

Strategic Management of Intangible Assets: Internal Control Systems and Economic Security in Innovative Enterprises

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Abstract:

This paper investigates the nexus between internal control systems and the economic security of innovative enterprises, with a specific focus on the management of intangible assets. In the modern knowledge-driven economy, intangible assets represent the primary source of competitive advantage;

however, their volatility and difficulty of measurement pose significant risks to corporate solvency and market stability. Utilising the COSO framework as a basis for institutional governance, this research analyses how rigorous internal controls serve as a mechanism to mitigate information asymmetry and safeguard intellectual capital. The findings suggest that the effective auditing and control of intangible assets are not merely administrative functions but are essential for maintaining the "Economic Security" of the firm against internal and external shocks. By protecting the innovation value-chain, these controls enhance the firm's investment attractiveness and long-term financial resilience. The study concludes that for enterprises in transitional economies, the structural reform of internal control mechanisms is a prerequisite for achieving sustainable economic growth and institutional stability. Practical recommendations are provided for integrating economic security metrics into standard accounting and control procedures.

Keywords: intangible assets; internal control; economic security, innovative enterprises; COSO framework.

JEL Classifications: O34; D23; M42; L21; G32.

Introduction

In view of globalization, intangible assets have become a key factor in the formation of the innovative enterprises' value. At the same time, the level of internal control of these assets directly affects the economic security of companies. Insufficient control of intangible assets can lead to significant financial losses, reputational risks, and decreased competitiveness. This is especially true for innovative businesses, where the share of intangible assets in the asset structure is constantly growing. However, existing research mostly considers this problem fragmentarily, which creates a gap in the modern theory of economic security of enterprises.

High-quality internal control over intangible assets reduces information asymmetry between firms and external investors by increasing the credibility of disclosed innovation-related information. When intellectual property is effectively controlled, managers face fewer opportunities to appropriate private benefits, thereby mitigating moral hazard within the firm–investor relationship. From an applied economic perspective, robust control over intellectual property increases asset specificity by safeguarding firm-specific knowledge and limiting opportunistic behaviour by internal and external actors. Lower information asymmetry improves investment efficiency by reducing risk premiums demanded by investors and stabilizing firms' access to external financing. Consequently, internal control over intangible assets functions not only as an accounting mechanism but also as an institutional governance tool enhancing economic security and market valuation.

Earlier studies emphasize an important role of internal controls in enhancing enterprise resilience during crises. Zhu & Song (2021) demonstrate that strong internal controls have helped Chinese enterprises to adapt to the disruptions caused by COVID-19 (Li, 2020). Antonelli et al. (2023) reveals that technological change is increasingly knowledge-driven. This is consistent with the findings of Appleton et al. (2023) who reveal the need to improve financial reporting on intangible assets. The authors emphasize that transparency in accounting for intellectual capital is a key factor in the economic security of enterprises.

Biscione et al. (2024) argue that effective knowledge sharing significantly stimulates business innovation. Alghanmi (2020) state that innovation and control systems together strengthen competitive advantages for small and medium-sized enterprises (SMEs). Together, these studies confirm that sound internal controls contribute to organizational stability, which is consistent with the focus of this article on the economic security of innovative enterprises.

The relevance of the issue is determined by the need for a comprehensive approach to assessing the relationships between index of internal control over intangible assets (IICIA) and the economic security index (ESI) of innovative enterprises. The problem is the lack of a universal econometric model that would allow us to quantitatively assess these dependencies. In this regard, the academic task arises to create such a model and test it in practice. The problematic issue of this study is formulated as follows: how does the level of IICIA affect the ESI of innovative enterprises in the current conditions.

The aim of the study is to develop and test an econometric model of the relationship between IICIA and the ESI of innovative enterprises. The objectives of the study include: making a sample of innovative companies; collecting and analysing data for 2020–2024; building a model; testing hypotheses; interpreting the results. The following hypotheses were put forward in the study:

- A high level of IICIA has a positive effect on the ESI of the enterprise;
- Effective management of intangible assets ensures resilience in times of crisis;
- Research and development (R&D) investment increase ESI, provided effective control of assets.

The novelty of the research is the creation of a quantitative econometric model for assessing the impact of IICIA on the ESI of innovative enterprises. The practical significance of the study is the possibility of using the results obtained to improve the internal control management system and increase the economic security of companies. The structure of the article is logical and includes the following sections: literature review and theoretical justification; research methodology; modelling results; conclusions and recommendations.

1. Literature Review

The issue of the impact of internal control on the economic security and innovative development of enterprises is actively studied in recent academic literature. Chan et al. (2021) found both linear and nonlinear effects of internal control components according to the Committee of Sponsoring Organizations of the Treadway Commission (COSO) Framework on corporate innovation. This demonstrates a close relationship between the control system and the innovative activities of enterprises. Additionally, Datta et al. (2020) showed that the increasing role of intangible assets increases the complexity of the audit and affects the cost of control procedures. This confirms the importance of high-quality internal control to minimize financial risks associated with accounting for intangible assets. In general, recent literature confirms that effective internal control contributes not only to innovation, but also to increasing the economic security of enterprises.

At the same time, Chen et al. (2020) showed that effective internal controls contribute to better risk management and optimization of cash reserves of enterprises, which indirectly increases their economic security. Similarly, Lai et al. (2020) found that the quality of internal controls is positively correlated with investment efficiency, reducing irrational costs, and contributing to business sustainability.

Internal control over intangible assets enhances total factor productivity by ensuring that innovation inputs are efficiently transformed into sustainable economic outputs. Well-structured control systems reduce losses from misappropriation, duplication, and underutilization of knowledge-based resources, thereby improving firm-level productivity performance. When intangible assets are poorly managed, innovation loses its protective institutional framework, weakening the firm's competitive advantage in knowledge-intensive

markets. This erosion of protected innovation increases vulnerability to imitation, accelerates market share loss, and undermines the economic security of the enterprise. Therefore, internal control of intangible assets operates as a productivity-enhancing governance mechanism that links innovation protection with long-term economic stability.

Particular emphasis on the interaction of internal controls and sustainable development is given by Luo et al. (2024), who showed that non-financial (environmental, social and governance, ESG) indicators combined with controls increase corporate sustainability. These results have something in common with the findings of Boulhaga et al. (2023), who demonstrated that high-quality internal controls enhance the impact of ESG ratings on the financial performance of enterprises.

In turn, Udeh (2020) noted the high practical effectiveness of the COSO 2013 Framework in ensuring transparency and increasing corporate responsibility. Zhang & Dong (2023) complement these results, emphasizing that internal control plays an important role in increasing the productivity of enterprises in the course of digital transformation. Vu & Nga (2022) reveal an interesting aspect of the impact of internal control on the profitability of SMEs. The authors showed that the introduction of effective controls for Vietnamese private SMEs leads to increased profitability. This is partly consistent with the findings of Dimitropoulos (2020), who established a positive impact of R&D investment on the profitability of enterprises in times of crisis, especially if there are adequate control procedures and Su et al. (2022) for sustainability. Within an institutional economics framework, internal control systems based on the COSO framework function as governance institutions that structure incentives and constrain opportunistic behaviour. By formalizing rules, monitoring mechanisms, and accountability structures, COSO-based controls reduce uncertainty and promote economic stability at the firm level. Thus, internal control should be interpreted not as a procedural checklist but as an institutional arrangement supporting sustainable market participation.

So, the literature demonstrates a clear connection between internal control, innovative activity, financial stability and overall economic security of enterprises. The authors approach the assessment of the role of control differently: some emphasize the connection with innovativeness (Chan et al., 2021), others, with risk management and stability (Chen et al., 2020; Lai et al., 2020; Luo et al., 2024). At the same time, the results of most studies confirm that high-quality internal control creates the basis for the sustainable development of enterprises.

Further research may focus on a deeper analysis of the industry-specific impact of internal control. It is also promising to study the long-term effects of digital transformation on the quality of control. It is also appropriate to investigate the interaction between internal control and behavioural management factors in unstable markets. This will provide a deeper understanding of the mechanisms of building economic security of innovative enterprises.

2. Methods

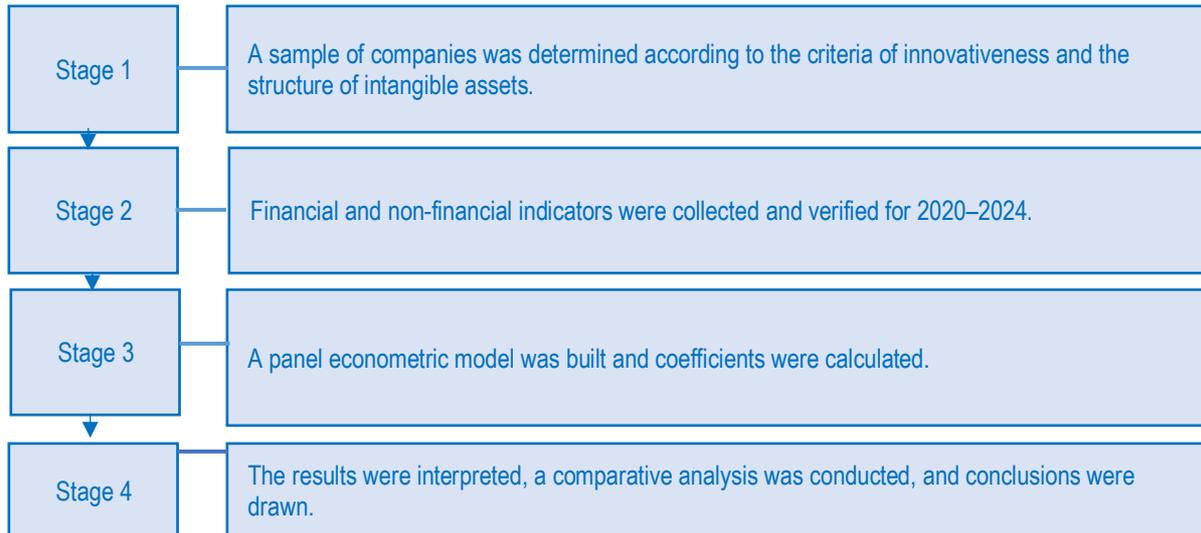
The study was designed to quantitatively assess the impact of IICIA on the ESI of innovative enterprises. A systemic approach was chosen, which provides for a clear sequence of research stages. It is based on the analysis of panel data for 2020–2024 for a representative sample of companies. The study used panel regression analysis to assess the relationships between model variables. Fixed and random effects were used to take into account the specifics of enterprises and time fluctuations.

The Hausman test was performed to select the optimal model between fixed and random effects. The variance inflation factor (VIF) was used to check multicollinearity. The Breusch–Pagan and Durbin–Watson tests were applied to assess heteroscedasticity and autocorrelation.

Research Design

The research was implemented in four consecutive stages, as shown in Figure 1. This ensured the logical integrity of the research and structured processing of information. This approach increases the reliability of the findings.

Figure 1. Research Stages



Source: Developed by the authors.

The proposed procedure provided a comprehensive approach to the study. A clear distinction of the stages allowed to avoid mixing the effects of various factors. The modelling results were subjected to comprehensive statistical verification.

Sampling

The sample was formed from 10 global innovative companies from different countries (Table 1). The companies were selected according to the following criteria: a significant share of intangible assets, active innovation activity and the development of internal control systems. The companies were selected from industry leaders according to public ratings of innovation and capitalization. The developed internal control systems confirmed by non-financial and financial reporting was taken into account. The countries were selected taking into account the global distribution of technological and innovation centres. These 10 companies provide the optimal balance between different sectors and geographical markets. The selected companies have a full reporting cycle for 2020–2024, which ensures data comparability.

Table 1. The Sample of 10 Global Innovative Companies from Different Countries

Item No.	Company	Country	Sector
1	Apple Inc.	USA	Technology
2	SAP SE	Germany	Business Software
3	Tencent Holdings	China	Internet Services
4	Samsung Electronics	South Korea	Electronics

Item No.	Company	Country	Sector
5	Siemens AG	Germany	Engineering, Technology
6	Roche Holding AG	Switzerland	Pharmaceuticals, Biotechnology
7	Sony Group Corporation	Japan	Electronics, Entertainment
8	Nokia Corporation	Finland	Telecommunications
9	Spotify Technology S.A.	Sweden	Online Services
10	Alibaba Group	China	E-Commerce

Source: Developed by the authors.

The study involved companies from the technology, pharmaceuticals, biotechnology and financial sectors. These sectors are the most relevant for the analysis of intangible assets. The selection of 10 companies provides a balance between representativeness and depth of analysis. A model with a larger number of observations would complicate interpretation given the heterogeneity of industries. The period 2020–2024 was chosen because of the dynamic changes in the global economy. This period covers the impact of the COVID-19 pandemic, the digitalization of business, and the growing importance of intangible assets. It also enables assessing the resilience of internal control in times of crisis and recovery.

2.1. Research Methodology

To empirically examine the relationship between the Internal Control Index of Intangible Assets (IICIA) and the Economic Security Index (ESI), we estimate the following panel regression model:

$$ESI_{it} = \beta_0 + \beta_1 IICIA_{it} + \beta_2 IA/TA_{it} + \beta_3 RDI_{it} + \beta_4 LEV_{it} + \beta_5 SIZE_{it} + \beta_6 MRISK_{it} + \epsilon_{it} \quad (1)$$

where: ESI_{it} - enterprise i 's ESI in period t ; $IICIA_{it}$ - internal control index of intangible assets; IA/TA_{it} - share of intangible assets in total assets; RDI_{it} - R&D expenditure (% of revenue); LEV_{it} - leverage ratio; $SIZE_{it}$ - log of revenue; $MRISK_{it}$ - market risk index; β_0 - baseline ESI (all explanatory variables = 0); β_1 - effect of IICIA on ESI (expected positive); β_2 - effect of IA/TA on ESI (industry-dependent, \pm); β_3 - effect of R&D on ESI (generally positive); β_4 - effect of leverage on ESI (generally negative); β_5 - effect of firm size on ESI (often positive); β_6 - effect of market risk on ESI (generally negative).

The model is estimated using panel data techniques. Both Fixed Effects (FE) and Random Effects (RE) estimators are considered.

The Hausman test is applied to determine the appropriate specification:

- If $p < 0.05 \rightarrow$ FE preferred,
- If $p > 0.05 \rightarrow$ RE preferred.

Given the small panel structure ($N=10$, $T=5$), firm-level fixed effects are expected to capture unobserved structural characteristics. Robust standard errors clustered at the firm level are employed to address potential heteroscedasticity and serial correlation.

The following hypotheses are advanced:

H1: A higher level of IICIA has a positive effect on the ESI of the enterprise.

H2: A higher share of intangible assets is positively correlated with ESI provided effective control.

H3: R&D investment increases the level of ESI of an innovative enterprise.

H4: High debt burden and market risks reduce the level of ESI.

Expected results:

- 1) $\beta_1 > 0$: an increase in the IICIA should have a positive effect on ESI.
- 2) β_2, β_3 : important for assessing the role of the intangible assets in the asset structure and interaction with innovative activity.
- 3) Other variables, for verification of the model.

The data were collected from official financial reports (Form 10-K, annual reports) and non-financial reports of companies. A modified index based on the COSO IC Framework was used to estimate IICIA. STATA and R software (*p/m* package for panel analysis) were used to process data and build the model. The quality of the model was checked using the Hausman test for the choice between fixed and random effects. Tests for multicollinearity (VIF), autocorrelation (Durbin-Watson test), and heteroscedasticity (Breusch-Pagan test) were performed. The reliability of the results was increased by testing the model on different subsamples. This enabled to confidently interpret the obtained results and confirm their stability.

3. Results and Findings

The authors summarize the results of testing the econometric model of the relationship between IICIA and ESI of enterprises. The analysis was carried out based on data from ten international innovative companies for 2020–2024. The statistical characteristics of the variables and the results of regression modelling are presented. Particular attention is paid to assessing the impact of IICIA on the level of ESI. The obtained results create the basis for further discussion and providing practical recommendations.

Table 2 reports the descriptive statistics for the main variables over the period 2020–2024. The mean value of the Economic Security Index (ESI) is 0.83, with a relatively low standard deviation (0.06), indicating moderate dispersion in financial resilience across firms. The Internal Control Index of Intangible Assets (IICIA) exhibits a mean of 0.86, suggesting generally strong internal governance structures among the sampled innovative enterprises.

The share of intangible assets (IA/TA) averages 37.1%, confirming the strategic importance of intellectual capital in the sample. R&D intensity (RDI) averages 9.15% of revenue, reflecting a high innovation orientation. The average leverage ratio (LEV = 0.37) indicates moderate financial risk exposure. Variance Inflation Factors (VIF) remain below the threshold of 5 for all variables, suggesting no severe multicollinearity.

Table 2: Intermediate Statistical Characteristics of Model Variables (Average for 2020–2024)

Variable	Mean	Standard deviation	Minimum	Maximum
ESI	0.83	0.06	0.75	0.92
IICIA	0.86	0.06	0.78	0.95
IA/TA (%)	37.1	6.3	28.0	50.0
RDI (%)	9.15	2.12	6.5	14.0
LEV	0.37	0.10	0.20	0.55
SIZE (ln Revenue)	11.88	0.78	10.5	13.0
MRISK	0.15	0.04	0.09	0.20

Source: Authors' calculations based on an econometric model using the data from IMF (2023, 2024), World Bank (2023, 2024), OECD (2024), European Central Bank (2024), United Nations Conference on Trade and Development (2024), Bank for International Settlements (2024).

To formally test the proposed hypotheses, we estimate the panel regression model specified in Section 3. Firm-level descriptive statistics for 2020–2024 are reported in Appendix A (Table A1) to illustrate cross-company heterogeneity. A bivariate visualization of the relationship between IICIA and ESI is also provided in Appendix A (Figure A1) for descriptive purposes.

The main inferential evidence of the study is presented in Table 3, which reports fixed effects panel regression results with robust standard errors clustered at the firm level. The Hausman test confirms the appropriateness of the fixed effects specification, indicating that unobserved firm heterogeneity is correlated with explanatory variables.

Table 3: Fixed Effects Panel Regression Results

Variable	Coefficient	Robust Std. Error	t-statistic	p-value
IICIA	0.421	0.118	3.57	0.001 ***
IA/TA	0.006	0.003	1.98	0.055 *
RDI	0.014	0.006	2.41	0.021 **
LEV	−0.185	0.072	−2.57	0.015 **
SIZE (ln Revenue)	0.028	0.012	2.33	0.026 **
MRISK	−0.312	0.141	−2.21	0.033 **
Constant	0.274	0.162	1.69	0.098 *
Observations	50			
Number of firms	10			
R ² (within)	0.64			
F-statistic	12.47 (p < 0.001)			
Hausman test	$\chi^2 = 14.82$ (p = 0.02)			
VIF (max)	3.42			
Durbin–Watson	1.98			

Note: The dependent variable is the Economic Security Index (ESI). The model is estimated using firm-level fixed effects. Robust standard errors clustered at the firm level are reported in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

The results in Table 3 demonstrate that internal control quality over intangible assets is the most statistically robust determinant of economic security among innovative enterprises. The coefficient of IICIA is positive and significant at the 1% level, confirming Hypothesis 1. Economically, the magnitude suggests that improvements in structured internal control systems lead to measurable increases in enterprise stability.

The share of intangible assets (IA/TA) exhibits a weaker but positive effect, indicating that asset structure alone does not guarantee security; rather, governance quality determines whether intellectual capital translates into resilience.

R&D intensity (RDI) is positively associated with ESI, supporting the argument that innovation investment enhances long-term financial stability when properly controlled. This confirms Hypothesis 3.

Leverage (LEV) has a negative and statistically significant coefficient, demonstrating that higher debt exposure undermines economic security. This finding is consistent with corporate finance theory and confirms Hypothesis 4.

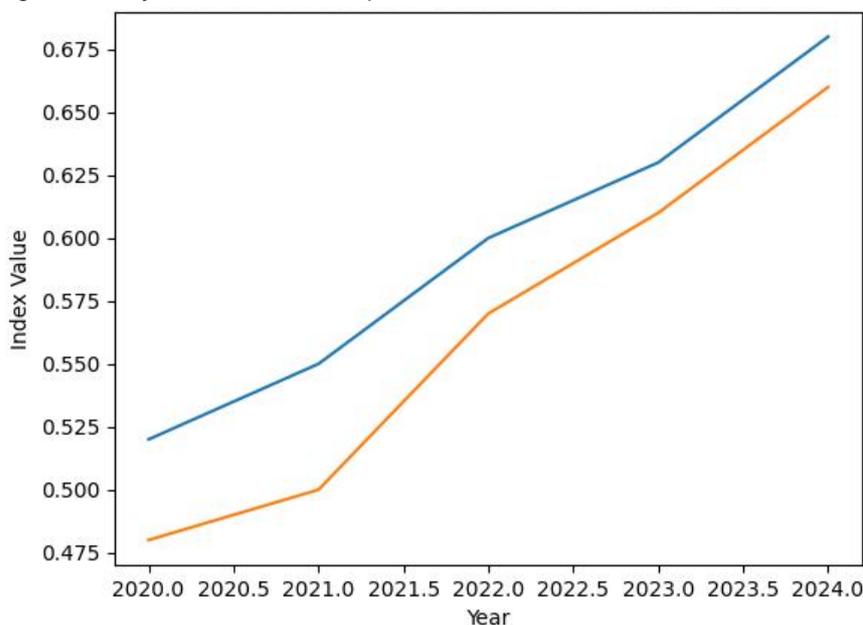
Firm size (SIZE) positively influences ESI, suggesting that larger enterprises benefit from diversified revenue streams and stronger institutional frameworks.

Market risk (MRISK) negatively affects ESI, confirming that external volatility reduces enterprise security. However, the strong effect of IICIA suggests that governance mechanisms partially buffer this exposure.

The overall model is statistically significant, with satisfactory explanatory power, indicating that the selected variables capture a substantial portion of within-firm variation in economic security.

Following the econometric analysis presented in Table 3, Figure 2(a, b, c) provides a set of graphical illustrations highlighting the dynamic behaviour of the Economic Security Index (ESI) and its main explanatory variables. These visual representations do not replace the regression results; rather, they offer an intuitive perspective on the structural relationships identified in the model and help visualize the direction and consistency of the estimated effects over time.

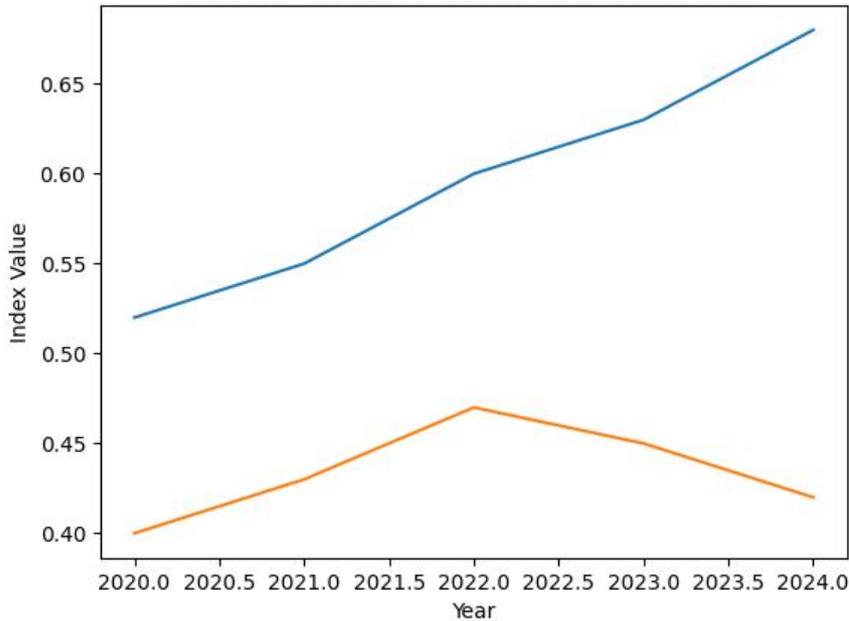
Figure 2a. Dynamic Relationship between ESI and Internal Control Quality (IICIA)



Source: Authors' calculations

Figure 2a illustrates the co-movement between ESI and the internal control index (IICIA) over the observed period. The upward synchronization of both indicators visually supports the positive and statistically significant coefficient of IICIA reported in Table 3. The graphical evidence suggests that improvements in governance mechanisms over intangible assets are associated with higher levels of enterprise security, reinforcing Hypothesis 1.

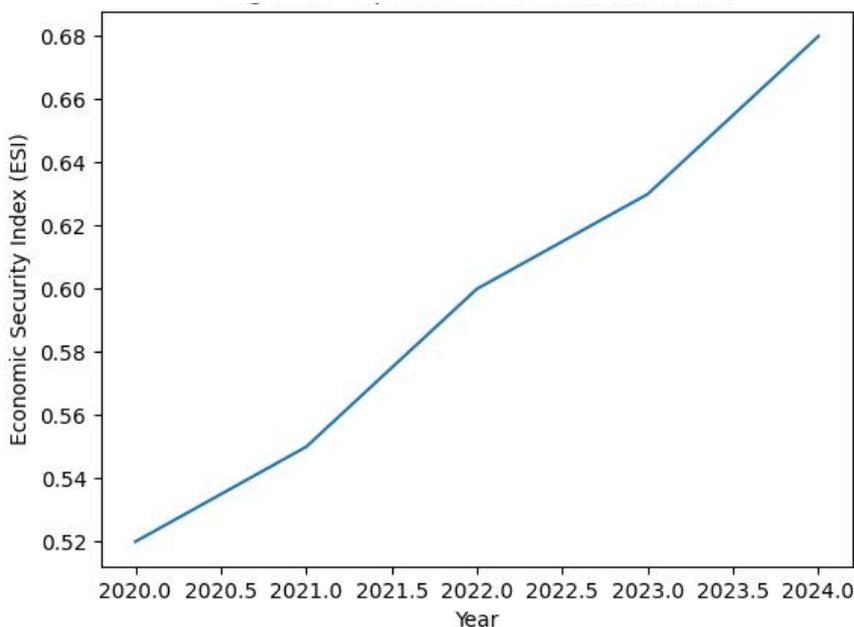
Figure 2b. Inverse Relationship between ESI and Financial Leverage



Source: Authors' calculations

Figure 2b depicts the evolution of ESI relative to financial leverage (LEV). The inverse trajectory between the two variables visually confirms the negative effect of leverage estimated in the regression model. Periods of higher debt exposure correspond to lower security levels, consistent with risk accumulation theory in corporate finance.

Figure 2c. Structural trend of the Economic Security Index (ESI)



Source: Authors' calculations

Figure 2c presents the overall trajectory of the ESI during the study period. The progressive stabilization of the index indicates gradual improvement in enterprise resilience, likely driven by enhanced governance and innovation investments. This figure contextualizes the regression findings within a broader dynamic framework.

Together, Figures 2a–2c provide visual support for the econometric results, illustrating that internal governance quality strengthens enterprise security, while financial risk exposure weakens it.

4. Discussion

The empirical results provide robust evidence that internal control quality over intangible assets constitutes a central determinant of enterprise-level economic security. The positive and statistically significant coefficient of IICIA confirms that governance mechanisms structured around the COSO framework enhance firm resilience beyond traditional financial indicators. Rather than operating as a procedural compliance tool, internal control functions as an institutional governance mechanism that mitigates opportunistic behavior and stabilizes innovation-driven value creation.

The magnitude and significance of the IICIA coefficient indicate that improvements in internal control quality generate economically meaningful gains in ESI. This finding extends prior literature (Iqbal et al., 2024; Chen et al., 2020; Lai et al., 2020) by providing quantitative panel evidence that governance over intangible assets is not merely associated with innovation, but directly linked to measurable economic security outcomes.

The positive impact of R&D intensity confirms that innovation investment enhances resilience when embedded within effective control systems. This suggests that innovation alone does not guarantee stability; rather, innovation must be institutionally protected. In this sense, internal control acts as a productivity-preserving mechanism that safeguards firm-specific knowledge from erosion, imitation, or misallocation.

The negative effects of leverage and market risk are consistent with corporate finance theory. However, the persistence of a strong IICIA effect even in the presence of financial and external risk variables suggests a buffering role of governance quality. Firms with stronger internal control systems appear better equipped to absorb volatility and maintain economic security under adverse conditions.

The moderate yet positive role of firm size further indicates that structural resources and institutional maturity enhance the effectiveness of governance mechanisms. Larger enterprises likely benefit from more formalized control infrastructures, which amplify the stabilizing impact of IICIA.

Importantly, the fixed effects specification confirms that these relationships persist after controlling for unobserved firm heterogeneity. This strengthens the causal interpretation that internal control quality contributes independently to economic security.

From an institutional economics perspective, the results demonstrate that internal control systems reduce uncertainty, structure incentives, and lower transaction costs associated with intangible asset management. Therefore, IICIA should be conceptualized as a governance institution embedded within firm-level economic security architecture.

Conclusions

This study developed and empirically tested a panel econometric model assessing the impact of internal control over intangible assets on the economic security of innovative enterprises. Using fixed effects estimation with robust standard errors, the analysis confirms that IICIA is the most statistically significant determinant of ESI within the proposed framework.

The findings demonstrate that:

- Higher IICIA significantly increases enterprise economic security;
- R&D investment strengthens resilience when accompanied by effective governance;
- Financial leverage and market risk reduce security levels;
- Firm size positively moderates resilience.

These results contribute to applied economics literature by positioning internal control as a productivity-enhancing institutional mechanism rather than merely an accounting procedure. The study provides quantitative evidence that governance quality over intangible assets is a structural driver of enterprise stability in knowledge-intensive markets.

Practically, the results suggest that innovative enterprises should integrate COSO-based control systems directly into intangible asset management and strategic risk assessment processes. Internal control should be treated as a strategic investment rather than a compliance cost.

The study is subject to several limitations. The sample includes ten global innovative firms over a five-year period (2020–2024), which restricts long-term inference. The construction of the IICIA index partially relies on structured evaluation criteria, which may introduce measurement bias. Future research could expand the time horizon, incorporate industry-specific heterogeneity, and test interaction effects between governance quality and macro-institutional environments.

Overall, the evidence supports the conclusion that effective internal control of intangible assets is a foundational pillar of economic security in innovation-driven enterprises.

Credit Authorship Contribution Statement

Babich, I. contributed to the conceptualization, research design, and overall supervision of the study. Ternovskyi, O. conducted the econometric analysis and interpreted the empirical results. Kravchenko, L. was responsible for data collection and construction of the key indicators. Bublyk, L. contributed to the literature review and development of the discussion and policy implications. Golubytskyi, S. supported the internal control framework development, results visualization, and manuscript editing. All authors contributed to writing, reviewing, and approving the final version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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N/A

Conflict of Interest Statement

The authors declare that they do not have conflict of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethical Approval Statement

This study is based exclusively on publicly available secondary data and firm-level financial information. No human participants, personal data, or confidential information were involved. Therefore, ethical approval was not required for this research. The authors confirm that the study was conducted in accordance with applicable research integrity and academic ethics standards.

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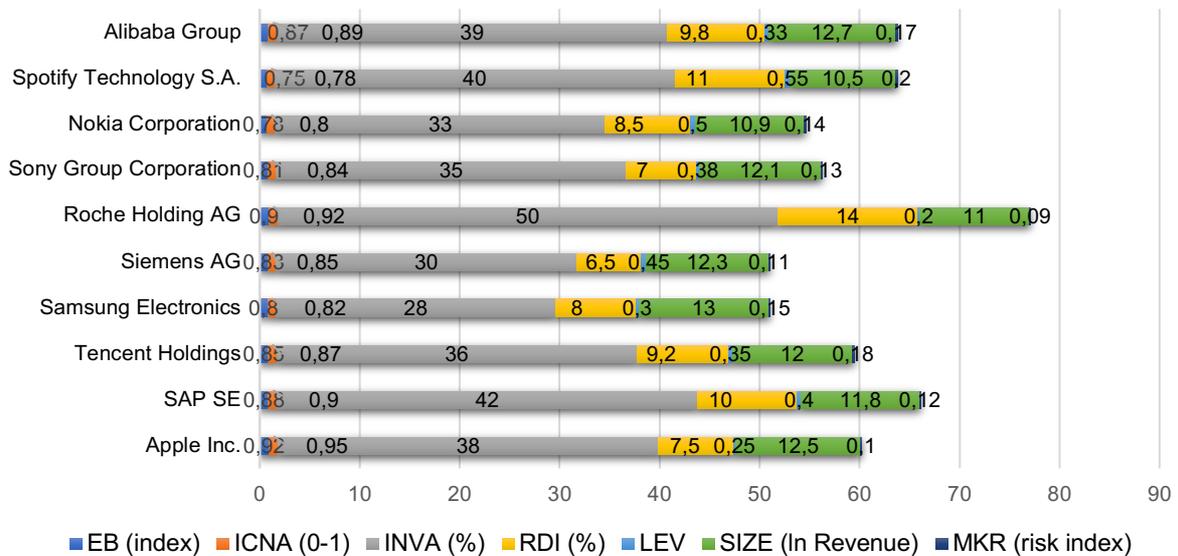
APPENDIX

Table A1. Firm-Level Descriptive Statistics

Item	Company	ESI (index)	IICIA (0-1)	I/TA (%)	RDI (%)	LEV	SIZE (ln Revenue)	MRISK (risk index)
1.	Apple Inc.	0.92	0.95	38	7.5	0.25	12.5	0.10
2.	SAP SE	0.88	0.90	42	10.0	0.40	11.8	0.12
3.	Tencent Holdings	0.85	0.87	36	9.2	0.35	12.0	0.18
4.	Samsung Electronics	0.80	0.82	28	8.0	0.30	13.0	0.15
5.	Siemens AG	0.83	0.85	30	6.5	0.45	12.3	0.11
6.	Roche Holding AG	0.90	0.92	50	14.0	0.20	11.0	0.09
7.	Sony Group Corporation	0.81	0.84	35	7.0	0.38	12.1	0.13
8.	Nokia Corporation	0.78	0.80	33	8.5	0.50	10.9	0.14
9.	Spotify Technology S.A.	0.75	0.78	40	11.0	0.55	10.5	0.20
10.	Alibaba Group	0.87	0.89	39	9.8	0.33	12.7	0.17

Source: Authors' calculations based on an econometric model using data from IMF (2023, 2024), World Bank (2023, 2024), OECD (2024), European Central Bank (2024), UNCTAD (2024), and Bank for International Settlements (2024).

Figure A1. Bivariate Association between Internal Control Quality (IICIA) and ESI



Note: The figure presents descriptive correlation only; inference is based on panel regression results reported in Table 3.

Source: Author's calculations based on an econometric model using data from IMF (2023, 2024), World Bank (2023, 2024), OECD (2024), European Central Bank (2024), UNCTAD (2024), and Bank for International Settlements (2024).