UDC 311.1:330.1:330.3
JEL Classification: M13; O30; O31

ASSESSING COMPETITIVE ADVANTAGES AND CHALLENGES OF THE UKRAINIAN TECH ECOSYSTEM DURING WARTIME

©2024 **LUKIANENKO I. G., SOVA Y. S.**

UDC 311.1:330.1:330.3
JEL Classification: M13; O30; O31

Lukianenko I. G., Sova Y. S.

Assessing Competitive Advantages and Challenges of the Ukrainian Tech Ecosystem during Wartime

The aim of the article is to identify the competitive advantages and key obstacles hindering the development of the technology sector in Ukraine during the period of martial law, as well as to develop potential scenarios for further development of the innovation ecosystem of Ukraine and appropriate strategies for implementation in each of the scenarios. An additional area of analysis is to test the hypothesis about the key role of investment in stimulating innovation. The study used general statistical and economic approaches, in particular, visual, scenario and correlation analysis. Within the framework of the study, it was demonstrated that the competitive advantages of the innovation ecosystem of Ukraine are a strong research and educational base, a high level of professionalism and technical skills of IT specialists, creativity and a number of innovative technological products. Among the main problems hindering its development are the level of stability of the institutional and regulatory environment, limited access to financial resources and lack of investment. It also confirmed the hypothesis that there is a statistically significant relationship between the level of investment in research and development (R&D) and the number of patents registered. The results of the study can be used to develop appropriate approaches to strategic analysis, in particular in terms of developing scenarios for the development of Ukrainian startups in the face of unprecedented risks, such as the period of martial law. Prospects for further research on this topic are a detailed quantitative and qualitative analysis of the impact of the implementation of programs for financing and stimulating investment in Ukrainian startups on the indicators of innovative development of the technological ecosystem of Ukraine. A separate research task is to develop a road-map for effective institutional changes necessary to ensure a favorable regulatory and business environment for Ukrainian startups based on international experience.

Keywords: *startup ecosystem, strategic scenario analysis, investments, innovative development, risks, economic development, competitive advantages, post-war recovery.*

DOI: *https://doi.org/10.32983/2222-0712-2024-2-264-271*

Fig.: *4.* ***Formulae:*** *2.* ***Bibl.:*** *22.*

Lukianenko Iryna G. *– Doctor of Sciences (Economics), Professor, Head of the Department of Finance, National University of "Kyiv-Mohyla Academy" (2 H. Skovorody Str., Kyiv, 04655, Ukraine)*

E-mail: *iryna.lukianenko@ukma.edu.ua*

ORCID: *http://orcid.org/0000-0002-4128-5909*

Researcher ID: *https://publons.com/researcher/1930228/iryna-lukianenko/*

Scopus Author ID: *https://www.scopus.com/authid/detail.uri?authorId=57189348551*

Sova Yevgenii S. *– PhD, Senior Lecturer of the Department of Finance, National University of "Kyiv-Mohyla Academy" (2 H. Skovorody Str., Kyiv, 04655, Ukraine)*

E-mail: *ye.sova@ukma.edu.ua*

ORCID: *https://orcid.org/0000-0001-8158-7031*

Researcher ID: *https://www.webofscience.com/wos/author/record/KIJ-9322-2024*

Scopus Author ID: *https://www.scopus.com/authid/detail.uri?authorId=57219597541*

УДК 311.1:330.1:330.3
JEL Classification: M13; O30; O31

Лук'яненко І. Г., Сова Є. С. Оцінка конкурентних переваг і викликів української технологічної екосистеми під час війни

Мета статті полягає у визначенні конкурентних переваг і ключових перешкод, що стримують розвиток технологічного сектора в Україні протягом періоду воєнного стану, а також розробці потенційних сценаріїв подальшого розвитку інноваційної екосистеми України та відповідних стратегій до імплементації в кожному зі сценаріїв. Додатковим напрямом аналізу є перевірка гіпотези про ключову роль інвестицій у стимулюванні інноваційної діяльності. У дослідженні використано загальні статистичні й економічні підходи, зокрема, візуальний, сценарний та кореляційний аналіз. У рамках дослідження було продемонстровано, що конкурентними перевагами інноваційної екосистеми України є потужна дослідницька та освітня база, високий рівень професійності й технічних навичок IT-спеціалістів, креативність і кількість інноваційних технологічних продуктів. Серед основних проблем, які перешкоджають її розвитку, можна виділити рівень стабільності інституційного й регуляторного середовища, обмежений доступ до фінансових ресурсів і дефіцит інвестицій. Було також підтверджено гіпотезу про те, що між рівнем інвестицій у дослідження

й розробку (R&D) та кількістю зареєстрованих патентів існує статистично значущий зв'язок. Результати дослідження можуть бути використанні для розробки відповідних підходів до стратегічного аналізу, зокрема в частині розробки сценаріїв розвитку українських стартапів в умовах безпрецедентних ризиків, таких як період воєнного стану. Перспективами подальших досліджень за цією тематикою є детальний кількісний та якісний аналіз впливу від впровадження програм із фінансування та стимулювання інвестицій в українські стартапи на показники інноваційного розвитку технологічної екосистеми України. Окремим дослідницьким завданням є розробка дорожньої карти щодо ефективних інституційних змін, необхідних для забезпечення сприятливого регуляторного й бізнес-середовища для українських стартапів на основі міжнародного досвіду.

Ключові слова: *стартап-екосистема, стратегічний аналіз сценаріїв, інвестиції, інноваційний розвиток, ризики, економічний розвиток, конкурентні переваги, післявоєнне відновлення.*

Рис.: *4.* ***Формул:*** *2.* ***Бібл.:*** *22.*

Лук'яненко Ірина Григорівна *– доктор економічних наук, професор, завідувач кафедри фінансів, Національний університет "Києво-Могилянська академія" (вул. Г. Сковороди, 2, Київ, 04655, Україна)*

E-mail: *iryna.lukianenko@ukma.edu.ua*

ORCID: *http://orcid.org/0000-0002-4128-5909*

Researcher ID: *https://publons.com/researcher/1930228/iryna-lukianenko/*

Scopus Author ID: *https://www.scopus.com/authid/detail.uri?authorId=57189348551*

Сова Євгеній Станіславович *– доктор філософії, старший викладач кафедри фінансів, Національний університет "Києво-Могилянська академія" (вул. Г. Сковороди, 2, Київ, 04655, Україна)*

E-mail: *ye.sova@ukma.edu.ua*

ORCID: *https://orcid.org/0000-0001-8158-7031*

Researcher ID: *https://www.webofscience.com/wos/author/record/KIJ-9322-2024*

Scopus Author ID: *https://www.scopus.com/authid/detail.uri?authorId=57219597541*

Introduction. The extremely challenging wartime and economic environment, especially since the beginning of 2022, has introduced new risks and trends to the Ukrainian tech ecosystem while exacerbating the existing issues.

Historically, the investments into R&D as % of GDP in Ukraine (0.29% in 2021) followed a downward trajectory and were far below the world's (2.71% in 2021) and European (2.28% in 2021) average levels [22]. A similar situation was observed in the gross capital formation as % of GDP: in 2021, the net increase in physical assets in Ukraine, at 14%, was lagging behind the world's (27%) and European (23%) averages. In 2022–2023, war-related factors further deteriorated the material and intellectual basis of Ukrainian economy that are essential for stimulating innovations [21]. Based on the report from European Commission, "35% of research infrastructure had been damaged or destroyed by March 2023 and 25% of the scientific workforce had left the country" [5].

Despite the negative impact of war, Ukrainian startups have succeeded in producing innovative solutions in the wake of globally trending technologies or their applications, such as artificial intelligence and unmanned vehicles (drones). As mentioned in the Ukraine Facility Plan for 2024–2027, Ukraine is one of the leading AI solutions developers in Eastern Europe with over 2,000 companies operating in the sector [1].

Both Ukrainian state authorities and society are determined to follow the EU accession path, which encompasses a set of reforms related to public administration and finances, judicial system, anti-corruption policies, financial markets, human capital, business environment, key strategic sectors and other measures described in the Ukraine Facility Plan. Digital transformation is one of the key sectors presented in the Ukrainian Facility Plan [1] where the state authorities plan to implement a set of reforms focused on fast and secure digital communication, favorable conditions for the *startup ecosystem development*, *integration with EU digital market*, digitalization of state services. To stimulate innovative development, the government has also established the Innovation Development Fund (the Ukrainian Startup Fund) and Committee for the Development of Artificial Intelligence under the management of the Ministry of Digital Transformation.

Hence, to foster innovations and the development of a digital economy under wartime conditions, it is essential to understand the current competitive position of Ukrainian tech ecosystem and the existing institutional measures put in place as well as to identify the ecosystem's key strategic strengths and gaps.

Literature review. The role of startups and innovative ecosystems for economic growth has been extensively analyzed in the academic literature. L. Peniaz emphasized the important role of startups in stimulating the economic development and transformation of innovative ecosystems through collaboration and highly flexible business models [11]. M. Nasachenko argued that the development of the startup ecosystem and the resulting innovations have a positive impact on the monetary transmission mechanism in Ukraine [10].

There have also been studies focused on the key issues impacting the development of the startup ecosystems, especially in a highly risky macroeconomic environment. When analyzing major challenges of startups in the crisis period, namely Covid-19 pandemic, Kuckertz et al. identified problems such as declining profitability and liquidity characterized by reduced sales and stable fixed costs, unfavorable economic climate leading to the deceleration of innovative activities, high uncertainty that discourages innovative experiments, etc. [14]. Possible solutions to mitigate such risks include (i) *startup-led* measures, such as regular collaboration with other startups across the network, joint sales and resource sharing initiatives, and concentrating on the core business segments while temporarily

downsizing other non-core activities, and (ii) *policymakers-led* measures, such as launching employee development programs, providing wage subsidies as well as incentives to investors to fund the startups' growth, fostering communication and cooperation within the startup community [14]. In their research on the resilience and recovery of Greek startups in response to Covid-19 pandemic, A. Vasilopoulos and C. Tsitsakis discovered that many young companies in Greece managed to expand their activities, hire additional personnel and launch new products despite the crisis situation.

One of the crucial roles in the successful performance of the startup ecosystem was the governmental support that spanned *from* tax reductions for angel investors and funding *to* creation of technological parks and innovation hubs for cooperation between the ecosystem's members [19]. In an interview conducted by McKinsey & Company, European venture capitalists listed the following key challenges that were on the sector's agenda in 2022: rising inflation, sustainable unit economics, revenue growth and profitability [8]. In Europe, sufficient funding is available for startups with robust business models and those operating in trending sectors such as cleantech, security and cybersecurity, biotech, and supply chain management [8].

Unresolved issues. Despite the relatively high interest of researchers in the role of innovative ecosystems for economic development, and the key challenges that startups are facing in developed countries during crisis periods, as well as their mitigating activities, there are still gaps in the literature. Additional research is needed to identify major issues and strategies for startups and tech ecosystems in developing economies, especially during periods of severe geopolitical, security and economic shocks, in particular the wartime.

The aim of the article is to identify competitive advantages and key gaps impeding the development of the tech sector in Ukraine during the wartime period, to develop potential scenarios for the further evolution of the Ukrainian innovative ecosystem, and to outline the respective strategies to be implemented in each scenario. Additionally, this paper aims to test the hypothesis that investments play a pivotal role in stimulating innovative activities.

Methodology. For the purposes of this study, we applied a set of economic and statistical methods which supported our strategic analysis of Ukrainian startup ecosystem identifying its areas of vulnerability and key competitive advantages as well as institutional changes required to strengthen the sector's resilience and to facilitate its future growth.

Our research methodology comprised the following interrelated steps:

Based on subject rankings, surveys, and tech research, we summarized key aspects of the competitive position of Ukrainian tech ecosystem and identified the key gaps and risks hindering its resilience and further development.

Furthermore, we tested one of the hypotheses derived from our economic analysis, i.e. investments are crucial for stimulating innovations, using statistical methods, including visual analysis of scatterplots and estimation of order association measures between variables (the metrics' values range from -1 to +1, where a negative number reflects a reverse relationship, and a positive one stands for a direct relationship) such as:

Kendall's tau-b, as presented in [15]:

$$\tau_b = \frac{C-D}{(C+D+X_0)(C+D+Y_0)}, \quad (1)$$

where C is the number of concordant pairs of orders,

D – the number of discordant pairs, X_0 is the number of pairs tied only on the X variable,

Y_0 – number of pair tied only on the Y variable;

Spearman's rank correlation coefficient, as presented in [13]:

$$\tau_S = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)}, \quad (2)$$

where n – is the number of pairs, d_i represents a difference in ranking of i-th pair

The final step involved a scenario-based analysis of the future development of Ukrainian startups ecosystem given two critical dimensions – availability of financial resources and security & political stability.

Results and discussion.

Ukrainian innovative performance – gap analysis

Based on the Global Innovation Index 2023, Ukraine gained the 55th rank among 132 countries under analysis (improving by 2 positions compared to the 57th rank in 2022), ranking as the 3rd most innovative economy in the group of 37 lower middle-income countries [20]. A detailed performance of Ukraine by pillar is presented in *fig.1*. Ukrainian economy demonstrated particular strengths in *human capital and research* (e.g. funding of education, tertiary enrollment), *business sophistication* (e.g. knowledge of workers, collaboration for innovations, import of high-tech services), *knowledge and technology outputs* (e.g. creation of knowledge and patents, knowledge impact, export of high-tech services), and *creative outputs* (e.g. trademarks, creative goods and services, online creativity).

Indeed, human capital is historically one of Ukraine's key competitive advantages and part of its international brand in tech industry. Ukraine is ranked 15th among 100 countries and is classified as a cutting-edge economy in terms of human capital by Coursera in 2023 [2]. By proficiency in the technology domain (includes cloud computing, programming, databases, security and software engineering, mobile and web development, etc.) Ukraine was ranked 3rd in the world in 2023 [2]. The national environment for human capital development can be characterized by a robust research and educational base (approximately, 181 universities, 133 colleges and 36 specialized IT schools and 43 IT courses), the network of international R&D centers (90 centers in total, including the R&D offices of large international tech companies) and more than 10 startup accelerators [9].

There were also certain areas for development with regards to the *effectiveness of institutions'* activities, *infrastructure and logistics* required for tech sector development, as well as and the sophistication of *credit and investment* markets. These are summarized in *fig.2.* The most critical features of the national economic and regulatory environment hampering the development of innovations include (i) effectiveness and stability of institutional and regulatory environment; (ii) investments into gross capital formation; (iii) availability of credit and funding from investors to startups.

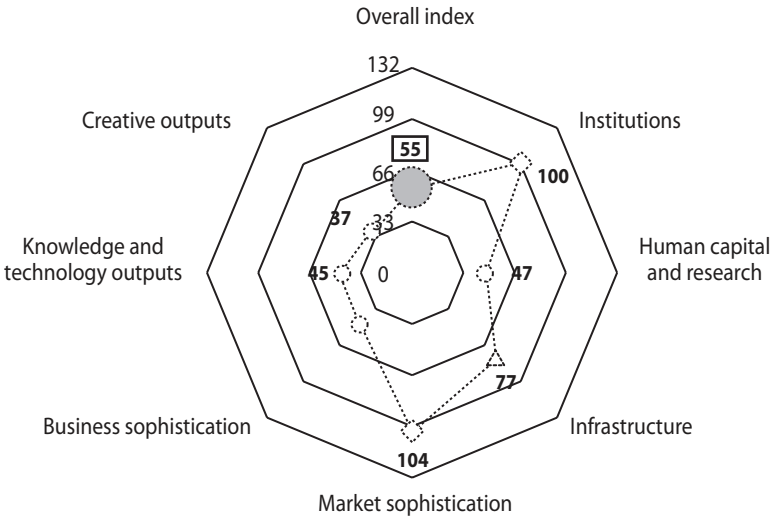

Fig. 1. Ranking of Ukrainian economy by pillar in the Global Innovation Index

Source: prepared by authors using data from [20]

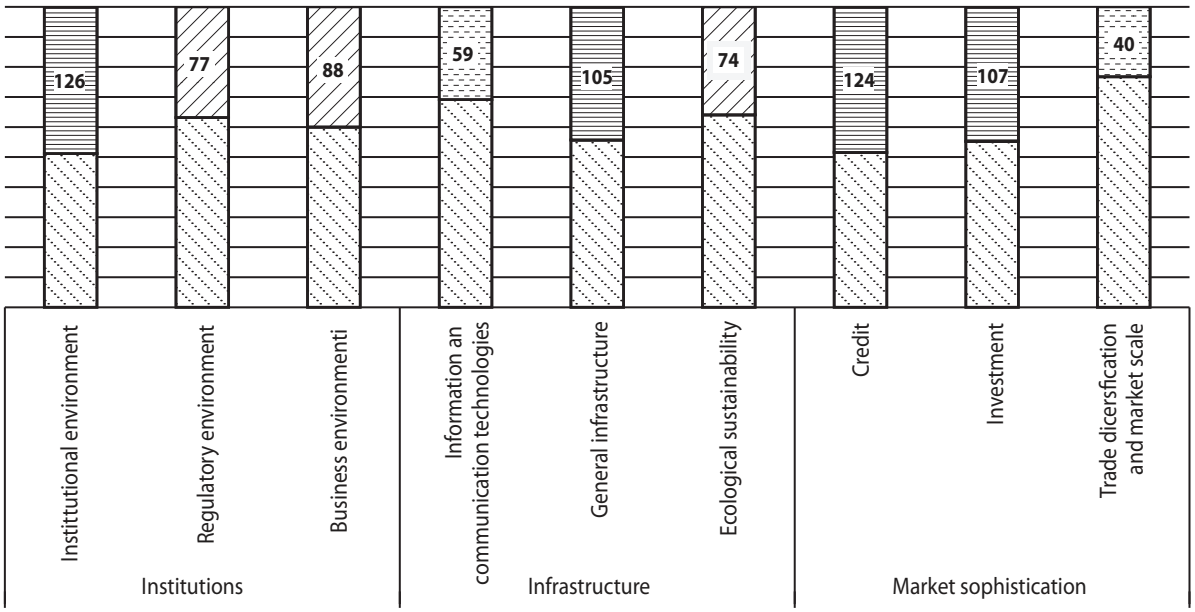

Fig. 2. Ranking of Ukrainian economy by pillar in the Global Innovation Index

Source: prepared by authors using data from [20]

It is noteworthy that the majority of pillars where the national economy has competitive advantage are mostly driven by businesses and professionals (bottom-up activities), except for *education* which is generally a product of both state financing policy and the workforce engagement. On the contrary, the weakest areas stem from institutional and regulatory ineffectiveness or credit and investment market underdevelopment (mostly top-down activities).

To some extent, suboptimal performance in state- or market-driven areas of innovative development can be attributed to the risks crystalized due to the temporary war impacts, which is generally supported by Ukraine's innovative performance in 2021 (in *institutions* and *markets sophistication* pillars Ukraine had better ranking in 2021). For example, the total volume of investments from venture capitalists, private equity and other funds decreased by 74% in 2022 ($218 million) as compared to 2021 ($832 million) based on the analysis of AVentures Capital [16].

However, even after accounting for negative war-related effects, significant gaps still remain in Ukrainian innovative environment, which hinders the development of tech companies, as described below.

Risk and key risk-mitigating initiatives

Still, there are a number of risks that had a severe impact on Ukrainian startups' standing in 2022 and which continue to pose significant challenges to their financial and operation performance. Below we summarized major risk areas that Ukrainian tech industry is facing under wartime conditions:

- *Operating*: talent relocation and/or drain that is further exacerbated by European companies actively recruiting highly-skilled IT specialists from Ukraine; temporary problems with the access to internet and electricity, issues not typically faced by other ecosystems worldwide; complicated planning and preparation of projections leading to sub-optimal resource management;
- *Financial*: in Ukraine, sales may be limited due to temporary economic contraction. Furthermore, attracting investment is more challenging due to elevated country risks, on top of the inherent risks of startups;
- *Security*: war-related physical security risks; constant psychological pressure amplified by travel, economic and other restrictions and specific daily routine that may lead to risk of depression or professional burnout.

In response to the risks listed above, the Ukrainian startup ecosystem is *increasing its global presence* in terms of customer base diversification through expansion to international markets, partial talent relocation, and entering strategic partnerships with foreign investors. Other important risk-mitigating initiatives led by European and Ukrainian institutions include but are not limited to the following:

- grants provided by international donors aiming to support the operating activities and growth of startups. For example, Google launched its Ukraine Support Fund allocating $5 million in 2022 and intending to allocate additional $10 million for 2024 and 2025. The eligible startups may receive up to $100,000 of non-dilutive funding each, mentorship, product support and up to $300,000 in cloud credits [17];
- international programs focused on integration of Ukrainian startups into EU tech ecosystem. For instance, under the European Innovation Council, the EU has funded the Seeds of Bravery project with a budget of $20 million focused on support of Ukrainian startups and their integration into European tech ecosystem. The startups may apply under different programs with the total non-refundable grant amount of up to $60,000 [12];
- national stimulating grants to support small businesses, in particular to boost the further growth of the tech sector. Currently, Erobota state project is targeted at small businesses offering them non-refundable grants and microgrants to stimulate the development of SME sector and increase employment. There is a new grant program announced, which may offer up to UAH 3.5 million for IT startups, or approximately $89,000 as of mid-April 2024 (currently, the program is in the process of development) [4];
- favorable tax regimes. Residents of Diia.City, a "unique tax and legal space for IT business" [3], are offered preferential tax rates. In addition, the investors in Ukrainian startups may receive a tax rebate, where the invested amount can be deducted from their total taxable income [3];
- state pre-seed and seed financing through Ukrainian Startup Fund (officially, "Innovation Development Fund"), which provided approximately $8.7 million of funding for more than 380 teams up to date [18]. With the current grant program of Ukrainian Startup Fund ($2.5 million in total), which is financed by Western NIS Enterprise Fund, Ukrainian early-stage startups may receive $20,000 - $50,000 of funding [18];
- institutional support led by Ministry of Digital Transformation, the Ukrainian Startup Fund and IT associations in the following forms: assistance in raising funds, institutional stimulation of the tech ecosystem growth, representation of Ukrainian tech sector at international level, knowledge-sharing and networking, linking startups with corporations requiring innovative solutions, organization of regular meetups for key ecosystem's stakeholders, etc.

Based on the implications of economic analysis, we hypothesized that such factors as affordable credit and diversified investment opportunities are crucial for innovative development, particularly if they are directed into research and development (R&D) activities. Using "patent applications per million inhabitants" as a proxy for innovations, we analyzed the relationship between R&D activities and the volume of innovations across 29 European countries, as depicted in *fig. 3.* Direct, relatively strong and statistically significant relationship between these two variables was confirmed by Kendall's Tau (tau = 0.64; p-value = $0.001^{*}\ 10^{-3}$); and Spearman's (rho = 0.82; p-value = $0.004^{*}10^{-3}$) rank correlation coefficients.

Key strategic scenarios of Ukrainian ecosystem development

Based on analysis of the environment where Ukrainian startups are operating, as well as risks hindering their further development, we identified the two major drivers, political stability and financial stability, that are instrumental in unveiling key strategic opportunities of Ukrainian tech ecosystem. Our scenario analysis is, therefore, based on these two dimensions, as depicted in *fig.4.*

Under high political stability and security, for the purposes of scenario analysis, we understand the cessation of active military actions based on favorable conditions and reliable safety guarantees for Ukraine. In addition, this would mean the mitigation of physical risks, including basic safety conditions for society and business, operating infrastructure, uninterrupted energy supply and other aspects of security and stability. Extensive financial resources are defined as significant inflow of foreign and domestic investments, availability of a wide range of state and donor-financed funding programs and grants, affordable financing instruments, development of capital markets.

Depending on the conditions of political and financial landscapes, we have constructed four possible scenarios for Ukrainian tech ecosystem development:

Crisis scenario is characterized by unstable economic conditions and ongoing security issues which lead to a lack of

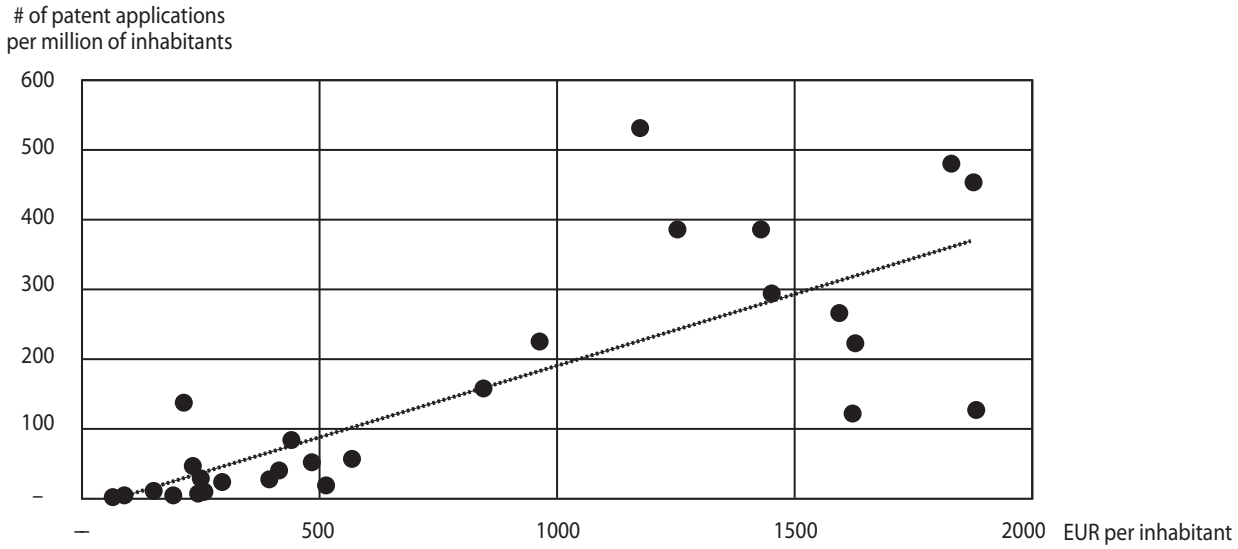

Fig. 3. Relationship between gross domestic expenditure on R&D (x-axis) and the number of patents applications (y-axis) across European countries in 2022

Source: prepared by authors using data from [6] and [7]

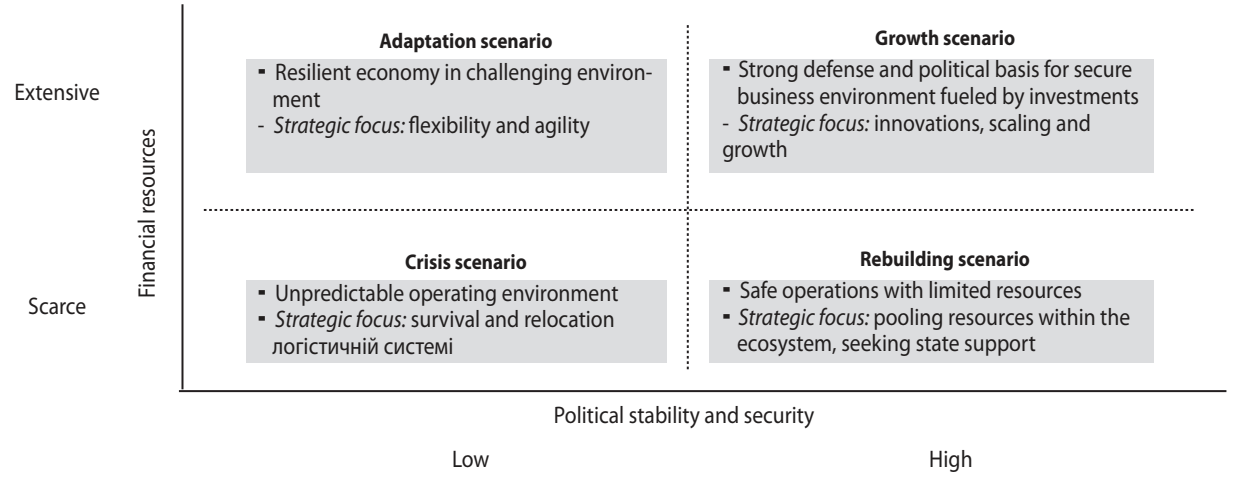

Fig. 4. Potential scenarios of Ukrainian ecosystem development

Source: prepared by authors based on their analysis

business and investment confidence. Such circumstances may significantly limit the launch of new startups while hindering the development of the existing entities. Most startups would choose a "survival strategy" by optimizing costs, partially relocating teams, and channeling most of their efforts on serving foreign markets to the extent possible.

In the *Adaptation scenario*, even though there are ongoing temporary political and security risks, the startup ecosystem manages to maintain resilience with the support of solid financial resources which may include private equity funds focusing on Ukraine, government grant programs as well as financial support from international donors. The startups will concentrate on projects that are less affected by security risks and can attract stable funding. In case of this scenario, it is crucial to establish highly agile operating models to be able to quickly respond to customer issues, continuously adapt production and distribution functions to dynamic business environment, develop business continuity plans to maintain uninterrupted business operations despite external security risks.

Rebuilding scenario would entail a stabilization of security situation in the country and reduction of geopolitical risks. The tech ecosystem will need to facilitate a rapid transformation and reconstruction of economy with limited financial resources. The startups will seek support through government grants or low-interest financing, whereas some teams will follow a bootstrapping strategy (i.e. self-financing their growth without attracting external financing). There may be some cooperation initiatives negotiated between the members of the tech ecosystem focused on pooling resources and sharing risks, contacts and experience.

Growth scenario, which implies significant improvements in geopolitical, security and financial environment, can establish a solid foundation for rapid economic growth. Diversified and significant investments into the tech sector will fa-

cilitate innovations and further development of the ecosystem through the launch of new startups, accelerators, incubators and funds. Many startups will follow expansionary strategies entering international markets, launching new products, engaging in M&A deals with the purpose of stimulating rapid growth and scaling of their businesses.

Conclusions. The Ukrainian startup ecosystem is currently facing unprecedented global shocks, including security, social and economic challenges, which amplify the inherent risks of a developing country. Despite negative tendencies, Ukrainian tech ecosystem can be characterized by relatively high level of human capital and creativity as well as active development of innovative products.

Our analysis revealed strong competitive advantages of the Ukrainian tech ecosystem in such areas as solid research and educational base, the professionalism and technical skills of the IT specialists, creativity and innovative technology outputs. We also identified key gaps that impede the development of Ukrainian startups, mostly stability of institutional and regulatory environment, access to financing and scarcity of funding from investors.

The hypothesis that investments are crucial for stimulating growth of innovations was further statistically confirmed by our analysis of correlations between R&D expenses and number of patents (adjusted for the size of population) across different European countries.

Finally, for maintaining resilience and supporting a further growth of the Ukrainian startup ecosystem, it is critically important to ensure sufficient funding and stable security environment. Presuming that availability of financial resources and political stability & security are the most critical drivers of Ukrainian startup ecosystem, as our previous economic analysis revealed, we constructed four possible scenarios and identified the key strategic priorities of the startups for staying resilient and competitive.

ЛІТЕРАТУРА

1. Cabinet of Ministers of Ukraine // Ukraine Facility Plan. 2024. URL: https://www.ukrainefacility.me.gov.ua/wp-content/uploads/2024/03/ukraine-facility-plan.pdf

2. 2023 Global Skills Report // Coursera. URL: https://www.coursera.org/skills-reports/global

3. Diia.City. URL: https://city.diia.gov.ua/

4. eRobota. URL: https://erobota.diia.gov.ua/#about

5. European Commission. Ukraine 2023 Report. Brussels : European Commission, 2023. 152 p. URL: https://neighbourhood-enlargement.ec.europa.eu/system/files/2023-11/SWD_2023_699%20Ukraine%20report.pdf

6. Eurostat. Gross domestic expenditure on R&D (GERD) at national and regional level.
DOI: 10.2908/RD_E_GERDTOT

7. Eurostat. Patent applications to the European Patent Office by applicants' / inventors' country of residence.
DOI: 10.2908/SDG_09_40

8. How start-ups can manage uncertain times: Insights from leading European venture capitalists // McKinsey & Company. URL: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/how-start-ups-can-manage-uncertain-times-insights-from-leading-european-venture-capitalists

9. Ministry of Digital Transformation of Ukraine // Ukrainian Tech Ecosystem Overview. URL: https://uatechecosystem.com/dashboard

10. Nasachenko M. Startup industry in Ukraine: a catalyst for post-war recovery and strengthening monetary transmission. *Scientific Papers NaUKMA. Economics*. 2023. Vol. 8, no. 1. P. 87–93.
DOI: 10.18523/2519-4739.2023.8.1.87-93

11. Peniaz L. The role of startups in creating innovative ecosystems. *Věda a perspektivy*. No. 1 (32).
DOI: 10.52058/2695-1592-2024-1(32)-15-25

12. Seeds of Bravery. Support of Ukrainian Deep Tech startups. URL: https://seedsofbravery.eu/

13. Spearman coefficient of rank correlation. *Encyclopedia of Mathematics*. URL: https://encyclopediaofmath.org/wiki/Spearman_coefficient_of_rank_correlation

14. Kuckertz A. et al. Startups in times of crisis – A rapid response to the COVID-19 pandemic. *Journal of Business Venturing Insights*. 2020. Vol. 13. P. e00169.
DOI: 10.1016/j.jbvi.2020.e00169

15. STAT 509: Design and Analysis of Clinical Trials. *PennState. Eberly College of Science*. URL: https://online.stat.psu.edu/stat509/

16. The DealBook of Ukraine 2023 Edition / Y. Sysoyev et al. AVentures. URL: https://www.slideshare.net/YevgenSysoyev/dealbook-of-ukraine-2023-edition

17. Ukraine Support Fund - Google for Startups. *Google for Startups*. URL: https://startup.google.com/programs/ukraine-support-fund/

18. Ukrainian Startup Fund, Techosystem, Ministry of Digital Transformation of Ukraine. «Promising UA Startups: Resilience Edition» Report. Kyiv, 2023. URL: https://uatechecosystem.com/downloads/report_ua_promising_startups.pdf

19. Vasilopoulos A., Tsitsakis C. How Start-up Ecosystem in Greece is Recovering from the Effects of the COVID-19 Pandemic. *KnE Social Sciences*. 2023.
DOI: 10.18502/kss.v8i1.12654

20 World Intellectual Property Organization. Global Innovation Index 2023: Innovation in the Face of Uncertainty : Book / ed. by S. Dutta et al. 16th ed. Geneva : World Intellectual Property Organization, 2023. 250 p.
DOI: 10.34667/tind.48220

21. World Bank. Gross capital formation (% of GDP). URL: https://data.worldbank.org/indicator/NE.GDI.TOTL.ZS

22. World Bank. Gross domestic expenditure on R&D (GERD) (% of GDP). URL: https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS

REFERENCES

"2023 Global Skills Report". Coursera. https://www.coursera.org/skills-reports/global

"Cabinet of Ministers of Ukraine". Ukraine Facility Plan. 2024. https://www.ukrainefacility.me.gov.ua/wp-content/uploads/2024/03/ukraine-facility-plan.pdf

"Diia.City". https://city.diia.gov.ua/

eRobota. https://erobota.diia.gov.ua/#about

"European Commission. Ukraine 2023 Report". Brussels : European Commission, 2023. https://neighbourhood-enlargement.ec.europa.eu/system/files/2023-11/SWD_2023_699%20Ukraine%20report.pdf

Eurostat. Gross domestic expenditure on R&D (GERD) at national and regional level.
DOI: 10.2908/RD_E_GERDTOT

Eurostat. Patent applications to the European Patent Office by applicants' / inventors' country of residence.

DOI: 10.2908/SDG_09_40

"How start-ups can manage uncertain times: Insights from leading European venture capitalists". McKinsey & Company. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/how-start-ups-can-manage-uncertain-times-insights-from-leading-european-venture-capitalists

Kuckertz, A. et al. "Startups in times of crisis - A rapid response to the COVID-19 pandemic". *Journal of Business Venturing Insights*, vol. 13 (2020): e00169.

DOI: 10.1016/j.jbvi.2020.e00169

"Ministry of Digital Transformation of Ukraine". Ukrainian Tesh Ecosystem Overview. https://uatechecosystem.com/dashboard

Nasachenko, M. "Startup industry in Ukraine: a catalyst for post-war recovery and strengthening monetary transmission". *Scientific Papers NaUKMA. Economics*, vol. 8, no. 1 (2023): 87-93.

DOI: 10.18523/2519-4739.2023.8.1.87-93

Peniaz, L. "The role of startups in creating innovative ecosystems". *Veda a perspektivy*, no. 1(32).

DOI: 10.52058/2695-1592-2024-1(32)-15-25

"Seeds of Bravery". Support of Ukrainian Deep Tech startups. https://seedsofbravery.eu/

"Spearman coefficient of rank correlation". Encyclopedia of Mathematics. https://encyclopediaofmath.org/wiki/Spearman_coefficient_of_rank_correlation

"STAT 509: Design and Analysis of Clinical Trials". PennState. Eberly College of Science. https://online.stat.psu.edu/stat509/

Sysoyev, Y. et al. "The DealBook of Ukraine 2023 Edition". AVentures. https://www.slideshare.net/YevgenSysoyev/dealbook-of-ukraine-2023-edition

"Ukraine Support Fund - Google for Startups". Google for Startups. https://startup.google.com/programs/ukraine-support-fund/

"Ukrainian Startup Fund, Techosystem". Ministry of Digital Transformation of Ukraine. «Promising UA Startups: Resilience Edition» Report. Kyiv, 2023. https://uatechecosystem.com/downloads/report_ua_promising_startups.pdf

Vasilopoulos, A., and Tsitsakis, C. "How Start-up Ecosystem in Greece is Recovering from the Effects of the COVID-19 Pandemic". *KnE Social Sciences* (2023).

DOI: 10.18502/kss.v8i1.12654

"World Bank. Gross capital formation (% of GDP)". https://data.worldbank.org/indicator/NE.GDI.TOTL.ZS

"World Bank. Gross domestic expenditure on R&D (GERD) (% of GDP)". https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS

World Intellectual Property Organization. Global Innovation Index 2023: Innovation in the Face of Uncertainty. Geneva: World Intellectual Property Organization, 2023.

DOI: 10.34667/tind.48220

Стаття надійшла до редакції 02.05.2024 р.

Статтю прийнято до публікації 18.05.2024 р.