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RETHINKING ADAPTIVE MANAGEMENT OF BUSINESS ORGANIZATIONS THROUGH THE LENS OF ANTIFRAGILITY

ABSTRACT

The article aims to develop a theoretical foundation and propose a conceptual framework for interpreting antifragility as a novel paradigm of adaptive management in business organizations operating under conditions of socio-economic volatility and increasing global uncertainty. Contemporary business environments are characterized by heightened turbulence driven by digital transformation, the globalization of markets, geopolitical shifts, and the rapid pace of technological innovation. In such circumstances, traditional management approaches are increasingly insufficient to ensure the long-term competitiveness and sustainability of enterprises. Within this context, the concept of antifragility offers a new perspective on strategic management. Unlike conventional adaptive models that primarily focus on resilience or stability, antifragility emphasizes the capacity of organizations not only to withstand disruptions but also to benefit from uncertainty, shocks, and systemic volatility. This perspective encourages a rethinking of managerial practices by viewing instability as a potential source of growth and competitive advantage. The study identifies key theoretical foundations underlying the development of antifragile business organizations. These foundations are associated with the integration of strategic flexibility, innovation-oriented development, effective knowledge management, and the active use of digital technologies. The research demonstrates that antifragility emerges from a complex interaction of managerial, institutional, technological, and socio-economic factors that collectively determine an enterprise's ability to respond to external shocks, transform business models, and generate new sources of competitive advantage. Particular importance in this process is attributed to the development of intellectual and social capital, diversification of business processes, the adoption of advanced technologies, and the establishment of flexible organizational structures. These elements strengthen the capacity of enterprises to learn rapidly, reconfigure internal processes, and adapt strategic priorities in response to dynamic market conditions. The main results of the study include the identification of key characteristics of antifragile business organizations and the substantiation of the strategic management role in enabling firms to transform instability into opportunities for development. Antifragility manifests itself through accelerated organizational learning, innovation-driven transformation, efficient resource allocation, and the formation of adaptive business models capable of maintaining sustainable performance under complex and uncertain market conditions. Based on these findings, a conceptual approach to managing antifragility in business organizations is proposed. This approach integrates strategic planning, innovation management, knowledge-based decision-making, and the application of modern digital technologies within managerial processes. The study concludes that the incorporation of antifragility principles into management systems creates favorable conditions for improving organizational performance, strengthening innovation capacity, and shaping new models of strategic governance in an increasingly unpredictable global environment. The practical implementation of antifragile management approaches can enhance enterprise competitiveness, reinforce their ability to adapt to continuous change, and support long-term economic development in volatile market environments.

Keywords: antifragility, adaptive management, strategic management, business organizations, environmental instability, strategic adaptation, enterprise resilience, managerial decision-making

JEL Classification: L26, M10, O31, D81

INTRODUCTION

The modern economic environment is characterized by a high level of uncertainty caused by global crises, technological transformations, geopolitical conflicts, and the accelerated digitalization of the economy. Under such conditions, traditional approaches to enterprise management that focus primarily on stability and risk minimization are becoming less effective. Consequently, increasing attention is being given to new managerial concepts aimed at strengthening organizational adaptability and ensuring the effective functioning of firms under conditions of instability.

One of the concepts that has gained increasing attention in recent years is antifragility. This concept considers instability not only as a source of risks but also as a potential driver of system development. Unlike the concept of resilience, which emphasizes the ability of a system to return to its previous state after a crisis, antifragility refers to the ability of a system to improve its performance under the influence of external shocks and uncertainty. In the context of business management, this implies the development of managerial mechanisms that enable enterprises to use crisis situations as opportunities for business model transformation, innovation implementation, and strengthening competitive advantages.

In the modern economy, the formation of antifragile business organizations is closely related to the development of innovation activity, the digital transformation of enterprises, and the expansion of high-growth firms. These factors determine the ability of companies to respond quickly to changes in the market environment, implement new technologies, and generate new sources of economic growth. In particular, innovation activity contributes to the technological modernization of the economy, while the digitalization of business processes increases management efficiency and optimizes operational activities.

A special role in these processes is played by high-growth enterprises, which act as drivers of economic dynamics and structural transformation. Such firms demonstrate the capacity for rapid business scaling, active innovation implementation, and the creation of new market segments. As a result, their activities contribute to productivity growth and the formation of new models of economic development.

At the same time, recent studies indicate that the relationship between innovation, digitalization, and enterprise productivity is complex and multidimensional. The level of innovation activity in the economy affects the pace of digital technology adoption, which in turn determines opportunities for productivity growth and the development of new business models. The interaction of these factors creates the conditions for the development of antifragile business organizations capable of operating effectively in conditions of economic instability.

The relevance of this study is determined by the need to develop new approaches to the management of business organizations under conditions of a turbulent economic environment. The analysis of entrepreneurial dynamics, innovation activity, enterprise digital transformation, and productivity allows a deeper understanding of the mechanisms underlying business antifragility and makes it possible to identify the key factors of adaptive organizational development.

LITERATURE REVIEW

The theoretical foundations of the antifragility concept originate from the works of N. Taleb, who proposed analyzing systems not only in terms of their resistance to shocks but primarily through their capacity to benefit from uncertainty, volatility, and stressors. In *Antifragile: Things That Gain from Disorder*, antifragility is defined as the property of systems to improve their performance when exposed to randomness, instability, and external disturbances, which fundamentally distinguishes it from fragility, robustness, or simple resilience (Taleb, 2012).

Further development of this idea is presented in the work of Taleb and Douady (2013), where the authors propose a mathematical interpretation of antifragility and outline the logic of its identification and mapping through asymmetric system responses to positive and negative shocks. This approach provides an important methodological basis for extending the concept from a philosophical and theoretical framework to the analysis of economic and managerial systems. In a more recent study, Taleb and West (2023) emphasize convex responses of systems as the mechanism through which instability may generate growth, innovation breakthroughs, and adaptive improvement. Although their analysis includes examples from several domains beyond finance, the conclusions are particularly relevant for business management, as they demonstrate that antifragility is achieved not through the avoidance of variability but through the design of decision structures capable of transforming environmental volatility into opportunities for development.

The managerial interpretation of antifragility is largely shaped by its distinction from related concepts such as resilience, reliability, and robustness. Munoz, Billsberry, and Ambrosini (2022) emphasize that resilience, robustness, and antifragility

represent fundamentally different organizational responses to crises. Resilience refers to the ability to recover after disruption, while robustness implies resistance to change without significant transformation. In contrast, antifragility involves qualitative improvement in system performance under adverse conditions. This distinction is essential for contemporary management research, as it shifts the analytical focus from traditional crisis management toward the design of organizational mechanisms capable of using instability as a catalyst for renewal and development.

The idea of designing antifragile systems has also been explored in the study by de Bruijn, Größler, and Videira (2020), where antifragility is considered a criterion for modeling dynamic systems. The authors argue that systems should be evaluated not only in terms of equilibrium conditions or their ability to return to a previous state, but also according to their capacity to generate new adaptive configurations under changing conditions. For business organizations, this perspective implies a transition from linear planning logic toward flexible management models in which uncertainty, experimentation, decentralization, and multiple development trajectories become inherent characteristics of organizational functioning.

From the perspective of applied organizational behavior, antifragility is increasingly associated with the ability of firms to respond effectively to sudden and unexpected disruptions. Usher and Whitty (2025) propose such an approach in their study of managing abrupt disruptions in complex projects, where they develop a hierarchy of antifragile responses. Their framework is particularly valuable for business management because it demonstrates that an effective response to destructive events extends beyond mitigation strategies and includes the ability to learn from shocks, redesign process architectures, and generate new managerial advantages. In this sense, antifragility may be interpreted as a higher stage of organizational adaptation in contemporary management systems.

At the same time, the study of antifragility cannot be separated from the broader entrepreneurial context. A significant contribution in this regard is provided by the Handbook of Entrepreneurship Research (Acs & Audretsch, 2010), which conceptualizes entrepreneurship as a key mechanism of structural change, economic renewal, and the emergence of new growth trajectories. Entrepreneurial organizations, particularly those emerging under turbulent conditions, often demonstrate higher adaptability compared to large, more inert corporations. Consequently, entrepreneurship may be regarded as a natural environment for the formation of antifragile practices, as it is closely associated with experimentation, opportunity recognition under uncertainty, and flexible responses to changing market signals.

A considerable body of recent research also highlights the role of social and intellectual capital as key determinants of organizational adaptability in complex environments. Daou, Joseph, Yousif, Fathallah, and Reyes (2019), examining business activity in fragmented societies, demonstrate that intellectual capital and accumulated knowledge strengthen the ability of organizations to maintain functionality and adapt to instability. A similar conclusion is reached by Chowdhury, Prayag, Orchiston, and Spector (2019), who show that in post-disaster contexts, social capital and adaptive resilience are directly associated with the performance of tourism organizations. From the perspective of antifragility, these findings indicate that internal organizational resources—such as knowledge, trust, interaction networks, and collective learning capabilities—function not merely as buffers against shocks but as factors capable of transforming crises into impulses for recovery and further development.

At the macro- and meso-levels of entrepreneurial development, the issue of business adaptability under conditions of instability is extensively examined in the OECD report SME and Entrepreneurship Outlook 2023 (OECD, 2023). The report highlights that small and medium-sized enterprises are particularly exposed to economic shocks; however, they simultaneously function as important sources of flexibility, innovation, and rapid structural adjustment within economic systems. This dual characteristic corresponds closely with the logic of antifragility, as it reflects the coexistence of vulnerability and transformation capacity within the small business sector. In addition, the Annual Report on European SMEs 2022/2023 (European Commission, 2023) confirms that SMEs remain a core structural component of the European economy, ensuring employment generation, organizational flexibility, and entrepreneurial renewal even during periods of crisis.

Another important strand of research addresses innovation as a fundamental basis for the development of antifragile business models. According to the European Innovation Scoreboard 2023 (European Commission, 2023), the innovative capacity of European economies remains uneven; nevertheless, innovation activity is consistently associated with increased competitiveness, modernization of business processes, and enhanced responsiveness of firms to environmental changes. In this context, innovation should be considered not only as a factor of efficiency but also as an institutional condition for antifragility, since it supports the generation of new solutions, product diversification, technological upgrading, and faster adaptive responses.

Digital transformation represents another key dimension of contemporary business adaptability. Eurostat data (2024a) indicate a gradual diffusion of digital technologies across enterprises, which significantly transforms operational models,

patterns of interaction with customers, and managerial decision-making processes. In this regard, digitalization functions not merely as a tool for operational optimization but also as a mechanism that increases organizational responsiveness to environmental change, which constitutes an essential condition for antifragility. A related perspective is presented in the study by Yankovyi, Stadniichuk, Zhosan, Shaulska, Garafonova, and Biriukov (2024), where the innovative transformation of financial institutions in the context of digitalization is analyzed through its influence on the management of social conflicts. The authors demonstrate that digital transformation affects not only the internal efficiency of institutions but also broader socio-managerial dynamics, which is particularly relevant for understanding antifragility in systems characterized by a high level of external turbulence.

An additional empirical perspective for examining antifragility is provided by the literature on business demography. The methodological framework for such analyses is established in the Eurostat–OECD Manual on Business Demography Statistics (OECD & Eurostat, 2007), which defines approaches for measuring enterprise creation, closure, survival, and growth. Building on this framework, recent Eurostat statistical data on business demography (Eurostat, 2024b) allow researchers to analyze the dynamics of enterprise entry and exit as indicators of continuous renewal within economic systems. From the perspective of antifragility, these dynamics are particularly significant because they demonstrate that instability within the economic environment leads not only to the disappearance of certain business structures but also to the emergence of new organizational forms that are better adapted to evolving conditions.

This interpretation is further reinforced by Eurostat statistics on high-growth enterprises (Eurostat, 2024c). Firms characterized by rapid expansion are of particular interest for the concept of antifragility because they illustrate situations in which organizations do not simply adapt to changing conditions but achieve accelerated development. In this sense, high growth may be interpreted as one of the empirical manifestations of antifragile behavior in business systems. Complementary evidence is provided by Eurostat structural business statistics (Eurostat, 2024d), which offer indicators related to productivity, value added, employment, and structural characteristics of enterprises of different sizes. These indicators are important for understanding how organizational flexibility, innovation capacity, and transformation speed are translated into measurable economic outcomes.

The concept of antifragility acquires particular relevance in the Ukrainian context. Garafonova (2023) emphasizes that the strategic prospects of Ukrainian organizations under conditions of European integration and the digital transformation of the global economy require a reconsideration of traditional development models, strengthening strategic flexibility, and utilizing new digital opportunities. These arguments correspond closely with the logic of antifragility, as they highlight the importance of transforming instability into a driver of organizational renewal rather than merely maintaining stability. In another study, Garafonova, Yankovyi, Zhosan, Lomachynska, Ananiev, and Dvornyk (2023) analyze international experience in innovative financial strategies aimed at post-war business revitalization in Ukraine. Their findings indicate that recovery processes should not be limited to restoring pre-crisis conditions; instead, they should rely on innovative financing mechanisms, the strategic redesign of business models, and the introduction of new management approaches. Such a perspective fully corresponds to the principles of antifragile development.

Therefore, the synthesis of the reviewed studies suggests that antifragility is gradually emerging as an independent paradigm of adaptive management in business organizations. Within this framework, antifragility should not be interpreted merely as a theoretical metaphor but as a productive managerial perspective explaining how firms can transform instability into a source of development, innovation, and long-term competitive advantage.

AIMS AND OBJECTIVES

This article aims to explore antifragility as an emerging paradigm of adaptive management in business organizations by examining the interaction between innovation activity, enterprise digitalization, the expansion of high-growth firms, and productivity dynamics within economic systems.

To accomplish this objective, the study focuses on several analytical directions. First, the dynamics of enterprise entry and exit are examined as indicators of the adaptive capacity of economic systems. Second, the study investigates current trends in innovation activity and evaluates the extent of digital transformation within the business sector. Third, particular attention is given to the role of high-growth enterprises in processes of structural economic transformation. Finally, the research analyzes the relationship between innovation processes, digitalization, and enterprise productivity.

METHODS

The methodological framework of the study combines economic-statistical, comparative-analytical, and econometric approaches that allow a comprehensive investigation of the mechanisms underlying the formation of antifragility in business organizations within a contemporary economic environment. A systemic perspective is applied to examine the interdependence of the main factors shaping the adaptive development of enterprises, including innovation activity, the level of business digitalization, the diffusion of high-growth firms, and productivity dynamics.

The empirical basis of the research consists of official statistical data obtained from international analytical databases, including Eurostat, the European Commission, and the OECD. These sources provide reliable, comparable, and representative indicators describing the development of the entrepreneurial sector in the countries of the European Union. The analysis covers the period from 2016 to 2023, which makes it possible to identify long-term trends in entrepreneurial development as well as to evaluate the response of economic systems to crisis events, particularly the COVID-19 pandemic and the economic transformations associated with it.

The study employs several complementary analytical methods. First, time-series statistical analysis is used to examine the dynamics of enterprise births and closures, the level of firms' innovation activity, the digital intensity of business operations, and productivity changes across enterprises of different sizes. This analysis allows the identification of key trends in the development of the entrepreneurial sector and provides insights into its adaptive capacity under changing economic conditions.

Second, a comparative economic analysis is conducted to evaluate differences in development dynamics across economic sectors and enterprises of different sizes. In particular, the productivity performance of small and medium-sized enterprises (SMEs) is compared with that of large firms, which enables the identification of specific patterns in their adaptation to crisis conditions.

Third, econometric and statistical techniques are applied to investigate the relationships between key development factors. In particular, correlation analysis is used to examine the relationships between indicators of innovation capacity, enterprise digitalization, and labor productivity. This approach allows the assessment of the strength of statistical relationships between these variables and clarifies their role in shaping the adaptive capacity of economic systems.

To formalize the relationship between the main factors influencing enterprise development, a generalized economic model is used to describe the dependence of enterprise productivity on innovation activity, digitalization, and the share of high-growth firms:

$$\text{Productivity}_i = \beta_0 + \beta_1 \text{Innovation}_i + \beta_2 \text{Digitalization}_i + \beta_3 \text{HGF}_i + \varepsilon_i,$$

where *Productivity* represents enterprise productivity; *Innovation* denotes the level of innovation activity; *Digitalization* reflects the degree of digital transformation of business processes; *HGF* represents the share of high-growth firms; β_0 – β_3 are model parameters; and ε_i is the stochastic error term.

The application of this model makes it possible to conceptualize the formation of antifragility in business organizations as the outcome of the interaction between technological, innovative, and managerial factors that shape economic development.

The overall research design is based on a sequential examination of several key dimensions of entrepreneurial sector development: entrepreneurial dynamics (enterprise creation and closure), firms' innovation activity, the digitalization of business processes, the expansion of high-growth enterprises, and productivity dynamics.

The integration of these indicators allows a comprehensive assessment of the adaptive capacity of the entrepreneurial sector and helps identify the key mechanisms through which antifragility emerges in modern economic systems. The proposed methodological approach makes it possible not only to analyze how economic systems respond to crisis conditions but also to identify the factors that transform environmental instability into a source of economic development.

RESULTS

One of the key indicators of the adaptability of economic systems is the dynamics of enterprise creation and closure. Within the framework of the antifragility concept, these indicators reflect the capacity of the economic environment to generate new business structures even during periods of economic instability.

The analysis of Eurostat data shows that during the period from 2016 to 2019, the countries of the European Union experienced a steady increase in the number of newly established enterprises. However, the pandemic crisis of 2020 caused a significant decline in entrepreneurial activity, which was reflected in a reduction in the number of new firms and a simultaneous increase in enterprise closures.

Nevertheless, in the period 2021–2024, the economic system demonstrated a relatively rapid recovery of entrepreneurial activity. This trend indicates the ability of the economic environment to undergo structural adjustment and renewal following crisis shocks (Table 1).

Table 1. Dynamics of enterprise births and deaths in the EU (2016–2024). (Source: compiled by the author based on Eurostat, Business Demography Database)

Year	Newly Established Enterprises (thousand)	Closed Enterprises (thousand)	Establishment Rate (%)	Closure Rate (%)
2016	2 980	2 530	10,0	8,5
2017	3 050	2 590	10,1	8,6
2018	3 120	2 650	10,2	8,7
2019	3 240	2 720	10,3	8,6
2020	2 960	2 940	9,4	9,3
2021	3 310	2 690	10,7	8,7
2022	3 420	2 810	10,6	8,7
2023	3 520	2 830	10,6	8,5
2024	3 580	2 870	10,6	8,5

The data indicate that despite the sharp decline in entrepreneurial activity observed in 2020, the number of new enterprises in the European Union recovered relatively quickly. By 2023, the number of newly established firms exceeded the number of enterprise closures by approximately 690 thousand, confirming the capacity of the economic system for adaptation and structural renewal.

Innovation plays a crucial role in shaping the antifragility of business organizations, as it enables firms to adjust to changes in the market environment and to develop new sources of competitive advantage.

An analysis of data from the Community Innovation Survey indicates that the share of innovation-active enterprises in the European Union has shown a steady upward trend throughout the analyzed period (Table 2).

Table 2. Dynamics of enterprise innovation activity in the EU (2016–2024). (Source: compiled by the author based on Eurostat, Community Innovation Survey)

Year	Innovation-Active Enterprises (%)	Product Innovations (%)	Process Innovations (%)
2016	46.4	28.5	30.8
2017	47.8	29.6	32.1
2018	49.0	30.2	33.5
2019	50.3	31.4	34.1
2020	49.8	30.7	34.8
2021	51.2	32.9	36.4
2022	52.7	34.5	37.1
2023	53.1	35.2	38.0
2024	54.0	36.0	38.9

Despite the crisis conditions observed in 2020, the level of innovation activity among enterprises demonstrates a stable upward trend, indicating the ability of businesses to use periods of instability as a stimulus for technological and organizational transformation.

The digitalization of business processes represents one of the key factors enhancing the adaptive capacity of modern enterprises. The adoption of digital technologies enables firms to optimize operational processes, improve management efficiency, and develop new business models.

The dynamics of digital intensity among enterprises in the European Union indicate a gradual increase in the level of business digitalization during the analyzed period (Table 3).

Table 3. Five-year dynamics of enterprise digital intensity in the EU (2019–2024). (Source: compiled by the author based on Eurostat, ICT usage in enterprises database)

Year	Low Level of Digitalization (%)	Medium Level (%)	High Level (%)
2019	60	31	9
2020	59	32	9
2021	56	34	10
2022	54	35	11
2023	52	36	12
2024	50	37	13

The data presented in the table indicate a gradual decline in the share of enterprises with a low level of digital intensity, accompanied by a simultaneous increase in the proportion of firms demonstrating medium and high levels of digital integration.

An analysis of the structural dynamics of the economy provides an opportunity to assess how different sectors respond to crisis conditions and to identify those that demonstrate the greatest capacity for adaptation within an unstable environment. From the perspective of the antifragility concept, economic sectors may exhibit different response patterns to external shocks: while some industries experience significant contraction, others are capable not only of rapid recovery but also of accelerated growth.

The analysis of gross value-added dynamics across the main sectors of the European Union economy reveals substantial differences in the speed and scale of sectoral adaptation to crisis conditions (Table 4).

Table 4. Growth dynamics of gross value added by economic sectors in the EU (2019–2024), %. (Source: compiled by the author based on Eurostat, National Accounts, and Structural Business Statistics)

Economic Sector	2019	2020	2021	2022	2023	2024
Information and Communication Technologies (ICT)	4.8	5.2	6.9	7.1	6.3	6.0
Professional, Scientific and Technical Services	3.7	-2.5	5.8	4.6	4.2	4.0
Financial Activities	2.9	2.1	4.2	3.8	3.5	3.3
Industry	1.8	-6.2	6.3	3.1	1.9	1.6
Trade	2.5	-4.3	5.2	3.7	2.8	2.5
Construction	3.1	-5.0	4.9	2.7	1.6	1.4
Tourism and Hospitality	3.4	-15.7	8.9	7.6	5.1	4.6

As shown in Table 4, the sectors most resilient to crisis conditions were those associated with digital technologies, particularly information and communication technologies and financial services. Even during the crisis year of 2020, these industries maintained positive growth dynamics.

In contrast, the most significant decline was observed in the tourism and hospitality sector, where the contraction in 2020 exceeded 15%. However, in the following years, this sector demonstrated one of the fastest recovery rates, indicating the capacity of economic systems for structural adjustment after major economic shocks.

From the perspective of the antifragility concept, such developments may be interpreted as a differentiated response of economic systems to instability, where certain sectors not only recover from crisis conditions but also achieve accelerated growth.

An important indicator of antifragility within economic systems is the share of high-growth enterprises (HGEs). These firms are characterized by significant increases in employment or revenues and play a key role in the structural transformation of the economy.

An analysis of Eurostat statistical data shows that the share of high-growth enterprises in the European Union fluctuates over time, reflecting the sensitivity of the entrepreneurial sector to economic shocks (Table 5).

Table 5. Dynamics of the share of high-growth enterprises in the European Union (2018–2024). (Source: compiled by the author based on Eurostat, Business Demography Statistics)

Year	Share of High-Growth Enterprises among Enterprises with 10+ Employees (%)	Estimated Number of Enterprises (thousand)
2018	11.9	165
2019	10.8	158
2020	9.4	140
2021	9.8	152
2022	9.2	160
2023	10.5	180
2024	10.9	188

The dynamics of high-growth firms are not linear. After reaching 11.9% in 2018, the indicator declined to 9.43% in 2020 and subsequently increased to 10.5% in 2023. This pattern is consistent with the logic of antifragility, as it suggests that some enterprises do not merely recover after economic shocks but transition to accelerated growth trajectories.

At the same time, for methodological accuracy, it should be noted that the high-growth indicator used by Eurostat is calculated as a rolling three-year measure. Therefore, it should be interpreted as reflecting accumulated growth over a given period rather than as a single-year change.

Another important indicator of enterprise performance is the dynamics of labor productivity (Table 6). In this context, particular attention is given to comparing productivity levels between small and medium-sized enterprises and large firms.

Table 6. Dynamics of enterprise productivity by firm size in the EU (2019–2024). (Source: calculated by the author based on the European Commission Annual Report on European SMEs and Eurostat Structural Business Statistics)

Year	Value Added Growth of SMEs (%)	Employment Growth of SMEs (%)	SME Productivity (%)	Value Added Growth of Large Enterprises (%)	Employment Growth of Large Enterprises (%)	Large Enterprise Productivity (%)
2019	3.4	1.1	2.3	3.9	0.8	3.1
2020	-6.0	-2.7	-3.4	-4.8	-1.9	-2.9
2021	7.1	3.0	4.0	8.2	2.3	5.8
2022	6.7	2.4	4.2	8.1	1.8	6.2
2023	4.3	1.6	2.7	5.1	1.2	3.9
2024	3.8	1.4	2.4	4.6	1.0	3.6

Official statistics indicate that in 2022, large enterprises outperformed SMEs in terms of nominal productivity dynamics, recording growth of 6.2% compared to 4.2% for SMEs. However, after adjusting for inflation, both groups experienced a decline in real productivity, with the contraction being more pronounced among SMEs (–4.6%) than among large firms (–2.8%).

A cumulative comparison with the baseline year of 2019 shows that this gap persists. According to nominal indicators, large enterprises demonstrate higher productivity growth, while in real terms, they exhibit a smaller decline compared with SMEs. From the perspective of the antifragility concept, this finding is particularly significant: SMEs tend to reflect higher levels of adaptability and entrepreneurial flexibility, whereas large firms are often more capable of maintaining productivity during inflationary and crisis-related shocks.

To evaluate the relationships between the key factors of adaptive enterprise development, a correlation analysis was conducted examining the links between innovation capacity of economic systems, the level of enterprise digitalization, and

labor productivity. This approach makes it possible to assess the extent to which these indicators are interrelated and how they contribute to the formation of conditions for the development of antifragile business organizations.

The analysis relies on aggregated statistical indicators from the European Innovation Scoreboard, together with data on enterprise digitalization and labor productivity obtained from Eurostat databases.

Table 7. Correlation Matrix of the relationship between innovation, digitalization, and economic growth in the EU. (Source: calculated by the author based on the European Commission European Innovation Scoreboard and Eurostat Digital Economy Indicators)

Indicator	Innovation Index	Enterprise Digitalization	Labor Productivity
Innovation Index	1.00	0.81	0.84
Enterprise Digitalization	0.81	1.00	0.76
Labor Productivity	0.84	0.76	1.00

Even within this cautious analytical framework, the correlation matrix provides a strong empirical argument. Both the digitalization of business — particularly through the adoption of cloud computing — and labor productivity demonstrate a strong positive association with the overall innovation capacity of the economic system. For the purposes of this study, these findings suggest that the antifragility of business organizations is shaped not only by organizational flexibility and diversification but also by the interaction between innovation capability, the adoption of digital technologies, and productivity-related effects.

In addition, OECD assessments indicate that a higher level of cloud computing adoption is associated with approximately a 3.5% increase in productivity for the average European firm over a five-year horizon. However, it should be noted that this estimate originates from a different econometric model and therefore does not represent a correlation coefficient; for this reason, it is not included in the correlation matrix.

The synthesis of the empirical findings makes it possible to propose a conceptual model of antifragility in business organizations that reflects the interrelationship between the key determinants of adaptive enterprise development.

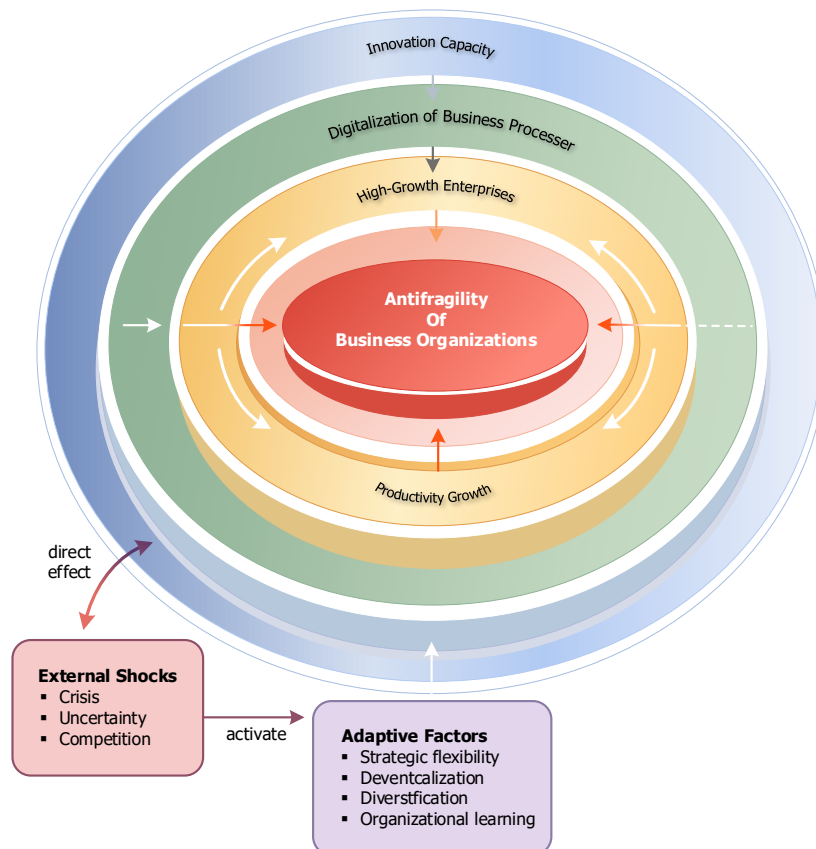


Figure 1. Empirical model of antifragility in business organizations: the relationship between innovation capacity, business process digitalization, high-growth enterprises, and productivity.

The empirical model presented in Figure 1 illustrates the mechanism through which antifragility emerges in business organizations. The model reflects a sequential relationship between innovation capacity, the digitalization of business processes, the expansion of high-growth enterprises, and productivity growth. Within this framework, innovation activity is considered the primary driver of organizational renewal, creating the conditions necessary for the digital transformation of managerial and operational processes.

Digitalization, in turn, increases the ability of enterprises to respond rapidly to changes in the market environment, facilitates business scaling, and contributes to the formation of a segment of high-growth firms. The expansion of this group of enterprises positively affects productivity dynamics, as it is associated with more efficient resource allocation, the implementation of new business models, and improved performance outcomes.

The combined influence of these factors contributes to the formation of antifragility in business organizations, understood as the capacity not only to withstand external shocks but also to transform environmental instability into a source of development and competitive advantage.

In addition, the model incorporates a set of adaptive moderating factors, including strategic flexibility, decentralized management structures, diversification, and organizational learning. These elements influence the strength of the relationships between the key variables and enhance the ability of firms to convert environmental turbulence into opportunities for growth.

DISCUSSION

The findings of this study confirm the growing relevance of the antifragility concept as an emerging managerial paradigm explaining how organizations can not only adapt to unstable environments but also derive additional advantages from uncertainty. This interpretation is consistent with the theoretical perspective proposed by Taleb (2012), who conceptualizes antifragility as the capacity of systems to improve their performance when exposed to stressors, randomness, and volatility. The empirical evidence obtained in this study suggests that organizations characterized by flexible governance structures, diversified resource bases, and the ability to rapidly reconfigure business processes demonstrate a higher capacity to respond effectively to crisis conditions.

At the same time, the results extend the approach proposed by Taleb and Douady (2013), who introduced a mathematical interpretation of antifragility based on asymmetric system responses to positive and negative environmental changes. In the context of business management, such asymmetry implies that antifragile organizations are capable of benefiting from environmental variability and uncertainty. The empirical analysis conducted in this research confirms that such asymmetric responses to external shocks may represent an important source of strategic advantage for enterprises operating in turbulent economic environments.

The results are also consistent with the arguments presented by Taleb and West (2023), who emphasize the importance of convex responses of systems to environmental changes. The findings of this study indicate that organizations adopting flexible managerial practices, innovation-oriented business models, and experimental approaches to strategy development are able not only to mitigate the negative effects of crises but also to create new opportunities for growth. This supports the view that uncertainty can function as a catalyst for innovation and strategic renewal.

Furthermore, the obtained results correspond with the conceptual framework proposed by Munoz, Billsberry, and Ambrosini (2022), who emphasize the need to distinguish between resilience, robustness, and antifragility in the analysis of organizational behavior. While resilience refers to the ability of a system to return to its previous state after a disturbance, antifragility involves the capacity of organizations to improve their structure and functioning as a result of shocks. The empirical findings of this study demonstrate that firms actively implementing innovation, diversifying their activities, and integrating digital management tools exhibit a higher potential for antifragile development compared with organizations primarily focused on maintaining stability.

An additional important factor influencing antifragility is organizational design and governance structure. In this respect, the results align with the conclusions of de Bruijn, Größler, and Videira (2020), who interpret antifragility as a key criterion in the design of dynamic systems. According to their perspective, systems should be structured in a way that enables them to generate new configurations in response to environmental changes. The analysis conducted in this study confirms that flexible organizational structures, decentralized decision-making processes, and the capacity for rapid adaptation of business processes represent critical prerequisites for the development of antifragile business organizations.

The findings also complement the research of Daou et al. (2019), who demonstrate the importance of intellectual capital in supporting organizational adaptability in unstable environments. The results obtained in this study indicate that knowledge resources, employees' innovative competencies, and effective information management significantly strengthen the ability of organizations to respond to crisis situations. These findings confirm the role of intellectual capital as a key resource underlying antifragile development.

Similar conclusions are reported by Chowdhury, Prayag, Orchiston, and Spector (2019), who show that social capital and adaptive resilience play an important role in determining organizational performance following crisis events. The results of the present study also indicate that cooperation between organizations, the development of partnership networks, and the establishment of trust-based relationships with stakeholders contribute to the ability of business structures to adapt to instability and to transform it into a source of development.

The findings further extend the approach proposed by Usher and Whitty (2025), who analyze the hierarchy of antifragile responses in complex projects. Their research suggests that effective management of sudden disruptions requires not only immediate reaction mechanisms but also the development of organizational learning processes. The results obtained in this study confirm that systematic analysis of crisis situations, accumulation of managerial experience, and the implementation of new management practices enable organizations to gradually strengthen their antifragile capacity.

From a broader economic perspective, the findings are consistent with the arguments presented in the Handbook of Entrepreneurship Research (Acs & Audretsch, 2010), which conceptualizes entrepreneurship as a key mechanism of economic adaptation and structural transformation. Entrepreneurial organizations typically demonstrate higher levels of flexibility, respond more rapidly to market changes, and are more capable of exploiting new opportunities emerging during periods of economic turbulence. This allows entrepreneurship to be interpreted as a natural environment for the development of antifragile business models.

The results are also consistent with international statistical studies of entrepreneurial development. In particular, the SME and Entrepreneurship Outlook 2023 (OECD, 2023) emphasizes the crucial role of small and medium-sized enterprises in ensuring economic flexibility and enabling rapid adaptation of economies to crisis conditions. Similar conclusions are presented in the Annual Report on European SMEs 2022/2023 (European Commission, 2023), which identifies SMEs as a central component of economic dynamism and innovation activity within the European economy.

In addition, Eurostat statistics on business demography, high-growth enterprises, and structural business indicators (Eurostat, 2024) further confirm the importance of innovation and organizational flexibility for economic development. The high rate of enterprise creation and the expansion of high-growth firms indicate continuous renewal within the economic system, which represents a characteristic feature of antifragile economic structures.

In the context of the Ukrainian economy, the results correspond with the findings of Garafonova (2023), who emphasizes that digital transformation and integration into the European economic space create new opportunities for the strategic transformation of Ukrainian organizations. Similarly, Garafonova et al. (2023) demonstrate that innovative financial strategies may serve as an important instrument for business recovery in the context of post-war economic transformation.

Moreover, the results of this study align with the approach proposed by Yankovyi et al. (2024), who analyze the influence of digital transformation of financial institutions on the management of social conflicts. Their findings indicate that digital transformation contributes to improved decision-making efficiency and supports the development of more flexible economic systems.

Overall, the findings of this research confirm and extend contemporary scientific approaches to understanding antifragility in business organizations. The results demonstrate that antifragility emerges through the interaction of innovation activity, flexible managerial practices, the development of intellectual and social capital, and the active adoption of digital technologies. In this sense, antifragility can be considered a promising conceptual framework for the development of new strategic management models capable of supporting business organizations in conditions of global instability.

CONCLUSIONS

This study examined antifragility as an emerging paradigm of adaptive management for business organizations operating in conditions of increasing economic instability. The analysis made it possible to comprehensively assess the interrelationship between innovation activity, the level of digitalization of business processes, the spread of high-growth enterprises, and the productivity dynamics of economic systems.

The findings indicate that modern economic systems are characterized by a high level of entrepreneurial dynamism reflected in the continuous restructuring of the business sector through the creation and closure of enterprises. Even during periods of economic crisis, entrepreneurial activity tends to recover, which demonstrates the capacity of the economic environment for structural adaptation. Such dynamics support the central premise of the antifragility concept, according to which instability may function not only as a source of risk but also as a mechanism of renewal and transformation within economic systems.

The study demonstrates that innovation activity represents one of the key drivers in the formation of antifragile business organizations. The increasing share of innovation-active enterprises contributes to technological modernization and strengthens the competitive capacity of firms. At the same time, the digitalization of business processes plays an equally important role by improving managerial efficiency, optimizing operational activities, and enabling the development of new business models.

The analysis also revealed that high-growth enterprises represent a critical structural component of antifragile economic development. These firms function as drivers of economic dynamics and innovation diffusion by scaling innovative solutions, generating new market segments, and stimulating accelerated economic growth.

The productivity analysis showed that large enterprises generally demonstrate higher productivity growth rates, whereas small and medium-sized enterprises exhibit greater flexibility and adaptive capacity in response to changing economic conditions. This suggests that antifragility emerges through different mechanisms across firms of different sizes: large enterprises contribute to systemic stability, while SMEs play a key role in generating innovation and facilitating structural transformation within the economy.

The correlation analysis further confirmed a strong positive relationship between innovation capacity, the digitalization of enterprises, and labor productivity. These results indicate that the combination of innovation-driven development, digital transformation, and entrepreneurial dynamism creates the structural conditions necessary for the emergence of antifragile business organizations.

Based on the synthesis of the empirical findings, the study proposes an empirical model of antifragility in business organizations that reflects the sequential relationship between innovation capacity, digital transformation of business processes, the expansion of high-growth enterprises, and productivity growth. Within this model, innovation functions as the primary development driver, digitalization accelerates adaptive processes, high-growth firms enable the scaling of innovative solutions, and productivity represents the final economic outcome of these interconnected dynamics.

Consequently, antifragility in business organizations can be interpreted as the capacity of firms not only to withstand crisis conditions but also to transform environmental instability into a source of development, innovation, and structural transformation. The development of antifragile business models therefore, requires the integration of strategic flexibility, innovation activity, digital transformation of management processes, and the strengthening of entrepreneurial ecosystems.

Future research may focus on the development of quantitative models for measuring the level of antifragility in enterprises, as well as on the analysis of sector-specific patterns of antifragile development across different industries. In particular, further investigation is needed to explore the role of antifragility in post-crisis and post-war economic recovery processes.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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The Authors declare that there is no conflict of interest.

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АНТИКРИХКІСТЬ ЯК НОВА ПАРАДИГМА АДАПТИВНОГО УПРАВЛІННЯ БІЗНЕС-ОРГАНІЗАЦІЯМИ

Метою дослідження є обґрунтування теоретичних засад і формування концептуального підходу до розуміння антикрихкості як нової парадигми адаптивного управління бізнес-організаціями в умовах соціально-економічної нестабільності та зростання глобальної невизначеності. У дослідженні встановлено, що сучасне бізнес-середовище характеризується високим рівнем турбулентності, який зумовлений процесами цифрової трансформації економіки, гло-

балізації ринків, геополітичних змін і прискоренням технологічних інновацій. За таких умов традиційні моделі управління виявляються недостатніми для забезпечення довгострокової конкурентоспроможності підприємств. Концепція антикрихкості дозволяє переосмислити підходи до стратегічного управління, оскільки передбачає здатність організацій не лише адаптуватися до кризових явищ, а й отримувати додаткові переваги в умовах нестабільності. У дослідженні визначено теоретичні передумови формування антикрихких бізнес-організацій, які ґрунтуються на поєднанні стратегічної гнучкості, інноваційної активності, ефективного управління знаннями та використання цифрових технологій. Доведено, що антикрихкість організацій формується під впливом комплексної взаємодії управлінських, інституційних, технологічних і соціально-економічних чинників, що визначають здатність підприємств реагувати на зовнішні шоки, трансформувати бізнес-моделі та формувати нові джерела конкурентних переваг. Особливу роль у цьому процесі відіграють розвиток інтелектуального та соціального капіталу, диверсифікація бізнес-процесів, використання інноваційних технологій і формування гнучких організаційних структур управління. Основними результатами дослідження є визначення ключових характеристик антикрихких бізнес-організацій та обґрунтування ролі стратегічного управління у формуванні здатності підприємств використовувати нестабільність як джерело розвитку. Встановлено, що антикрихкість проявляється через здатність організацій до швидкого навчання, інноваційної трансформації, ефективного використання ресурсів і формування адаптивних бізнес-моделей, які забезпечують стійке функціонування підприємств у складних умовах ринкового середовища. Запропоновано концептуальний підхід до управління антикрихкістю бізнес-організацій, який передбачає інтеграцію стратегічного планування, інноваційного розвитку, управління знаннями та використання сучасних цифрових технологій у процесах ухвалення управлінських рішень. Зроблено висновок, що впровадження принципів антикрихкості в систему управління бізнес-організаціями створює передумови для підвищення ефективності їхньої діяльності, розвитку інноваційного потенціалу та формування нових моделей стратегічного управління в умовах глобальної нестабільності. Реалізація антикрихких управлінських підходів сприятиме підвищенню конкурентоспроможності підприємств, посиленню їхньої здатності до адаптації та забезпеченню довгострокового економічного розвитку в умовах постійних змін ринкового середовища.

Ключові слова: антикрихкість, адаптивне управління, стратегічне управління, бізнес-організації, нестабільність середовища, стратегічна адаптація, стійкість підприємств, управлінські рішення

JEL Класифікація: L26, M10, O31, D81