

Development of a Managerial Antifragility Model in Commercial Firms and Elucidation of Its Impact on Corporate Financial Risk Management

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Abstract

On the one hand, this study serves as an operational roadmap to assist managers in making optimal decisions in high-risk business environments, and on the other hand, it provides a practical framework for policymakers to stabilize and sustain the business environment. The aim of this study is to develop an antifragility model for commercial managers and to examine its impact on corporate financial risk management. This study is applied in terms of purpose and employs a mixed-method (qualitative–quantitative) approach. In the qualitative phase, using Interpretive Structural Modeling (ISM), the dimensions and relationships among antifragility factors were identified and analyzed across three scenarios: economic, political–geographical, and market–competition. In the quantitative phase, Structural Equation Modeling (SEM) was used to test the relationships among variables and to assess the model fit. The statistical population consisted of managers and experts in the financial and commercial sectors. The results indicated that managerial antifragility is a multidimensional and network-based construct, in which factors such as flexible financial management, export market diversification, and product innovation were identified as the most important driving forces across different scenarios. Furthermore, the quantitative results showed that managerial antifragility has a positive and significant effect on corporate financial risk management and explains a substantial portion of its variance. Overall, the findings suggest that antifragility is not merely an individual trait but a strategic and systemic capability in organizational management that can reduce financial risks and create sustainable competitive advantage through financial flexibility, diversification, innovation, and dynamic decision-making.

Keywords: Antifragility, Commercial Managers, Financial Risk Management,

چکیده

این پژوهش با هدف طراحی مدل «پادشکندگی» برای مدیران بازرگانی و ارزیابی اثر آن بر مدیریت ریسک‌های مالی بنگاه‌ها در شرایط نااطمینانی و بی‌ثباتی اقتصادی تدوین شده است؛ رویکردی که هم‌زمان یک نقشه‌راه عملیاتی برای تصمیم‌گیری مدیران بنگاه‌های تجاری-صنعتی و چارچوبی کاربردی برای سیاست‌گذاران در جهت تثبیت محیط کسب‌وکار فراهم می‌سازد. روش‌شناسی این مطالعه از نوع آمیخته (کیفی-کمی) است. در فاز کیفی، با استفاده از روش مدل‌سازی ساختاری تفسیری، ابعاد و پیوندهای پادشکندگی در سه سناریوی کلیدی «اقتصادی»، «سیاسی-جغرافیایی (ژئوپلیتیک)» و «بازار رقابت» استخراج و ساختاریندی شد. سپس در فاز کمی، روابط علی میان متغیرها از طریق مدل‌سازی معادلات ساختاری با جامعه آماری مدیران و کارشناسان ارشد مالی و بازرگانی مورد آزمون و تأیید قرار گرفت. یافته‌ها نشان می‌دهد پادشکندگی مدیریتی سازه‌ای چندبعدی و شبکه‌ای است که اصلی‌ترین پیشران‌های آن در تمامی سناریوها شامل «مدیریت مالی منعطف»، «تنوع‌بخشی به بازارهای صادراتی» و «نوآوری در محصول» است. همچنین نتایج نشان داد این قابلیت اثر مستقیم، مثبت و معناداری بر ارتقای تاب‌آوری و کنترل ریسک‌های مالی بنگاه دارد. از دیدگاه اقتصاد و مدیریت صنعتی، پادشکندگی فراتر از تاب‌آوری انفعالی، قابلیت ساختاری و استراتژیک است که به بنگاه‌های اقتصادی امکان می‌دهد در مواجهه با تکانه‌های کلان ارزی، ژئوپلیتیکی و رقابتی، شوک‌ها را به فرصتی برای بازآفرینی، کاهش ریسک و خلق مزیت رقابتی پایدار تبدیل کنند.

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1. Introduction

In today's complex and high-risk markets, the psychological and behavioral characteristics of commercial managers are recognized as key determinants of firms' financial success (Rüser, 2024). Managerial antifragility defined as the capacity of managers to confront, withstand, and recover from challenging conditions and crises has emerged as a critical factor in mitigating volatility and enhancing the effectiveness of financial risk management (Axenie et al. 2023). Recent studies indicate that managers with higher levels of antifragility are better equipped to make sound decisions under conditions of uncertainty and can control and reduce corporate financial risks through more systematic and structured mechanisms (Lee & Kim, 2025). Despite the significance of this issue, the precise role of managerial antifragility in financial risk management has received limited attention in many traditional financial models and therefore warrants more indepth examination and conceptual modeling (Wang et al., 2025). The term antifragility was first introduced by Nassim Nicholas Taleb in 2012. In his book *Antifragile: Things That Gain from Disorder*, he argues that some systems benefit from crises and abrupt changes; they grow and improve when exposed to volatility, disorder, stressors, and chaos (Lyu et al., 2024). Such organizations exhibit a strong propensity to engage with risk and ambiguity. It is important to note that antifragility is a broader concept than resilience and robustness. A resilient organization merely endures external shocks and continues along its path without substantial change; by contrast, in antifragile systems, the organization not only avoids capitulation under high pressure and volatility, but also becomes stronger by patterning, learning, and adapting through crises. This principle can be extended to a wide range of phenomena that evolve over time (Rafi et al., 2016). In recent years, particularly following the 2008 financial crisis, this framework has attracted considerable attention from scholars and practitioners. Antifragility is now rapidly expanding as a strategic construct, because its implementation enables institutions not only to stabilize their current position, but also to enhance their standing and secure a larger share of today's intensely competitive international markets by overcoming crises and optimizing organizational routines (Barth & Schreft, 2025).

Within the contemporary business ecosystem, rapid transformations in economic and political arenas, together with shifting market dynamics, have generated substantial risks for commercial activities. Despite access to diverse information channels, a considerable number of firms still lack the capability to anticipate plausible scenarios and to assess their implications for organizational performance. This challenge is particularly evident in export destinations such as Iraq, the United Arab Emirates, and other neighboring countries, where exchangerate volatility, changes in customs regulations, and major political events can fundamentally alter profit margins and business survival within a short period of time (Munoz et al., 2022).

A review of the domestic research literature indicates that the concept of antifragility has largely been overlooked in the field of commerce, with most studies primarily focusing

on constructs such as resilience and risk management. Consequently, this issue represents a noteworthy research gap. Accordingly, a fundamental deficiency in this domain is the absence of a structured and practical framework for assessing the antifragility of commercial firms when confronted with diverse scenarios, one that can integrate retrospective data with expert perspectives to accurately identify potential risks and emerging opportunities. The necessity and significance of the present study can therefore be examined from two principal perspectives:

First, to provide a practical tool for managers and decisionmakers in commercial firms to anticipate economic, political, and market scenarios and to evaluate their potential effects on sales, profitability, and supply chains.

- Second, to enhance organizational antifragility by proposing strategies such as market diversification, contractual flexibility, diversified supply networks, and adaptive financial management. Understanding these aspects enables managers and traders to make strategic decisions based on realistic, scenariooriented analyses, allocate resources more efficiently, mitigate the impact of unexpected shocks, and strengthen their competitiveness in both domestic and international markets.

The necessity of this study stems from the growing complexity and volatility of contemporary business environments, where firms need a deeper understanding of how managerial behavioral characteristics shape risk management strategies and organizational responses to uncertainty. Such an understanding is essential for maintaining financial stability, improving decision-making, and enhancing organizational performance under conditions of heightened risk. This issue is particularly relevant in high-risk industries, including finance, energy, and information technology, where managerial decisions can substantially influence firms' exposure to uncertainty and their ability to manage potential disruptions. Identifying the relationship between managerial characteristics and risk management can therefore provide valuable insights for managers, investors, and policymakers seeking to develop more effective and forward-looking approaches to risk management (Sun et al., 2023). Consequently, investigating and modeling the impact of managerial antifragility on financial risk management facilitates the development of behavior-based managerial solutions and addresses extant research gaps in this domain.

Accordingly, the present study serves as an operational roadmap to assist managers in making optimal decisions within high-risk business environments while simultaneously providing a practical framework for policymakers to stabilize and sustain the business environment. To achieve this mission, the following objectives are delineated and proposed:

Identifying the fundamental components (including crises, strategic decisions, and relevant indicators).

- Determining the causal relationships among the identified components.
- Constructing the Direct Mode of Dependency Matrix (DMDM).

- Analyzing and evaluating the extent to which crises and corrective actions influence the level of antifragility.
- Formulating actionable strategies to enhance antifragility capacity in commercial firms, drawing on the results of scenario analysis within the Interpretive Structural Modeling (ISM) framework.
- Validating the antifragility scenarios in commerce and their effects on corporate financial risk management through Structural Equation Modeling (SEM).

2. Theoretical Literature

Antifragility is a concept that extends beyond resilience and was first introduced by Taleb (2012). Unlike resilience, which focuses on an organization's ability to recover and return to its precrisis state, antifragility refers to the capacity for growth, advancement, and the strategic utilization of volatility and disruptions. The theoretical foundations of organizational antifragility are grounded in the principle that firms operating in turbulent and high-risk ecosystems, such as the environment of international trade and the constraints imposed by sanctions, should not merely focus on absorbing shocks and resisting disturbances. Rather, they should transform these threats into opportunities for organizational learning, innovation creation, and sustainable development (Guo, 2025).

The core components of this framework include diversification (in resource allocation, market penetration, and network development), flexibility (in organizational structure, contractual arrangements, and strategic planning), organizational learning and innovation (leveraging trial-and-error approaches to improve performance), as well as synergy and networking (establishing supportive interactions at both intra and interorganizational levels). Relying on such a conceptual framework enables commercial firms to confront major economic and political risks and market volatility not only by ensuring their survival but also by significantly strengthening their competitive position and market advantage (Jin & Lee, 2025).

2-1. Hypothesis Development

Economic Scenarios

During periods of economic recession, the decline in aggregate demand leads to a significant reduction in cash inflows, thereby increasing liquidity risk and threatening the financial structure of firms. Under such conditions, fixed costs remain uncovered, exerting additional pressure on financial stability. Antifragile firms, however, maintain positive cash flow ($CF > 0$) through market portfolio diversification and dynamic pricing strategies. This flexibility enables them to capitalize on the exit of weaker competitors and expand their market share (Ivanov & Dolgui, 2020). Severe exchange rate volatility heightens market risk, particularly currency risk, and renders profit margins and cost

structures highly unpredictable. Organizations that employ hybrid hedging strategies and flexible currency contracts can not only protect the value of their assets but also benefit from arbitrage opportunities created by currency fluctuations by incorporating optionality into their international financing strategies (Madura, 2020). Persistent inflation implies a continuous increase in operational costs and a growing demand for working capital, which directly heightens the risk associated with declining purchasing power (Bekaert & Wang, 2010). Within an antifragile framework, the strategic conversion of excess liquidity into tangible assets, particularly critical raw materials, can serve as an effective mechanism for mitigating exposure to inflationary pressures. Furthermore, employing dynamic optimization approaches to resource allocation enables firms to adjust investment decisions in response to changing economic conditions, thereby reducing the adverse effects of inflation on asset returns and enhancing the firm's capacity to benefit from market volatility. (Cieslak & Pflueger, 2023). Accordingly, the following hypothesis is proposed:

H1: *Economic scenarios*, specifically market diversification and pricing flexibility, have a significant effect on corporate financial risk management.

Political and Geopolitical Scenarios

The imposition of sudden trade restrictions significantly elevates concentration risk and can push revenue streams to the brink of default or bankruptcy. Strategies such as geographical diversification of target markets and the design of modular value chains reduce a firm's systematic dependence on any single market and safeguard its capital structure against geopolitical shocks (Gereffi, 2020). Such crises often degrade logistical infrastructure, thereby increasing operational and credit risks and prolonging the cash conversion cycle. Employing decentralized distribution networks, regional strategic warehouses, and the ability to rapidly reroute shipments creates systemic resilience and prevents the erosion of working capital (Sodhi & Tang, 2021). Increases in tariffs or changes in freetrade regulations generate unexpected costs and compress profit margins. Establishing contractual flexibility, for instance, through tariff risk sharing clauses, and agility in switching sourcing alternatives allow firms to distribute financial risk across the supply chain and manage cost structures more effectively (Handley et al., 2020). Accordingly, the following hypothesis is proposed:

H2: *Political and geopolitical scenarios*, including exportmarket diversification and contractual flexibility, have a significant impact on corporate financial risk management.

Market and Competitive Scenarios

The entry of lowcost competitors directly threatens profitability risk and places downward pressure on return on equity. Rather than engaging in price wars, antifragile organizations create new sources of value through agile product innovation and the development of dynamic capabilities, thereby shifting toward market segments characterized by relatively inelastic demand (Teece, 2018). Such competitive shifts increase the risk of inventory

obsolescence and necessitate the recognition of asset impairment charges in financial statements. The implementation of agile methodologies, such as smallscale market testing, together with the application of real options theory, minimizes sunk costs and rapidly reallocates capital toward projects with a positive net present value ($NPV > 0$) (Trigeorgis & Reuer, 2017). Supply disruptions lead to production stoppages and can drive cash inflows to zero while financial and fixed costs remain unchanged. Strategies centered on the development of a multisourcing supplier base and the use of digital twins for realtime supply chain monitoring prevent bottlenecks and ensure the continuity of financial operations (Craighead et al., 2020). Accordingly, the following hypothesis is proposed:

H3: *Market and competitive scenarios*, including product innovation and flexible branding, have a significant effect on corporate financial risk management.

Independent Variables: Commercial Antifragility Indicators

- Economic scenarios
- Political and geopolitical scenarios
- Market and competitive scenarios

Dependent Variable: Corporate financial risk management

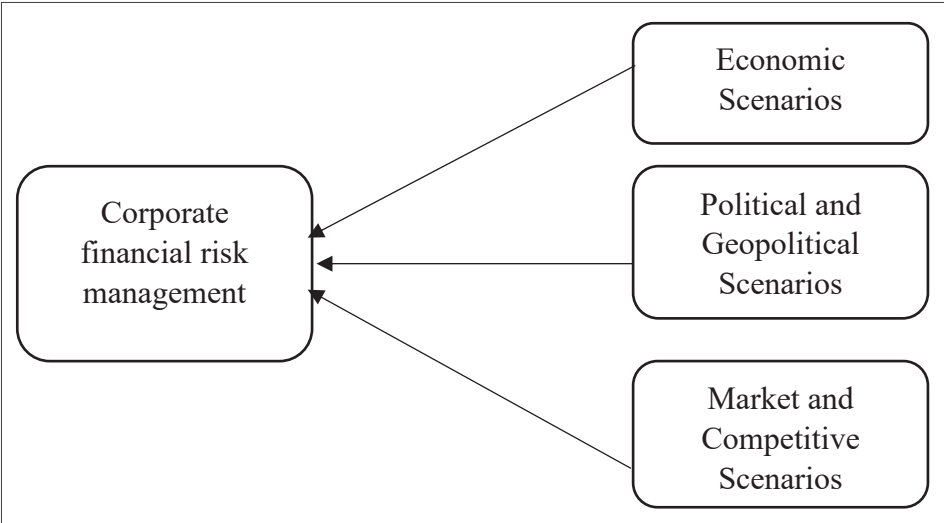


Figure 1. Conceptual Model of the Study Derived from the Qualitative Phase of the Research

2-2. Literature Review

The concept of antifragility, as a paradigm that goes beyond resilience and robustness, has in recent years attracted considerable attention among scholars in the fields of management and economics (Ivanov, 2020). Nevertheless, a review of the existing literature indicates that both domestic and international studies have predominantly focused on macrolevel notions

of antifragility within supply chains or complex systems (Khodaparast et al., 2023). Empirical works that specifically seek to explicate a “managerial antifragility model in commercial firms” and to examine its direct impact on “corporate financial risk management” are extremely limited and rare.

This paucity of research highlights a significant scholarly gap in understanding how managers can transform financial volatility and shocks into opportunities for growth. This gap further underscores the necessity and originality of the present study. Accordingly, in this section given the scarcity of fully aligned studies, we review and elaborate on those domestic and international works that are most closely related, in conceptual terms, to the variables of this research (including organizational resilience, managers’ dynamic capabilities, enterprise risk management under conditions of uncertainty, and the generic applications of antifragility in finance). This review is intended to provide the theoretical foundations required to develop the proposed research model. Some of these studies are presented below.

Khodaparast et al. (2023) examined supply chain antifragility in the textile industry by identifying and prioritizing the factors that enable supply chains to improve their performance when exposed to uncertainty, disruptions, and external stressors. Using the Best-Worst Method (BWM) and the Combined Compromise Solution (CoCoSo), the study evaluated the relative importance of antifragility-related factors and provided a structured approach for prioritizing strategic responses to supply chain disruptions. The findings highlight the importance of identifying critical stressors and developing capabilities that allow supply chains not merely to withstand disruptions, but to adapt and improve through exposure to uncertainty. This perspective supports the broader view of antifragility as a strategic capability that enables organizations to transform environmental turbulence and disruption into opportunities for adaptation and performance improvement. Corvello et al. (2024) examined antifragility in 181 innovative Italian start-ups and found that intangible resources, tangible slack resources, and absorptive capacity contribute to the development of organizational antifragility. Their findings indicate that antifragility enables start-ups not merely to survive crises but to adapt, improve their position, and achieve better performance following disruptive events. Moradi and Seyghali (2025) conducted a study titled “Examining the Role of Antifragile Business Processes in Explaining the Impact of Digital Transformation on Enterprise Risk Management.” The findings reveal that firms designing their business processes in an antifragile manner are not merely resistant to environmental disruptions but actively leverage volatility and crises as opportunities for growth and organizational learning. The novelty of this study lies in integrating three relatively distinct yet complementary domains, digital transformation, antifragility, and enterprise risk management, and proposing a conceptual framework for the intelligent resilience of organizations in the digital era. Based on the results, the authors recommend that business managers enhance organizational capabilities to address emerging risks and rapid environmental changes by prioritizing data-driven strategies and digitally redesigning core processes.

3. Research Methodology

3-1. Qualitative Phase

The present study is applied in orientation and employs a mixed methods design (qualitative–quantitative), aiming to examine the level of business antifragility in the face of various economic, political, and market scenarios. To this end, a combination of secondary data and expert insights was utilized.

In the first step, through monitoring historical documents and timeseries data (such as GDP growth rates, inflation, exchange rate volatility, and foreign trade indicators), plausible economic scenarios, such as international recession and domestic inflation, were identified. Subsequently, geopolitical and policy developments (including trade sanctions, conflicts in target export markets, and changes in customs procedures) were analyzed with reference to official sources such as the Customs Administration and the Trade Promotion Organization. Furthermore, in order to analyze competitive market scenarios, documents such as sales trends, competitors' reports, and changes in customer preferences were examined. It should be noted that the extraction and selection of indicators and subindicators were carried out using the Delphi method and the dimensions of the Interpretive Structural Modeling (ISM) questionnaire. Finally, after screening and ranking the criteria, the ISM technique and MicMac software were employed to uncover causal relationships among the variables and to analyze the scenarios. Accordingly, the operational steps for administering and analyzing the questionnaires were designed as follows:

- **Firstround questionnaire:** In the first round, experts with a minimum of 10 years of professional experience, at least 30 years of age, and holding at least a master's degree were asked to rank each of the identified economic, political and geopolitical, and market and competitive indicators.
- **Secondround questionnaire:** In the second round, all criteria and subcriteria of each main scenario selected from the first questionnaire were weighted based on the interpretive structural modeling matrix. In this stage, experts were requested to complete the matrix according to its predefined scales.

Collection and Analysis of Empirical Data and Integration with Expert Judgments

Following data collection, industry and market experts were engaged to estimate the probability of occurrence of each scenario and the magnitude of its impact on business operations. The results of structured interviews with 30 experts in the field of commerce are presented in the subsequent section. The following scenarios were considered, and the corresponding data were ultimately compiled as inputs for the scenario analysis model.

Table 1. Economic Scenarios

Scenario	Description	Potential Impact on Business	Related Antifragility Indicator
Global economic recession	Decline in external demand due to economic downturn in target markets (e.g., Iraq, the UAE)	Reduced sales and profitability	Market diversification; pricing flexibility
Exchange rate volatility	Sudden increase or decrease in the value of the U.S. dollar or the Iranian rial	Higher import costs and fluctuations in selling prices	Contract diversification; flexible financial management
High domestic inflation	Rising costs of packaging, transportation, and warehousing	Reduced profit margin	Cost optimization; flexible inventory expansion

Table 2. Political and Geopolitical Scenarios

Scenario	Description	Potential Impact	Antifragility Indicator
Export sanctions	Restriction of exports to the target country	Loss of part of the market	Diversification of export markets; flexible contracts
Unrest or war in the destination country	Disruption in logistics and the market	Delivery delays; loss of customers	Multiple transportation routes; regional warehouses
Changes in customs regulations	Increased tariffs or new regulatory requirements	Higher export costs and longer processing time	Operational and contractual flexibility

Table 3. Market and Competitive Scenarios

Scenario	Description	Potential Impact	Antifragility Indicator
Entry of a new low-price competitor	Reduction in market share and pressure on prices	Decline in sales and profit margins	Product innovation; flexible branding
Change in consumer preferences	Decreased demand for the core product	Decline in sales	Development of alternative products; smallscale market testing
Sudden disruption of a key supplier	Product shortage	Supply chain disruption	Diversified supplier network; alternative contracts

- Economic variables were calculated quantitatively based on numerical indicators such as the exchange rate, inflation, and gross domestic product (GDP).
- Political/geopolitical variables were measured dichotomously (occurrence/nonoccurrence) with reference to factors such as sanctions, political unrest, and regulatory changes.

- Market and competitive variables were also evaluated as binary events (occurrence/nonoccurrence), including entry of new competitors, changes in consumer preferences, and supply disruptions.
- The Antifragility Index was assessed through the Failure Learning Index (FLI), which measures the extent to which an organization or manager, after experiencing a shock or crisis, revises decisions and improves overall performance. The simple and practical formula is presented as follows:

$$\text{Failure-Learning Index (FLI)} = \frac{\text{Number of revised decisions}}{\text{Total of shocks}}$$

- Number of revised decisions: Refers to the actions, strategies, or decisions that were modified or improved following a failure or shock.
- Total number of crises: Refers to the number of stressful or unpredictable events that have occurred.

3-2. Quantitative Phase

In this stage, following the definition of the scenarios and the proposed model, the model was validated and its explanatory power regarding the financial performance of firms was examined. The statistical population consisted of financial managers and business owners in Tehran. Due to the large size of the population, the questionnaire was distributed using a stratified sampling method, based on the results of the prior qualitative study that had initially conceptualized antifragility within the context of commerce. The sample size was determined to be 384 respondents using the Cochran formula. Data were collected through a researcher-developed questionnaire designed to measure business antifragility, along with adapted and localized indicators for enterprise risk management, developed on the basis of the conceptual model and theoretical literature. After conducting descriptive analysis of the data, Structural Equation Modeling (SEM) using SmartPLS was employed to test the research hypotheses and evaluate the proposed model. Additionally, SPSS software was used for descriptive and complementary statistical analyses. The questionnaire utilized in this study was based on an instrument previously developed by Moradi and Seyghali (2025), whose validity and reliability had already been established in their research.

Measurement of Corporate Financial Risk Management Variable

In this study, the variable of corporate financial risk management is measured using a questionnaire based on a five-point Likert scale, designed to assess the processes of identifying, evaluating, controlling, monitoring, and responding to financial risks. This questionnaire captures the perceptions of managers and financial experts regarding the effectiveness and comprehensiveness of financial risk management in the firms under investigation. The items in this instrument are structured to cover the key dimensions of

financial risk management, including the systematic identification of financial risks, the existence of financial controls to mitigate such risks, the continuous monitoring of risk exposure, and planning for crisis situations. The validity and reliability of this questionnaire have been confirmed in previous studies, and in the present research, they will also be evaluated through factor analysis and internal consistency indicators, including Cronbach's alpha and Composite Reliability (CR) (Mikes & Kaplan, 2014).

Measurement of the Antifragility Variable

This instrument was developed based on the author's empirical study, Moradi (2025), and represents the first antifragility assessment form in the field of commerce, constructed around three major scenarios: economic, political–geographical, and market–competitive. Accordingly, the questionnaire was designed because of these three key dimensions: economic, political–geographical, and market–competitive. This instrument was first examined and analyzed in Moradi (2025), presented at the Third Conference on Engineering and Management of Organizational Processes.

Instruction:

Please indicate your level of agreement with each statement using the following scale:

- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

Note: Items marked with ® are reverse-coded and should be scored in the opposite direction during data analysis.

Administration, Scoring, and Recommended Tests:

1) Scoring

First, all items marked with ® are reversecoded.

- The mean or sum of the items within each subscale is computed as the subscale score.
- The mean or sum of the subscale scores is then computed as the overall “Commercial Antifragility” score, if required.

The interpretation of overall antifragility scores is presented in Table 4.



Table 4. Interpretation of Overall Antifragility Scores

Overall Mean (Three Dimensions)	Interpretation	Recommended Action
4.1 – 5.0	Antifragile	The organization benefits from crises and grows through them. Focus on stabilizing learning and scalability.
3.1 – 4.0	Resilient with growth potential	The organization can survive crises but derives limited benefit from volatility.
2.1 – 3.0	Semifragile	A redesign of financial and contractual systems is required. Emphasize supply diversification and innovation.
1.0 – 2.0	Fragile	The likelihood of collapse under economic and political shocks is high. A fundamental redesign of the business model is essential.

4. Findings

4-1. Demographic Information of Experts

The results indicate that the expert sample consisted of 30 individuals, of whom 24 were male and 6 were female. The average age of the participants was 45.8 years. The mean age of chief executive officers within the sample was slightly higher than the overall average, reaching 46.8 years. Regarding educational background, the highest frequency corresponded to the field of Business Management, with 15 participants. This was followed by Industrial Management, Accounting, Public Administration, and Law. In terms of educational level, the Master's degree category showed the highest representation with 21 individuals, while Doctoral degree holders ranked second. This demographic and educational composition reflects the emphasis of the organizations under study on managerial expertise and a high level of academic knowledge. Such characteristics can play an essential role in enhancing strategic decisionmaking, crisis management, and the management of commercial scenarios.

4-2. Estimation of Scenarios in the Interpretive Structural Model

Step 1: Construction of the Structural SelfInteraction Matrix (SSIM)

In this step, the experts compare the criteria pairwise and respond to the pairwise comparisons using the following symbols. For each pair of criteria, one of the letters V, A, X, O is assigned according to the definitions below:

- **V:** The factor in row *i* leads to (helps achieve) the factor in column *j*.
- **A:** The factor in column *j* leads to (helps achieve) the factor in row *i*.
- **X:** Both the row and column factors lead to each other (factors *i* and *j* have a bidirectional relationship).
- **O:** There is no relationship between the row and column factors.

Step 2: Derivation of the Initial Relationship Matrix

Following the identification of the relevant variables and the assessment of their interrelationships by the expert panel, an initial relationship matrix was constructed for each of the three analytical scenarios. In this stage, the judgments obtained from the experts were converted into numerical values representing the strength of the relationship between each pair of variables. The relationships were coded using a four-point scale, in which 0 indicates no relationship, 1 indicates a weak relationship, 2 indicates a moderate relationship, and 3 indicates a strong relationship. Accordingly, the value assigned to cell (ij) represents the assessed influence or relationship of variable (i) on variable (j). The diagonal elements were assigned a value of zero because a variable was not considered to exert a direct relationship on itself.

Based on this procedure, three initial relationship matrices were developed corresponding to the economic, political–geographical, and market and competitive scenarios. The resulting matrices preserve the direction and intensity of the relationships identified by the experts and provide the input required for the subsequent stages of the ISM/MICMAC analysis. The initial matrices for the three scenarios are presented in Tables 5–7.

Table 5. Initial Reachability Matrix for the Economic Scenario

	1: Price	2: Finance	3: Costs	4: Inventory
1: Price	0	2	3	2
2: Finance	3	0	3	2
3: Costs	3	3	0	3
4: Inventory	2	1	2	0

Table 6. Initial Reachability Matrix for the Political–Geographical Scenario

	1: Diversification	2: Contracts	3: Transportation	4: Warehousing	5: Contractual Terms
1: Diversification	0	3	3	3	3
2: Contracts	1	0	3	2	2
3: Transportation	1	1	0	2	2
4: Warehousing	3	2	2	0	1
5: Contractual Terms	1	2	2	3	0

Table 7. Initial Reachability Matrix for the Market and Competitive Scenario



	1: Innovation	2: Branding	3: Product Development	4: Market Testing	5: Contract
1: Innovation	0	3	3	3	3
2: Branding	2	0	3	3	3
3:Product Development	2	1	0	2	2
4: Market Testing	2	2	1	0	2
5: Contract	2	2	2	1	0

Step 3: Consistency Adjustment of the Reachability Matrix

In the third step, the initial reachability matrix must be refined and made consistent. This consistency is achieved by adding transitive (secondary) relationships that may not appear explicitly in the initial matrix. After these adjustments, the intensity of influence among variables can be examined. It should be noted that the numerical values in each row represent the influence exerted by that variable on others, while the values in each column reflect the dependence of that variable on others. The consistency rule is assessed as follows: If

- $i, j = 1 \quad i, j = 1 \quad i, j = 1$
- $j, k = 1 \quad j, k = 1 \quad j, k = 1$

then

- $i, k = 1 \quad i, k = 1 \quad i, k = 1$

In other words, if Criterion A influences Criterion B, and Criterion B influences Criterion C, then Criterion A must also influence Criterion C. Due to the considerable length of the finalized consistency matrices, they are not presented in the article. Instead, only the key outputs are reported.

Step 4: Determining the Levels of Variables

Following the construction of the final reachability matrix, the hierarchical levels of the identified variables were determined using the reachability set, antecedent set, and their intersection. For each iteration, the reachability and antecedent sets were identified for all remaining variables, and the intersection between the two sets was subsequently calculated. Variables for which the reachability set was identical to the intersection set were assigned to the corresponding hierarchical level and removed from the subsequent iteration. This procedure was repeated until all variables were assigned to a hierarchical level. The resulting levels provided the basis for constructing the final ISM hierarchical structure and identifying the relative position of the variables within the model. At the end of the calculations for each scenario, the final levels and the accuracy percentage of each scenario are determined. A summary of these results is presented in Table 8.

Table 8. Percentage of Variable Levels

Variable	Reachability Set	Antecedent Set	Intersection	Level
Diversification	1, 3, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 14	1, 3	III
Price Flexibility	2, 3, 5	2, 4, 5, 6, 9	2, 5	II
Contract Diversification	3, 10, 12	1, 2, 3, 4, 5, 6	3	I
Flexible Financial Management	4, 5, 6	2, 4, 5, 6	4, 5, 6	III
Cost Optimization	5, 6	2, 4, 5, 6, 9	5, 6	II
Flexible Inventory Increase	6	4, 5, 6, 7, 8	6	I
Multiple Transportation Routes	7, 8	7, 8, 9	7, 8	II
Regional Warehouses	8	7, 8	8	I
Operational Flexibility	9, 10, 12	4, 7, 9	9	III
Product Innovation	10, 11, 12	1, 3, 9, 10, 11	10, 11	II
Branding	11	1, 10, 11	11	I
Substitute Product Development	12	1, 3, 9, 10, 12	12	I
Small Market Testing	13, 10	13, 14	13	III
Diversified Supplier Network	14, 7, 8	14	14	I

Step 5: Drawing the Interaction Network

In this stage, based on the hierarchical levels of the criteria obtained from the ISM model and the relationships identified among them, the interaction network is constructed. The first level is considered the most dependent level, while the final level represents the most influential level. Accordingly, the research model can be illustrated for each scenario in terms of the influence power and dependence degree of each criterion. As an example, the influence–dependence diagram of the economic scenario, which depicts the relative influence and dependence of variables, is presented. The positioning of variables in this diagram can be interpreted as follows in the figure 2. The influence–dependence diagram of the economic scenario, which illustrates the influence power and dependence of the variables.

- Price flexibility: This variable is usually the result of financial management policies and cost optimization strategies; however, it can also influence sales and inventory levels. Therefore, it exhibits high dependence and moderate influence.
- Flexible financial management: This acts as a key enabler through mechanisms such as flexible budgeting (cost reduction) and working capital control (inventory management). This criterion has high influence power and low dependence.
- Cost optimization: This originates from financial management but also affects pricing decisions and inventory levels. Therefore, it demonstrates relatively high influence and moderate dependence.

- Flexible inventory increase: This variable is highly dependent on financial management and pricing policies. On its own, it has a limited strategic role; however, it holds operational importance within the supply chain. Thus, it has high dependence and low influence power.

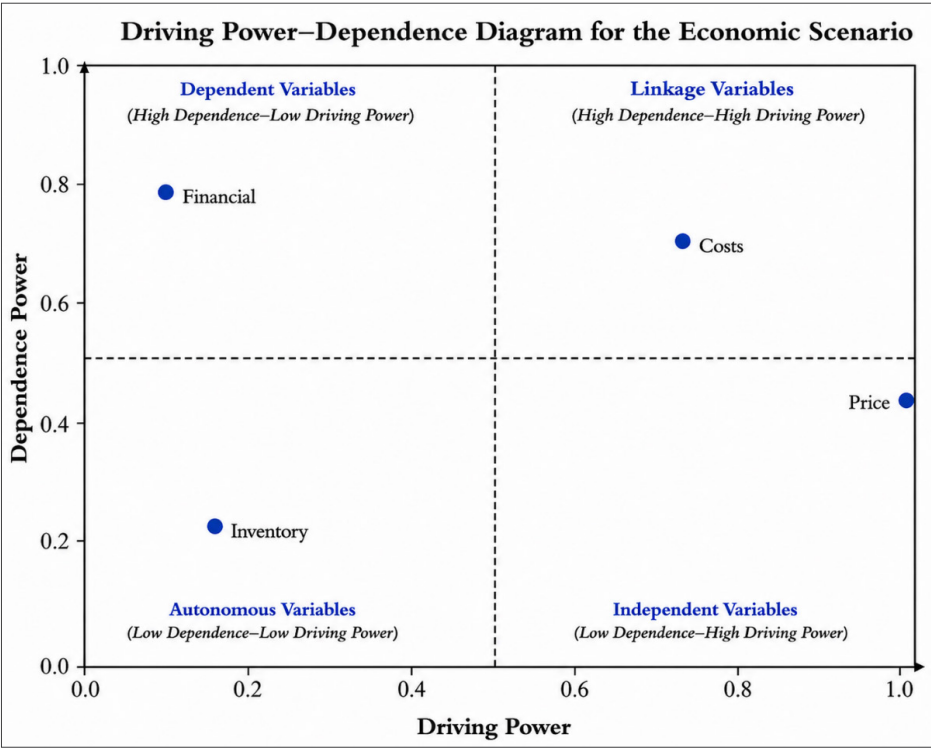


Figure 2: Dependence-Influence Diagram of the Economic Scenario

- The influence–dependence diagram of the political–geographical scenario in the figure 3, can likewise be illustrated in terms of power of influence and degree of dependence.
- Export market diversification: This requires flexible contracts, multiple transportation routes, and regional warehouses; however, it acts as the main driving factor (driver) itself.
- Flexible contracts: These provide the foundation for entering new markets and achieving operational flexibility. They exhibit high influence and moderate dependence.
- Multiple transportation routes: These serve as a supporting tool for exports and access to diversified markets. They depend on market decisions and contractual arrangements, but they affect regional warehouses and operational flexibility.

- Regional warehouses: These are highly dependent on transportation routes and contractual structures. They have relatively low influence and function mainly as a dependent factor.
- Operational and contractual flexibility: This is both an outcome of flexible contracts and a facilitator of diversified markets. It plays a linkage role.

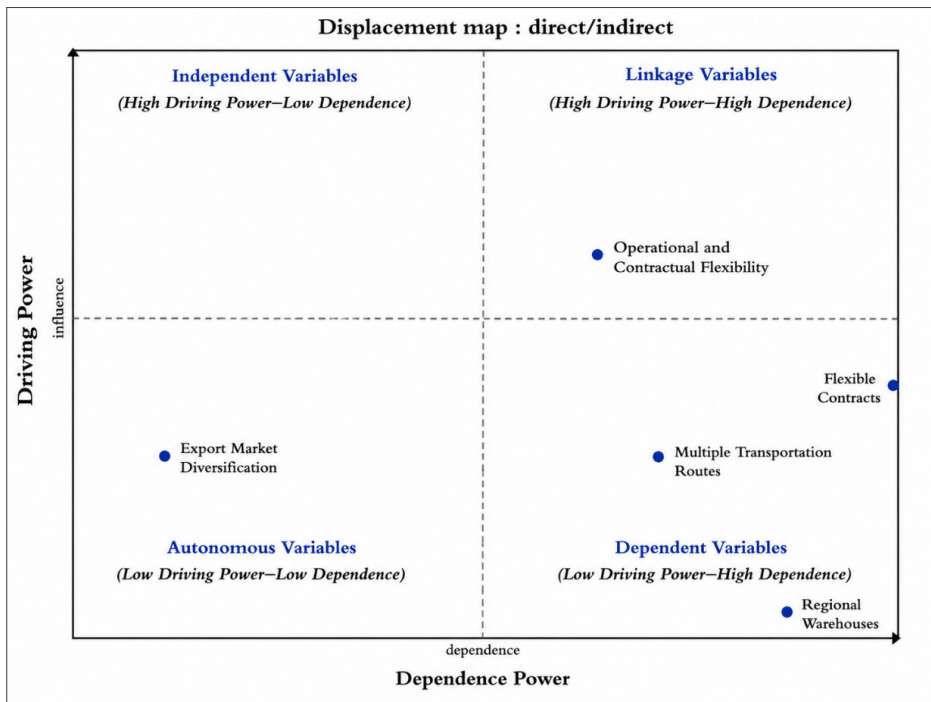


Figure 3: Dependence-Influence Diagram of the Political and Geographical Scenario

The influence–dependence diagram of the market and competition scenario in figure 4, can also be illustrated in terms of influence power and degree of dependence.

- Product innovation: This is the starting point of competition; without innovation, sustainable branding or the development of alternative products is not possible. Therefore, it acts as the main driver.
- Branding: This is the result of innovation and market testing, but it can also influence product development and alternative contractual arrangements. It therefore has moderate-to-high influence and moderate dependence.
- Development of alternative products: This is a function of innovation and market testing and, in a sense, serves as a defensive strategy in competition. Thus, it plays a linkage role.
- Small-scale market testing: This is highly dependent on product innovation and

serves as a prerequisite for branding and product development. On its own, it has low influence and functions as a dependent factor.

- Alternative contracts: These are usually the result of strong innovation and branding, enabling the firm to establish agreements with new partners. Therefore, they function as a dependent factor.

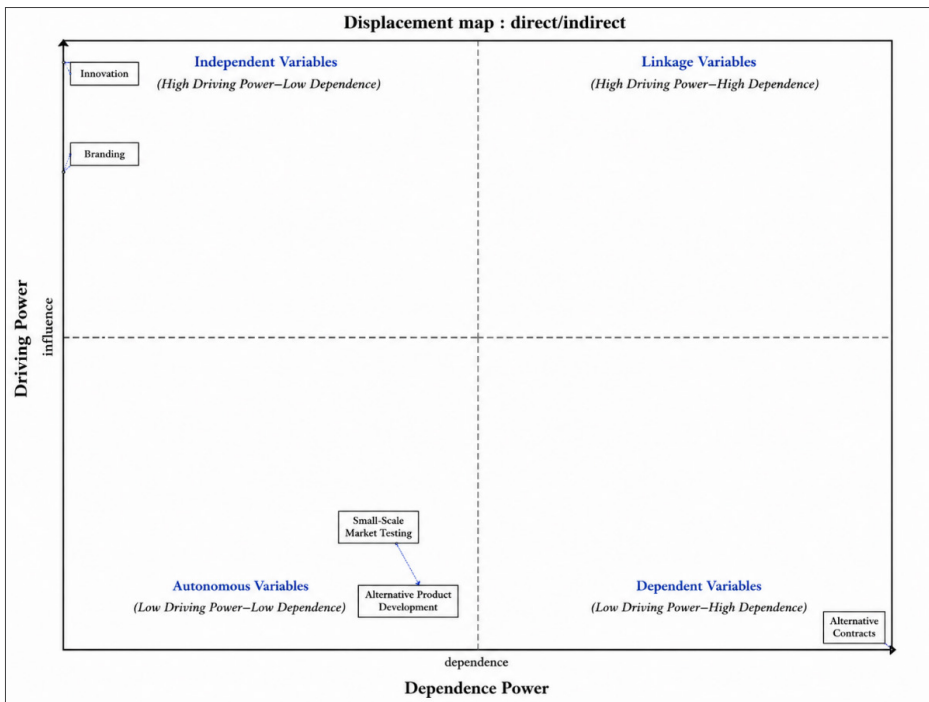


Figure 4: Dependence-Influence Diagram of Market and Competition Scenarios

4.3. Model Validation Using the Structural Equation Modeling (SEM) Approach

4-1. Demographic Information

The results indicate that the sample population consists of 384 individuals, including 227 males and 157 females. The average age distribution of the respondents is 59. The concentration of chief executive officers in the sample is slightly above the overall average, with the average age of CEOs ranging between 35 and 45 years. In terms of organizational position, the largest group of respondents holds the position of Chief Executive Officer (CEO), with a frequency of 93. This is followed by production specialists, IT managers, accountants, and sales managers. Furthermore, regarding work experience, many respondents are active in

the financial and commercial sectors, accounting for 42.4 percent of the total respondents.

42. Descriptive Statistics

The results of descriptive statistics show that the variable Corporate Financial Risk Management has the lowest mean value, indicating the relative distribution of respondents' answers across this dimension. The skewness and kurtosis values further confirm that data distribution is normal: skewness coefficients for all variables fall within the range of -3 to $+3$, and kurtosis values for all components are also within the same acceptable range (-3 to $+3$). Therefore, it can be concluded that the distribution of data for all variables is statistically normal.

Table 9. Descriptive Statistics of the Variables (Source: Researcher's findings)

		Economic Scenarios	Political and Geopolitical Scenarios	Market and Competitive Scenarios	Corporate financial risk management
N	Valid	384	384	384	384
	Missing	0	0	0	0
Mean		4.093	3.940	3.814	3.809
Median		4.083	4.00	3.800	3.900
Std. Deviation		.697	.729	.7665	.7972
Skewness		-.775	-.394	-.228	-.252
Kurtosis		1.131	.157	-.095	-.346
Minimum		1.0	1.0	1.0	1.0
Maximum		5.0	5.0	5.0	5.0

Given the exploratory nature of the proposed managerial antifragility model and the predictive orientation of the study, Partial Least Squares Structural Equation Modeling (PLSSEM) was employed. PLSSEM is particularly suitable for complex models with newly developed constructs and formative or reflective measurement structures. Furthermore, the relatively large sample size ($n = 384$) ensures sufficient statistical power for path estimation and bootstrapping procedures. The sample size of 384 respondents exceeds the minimum requirement for structural equation modeling and satisfies the 10times rule recommended for PLSSEM.

4-3. Evaluation of the Model Based on Measurement Criteria

The values presented in Table 10 indicate that the measurement instrument used in this study enjoys an acceptable level of reliability. As observed, the composite reliability coefficients for all constructs are above 0.70.



Table 10. Evaluation of the Model Based on Measurement Criteria (Source: Researcher's findings)

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Corporate financial risk management	0/915	0/929	0/568
Economic Scenarios	0/867	0/891	0/506
Market and Competitive Scenarios	0/898	0/909	0/595
Political and Geopolitical Scenarios	0/869	0/881	0/568

The results showed that the square root of the AVE values for the latent variables, located on the main diagonal of the matrix, were greater than the corresponding inter-construct correlation values. Therefore, it can be concluded that the discriminant validity of the research model is established at an acceptable level.

Table 11. Correlation Values Based on the Fornell and Larcker Criterion (Source: Researcher's findings)

	Corporate financial risk management	Economic Scenarios	Market and Competitive Scenarios	Political and Geopolitical Scenarios
Corporate financial risk management	0/754			
Economic Scenarios	0/517	0/711		
Market and Competitive Scenarios	0/746	0/679	0/771	
Political and Geopolitical Scenarios	0/718	0/636	0/751	0/753

4-4. Evaluation of the Model Based on Structural Criteria

Since the acceptance or rejection of hypotheses is determined based on the significance of path coefficients, we examined the significance values illustrated in Figures 2 and 3. The factor loadings for all variables are above 0.20, indicating acceptable levels. Conversely, if the factor loadings for any variable were below 0.20, it would suggest a weak relationship. To confirm or reject the hypotheses, the t-statistics were used, as presented below. As shown in Figure 3, the t-statistic values for all paths exceed 1.96, indicating that the hypotheses are supported and confirmed.

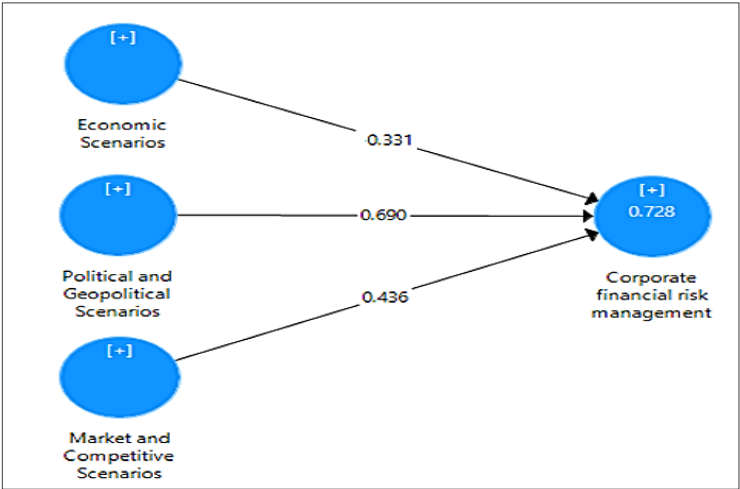


Figure 2. Factor Loadings Results of the Measurement Model in Standardized Coefficients
(Source: Researcher's findings)

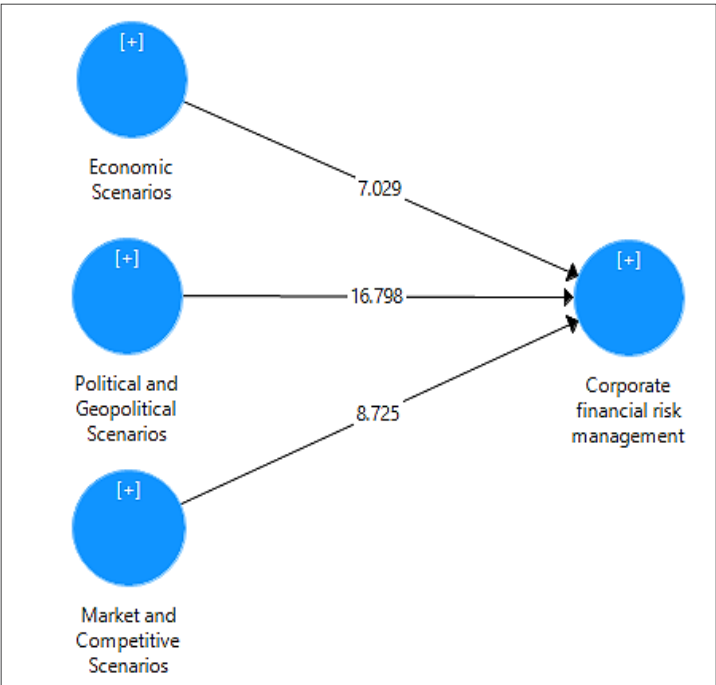


Figure 3. Factor Loadings Results of the Measurement Model in Significance Coefficients
(Source: Researcher's findings)

As shown in Table 12, the values for the exogenous variables in this study are above 0.25, indicating a strong model fit.

Table 12. Structural Model Fit Indices (Source: Researcher’s findings)

	R Square	f Square	Redundancy	Q2
Corporate financial risk management	0/726	0/728	0/819	0/407

4-5. Evaluation of the Model Based on Overall Fit Criteria

The Standardized Root Mean Square Residual (SRMR) is one of the well-known goodness-of-fit indices in structural equation modeling. Its value ranges from 0 to 1, where values less than 0.08 (and in some references less than 0.05) indicate a good model fit. The results presented in Table 13 demonstrate a strong model fit according to the SRMR criterion. These values indicate a good overall fit of the estimated model, as the SRMR values for both the saturated and estimated models are below the commonly accepted threshold of 0.08.

Table 13. SRMR Index (Source: Researcher’s findings)

Indicator	Saturated Model	Estimated Model
SRMR	0.073	0.079
d_ ULS	23.302	26.313

5. Discussion and Conclusion

The results of the qualitative section of the study indicated that antifragility in commercial management possesses a multidimensional and network-based nature, in which economic, political, geographical, market, and competitive factors interactively influence an organization’s ability to cope with risks and crises. The ISM model analysis and the dependence–driving power diagrams revealed that certain variables function as fundamental driving forces, while others are primarily influenced by managerial decisions and macro-level policies. These findings suggest that organizational antifragility is not merely limited to reacting to crises; rather, it requires the development of structural, financial, and strategic mechanisms capable of strengthening organizations under conditions of uncertainty. Within the economic scenario, “flexible financial management” was identified as the most influential driving factor. This finding demonstrates that managers’ capabilities in flexible budgeting, working capital control, and cost management constitute the foundation of other organizational antifragile capabilities. Organizations with more flexible financial structures are better able to implement dynamic pricing, inventory control, and rapid responses to market fluctuations. This finding is consistent with Taleb’s antifragility theory,

which argues that antifragile systems must possess the capacity to absorb shocks and transform environmental pressures into opportunities. Furthermore, the findings align with studies on financial resilience and organizational crisis management, which emphasize financial flexibility as a key determinant of organizational survival and growth in unstable economic environments. In the political and geographical scenario, “diversification of export markets” and “flexible contracts” demonstrated the highest driving power. These findings indicate that under conditions of sanctions, political instability, and supply chain disruptions, organizations that reduce their dependence on limited markets and routes are more likely to succeed. Market diversification and the creation of alternative transportation routes can therefore be considered antifragile strategies, as they reduce organizational vulnerability arising from geographical concentration. This finding is consistent with studies in antifragile supply chains and international trade, which highlight the importance of operational flexibility, supplier diversification, and dynamic contractual arrangements in reducing environmental risks. Moreover, the role of “operational and contractual flexibility” as a linkage factor indicates that antifragility in international trade environments requires simultaneous coordination among legal, logistical, and marketing structures. In the market and competition scenario, “product innovation” emerged as the most significant driving factor. This finding suggests that organizations operating in highly competitive markets cannot survive solely by relying on traditional products and fixed business models. Product innovation not only facilitates branding and the development of substitute products but also enables entry into new markets and the establishment of diverse contractual relationships. This finding is aligned with theories of dynamic competitive advantage and dynamic capabilities, which emphasize that successful organizations continuously reconfigure their products and business models. In addition, the findings are consistent with studies in innovation management and antifragility, which identify innovation as one of the most critical mechanisms for transforming crises into opportunities.

Across the three scenarios, the comparative analysis reveals that although the nature of the factors differs across domains, a consistent underlying pattern emerges. Strategic and flexible variables consistently act as driving forces, whereas operational and execution-oriented variables tend to be more dependent. In the economic scenario, flexible financial management played a foundational role; in the political–geographical scenario, export market diversification and flexible contracts emerged as key drivers; and in the market–competition scenario, product innovation was identified as the primary driving factor. This pattern indicates that managerial antifragility is formed when managers simultaneously develop financial, strategic, and innovative dimensions within the organization. Accordingly, antifragility is not a temporary characteristic but a systemic and dynamic capability that is strengthened through continuous learning, diversification, flexibility, and innovation. Overall, the findings suggest that companies aiming to effectively manage financial and business risks in turbulent environments should move beyond traditional and static approaches

and instead adopt antifragile management models. Such an approach can enhance organizational competitiveness, reduce vulnerability, and enable the transformation of crises into opportunities for sustainable growth and development. The model evaluation results indicated that the proposed model demonstrates satisfactory validity and goodness of fit, as all factor loadings exceeded 0.2 and t-values were above 1.96, confirming the significance of relationships and supporting the acceptance of the research hypotheses. Furthermore, the RI value of 0.726 indicates that the antifragility model of commercial managers explains approximately 72% of the variance in corporate financial risk management. The *f*² and QI values also indicate strong effect size and adequate predictive relevance of the model. Overall, the findings demonstrate that managerial antifragility plays an effective role in improving financial risk management and enhancing firms' capacity to cope with crises and environmental volatility.

5.1. Comparison with Previous Studies

The findings of the present study are broadly consistent with previous research on organizational antifragility, while extending the existing literature by placing managerial antifragility at the center of corporate financial risk management. Khodaparast et al. (2023), in their study of antifragility in textile supply chains, emphasized the importance of identifying critical stressors and developing capabilities that enable organizations to adapt and improve under conditions of uncertainty and disruption. Consistent with this perspective, the present study demonstrates that managerial antifragility can translate exposure to financial and environmental uncertainty into opportunities for adaptive action through greater financial and operational flexibility. The findings also support the results of Corvello et al. (2024), who demonstrated that tangible slack resources, intangible resources, and absorptive capacity contribute to organizational antifragility and that antifragility is positively associated with financial performance in innovative start-ups. In line with these findings, the present study highlights financial flexibility, resource reconfiguration, and adaptive managerial responses as important mechanisms through which firms can respond constructively to financial shocks rather than merely absorb their negative effects. However, while Corvello et al. (2024) primarily examined the organizational resources underlying antifragility and its relationship with performance, the present study focuses specifically on the managerial dimension of antifragility and its implications for financial risk management. The findings are also consistent with Moradi and Seyghali (2025), who emphasized the role of antifragile business processes in enabling firms to transform disruption and volatility into opportunities for organizational learning and growth. The present study extends this process-oriented perspective by demonstrating that managerial antifragility can influence financial risk management through mechanisms such as financial flexibility, operational adaptability, market diversification, dynamic contractual arrangements, product innovation, branding, and the development of substitute products. These findings suggest that antifragility is not

simply a characteristic of organizational processes or resources but can also be understood as a managerial capability that shapes how firms interpret, respond to, and strategically exploit uncertainty. Overall, the present study extends previous research in three important respects. First, it shifts the focus of antifragility research from predominantly supply-chain and organizational-level analyses toward the managerial level. Second, it establishes a direct conceptual and empirical link between managerial antifragility and corporate financial risk management, an area that remains relatively underexplored in the existing literature. Third, it demonstrates that effective financial risk management under uncertainty involves more than risk reduction or organizational recovery; it also requires the ability to reconfigure resources, diversify markets, maintain financial flexibility, and pursue innovation in response to adverse conditions. Accordingly, the findings reinforce the view of managerial antifragility as a strategic capability through which firms can not only withstand uncertainty but also learn, adapt, and create opportunities for improved performance and sustainable competitive advantage.

5.2. Practical Recommendations

Accordingly, the following recommendations are presented:

- **Institutionalizing an Antifragile Mindset among Managers and Organizational Leaders:** The findings of the study indicated that flexible financial management, innovation, and dynamic decision-making are among the most important determinants of managerial antifragility. Accordingly, organizations are advised not to rely solely on traditional managerial training programs, but to design specialized coaching programs aimed at developing an “antifragile mindset.” In this approach, managers should learn that crises are not merely threats but can serve as platforms for business model reinvention, identification of new opportunities, and correction of inefficient structures. Managerial coaching can help reduce fear-based and conservative cognitive patterns, while strengthening managers’ ability to analyze ambiguity, make decisions under uncertainty, and learn from failure. Such a mindset enables managers to avoid reactive and defensive responses during crises and instead guide organizations toward growth amid turbulence.
- **Designing Dynamic and Multi-Layered Financial Structures to Reduce Corporate Vulnerability:** The findings revealed that flexible financial management is the most influential factor in corporate financial risk management. Therefore, it is recommended that organizations move away from rigid financial structures toward agile financial models. This includes establishing intelligent liquidity reserves, diversifying revenue streams, reducing dependence on a single income source, and developing scenario-based financial planning for crisis conditions. From a coaching perspective, managers should develop “scenario thinking,” enabling them to design multiple alternative pathways for organizational continuity before crises occur.

Such structures not only reduce the risk of financial distress but also enable firms to identify and exploit investment and growth opportunities faster than competitors during turbulent periods.

- **Developing an Organizational Culture Based on Learning from Failure and Continuous Feedback:** One of the main barriers to antifragility in organizations is fear of mistakes and a blame-oriented culture. The results showed that antifragile organizations transform crises and errors into opportunities for learning and improvement. Accordingly, managers should create an environment in which employees can openly share unsuccessful experiences without fear, allowing the organization to use these insights to improve processes. In a coaching-oriented approach, failure is not the end of the path but a valuable source of data for individual and organizational development. Conducting structured crisis review sessions, documenting unsuccessful experiences, and establishing continuous feedback loops can help organizations avoid repeating mistakes and instead use them as drivers of learning and innovation.
- **Strengthening Strategic Flexibility through Market Diversification and Dynamic Contracts:** The qualitative findings indicated that export market diversification and flexible contracts play a key driving role in reducing political and geographical risks. Accordingly, firms are advised to avoid excessive dependence on a single market, supplier, or customer and instead design multiple alternative pathways for sales, procurement, and logistics. From a coaching perspective, managers should develop “non-linear thinking,” enabling them to avoid linear forecasting based solely on current conditions and prepare for unexpected scenarios. Flexible contracting, collaboration with diverse partners, and the development of alternative markets help organizations avoid operational lock-in during crises and enhance adaptability.
- **Continuous Investment in Innovation and Development of Substitute Products:** The study found that product innovation is the most important driving factor in the market and competition scenario. This indicates that antifragile organizations do not remain passive in the face of market changes; rather, they actively become agents of change by creating new products and services. Therefore, it is recommended that managers allocate a portion of organizational resources to research and development, experimentation with new ideas, and continuous assessment of evolving customer needs. In a coaching framework, managers should foster a “creative and opportunity-oriented mindset” within teams so that employees are not merely process executors but active contributors to solution generation. This approach not only enhances competitive advantage but also strengthens organizational resilience and even increases robustness against market shocks.
- **Shifting Risk Management from Crisis Control to Opportunity Creation:** Many organizations view risk management solely as a tool for minimizing losses; however, the findings of this study indicate that antifragility emerges when organizations can

extract growth opportunities from crises. Accordingly, managers are encouraged to shift risk management from a defensive and reactive approach toward a learning-oriented and opportunity-driven perspective. For instance, during economic downturns, instead of cutting investments entirely, organizations can focus on areas where competitors are weakening. In a coaching-oriented approach, managers should recognize that every crisis contains valuable information about weaknesses, opportunities, and future market directions. Such a perspective can transform organizations from vulnerable entities into antifragile and growth-oriented systems.

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