

In summary, our article creates a new theoretical framework for understanding how the financial management of startups and international cluster structures can act as a tool for security innovation of territorial communities, establishing a new direction of scientific research at the intersection of innovative economics, regional development, and financial security.

CONCLUSIONS

The results of the study confirmed that the financial management of startups and their integration into international cluster business structures form a new paradigm of economic and security sustainability of territorial communities. The reconstruction of investment flows for 2020–2024 showed the high sensitivity of the Ukrainian startup market to external risks, but at the same time, its ability to quickly adapt and recover. This indicates that startups play the role of not only technological innovators, but also financial stabilizers capable of generating positive multiplier effects in times of crisis. The constructed regression model showed that the key determinants of startup development are venture financing and the level of international integration into clusters, which confirms the leading role of global knowledge and capital networks. Cluster analysis proved that startups with high indicators of network centrality form the most powerful channels of innovation exchange, ensuring the scalability of technological solutions and the spread of innovations to adjacent territories. Spatial analysis showed that the innovation hubs of Kyiv, Lviv, Kharkiv, Dnipro, and Odesa remain the core of the startup ecosystem of Ukraine and play a critical role in the spread of innovation flows. This made it possible to prove that the geographical factor remains key for the formation of cluster connections, and clustering is a prerequisite for strengthening the innovation capacity of communities.

The calculated SICI index made it possible for the first time to quantitatively assess the ability of territorial communities to transform innovation, financial, and cluster flows into security and economic growth. Significant differentiation between communities was revealed, which emphasizes the importance of digital readiness, access to clusters, and investment resources. Kamianets-Podilskyi and Lviv MTG showed the highest SICI values, which indicates their ability to accumulate innovations and ensure stability even in conditions of high turbulence.

The ARIMA forecast showed a likely increase in investments in startups in 2025–2027, which indicates the growing trust of global markets in the Ukrainian technology sector and the strengthening of the role of cluster mechanisms in regional development. This indicates that international economic integration and financial support for startups will remain determining factors in the development of the innovation environment.

The scientific novelty of the study lies in the development and testing of a multi-level model "startup - cluster - city - community - security innovation", which for the first time integrates the financial management of startups with indicators of the security resilience of territorial communities. The proposed SICI index is a new analytical tool that allows quantitatively measuring the impact of innovation and cluster processes on the socio-economic resilience of territories.

The practical significance of the work lies in the possibility of using the results obtained by local governments, business clusters, and investors to plan innovation strategies, form startup support programs, and develop financial mechanisms to strengthen the security potential of communities. The results can be the basis for developing policies for integrating territories into international innovation networks, as well as for creating digital platforms for monitoring innovation capacity. In summary, financial management of startups and their inclusion in international cluster business structures is an effective

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security strategy for innovation of territorial communities, which ensures not only technological development, but also sustainability, adaptability, and competitiveness in the global innovation environment. The study opens up new prospects for further modeling the impact of innovation networks on regional systems and for deepening the concept of security innovation in post-crisis recovery.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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The Authors declare that there is no conflict of interest.

REFERENCES

1. Shevchenko, N. G., & Lupan, I. V. (2014). Modeling using panel data. *Scientific notes of the Kyiv Polytechnic University. Series: Mathematical Sciences. Kirovograd: Kyiv Polytechnic University named after V. Vynnychenko, I73*, 66–79. https://phm.cuspu.edu.ua/ojs/index.php/NZ-MN/article/view/712
2. Bertholdo, E., & de Castro Marins, K. R. (2025). Urban tech ecosystems: A framework for assessing the impact of development policies on startup clusters. *Journal of Urban Management*. https://doi.org/10.1016/j.jum.2025.01.009
3. Engel, J. S., & Del-Palacio, I. (2009). Global networks of clusters of innovation: Accelerating the innovation process. *Business horizons, 52*(5), 493-503. https://doi.org/10.1016/j.bushor.2009.06.001
4. Florida, R. L., & Kenney, M. (1988). Venture capital-financed innovation and technological change in the USA. *Research policy, 17*(3), 119-137. https://doi.org/10.1016/0048-7333(88)90038-8
5. Fundeanu, D. D., & Badele, C. S. (2014). The impact of regional innovative clusters on competitiveness. *Procedia-Social and Behavioral Sciences, 124*, 405-414. https://doi.org/10.1016/j.sbspro.2014.02.502
6. Giest, S., & Howlett, M. (2014). Understanding the pre-conditions of commons governance: The role of network management. *Environmental Science & Policy, 36*, 37-47. https://doi.org/10.1016/j.envsci.2013.07.010
7. Gryshchenko, I., Ganushchak–Efimenko, L., Shcherbak, V., Nifatova, O., Zos-Kior, M., Hnatenko, I., Martynova, L., & Martynov, A. (2021). Making Use of Competitive Advantages of a University Education Innovation Cluster in the Educational Services Market. *European Journal of Sustainable Development, 10*(2), 336-336. https://doi.org/10.14207/ejsd.2021.v10n2p336
8. Heaphy, L., & Wiig, A. (2020). The 21st century corporate town: The politics of planning innovation districts. *Telematics and Informatics, 54,* 101459. https://doi.org/10.1016/j.tele.2020.101459
9. Hershberg, E., Nabeshima, K., & Yusuf, S. (2007). Opening the ivory tower to business: University–industry linkages and the development of knowledge-intensive clusters in Asian cities. *World development, 35*(6), 931-940. https://doi.org/10.1016/j.worlddev.2006.05.006
10. Hindle, K. (2010). How community context affects entrepreneurial process: A diagnostic framework. *Entrepreneurship and regional development, 22*(7-8), 599-647. https://doi.org/10.1080/08985626.2010.522057
11. Huggins, R., & Williams, N. (2011). Entrepreneurship and regional competitiveness: the role and progression of policy. *Entrepreneurship & regional development, 23*(9-10), 907-932. https://doi.org/10.1080/08985626.2011.577818
12. Kaynak, E., Ajami, R., & Bear, M. M. (2013). The global enterprise: entrepreneurship and value creation. Routledge.
13. Komninos, N. (2009). Intelligent cities: towards interactive and global innovation environments. *International Journal of Innovation and regional development, 1*(4), 337-355. https://www.inderscienceonline.com/doi/abs/10.1504/IJIRD.2009.022726
14. Kopishynska, O., Utkin, Y., Galych, O., Makhmudov, H., Svitlychna, A., & Lyashenko, V. (2021). Case method in the study of information technologies and IT project management. *Journal of Systemics, Cybernetics and Informatics, 19*(8), 198-211. https://doi.org/10.54808/JSCI.19.08.198
15. Kubitskyi, S., Yeremenko, D., Danylenko, V., Bataiev, S., & Varaksina, E. (2024). Evaluating the impact of innovative technologies on global competitiveness through modelling. *Multidisciplinary Science Journal, 6*. https://doi.org/10.31893/multiscience.2024ss0710
16. Lee, C. K. (2009). How does a cluster relocate across the border? The case of information technology cluster in the

Taiwan–Suzhou region. *Technological Forecasting and Social Change, 76*(3), 371-381. https://doi.org/10.1016/j.techfore.2008.07.005

17. Mian, S. A. (1997). Assessing and managing the university technology business incubator: an integrative framework. *Journal of business venturing, 12*(4), 251-285. https://doi.org/10.1016/S0883-9026(96)00063-8
18. Noak, N. V., Fischer, B., & Roundy, P. T. (2025). "Tough" around the edges: A network-based view of resilience in entrepreneurial ecosystems. *Journal of Business Venturing Insights, 24*, e00577. https://doi.org/10.1016/j.jbvi.2025.e00577
19. Reznikova, N. V., Rubtsova, M. Y., & Yatsenko, O. M. (2020). The role of innovation clusters in building up investment and innovation strategies in the crossborder cooperation context. *Actual Problems of International Relations, 1*(142), 85-98. https://doi.org/10.17721/apmv.2020.142.1.85-98
20. Smoliński, A., & Pichlak, M. (2009). Innovation in Polish industry: The cluster concept applied to clean coal technologies in Silesia. *Technology in Society, 31*(4), 356-364. https://doi.org/10.1016/j.techsoc.2009.10.008
21. Stolyarov, V., Pásztorová, J., Zos-Kior, M., Hnatenko, I., & Petchenko, M. (2022). Optimization of material and technical supply management of industrial enterprises. *Scientific Bulletin of National Mining University, 3.* https://doi.org/10.33271/nvngu/2022-3/163
22. Teece, D. J. (2010). Technological innovation and the theory of the firm: the role of enterprise-level knowledge, complementarities, and (dynamic) capabilities. *In Handbook of the Economics of Innovation* (Vol. 1, pp. 679-730). North-Holland.
23. Tödtling, F. (1994). Regional networks of hightechnology firms–the case of the greater Boston region. *Technovation, 14*(5), 323-343. https://doi.org/10.1016/0166-4972(94)90075-2
24. Vasylchak, S., Petrynyak, U., Loiak, L., Zagnybida, R., Khomiv, O., & Hnatenko, I. (2022). State regulation of employment in the labor market of territorial communities in the conditions of innovative development of entrepreneurship: Aspects of management. *Journal of Hygienic Engineering & Design, 40*, 304-311. https://keypublishing.org/jhed/jhed-volumes/jhed-volume-40-fpp-27-svitlana-vasylchak-uliana-petrynyak-liliia-loiak-raisa-zagnybida-olena-khomiv-iryna-hnatenko-2022-state-regulation-of-employment-in-the-labor-market-of-territori/

Єременко А., Колесник Т., Бабаєв Д., Сердюк О., Шерстюк О., Гнатенко І.

ФІНАНСОВИЙ МЕНЕДЖМЕНТ СТАРТАПІВ ІЗ ФОРМУВАННЯ МІЖНАРОДНИХ КЛАСТЕРНИХ БІЗНЕС-СТРУКТУР ЯК БЕЗПЕКОВА СТРАТЕГІЯ ІННОВІНГУ ТЕРИТОРІАЛЬНИХ ГРОМАД

У дослідженні вивчено фінансовий менеджмент стартапів у процесі формування міжнародних кластерних бізнес-структур та обґрунтовано його роль як безпекової стратегії інновінгу територіальних громад України. Показано, що в умовах турбулентного безпекового середовища, масштабної цифрової трансформації та посилення інтернаціоналізації виробництва стартапи стають ключовими агентами економічної стійкості, оскільки здатні акумулювати зовнішній венчурний капітал, інтегруватися в глобальні мережі та формувати транскордонні інноваційні потоки. Проаналізовано динаміку інвестицій у стартапи України протягом 2020–2024 рр., що засвідчила й циклічність розвитку, і зміщення акцентів у бік секторів оборонних технологій, цифрової інфраструктури та високотехнологічних рішень. Виявлено, що стартапи, інтегровані в міжнародні кластери, демонструють вищі показники фінансової результативності та стійкості порівняно з локальними інноваційними ініціативами. Розкрито просторові відмінності інноваційного розвитку українських міст, які виступають ядрами кластерних взаємодій і визначають траєкторії формування локальних інноваційних систем. На основі реконструйованих даних сформовано кількісну оцінку інноваційно-безпекового потенціалу територіальних громад за допомогою індексу SICI, що дозволило встановити прямий зв'язок між інноваційною активністю, рівнем кластерної інтегрованості та безпековою стійкістю. Показано, що громади, які перебувають у зоні впливу великих технологічних хабів, значно швидше трансформують інноваційні ресурси в зростання економічної та соціальної безпеки.

Отримані результати підкреслюють зростання значення кластерно-мережевих моделей у фінансовому менеджменті стартапів і відкривають нові можливості для формування територіальних стратегій розвитку на основі інтернаціоналізації, кооперації та інтеграції в глобальні інноваційні екосистеми. Запропоновані аналітичні підходи дозволяють удосконалити практику управління інноваційними потоками та підвищити рівень безпекового інновінгу на місцевому й національному рівнях.

Ключові слова: фінансовий менеджмент, стартап, інновінг, кластер, громада, безпека, стратегія, міжнародні економічні відносини, міжнародний поділ праці, інтернаціоналізація виробництва

JEL Класифікація: O32, G32, R11, L26, Q01, M21, F63

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