Transformation of Investment Resources in the Development of the Startup Ecosystem in Ukraine[1]

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Abstract. *The article offers a comprehensive analysis of how Ukrainian start-ups have evolved their investment resources and mechanisms for attracting them, all within the context of significant geopolitical challenges. It examines not only the classification of funding sources but also the profound transformations in investor psychology, founder strategies, and the overall structure of the innovation ecosystem. Based on the analysis of current data, it is proven that the Ukrainian technology sector, having passed an extreme test of stress resistance, demonstrates its own model of anti-fragile adaptation. It is returning to pre-war capital attraction indicators not by restoring old ties, but by building qualitatively new ones. It is argued that the crisis has served as a catalyst for the transition from a growth-at-any-cost paradigm to strategies for sustainable, profitable, and globally integrated business. Particular attention is given to analyzing untapped potential at the intersection of national needs and global investment trends. The concept of impact investing as a strategic direction for attracting capital to projects that contribute to post-war reconstruction and the resolution of acute social problems is explored in detail. The critical need for actively integrating the large Ukrainian corporate sector into the innovation ecosystem through the creation of corporate venture funds and accelerators, which could become the most powerful source of domestic investment, is substantiated. A conceptual framework for the further evolution of public policy is proposed: a transition from direct grant support to institutional market*

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stimulation through a "fund of funds" model. The conclusions present a comprehensive vision of the future of the Ukrainian startup ecosystem as a testing ground for developing and implementing sustainability technologies.

Keywords: *startup, investment resources, venture capital, business angels, impact investing, corporate investment, startup ecosystem, mil-tech, dual-use, CVC.*

JEL Classification: *G24, G31, G32, H56, L26, L64, M13, O32, O38*

1 Introduction

In economic theory, innovation plays a key role as a driver of progress. In the 21st century, the main agents of this process have become startups – young technology companies that challenge established business models. For Ukraine, which is facing a double challenge in the context of full-scale war – protecting its sovereignty and laying the foundations for future economic modernisation – the development of its own startup ecosystem is becoming a strategic step.

The relevance of this study is determined by a unique historical moment. Despite predictions, the technology sector not only survived but also demonstrated a high capacity for adaptation. Data from Forbes Ukraine shows that by early 2024, the volume of investments attracted by Ukrainian start-ups had returned to 2021 levels (Foreign direct investment in Ukraine). However, this is backed by profound qualitative changes, including the birth of a new, more mature and sustainable ecosystem.

Analysis of recent studies and publications. To substantiate the scientific novelty and determine the role of this work in the global scientific discourse, a bibliometric analysis of available publications was conducted using the Bibliometrix software package for RStudio. This method allows visualising the structure of the scientific field, identifying key topics and research gaps.

First of all, the analysis of keyword frequency (Fig. 1) shows which topics are most frequently researched. The area of the rectangles is directly proportional to the frequency of mention of the term. As expected, the term "investments" occupies the largest block, confirming its central role. The classic concepts of "innovation", "decision making", "venture capital" and "entrepreneurship" also carry significant weight. This indicates that the scientific community is primarily focused on studying the traditional aspects of venture capital attraction, the role of innovation, and the decision-making process of investors.

A co-occurrence network (Fig. 2) provides a deeper understanding of the relationships between topics. It visualises which concepts are most often studied together, forming thematic clusters marked with different colours. The central node connecting all clusters is again an "investment". Several main areas can be clearly identified: the red cluster brings together topics related to enterprise resource management, financial markets, and performance evaluation; the blue cluster links innovation with sustainable development, economic growth, and entrepreneurship; and the green cluster focuses

Figure 1 Thematic map of keywords in startup financing studies

Source: constructed by the authors using RStudio software, Bibliometrix package

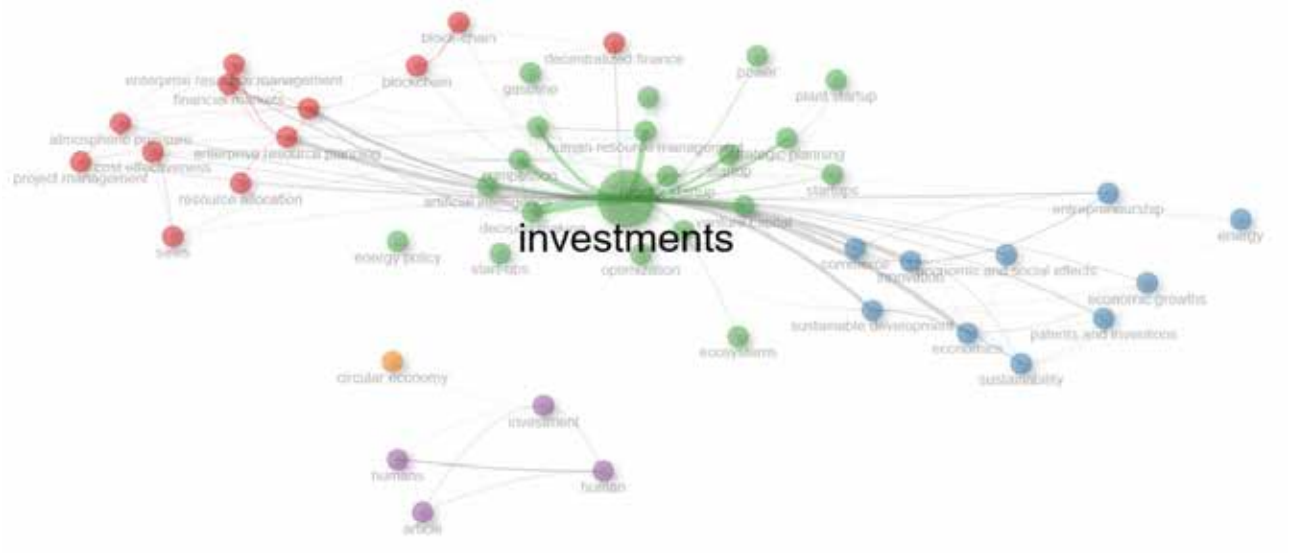

Figure 2 Co-occurrence network of keywords

Source: constructed by the authors using RStudio software and the Bibliometrix package

on strategic planning, competition, and human resource management in start-ups.

This structure shows that research is conducted within established paradigms, but specific conditions, such as crisis or war, do not form a separate, powerful cluster.

The most important conclusions for our study are provided by the strategic diagram (Fig. 3), which positions topics based on their centrality and development.

The quadrant of well-developed and important topics includes decision-making and competition. This is the core of contemporary research. Among the important but not yet fully developed concepts are investments, innovation, and venture capital. This means that despite the large number of publications, these fundamental topics still have significant potential for further study. The quadrant of emerging and disappearing topics attracts particular attention. Here we see such keywords as "Ukraine", "sustainable entrepreneurship", "corporate venture capital", and "open innovation". This is direct evidence of the scientific novelty of our work. The topic of investment in Ukrainian start-ups, along with research into non-classical models like corporate investment, is underrepresented in

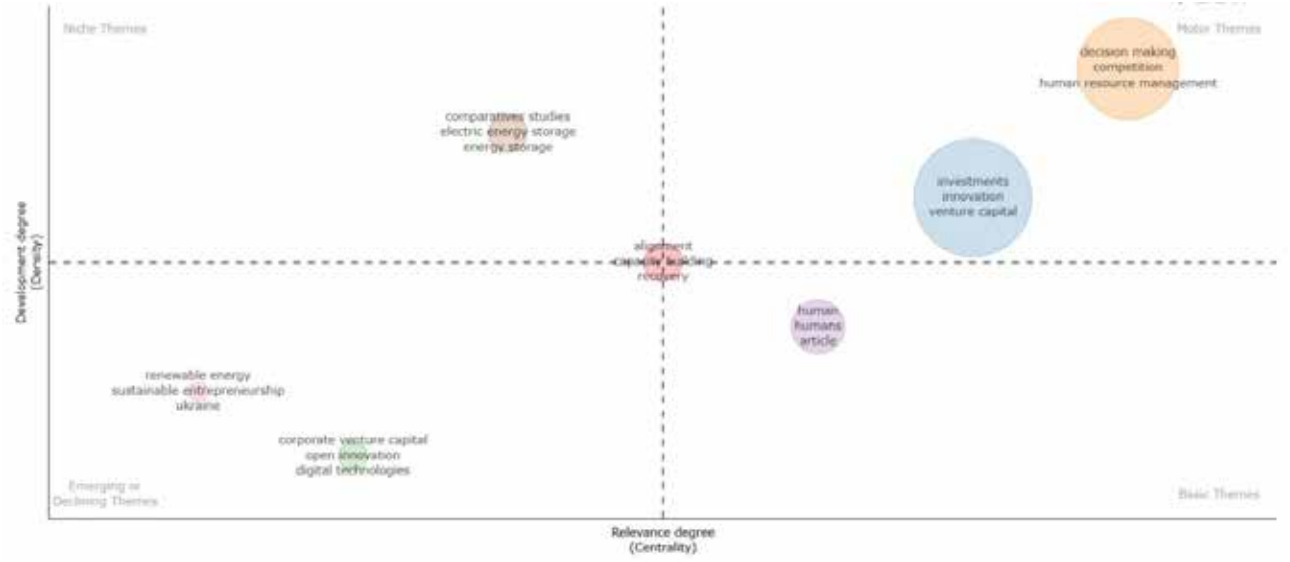

Figure 3 Strategic diagram of thematic clusters

Source: constructed by the authors using RStudio software, Bibliometrix package

global scientific discourse and is in the early stages of development.

Finally, an analysis of the geography of research (Fig. 4) shows that the scientific landscape is predominantly shaped by the United States, India, and China. Ukraine ranks fifth with 21 publications, which is a significant result but also indicates that the Ukrainian context has not yet become the subject of broad international scientific analysis.

Thus, the global scientific discourse focuses on the classical aspects of venture financing in stable economies. On the other hand, studying new paradigms, such as corporate investment, and analyzing their application in Ukraine's unique conditions is a relevant and insufficiently studied scientific problem. This article aims to fill this gap.

The goal of this work is to develop a comprehensive conceptual framework for analysing the transformation of investment resources using Ukraine as an example, and to justify a new paradigm for ecosystem development based on the synergy of global integration, internal corporate capital, and strategic government incentives.

2 Theoretical basis

The life cycle of a start-up is inextricably linked to the evolution of its funding sources. The initial stages of bootstrapping and 3F are replaced by the attraction of "smart money" from business angels (Dyba, Yurkevych, 2024). And venture funds are attracted to scaling. In Ukraine, the Ukrainian Startup Fund plays an important role in the early stages, helping projects overcome the "valley of death" (About us. Ukrainian Startup Fund). This evolution can be illustrated using a classic life cycle model (Fig. 5).

The full-scale war became an evolutionary filter that not only preserved but radically changed

Country	Freq
USA	103
INDIA	65
CHINA	64
ITALY	37
UKRAINE	21
UK	20
GERMANY	18
CANADA	14
FRANCE	14
SPAIN	11

Figure 4 Geographical distribution of scientific publications by country

Source: constructed by the authors using RStudio software, Bibliometrix package

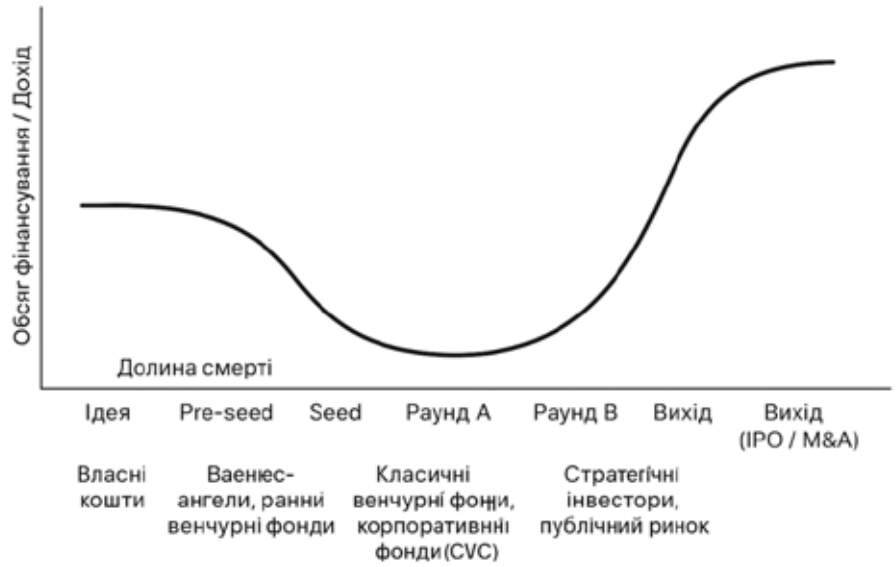

Figure 5 Stages of the startup life cycle and sources of funding

the Ukrainian startup landscape, accelerating the formation of a new, more mature, and sustainable market. This was not a linear process, but rather a qualitative leap that forced all players in the ecosystem to rethink the fundamental principles of their work. The scale of these processes is clearly illustrated by the dynamics of foreign direct investment (Foreign direct investment in Ukraine). While in 2021, the FDI balance in Ukraine was +$6,885 million, by the end of 2022, this figure had fallen by 91% to just +$623 million. This financial shock and the actual disappearance of foreign capital became a catalyst for fundamental changes, which can be analysed in several key areas. The key differences in the investment landscape before and after the full-scale invasion are systematised in Table 1.

3 Results

As can be seen from the table, there has been a change in the investor profile and expectations. Until 2022, the Ukrainian ecosystem, like the rest of the world, operated on the principle of "cheap money". Venture capital funds were engaged in an arms race, trying to invest in as many companies with large potential markets as possible. At the same time, they often neglected profitability indicators. After 24 February, this world disappeared. Capital became scarce and expensive. Volatile and speculative investors left the market, leaving only strategic players who demand not just beautiful presentations, but also a perfect business model. There has been a shift from growth at any cost to capital efficiency. Whereas previously the key question was "How fast can you grow?", today it is "How many months/years can you operate on the funds raised, and how effectively does each investment turn into income?". The due diligence process has become much more in-depth, with a focus on unit economics, paths to profitability, and testing business models for stress resistance. Investors are looking not just for "unicorns" but for "camels" – that is, startups that can survive in the desert without constant external injections of capital.

This shift has led to a reassessment of priority industries. This is not just a change in trends, but a structural restructuring of Ukraine's competitive advantages. Previously, the main advantage was access to high-quality technological talent at a relatively low cost. The war has provided a unique advantage: expertise and a testing ground for technologies in conditions of real need. The Mil-Tech sector has become the quintessence of this phenomenon. Ukrainian start-ups have gained access to a feedback cycle where, for example, a developer of software for reconnaissance drones can receive feedback from a front-line operator within hours rather than months. This allows for iterative product improvements at an increased rate, which gives a tangible competitive advantage in the global arms market (The technology sector returns to 2021 levels).

The dual-use direction is no less important. Investors understand that the defence procurement market can be unstable, so they give preference to companies whose technologies have clear applications in the civilian sector. For example, artificial intelligence algorithms for recognising camouflaged enemy equipment can be adapted for precision farming. And situational awareness systems for military headquarters are being transformed into platforms for managing the logistics of large corporations.

At the same time, a new concept began to form in the minds of international investors – a "premium for resilience", or demonstrated anti-fragility. This is not just resilience, but the ability

Table 1 Transformation of the investment landscape for Ukrainian startups

Parameter	Approach before 24 February 2022	Approach after 24 February 2022
Key investor focus	Hypergrowth, market share capture	Sustainability, operating profitability, capital efficiency
Priority sectors	SaaS, E-commerce, MarTech, GameDev	Mil-Tech, Dual-Use, cybersecurity, energy, reconstruction technologies
Geographical strategy	Focus on Ukraine and CIS markets with further expansion	"Global from day one", hybrid model (R&D in Ukraine, head office in the EU/USA)
Perception of origin	Neutral or as a risk factor	Positive, as proof of the team's «anti-fragility» and resilience
Capital value	Preference was given to financial injections	Critical growth in the role of "smart money", mentoring, access to networks
Role of the state	Support in the early stages	Strategic support for defence innovations, intensification of international assistance

to become stronger as a result of chaos. Until 2022, the Ukrainian origin of a start-up was often viewed through the prism of a geopolitical discount. After the invasion, the situation changed dramatically. A team that not only survived but also established decentralised work, ensured uninterrupted power and internet supply, organised the relocation of employees, and at the same time continued to develop the product, attract customers, and fulfil obligations, passed the world's toughest stress test. For an investor, this removes a significant part of the execution risk. The question "How did your team perform in the first months of the invasion?" has become a standard part of due diligence. And the answer to it may be worth more than perfect financial forecasts. This transforms Ukrainian origin from a risk factor into a kind of quality mark, indicating strong motivation and operational excellence.

The very nature of this resilience has evolved from passive survival to active operational resilience. This is not just a psychological trait, but a set of specific crisis protocols and management models created "in battle". Ukrainian startups are forced to instantly switch from long-term strategic planning to short and flexible sprints, where the horizon of predictability has shrunk from years to weeks. They have mastered the practice of building decentralised, autonomous teams capable of functioning under conditions of disrupted communications. New standards of infrastructure security have been established, and the availability of generators, multiple backup internet providers, and Starlink terminals in the office has transitioned from an option to a basic requirement. In addition, the war has crystallised a mission for many teams that goes beyond business. In particular, work is no longer just a way to earn money – it has become a form of resistance, a way to support the country's economy and help the Armed Forces. This common goal has shaped a corporate culture characterized by high cohesion and loyalty, which is an intangible but extremely valuable asset in the eyes of a prudent investor.

In response to the new realities, Ukrainian start-ups have massively switched to a "Global from day one" strategy. This is a clear strategy for legal and operational risk management. It has become standard practice to register a holding company in the United States, which provides access to the American legal system and venture capital. Operations and sales in the European market are often conducted through a subsidiary in Poland, the Baltic states, or Portugal, which simplifies compliance and banking services. At the same time, the most valuable asset – the development and research centre – remains in Ukraine, maintaining access to talented engineers at a competitive cost (How Ukrainian start-ups attract investment). This distributed architecture is a form of jurisdictional arbitrage: the start-up takes advantage of each jurisdiction while minimising its inherent disadvantages. This allows Ukrainian intellect to be packaged in a legal shell that is understandable and safe for international investors, sending a powerful signal about the maturity and global mindset of the founders.

Despite its achieved stability, the Ukrainian startup ecosystem still has enormous untapped potential. Unlocking it requires going beyond traditional financing models.

One of the most promising areas is impact investing. For Ukraine, this is not just a trend, but a strategic necessity. Post-war reconstruction will require innovative solutions in areas such as energy efficiency, modern prosthetics, psychological rehabilitation, educational technologies to overcome educational losses in children, and agricultural technologies for demining fields. Every startup in these sectors generates a powerful social impact. This opens the door to capital from international financial institutions such as the EBRD and the World Bank, as well as from specialised impact funds for which the mandate for reconstruction and social development is key. To attract these resources, Ukrainian startups need to learn how to professionally measure and report on their impact using globally recognized standards such as IRIS+ from the Global Impact Investing Network, turning their social mission into a compelling investment argument.

Another, even more powerful but virtually untapped reservoir of capital is Ukraine's large corporate sector. For national giants in agriculture, metallurgy, energy, and retail, investment in innovation is not charity, but a matter of long-term survival and competitiveness. Instead of trying to develop all innovations within slow corporate structures, they can use the startup ecosystem as their external R&D department. A systemic solution is to create corporate venture funds. For example, a large agricultural holding company could create a fund to invest in Ukrainian startups developing drones for crop monitoring, biotechnology for increasing yields, or platforms for optimizing grain logistics. In addition to direct financing, corporations can apply the "venture client" model by becoming the first major client for a startup, which provides the most valuable benefits: market validation and stable income.

Finally, the role of the state itself must evolve. Direct grant support from the USF is indispensable in the early stages, but it cannot and should not

replace market capital. A more effective strategy for stimulating a mature market is to introduce a "fund of funds" model, which has worked successfully in Israel and many European countries. Under this model, the state does not invest directly in start-ups through a specialised institution, but acts as an "anchor" investor in newly created private venture funds managed by independent professional teams. The state can invest, for example, 25–30% of the total fund size, provided that the remaining 70–75% is raised by the team from private investors. This mechanism has a triple effect: it multiplies state funds with private capital, transfers investment decisions to professionals, minimising corruption risks, and, most importantly, creates Ukraine's own class of professional venture managers, which is critical infrastructure for the long-term development of the ecosystem.

4 Discussion

This study complements and deepens the existing scientific discourse on investment support for start-ups, while offering a new perspective dictated by unique crisis conditions. An analysis of scientific works over the past five years shows that, prior to our study, attention was mainly focused on several key areas. First, it involved classifying funding sources and describing their mechanisms under stable market conditions. Many authors have analysed in detail the role of venture capital, business angels, crowdfunding, and government grants, creating a taxonomy of investment instruments (Karpenko, 2024; Sabara,2024; Pelykh, 2023). Secondly, considerable attention has been paid to venture financing as a key driver of innovative development, with a direct link between venture fund activity and economic growth rates proven (Metelenko, Shirinyan, Shirinyan, 2021; Kostyuk, 2023). Thirdly, researchers actively studied the elements of the national innovation infrastructure and the role of the state in its development, as well as emphasised the importance of favourable regulatory policy and institutional support (Maslak, Yatsenko, 2024; Savchuk, Petrenko, 2024; Volkov, Kravchenko, 2023).

The results obtained in these studies are fundamental and form the theoretical basis for understanding the ecosystem. They rightly point to the critical importance of investment support for the life cycle of a start-up (Tkachenko, 2024; Ivanova, 2024). However, our study correlates with these results not as a refutation, but as a dynamic addition and contextualisation. While previous works described the system mainly in a static state, our study focuses on its transformation under the influence of external shocks.

Conclusions about changes in investor profiles and the transition from a paradigm of growth at any cost to capital efficiency do not deny the central role of venture capital (Metelenko, Shirinyan, Shirinyan, 2021); instead, they show how the decision-making criteria of venture investors themselves have changed. Whereas previously the assessment of the potential market dominated, today the analysis of business model sustainability and operational excellence has come to the fore.

Our study further expands the understanding of priority industries. While previous works discussed innovation in general, we show how the geopolitical context creates unique competitive advantages for the Mil-Tech and Dual-Use sectors. This correlates with studies on the importance of public policy (Maslak, Yatsenko, 2024), but adds a new aspect. In particular, government policy in wartime does not simply create framework conditions, but acts as a direct customer and catalyst for entire technological niches that were previously on the periphery.

Finally, the outlined concept of operational resilience serves as a new framework for assessing the intangible assets of Ukrainian start-ups. Previous studies of the ecosystem (Pelykh, 2023; Volkov, Kravchenko, 2023) focused on formal elements such as the number of companies, the volume of investment, and the presence of institutions, whereas we show that in crisis conditions, informal, cultural, and managerial factors come to the fore, becoming decisive for survival and investment attractiveness. Thus, our study not only describes the state of the Ukrainian startup ecosystem but also offers a model for analyzing any innovation system in conditions of high turbulence, complementing existing theoretical models with a measure of anti-fragility.

5 Conclusions

The study proves that Ukraine's startup ecosystem has undergone a process of profound qualitative transformation as a result of full-scale war. This process can be characterised as a transition from a survival model to an anti-fragile adaptation model, where external shocks do not destroy the system but make it stronger and more competitive. The future of Ukraine's innovative economy lies in the synergistic interaction of three key forces: global integration and a focus on impact investing, the release of domestic capital through corporate involvement, and the evolution of public policy into a strategic market catalyst. The implementation of this tripartite model will enable Ukraine to transform its technological ecosystem into a powerful driver of economic modernisation and establish itself on the world stage as a source of unique sustainability technologies.

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