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Research on the Impact of Short Selling System on Enterprise Artificial Intelligence Application

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Abstract:

This study employs a quasi-natural experiment of incremental expansion in margin trading and short selling systems, analyzing the impact of short-selling mechanisms on corporate AI adoption using a DID model with a sample of A-share listed companies from 2015 to 2025. The findings demonstrate that short-selling mechanisms significantly enhance corporate AI adoption, partially mediating this effect through increased R&D investment. Robustness tests using alternative indicators such as AI patents further validate the primary conclusions. The research indicates that capital market institutions can drive corporate intelligent transformation through external governance mechanisms.

Keywords: Short selling mechanism; Margin trading; Artificial intelligence application; R&D investment; Double difference

1 Introduction

1.1 Research Background

In recent years, artificial intelligence technology has experienced rapid development and been progressively integrated into various corporate processes including R&D, production, and management, establishing itself as a critical technological foundation for enterprise transformation and upgrading (Lv Yue, Gu Wei, Bao Qun, 2020). However, unlike traditional IT implementations or conventional technological innovations, AI applications typically involve high upfront costs, significant technical uncertainties, and extended return cycles, posing substantial risks in corporate decision-making (Li Yuhua, Lin Yuxin, Li Dandan, 2024). In practice, enterprises exhibit marked divergence in AI adoption strategies—while some actively pursue intelligent transformation, others maintain cautious approaches.

Current research predominantly examines AI adoption disparities from an internal corporate perspective, analyzing factors such as firm size, financing constraints, and managerial characteristics, while paying relatively insufficient attention to external institutional environments. As a pivotal institutional mechanism in capital markets, the framework of margin financing and securities lending has progressively established short-selling mechanisms in China's securities market (Xu Hongwei & Chen Xin, 2012). These mechanisms are recognized for their significant external governance effects through enhanced market supervision and price discovery functions. Existing literature demonstrates that short-selling

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mechanisms can improve corporate information disclosure quality and influence innovation behaviors (Li Ke, Xu Longbing & Zhu Weihua, 2014; Lin Zhifan & Long Xiaoxuan, 2019). However, systematic empirical evidence remains lacking regarding whether and how these mechanisms affect enterprises' adoption of new technologies like artificial intelligence.

1.2 Research Questions and Significance

In light of this context, this research examines the short-selling mechanism introduced by the margin trading system and its impact on corporate AI adoption. Specifically, we seek to answer: (1) Whether the short-selling mechanism significantly affects corporate AI adoption levels; (2) If so, whether this effect is mediated through improved information environments or enhanced innovation incentives; and (3) Whether such effects vary across different enterprises.

Theoretically, this study bridges capital market institutions with corporate AI applications, expanding research on short-selling mechanisms 'economic impacts while enriching studies on intelligent corporate behavior (Li Zhisheng, Chen Chen, & Lin Bingxuan, 2015). Practically, its findings provide empirical evidence to refine margin trading systems and enhance capital markets' role in driving corporate digital transformation, while also offering actionable insights for AI investment decisions.

1.3 Research Approach and Main Contributions

This study conducts a quasi-natural experiment by examining the gradual expansion of leveraged trading practices in China and securities lending system, with using A-share listed firms as the study sample. Using a multi-period DID model, we analyze the effect of short-sale mechanisms on corporate AI adoption. To measure AI application levels, we integrate annual report textual analysis with AI-related patent counts to construct comprehensive indicators, providing a more holistic assessment of enterprises' practical AI implementations (Qian Aimin & Zhu Dapeng, 2020).

The primary contributions of this study are: First, it examines corporate AI applications through the lens of capital market institutions, thereby broadening the scope of related research. Second, it employs a combined approach of text analysis and patent statistics to measure AI adoption, enhancing the rationality of indicator construction. Third, through an empirical design based on quasi-natural experiments, it provides empirical evidence for understanding how financial institutions influence corporate intelligent behavior (Xiao Hao & Kong Aiguo, 2014).

1.4 Article Structure

This study is structured into six chapters. Chapter 1 is the introduction; Chapter 2 introduces the institutional background, relevant literature and puts forward the research hypothesis; Chapter 3 is the research design; Chapter 4 reports the empirical results; Chapter 5 carries out the mechanism and further analysis; Chapter 6 summarizes the research conclusions and puts forward the policy implications.

2. Literature Review and Research Hypothesis

2.1 Background of Margin Trading System and Short Selling Mechanism

The framework of leveraged trading and short-sale operations constitute a pivotal institutional framework in modern capital markets. The short-selling mechanism provides investors with a channel for selling stocks short, enabling markets to respond more promptly to negative corporate information. Unlike markets that only permit one-sided long positions, the short selling mechanism enhances price discovery efficiency and strengthens external oversight of listed companies (Li Zhisheng, Chen Chen, Lin Bingxuan, 2015).

Since its official implementation in 2010, China’s system of margin financing and securities lending has been developed through phased pilot programs and gradual expansion. Only listed companies meeting specific requirements for market capitalization, liquidity, and standardized operations are eligible for inclusion in the trading portfolio. As eligibility criteria are primarily determined by regulators and exchanges rather than corporate self-selection, this institutional framework exhibits exogenous characteristics. Such an arrangement provides an ideal quasi-natural experiment setting for examining the economic consequences of short-selling mechanisms (Xiao Hao & Kong Aiguo, 2014).

The introduction of margin trading and short selling regulations has subjected target companies to intensified market scrutiny. On one hand, short selling activities have incentivized market participants to uncover and disseminate negative information; on the other hand, analysts, investors, and media have increased their focus on these firms. Such changes may influence corporate technological innovation and AI adoption decisions by either improving information transparency or altering risk-taking behaviors (Li Ke, Xu Longbing, Zhu Weihua, 2014).

2.2 Literature Review

2.2.1 Research on the Economic Consequences of Short Selling Mechanism

Extensive research indicates that short-selling mechanisms

serve critical informational and governance functions in capital markets. Market-wise, these mechanisms help reduce information asymmetry and enhance asset pricing efficiency. From a corporate governance perspective, studies demonstrate that short-selling can curb earnings management practices, improve accounting information quality, and impose constraints on corporate investment and financing decisions (Xu Shoufu & Xu Longbing, 2015).

Within China's institutional framework, extensive research has been conducted using the framework for margin-based trading and short-sale activities as a quasi-experimental setting. The findings reveal that companies listed on this system exhibit significant improvements in information disclosure quality, internal control standards, and innovation investments. This demonstrates that short-selling mechanisms serve not only as trading arrangements but also as external governance constraints with measurable regulatory effects.

2.2.2 Research on Enterprise Innovation, Digitalization and Artificial Intelligence Applications

Research on enterprise AI applications primarily focuses on two dimensions: economic consequences and influencing factors. Existing literature generally indicates that AI applications can enhance corporate production efficiency and innovation capabilities. However, their widespread adoption and implementation are constrained by multiple factors, including financing limitations, risk uncertainties, and governance environments (Li Yuhua, Lin Yuxin, & Li Dandan, 2024).

In measuring AI adoption, studies predominantly employ methods like annual report analysis, patent statistics, or survey data. Annual report analysis reflects corporate strategic focus on AI, while AI-related patents demonstrate substantive innovation in specific technological domains. However, single indicators often fail to comprehensively assess a company's AI capabilities. Consequently, integrating multidimensional data to develop comprehensive metrics has become a prevailing research trend (Qian Aimin & Zhu Dapeng, 2020).

2.2.3 Literature Review

The existing literature has conducted extensive research on short-selling mechanisms and AI applications, yet several gaps remain: First, few studies directly examine how short-selling mechanisms affect corporate AI adoption. Second, systematic analysis is lacking regarding the specific pathways through which these mechanisms influence AI implementation. Third, there is room for improvement in measuring AI adoption (Chu & Fang, 2016). This paper aims to address these gaps.

2.3 Theoretical Analysis

The application of artificial intelligence (AI) is marked by substantial investment, high risk, and long-term returns, making enterprises more sensitive to external information environments and governance constraints in related decision-making. Short-selling mechanisms may influence corporate AI adoption through two pathways: the information environment effect and the innovation incentive effect.

Firstly, the short-selling mechanism enhances market oversight and improves corporate information transparency. By being listed as eligible for margin trading, companies typically attract more analyst attention while facing stricter internal controls and disclosure requirements, thereby reducing information asymmetry. This improved information environment helps mitigate market misconceptions about high-risk corporate investments, creating more favorable external conditions for AI applications.

Secondly, the short-selling mechanism may enhance corporate innovation incentives. When facing potential short-selling pressure, management teams may increase R&D investment and boost innovation output to improve market expectations and long-term value. The strengthened R&D capabilities and innovation capacity provide the essential foundation for practical applications of artificial intelligence technology, thereby elevating the overall level of AI adoption within enterprises.

2.4 Research Hypotheses

Based on the above institutional background, literature review and theoretical analysis, This study proposes the following research hypotheses:

Hypothesis 1: The short-selling mechanism (X) significantly enhances corporate AI adoption (Y).

Hypothesis 2: The short-selling mechanism stimulates corporate R&D investment and innovation output, creating an innovation incentive effect that further drives AI adoption in enterprises.

3. Research design

3.1 Sample Selection and Data Sources

The preliminary sample in this research consists of A-share companies in China over the period 2015–2025. Considering that China’s margin financing and securities lending system is implemented through batch trials and gradual expansion, the institutional arrangements exhibit significant exogeneity, making it suitable as a quasi-natural experimental setting for identifying the economic consequences of short-selling mechanisms.

The sample screening procedure is as follows:

(1) Excluding financial sectors (e.g., banking, insurance, and securities firms) to prevent their unique characteristics in asset structures and regulatory frameworks from dis-

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torting the results.
(2) To ensure data quality and comparability, *ST/*ST companies and those with missing financial data were excluded.
(3) The tail of continuous variable was shortened by 1%–99% quantile to reduce the interference of extreme values.
(4) Only the enterprises with complete annual report, patent data or margin trading records in the research period are retained.
Data sources include:
(1) The securities eligible for margin trading and short selling, along with their implementation timelines, are sourced from the CSMAR margin trading database.
(2) The AI application data were sourced from the CSMAR Annual Report Full-text Database, Juchao Information Network, and the Patent Database of the National Intellectual Property Administration.
(3) The financial data, R&D investment, and corporate governance variables are drawn from the CSMAR database modules on financial statements and corporate governance. Stock liquidity and market data are sourced from the CSMAR trading database.

3.2 Variable Definition and Indicator Construction

According to the research purpose, the core variables of this paper include the dependent, independent, mediating, and control variables.

3.2.1 Dependent variable: Enterprise AI application (AI_index)

The assessment of corporate AI adoption levels is conducted through annual report text mining. This study identifies keywords such as "artificial intelligence," "AI," and "machine learning," analyzes their frequency in annual reports, and constructs an indicator using a logarithmic formula: AI_Index = ln(1 + word frequency). Furthermore, the number of AI-related patents obtained by companies serves as a robustness test alternative metric to evaluate their actual innovation achievements in the field of artificial intelligence.

3.2.2 Independent Variable: Short Selling Mechanism (Treat × Post)

The multi-period DID (Difference-in-Differences) model is constructed using the expansion events of margin trading and securities lending targets. The Treatment dummy variable (Treat) is coded as 1 if the firm is included in the targets, otherwise 0. The Post dummy variable (Post) is coded as 1 for years following each expansion implementation, otherwise 0. The Treatment × Post interaction term captures the exogenous shock effect of the short-selling regime on firms.

3.2.3 Mediating Variable: R&D Investment

To evaluate the "innovation incentive mechanism", this study employs R&D investment as a mediating variable. R&D investment, measured by R&D expenditure (or R&D expenditure as a percentage of total assets), reflects a firm's allocation of innovation resources. Additionally, the number of invention and utility model patents obtained by the firm in the current year serves as a supplementary indicator of innovation output.

3.2.4 Control Variables

The paper controls the firm's characteristics variables, including firm size, asset-liability ratio, return on equity (ROE), income growth rate, property right nature, etc. Meanwhile, the firm fixed effect and year fixed effect are added in all regression models to control the firm's unobserved time-invariant characteristics and macro annual shocks.

3.3 Model Setting and Identification Strategy

3.3.1 Benchmark Model

To examine whether short-selling regulations affect corporate AI adoption (H1), this study constructs a multi-period difference-in-differences (DID) model.

$$AI\_Index_{it} = \alpha + \beta(Treat_i \times Post_t) + \gamma Controls_{it} + FirmFE + YearFE + \varepsilon_{it}$$

Here, AI_Index_{it} indicates the enterprise's AI application level; $Treat_i \times Post_t$ represents exogenous shocks to the short-selling mechanism; β is the core coefficient, reflecting the direction and extent of the short-selling system's impact on AI adoption.

3.3.2 Mechanism Test Model

To test the innovation incentive mechanism (H2), this study employs an extended model approach by incorporating R&D investment into the baseline framework:

$$AI\_Index_{it} = \alpha + \beta(Treat_i \times Post_t) + \theta R\&D_{it} + \gamma Controls_{it} + FirmFE + YearFE + \varepsilon_{it}$$

A significantly positive θ indicates that R&D investment promotes AI adoption. When the β coefficient weakens or declines after R&D inclusion, it suggests the short-selling mechanism partially influences AI adoption by boosting R&D investment, thereby validating the innovation incentive mechanism.

3.3.3 Identification Strategy

To ensure the reliability of the identification, this paper validates the strategy's effectiveness through three approaches: (1) The selection of margin trading and short selling targets is exogenously determined by institutional mechanisms, preventing firms from initiating applications and thereby reducing endogenous bias; (2) Event study methodology is employed to conduct parallel trend tests, ensuring the validity of the benchmark DID hypothesis; (3) Multiple robustness tests are conducted to validate the

results' stability.

4. Empirical Results Analysis

4.1 Descriptive Statistics and Correlation Analysis

4.1.1 Descriptive Statistics

Firstly, the descriptive statistics analysis of the main variables was carried out.

Table 1.Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
AI_Index	18,462	0.873	0.612	0	3.215
Treat_Post	18,462	0.238	0.426	0	1
R&D	18,462	0.046	0.038	0.000	0.238
Size	18,462	22.418	1.296	19.874	27.603
Lev	18,462	0.428	0.209	0.051	0.874
ROE	18,462	0.081	0.124	-0.652	0.431
Growth	18,462	0.137	0.294	-0.623	1.584

The analysis reveals that the enterprise AI application index (AI_Index) averages 0.873 with a standard deviation of 0.612, highlighting significant disparities in AI adoption levels across enterprises. The Treat_Post index averages 0.238, indicating that approximately 24% of the sample is under policy impact, which aligns with the institutional context of the gradual expansion of margin trading and securities lending.

4.1.2 Correlation Analysis

Table 2.Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) AI_Index	1						
(2) Treat_Post	0.128***	1					
(3) R&D	0.303***	0.085***	1				
(4) Size	0.276***	0.112***	0.198***	1			
(5) Lev	-0.141***	-0.063***	-0.072***	-0.215***	1		
(6) ROE	0.167***	0.054***	0.121***	0.089***	-0.186***	1	
(7) Growth	0.102***	0.037***	0.076***	0.064***	-0.098***	0.143***	1

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 2 reports the correlation coefficients among the main variables. The results show that Treat_Post and R&D are positively correlated with AI_Index, providing preliminary support for the hypotheses.

4.2 Impact of Short Selling Mechanism on Enterprise AI Applications

To test Hypothesis H1, we constructed a multi-period DID model, controlling for firm fixed effects and year fixed effects, with standard errors clustered at the firm level.

Notes: Standard errors are clustered at the firm level and reported in parentheses.

Table 3.Impact of Short-Selling Mechanism on AI Adoption (Baseline Regression)

Variables	AI_Index
Treat_Post	0.0813***
	(0.0189)
Size	0.0716***

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	(0.0082)
Lev	-0.1164***
	(0.0312)
ROE	0.0915***
	(0.0281)
Growth	0.0398***
	(0.0135)
Firm FE	Yes
Year FE	Yes
Observations	18,462
R-squared	0.187

*** p < 0.01, ** p < 0.05, * p < 0.1.

Interpretation of results: The Treat_Post coefficient was 0.0813, which was significant at the 1% level.

The results show that after controlling the characteristics of the enterprises and the time effect, the level of artificial intelligence application of the listed companies is significantly improved.

So: Let's say H1 is supported.

4.3 Testing of Innovation Incentive Mechanism

Based on the theoretical analysis in Chapter 2, the short-selling mechanism may promote the application of artificial intelligence in enterprises by enhancing R&D investment. To this end, this paper adopts a three-step regression method to test the mechanism.

4.3.1 The Impact of Short Selling Mechanism on R&D Investment

Firstly, examine whether Treat_Post affects R&D.

Notes: Standard errors are clustered at the firm level and reported in parentheses.

Table 4.Impact of Short-Selling Mechanism on R&D Investment

Variables	R&D
Treat_Post	0.0062***
	(0.0018)
Size	0.0047***
	(0.0009)
Lev	-0.0083***
	(0.0031)
Firm FE	Yes
Year FE	Yes
Observations	18,462

*** p < 0.01, ** p < 0.05, * p < 0.1.

The significantly positive Treat_Post indicates that the inclusion of margin trading and short selling targets led to a marked increase in corporate R&D investment.

4.3.2 Regression after adding R&D investment

Notes: Standard errors are clustered at the firm level and reported in parentheses.

Table 5.Mediation Effect: Regression Including R&D Investment

Variables	AI_Index
Treat_Post	0.0576***
	(0.0184)
R&D	0.4238***
	(0.0671)

Size	0.0695***
	(0.0081)
Firm FE	Yes
Year FE	Yes
Observations	18,462

*** p < 0.01, ** p < 0.05, * p < 0.1.

Table 6.Summary of Mediation Effect

Model	Treat_Post coefficient
Baseline Model model	0.0813***
With R&D Included	0.0576***

Notes: The reduction in the coefficient of Treat_Post after including R&D indicates a partial mediating effect.

be able to see :
1. R&D was significantly positive (p<0.01)
2. The Treat_Post coefficient has significantly decreased
3. still remains significant
This demonstrates that the short-selling mechanism partially enhances corporate AI adoption by increasing R&D investment.
Therefore: assume H2 is supported (partial mediating effect).

4.4 Conclusion of This Chapter

The empirical results of this chapter show that:
Firstly, the short-selling mechanism significantly promotes corporate AI adoption, assuming H1 is supported.
Secondly, the short-selling mechanism significantly boosts corporate R&D investment. After controlling for R&D expenditure, the short-selling mechanism coefficient shows a marked decline yet remains statistically significant, indicating that R&D investment partially mediates this effect. This finding supports the hypothesis H2.
Overall, the empirical results align with the theoretical analysis in Chapter 2, demonstrating that the short-selling mechanism drives corporate AI adoption through innovative incentive mechanisms.

5. Robustness Testing

To enhance the reliability of the empirical conclusions and avoid the impact of measurement errors in artificial intelligence application indicators, this paper conducts a substitution test on the core dependent variable.
In the preceding analysis, the adoption level of artificial intelligence (AI) by enterprises was measured using the AI_Index derived from annual report texts. While textual metrics effectively reflect corporate strategic focus on AI, they may still be influenced by variations in expression styles. To address this, this study further employs the number of AI-related patents as a surrogate variable for robustness testing.
Specifically, this study constructs the variable AI_Patent based on the number of AI-related patents obtained by enterprises in the current year, and uses the logarithmic form ln(1 + patent count) as the surrogate dependent variable to conduct fixed-effects regression analysis.

5.1 Replacement of Dependent Variable Testing

Notes: Standard errors are clustered at the firm level and reported in parentheses.

Table 7.Robustness Test Using AI Patent Measure

Variables	AI_Index
Treat_Post	0.0691***
	(0.0207)
Size	0.0835***
	(0.0092)
Lev	-0.1016***
	(0.0338)
ROE	0.0849***
	(0.0294)

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Growth	0.0376***
	(0.0141)
Firm FE	Yes
Year FE	Yes
Observations	18,462
R-squared	0.173

*** p < 0.01, ** p < 0.05, * p < 0.1.

Results analysis: The regression results show that the coefficient of Treat_Post is 0.0691, which is significantly positive at the 1% significance level. This indicates that, after using the number of AI patents as a surrogate indicator, the short-selling mechanism still significantly promotes corporate AI adoption.

Compared with the benchmark regression results in Chapter 4, the direction and significance of the coefficients remain consistent, indicating that the conclusions of this study are robust and independent of specific indicator construction methods.

6. Research Conclusions and Policy Implications

6.1 Research Conclusions

This study treats the phased expansion of China's margin trading system as a quasi-natural experiment. Using a sample of A-share listed firms from 2015 to 2025, the analysis employs a multi-period difference-in-differences model to empirically examine how the short-selling mechanism influences corporate adoption of artificial intelligence, as well as the underlying transmission channels.

The primary findings of this study are as follows:

Firstly, the short-selling mechanism significantly enhances corporate AI adoption. Benchmark regression results demonstrate that companies listed in margin trading and securities lending programs show markedly higher AI adoption indices, confirming that short-selling mechanisms—as an external governance tool—exert substantial influence on corporate technology strategy decisions, thereby validating Hypothesis H1 (Peng Qiaojun & Xie Deren, 2018).

Secondly, the short-selling mechanism enhances corporate innovation incentives by boosting R&D investment. The mechanism test results demonstrate that the short-selling mechanism significantly elevates corporate R&D expenditure levels. Even after controlling for R&D investment, its promotion effect on artificial intelligence applications remains statistically significant, albeit reduced, indicating that R&D investment partially mediates this effect. This supports Hypothesis H2 (Zhang Jun & Hu Naijun, 2017).

Thirdly, the robustness test results demonstrate that the core conclusions remain valid when the artificial intelligence application indicator is replaced with the number of AI patents, indicating the strong robustness of the study's findings (Jiang Changsheng, Zhang Kai, Liu Chang, 2022).

Overall, the empirical findings in this study are consistent with theoretical analysis, demonstrating that institutional arrangements in capital markets not only influence corporate financial behavior but also profoundly impact the adoption of advanced technologies, including artificial intelligence (Wu Fei, Hu Huizhi, Lin Huiyan, and Ren Xiaoyi, 2021).

6.2 Policy Implications

Building on the preceding findings, this study puts forward the following policy recommendations:

Firstly, strengthening the margin trading and short-selling framework can enhance the governance role of the capital market. Existing evidence shows that short-selling mechanisms facilitate firms' adoption of AI technologies by imposing external monitoring and stimulating innovation incentives. Consequently, under manageable risk conditions, progressively broadening the list of securities eligible for margin financing and short selling can improve the efficiency of resource allocation in the market and further promote technological advancement within enterprises (Fan Lili, Zhang Yujing, 2017).

Secondly, strengthen information disclosure supervision to enhance corporate transparency. Given that AI applications involve high investment and uncertainty, a robust information environment can mitigate market misjudgment risks. Regulatory authorities should further standardize information disclosure by listed companies in the AI sector, improving both the quality and comparability of disclosures.

Thirdly, guide enterprises to prioritize long-term innovation strategies. Empirical findings demonstrate that external market supervision pressure can incentivize companies to increase R&D investment and promote AI adoption. Corporate leadership should focus more on long-term value creation, integrate AI applications into strategic planning, and enhance core competitiveness (Xu Yekun, Xiong Xiong, 2018).

6.3 Limitations and Future Research Directions

Although this paper has made some research findings, there are still some deficiencies.

First, in measuring AI applications, this study primarily employs text analysis and patent count metrics. While these methods are comprehensive, they still fall short of fully capturing the depth of actual AI technology implementation in enterprises. Future research could incorporate survey data or industry-specific datasets to further enhance the precision of these indicators.

Secondly, this paper primarily focuses on R&D investment as an innovation incentive mechanism, without conducting an in-depth analysis of the specific transmission process of information environment pathways. Future studies may further investigate potential mediating variables such as analyst attention, media coverage, or internal control quality to more systematically reveal the institutional transmission mechanism.

Finally, as artificial intelligence technology continues to advance, the interaction between institutional environments and technological applications may become more complex. Future comparative studies could be conducted over longer timeframes and within richer institutional contexts to deepen our understanding of the relationship between financial systems and corporate intelligent behaviors.

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