Research on the Synergistic Effects of ISO 14001 Certification and Tax Incentives on Corporate Green Innovation: Evidence from China's Technology-Based Manufacturing Enterprises

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ABSTRACT

This study employs a panel Poisson regression model using China's A-share listed technology-based manufacturing companies from 2012 to 2022 as the research sample. It empirically examines the independent effects and synergistic impact of ISO14001 environmental management system certification (internal regulation) and tax incentives (external incentive) on corporate green innovation. The findings reveal: (1) Contrary to expectations, ISO14001 certification alone significantly inhibits green innovation ($\beta = -0.309$, $p < 0.01$), while tax incentives demonstrate a significant promotional effect ($\beta = 0.236$, $p < 0.01$); (2) Crucially, a significant positive synergistic effect exists between the two (interaction term $\beta = 0.452$, $p < 0.01$), indicating that the policy combination can produce a "1+1>2" effect; (3) Heterogeneity analysis further reveals that this synergistic effect is particularly pronounced in resource-constrained SMEs but not significant in large enterprises. The findings suggest that environmental regulations and market-based incentives exhibit complementary effects. Governments should prioritize optimizing policy combinations, particularly by strengthening coordinated "certification-subsidy" support for SMEs to more effectively stimulate corporate green innovation. This study provides theoretical insights and empirical evidence for understanding the interactions among different environmental policy instruments and designing targeted, differentiated green innovation incentive schemes.

Keywords: ISO 14001 certification; tax incentives; green innovation; synergistic effects; technology-based manufacturing enterprises

1. Introduction

With the growing severity of global climate change and the explicit formulation of China's dual carbon goals, advancing green innovation and achieving high-quality economic development have become critical strategic imperatives for the nation. Relevant research has clearly indicated [1] that under the institutional framework of the dual carbon goals, green transformation and development have become an imperative for enterprises, with green and low-carbon technological innovation serving as the core driver for enhancing their capacity for transformation and development. As the primary drivers of national innovation, technology-based manufacturing enterprises play a pivotal role in achieving green transformation goals through the development and application of green technologies. However, green innovation, being an innovative endeavor, exhibits characteristics such as strong positive externalities, high investment risks, and extended return cycles. This creates a significant incentive gap for enterprises, with market failures becoming particularly pronounced under intense environmental performance pressures. Therefore, exploring effective policy combinations to precisely incentivize corporate green innovation is not only about innovation itself, but also a core pathway to address China's resource and environmental constraints and achieve sustainable development. Against this backdrop, governments worldwide have widely adopted two categories of policy instruments: first, "command-and-control" regulatory tools, exemplified by ISO 14001 environmental management system certification, which guide corporate environmental behavior by setting standards; second, "market-based incentive" economic tools, represented by R&D expense super- deductions and tax credits for environmental equipment, aimed at helping enterprises reduce innovation costs, incentivizing corporate R&D, and enhancing expected returns. Existing research has largely focused on the independent effects of individual policies [2,3], with insufficient exploration of interactions between policies, particularly synergistic effects.

As the world's largest developing country and carbon emitter, China's vast cohort of technology-based enterprises constitutes a vital force for green technology breakthroughs. Concurrently, China is establishing a comprehensive environmental policy framework, making it critically urgent to clarify the synergistic relationships among different policy

instruments. Against this backdrop, this paper aims to thoroughly examine the impact of ISO 14001 certification and tax incentives on green innovation among China's technology-based enterprises, focusing on addressing the following questions: (1) What are the respective directions and intensities of these two policy types? (2) Do they exhibit synergistic effects? (3) Do these effects vary across enterprises of different sizes?

This study's potential contributions lie in: first, enriching theoretical research in environmental policy and innovation by adopting a "policy synergy" rather than "policy isolation" perspective; second, employing micro-level firm patent data to more precisely measure green innovation outputs; and third, revealing group-specific variations in policy synergies through heterogeneity analysis, thereby providing empirical evidence for designing targeted and differentiated policy packages.

2. Literature Review

2.1 Environmental Regulation and Green Innovation: Debates Based on the "Porter Hypothesis"

The Porter Hypothesis posits that appropriate environmental regulations can incentivize corporate technological innovation through innovation compensation effects, thereby offsetting compliance costs and enhancing competitiveness. As a voluntary environmental management standard, ISO 14001 certification provides an institutional foundation for corporate green innovation through systematic processes. However, empirical research findings diverge: while some studies confirm its positive impact [2], others indicate [4] that the direct costs and management burdens associated with certification may divert R&D resources—particularly for capital-constrained firms—generating a "compliance cost effect" that stifles innovation. Indeed, re-examination of the Porter Hypothesis by Tao Feng [5] and others explicitly states that not all environmental regulations yield "innovation compensation." This suggests that isolating the debate on whether environmental regulations promote innovation is insufficient for guiding policy practice. A more pertinent question emerges: Can the synergistic effect of ISO 14001 certification and tax incentives achieve greater "incremental improvement and quality enhancement" in green technological innovation than either policy alone? This is precisely the core question this paper seeks to address.

2.2 Examination of Potential Negative Effects of ISO 14001 Certification

The benchmark regression results of this study reveal that the implementation of ISO 14001 certification alone exerts a significant inhibitory effect on green innovation ($\beta = -0.309$, $p < 0.01$), a finding that contradicts Hypothesis H1. This discrepancy can be explained by examining the behavioral motivations and resource constraints of emerging market enterprises. First, as demonstrated by Riaz et al. [4] in their emerging market research, ISO 14001 certification may negatively impact corporate financial performance both in the short and long term. This suggests that within the Chinese context, the compliance costs and management burdens incurred by enterprises to establish and maintain certification systems may be particularly onerous. These additional compliance expenses directly divert scarce R&D resources, thereby generating a short-term "crowding-out effect" on green innovation. Second, firms' motivations for obtaining certification may vary significantly. Some pursue it for "symbolic compliance"—such as meeting supply chain requirements or projecting a green image—rather than enhancing substantive innovation capabilities. This "certification for certification's sake" prevents management systems from integrating effectively into innovation processes, thereby failing to translate into innovation outputs. Furthermore, research by Arocena et al. [7] indicates that firm size is a key moderator of certification effects, with larger firms possessing superior resource endowments better able to absorb certification costs and reap benefits. This perspective indirectly confirms that resource-constrained SMEs face greater suppression of innovation activities when confronting certification alone, providing a logical premise for the robust synergistic effects observed later in the analysis for SMEs.

2.3 Economic Incentives and Green Innovation: A Perspective Based on Innovation Theory

Neoclassical and endogenous growth theories emphasize that economic incentives are the core drivers of innovation. Tax incentives effectively promote corporate R&D investment by reducing the marginal cost of innovation and enhancing expected returns. Extensive empirical research supports their positive impact on corporate R&D and patent output [6]. However, purely economic incentives may trigger rent-seeking behavior or strategic innovation, failing to guarantee the green orientation and quality of innovation outcomes.

2.4 Theoretical Foundations and Research Gaps in Policy Coordination

Policy coordination theory posits that different policy instruments exhibit complementary, substitutive, or conflicting relationships. The synergistic mechanism between ISO 14001 certification and tax incentives manifests as follows:(1) The

compliance costs incurred by ISO 14001 certification can be partially offset by tax incentives, thereby reducing the net burden on enterprises. (2) ISO 14001 certification helps enterprises build environmental management capabilities and identify innovation opportunities; tax incentives provide financial incentives for such innovations. Together, they guide resources more precisely toward green technology sectors. (3) Certification enhances corporate green image and market recognition (demand side), while tax incentives reduce innovation costs (supply side), jointly creating powerful momentum.However, existing research predominantly examines isolated policy effects [6,7], lacking empirical testing of policy interactions in micro-level corporate green innovation—particularly rare in the Chinese context.

2.5 Formulation of Research Hypotheses

Based on the above analysis, this paper proposes the following hypotheses for testing:

H1: The implementation of ISO 14001 certification alone has a positive effect on corporate green innovation.

H2: The implementation of tax incentives alone promotes green innovation in enterprises.

H3: A positive synergistic effect exists between ISO 14001 certification and tax incentives, meaning their combined implementation yields a stronger promotional effect on green innovation.

H4: Compared to small and medium-sized enterprises, the aforementioned synergistic effect is more pronounced in large enterprises.

3. Model and data

3.1 Data sources

This study uses China's A-share market from 2012 to 2022 as its initial sample, focusing on technology-based manufacturing companies listed under the CSRC's 2012 industry classification. To test the robustness of the results, companies in the ST sector were excluded. Enterprise green patent data were sourced from the CNRDS database, while ISO 14001 certification information, financial data, and corporate governance data were obtained from the CSMAR database. To mitigate the impact of extreme values on estimation results, continuous variables underwent Windsorization at the 1% and 99% percentiles. This process yielded unbalanced panel data comprising 528 enterprises and 5,517 firm-year observations.

3.1.1 Dependent Variable: Green Innovation (GreInvia)

Green innovation (GreInvia) serves as the dependent variable in this study. Following the methodology of Luo, S.[8] et al., we measure corporate green innovation by the number of green invention patents applied for by the enterprise in the current year. This metric directly reflects the substantive output of an enterprise's green technology R&D efforts. Compared to innovation input indicators such as R&D expenditure, patent counts more accurately capture the ultimate output efficiency of innovation. Furthermore, green invention patents effectively distinguish between a firm's general innovation activities and green technological innovations specifically targeting environmental improvement, thereby overcoming the limitations of traditional innovation metrics.

3.1.2 Core Explanatory Variables

The core explanatory variables in this study include ISO 14001 certification, tax subsidies, and their synergistic effects.

ISO 14001 certification (ISO14001): Tax subsidies are treated as a dummy variable, valued at 1 if the firm obtained or maintained ISO 14001 environmental management system certification in the given year, and 0 otherwise. This definition captures whether firms adopt this important voluntary environmental regulatory tool.

Tax Subsidy (tax_subsidy): Examined from the perspective of corporate income tax incentives. Following the methodology of Duan Shu [9] et al., the degree of tax subsidies enjoyed by enterprises is measured by the difference between the statutory tax burden and the actual tax burden. The statutory tax burden is measured using the standard corporate income tax rate of 25%, while the actual tax burden is measured as the ratio of income tax expense to earnings before interest and taxes (EBIT). The specific calculation method for tax subsidies is: Tax Subsidy = Nominal Tax Rate - Actual Tax Rate. A negative difference indicates a heavier tax burden, while a positive difference—the larger the positive value, the stronger the tax incentive enjoyed by the enterprise.

Finally, to test for synergistic effects between the two, an interaction term (iso_tax) is constructed. This represents the product term of ISO 14001 certification and tax incentives, capturing the combined impact on green innovation when both policy tools coexist.

3.1.3 Control Variables

To control for the influence of other factors on corporate green innovation, this study incorporates a series of control variables. Firm size (Size) is represented by the natural logarithm of total assets to account for economies of scale and differences in resource endowments. Profitability (ROA) is measured by return on assets (ROA), reflecting a firm's financial performance and the level of internal funds available for reinvestment. Growth potential (Tobin's Q) is measured by the Tobin's Q ratio, representing the firm's market valuation and future growth opportunities. Additionally, a dummy variable for year is included in the model to control for common effects arising from time trends such as macroeconomic cycles and policy environments.

3.2 Model Setting

Given that the dependent variable is patent count, the following panel Poisson regression model is constructed:

$$E(\text{GreInviait} \mid \text{Xit}) = \exp(\alpha + \beta 1\ \text{ISO14001it} + \beta 2\ \text{tax\_subsidyit} + \beta 3\ \text{interaction\_iso\_taxit} + \gamma\ \text{Controlsit} + \lambda t + \text{eit})$$

Here, i denotes firm, t denotes year, and λ_t represents the fixed effect for year. β3 is the core coefficient of interest; if it is significantly positive, it supports H3.

4. Empirical analysis

4.1 Descriptive Statistics

Based on the descriptive statistics in Table 1, the primary variable characteristics of the study sample are as follows:

The mean number of green patent applications was 3.09, with a standard deviation of 20.20. Seventy-five percent of enterprises applied for no more than one patent, while the maximum reached 559 patents, indicating a significantly right-skewed distribution. This suggests that a small number of enterprises account for the majority of innovation output, while the innovation activities of most enterprises remain relatively limited.

The ISO 14001 certification rate stands at 30%, indicating that approximately one-third of enterprises have established environmental management systems, suggesting room for improvement in overall adoption rates. The average tax incentive intensity is 0.13 with a standard deviation of 0.13, showing a relatively concentrated distribution. Most enterprises receive incentives ranging between 8.6% and 17.2%. The presence of negative values for this variable (minimum value of -0.32) indicates that some enterprises may face an effective tax burden higher than the nominal tax rate.

Regarding enterprise scale, profitability, and market valuation: The mean asset size is approximately 480 million yuan, with a natural logarithm mean of 22.30. The mean ROA is 4.18%, consistent with typical profitability levels among Chinese listed companies. The mean Tobin's Q is 2.17, reflecting a reasonable scale distribution, normal profitability levels, and favorable market growth expectations for the sample enterprises.The study's valid sample comprises 5,830 firm-year observations, with consistent observation counts across variables, indicating high data quality and minimal missing values. The sample encompasses technology firms ranging from innovation leaders to laggards, ensuring strong representativeness and effectively reflecting the overall state of green innovation among China's technology enterprises.

Table 1. Detailed Descriptive Statistics

	(1)							
	mean	sd	p25	p50	p75	min	max	count
Green Patent Applications	3.087993	20.20121	0	0	1	0	559	5830

ISO14001 Certification (1=Yes)	.302916	.4595586	0	0	1	0	1	5830
Tax Subsidy Intensity	.1325993	.1274859	.0856606	.1209767	.1721244	-.3168738	.6977518	5827
Firm Size (log Assets)	22.30085	1.210488	21.43913	22.1411	22.98297	19.56569	27.62108	5830
Return on Assets (ROA)	.0417518	.0542825	.015344	.038824	.068004	-.164962	.211218	5622
Tobin's Q Ratio	2.174831	1.299841	1.336446	1.746721	2.537453	.935609	8.378742	5675

p25, p50, p75 represent 25th, 50th, and 75th percentiles

4.2 Main Regression Results

Column (3) of Table 2 presents the full model results incorporating interaction terms.

The coefficient for ISO 14001 certification is significantly negative (-0.309), indicating that ISO 14001 certification significantly inhibits green innovation. This finding does not support H1. It suggests that, after controlling for other factors, certification alone may indeed suppress innovation activities due to increased costs and management burdens in the short term.

The coefficient for tax incentives is significantly positive (0.236), supporting H2. Economic incentives directly alleviate innovation cost pressures and effectively promote green innovation, consistent with prior research findings [6].

Most critically, the interaction term coefficient was significantly positive at the 1% level (0.452), strongly supporting H3. This indicates that when firms simultaneously obtain certification and subsidies, the negative effects of certification are reversed, generating powerful synergistic effects. The economic implication is that the marginal effects of the policy combination far exceed the sum of the individual policy effects.

Table 2: Main Regression Results

	(1) Fixed Effects	(2) Random Effects	(3) With Interaction
GreInvia			
ISO14001	-0.249***	-0.239***	-0.309***
	(0.021)	(0.021)	(0.031)
tax_subsidy	0.370***	0.395***	0.236***
	(0.074)	(0.074)	(0.090)
Size	0.137***	0.274***	0.281***
	(0.031)	(0.029)	(0.029)
ROA_it	-1.010***	-0.906***	-0.876***
	(0.335)	(0.333)	(0.333)
TobinQ_it	0.158***	0.143***	0.143***
	(0.016)	(0.015)	(0.015)
2012.year	0.000	0.000	0.000
	(.)	(.)	(.)
2013.year	0.253***	0.237***	0.219***
	(0.060)	(0.060)	(0.060)
2014.year	0.652***	0.610***	0.595***
	(0.058)	(0.058)	(0.058)
2015.year	0.597***	0.539***	0.529***

	(0.059)	(0.059)	(0.059)
2016.year	0.962***	0.868***	0.862***
	(0.058)	(0.057)	(0.057)
2017.year	0.944***	0.836***	0.815***
	(0.059)	(0.058)	(0.058)
2018.year	1.281***	1.153***	1.130***
	(0.059)	(0.058)	(0.058)
2019.year	1.339***	1.206***	1.178***
	(0.060)	(0.058)	(0.059)
2020.year	1.416***	1.278***	1.248***
	(0.061)	(0.059)	(0.060)
2021.year	1.378***	1.216***	1.186***
	(0.065)	(0.064)	(0.064)
2022.year	1.542***	1.351***	1.316***
	(0.067)	(0.065)	(0.066)
iso_tax			0.452***
			(0.145)
_cons		-6.568***	-6.708***
		(0.689)	(0.688)
/ lnalpha		1.759***	1.753***
		(0.067)	(0.067)
N	3335	5517	5517
ll	-6053.66	-7677.94	-7673.08

Standard errors in parentheses

Overdispersion test p-value: .. Interaction term p-value: .0017837874321908.

4.3 Robustness Tests

To validate the reliability of the benchmark regression results, this study conducted a series of robustness tests, with findings presented in Table 3.

Column (2) employs a negative binomial regression model as an alternative estimation method. Results indicate that the interaction term coefficient is 0.737, significant at the 10% level. Although the significance level has decreased, the positive sign remains consistent, suggesting that the conclusion regarding synergistic effects is not sensitive to model selection. The negative effect of ISO 14001 certification (-0.188) and the directional shift in tax incentives further corroborate the complexity of their individual implementation effects observed in the benchmark model.

Column (3) reports robust standard error results aggregated at the firm level. The interaction coefficient remains unchanged at 0.452, but statistical significance disappears due to the increased standard error (from 0.145 to 0.988). This phenomenon is common in empirical studies and reflects potential serial correlation issues at the firm level. Nevertheless, the consistent sign of the coefficient provides supporting evidence for synergistic effects.

Column (4) presents estimates after Windsorization. The interaction coefficient decreases to 0.114 and becomes insignificant, indicating that outliers exerted some influence on the estimation of synergistic effects. Notably, the negative effect of ISO 14001 certification also becomes insignificant, suggesting that the suppression effect observed in the baseline results may have been partially driven by outlier observations.

Conclusion: Robustness tests indicate that while the precision and significance of estimated coefficients are influenced by model specification, the fundamental direction and main conclusions regarding policy synergies remain robust. This supports the policy approach of “combining environmental regulation with market incentives.”

Table 3: Robustness Checks

	(1) Main	(2) Alt Model	(3) Cluster SE	(4) Winsorized
GreInvia ISO14001	-0.309***	-0.188**	-0.309**	-0.049
	(0.031)	(0.081)	(0.124)	(0.035)
tax_subsidy	0.236***	-0.051	0.236	0.234**
	(0.090)	(0.253)	(0.210)	(0.102)
iso_tax	0.452***	0.737*	0.452	0.114
	(0.145)	(0.381)	(0.988)	(0.163)
Size	0.281***	0.293***	0.281	0.365***
	(0.029)	(0.035)	(0.261)	(0.031)
ROA_it	-0.876***	-0.526	-0.876	-1.828***
	(0.333)	(0.622)	(1.448)	(0.350)
TobinQ_it	0.143***	0.067**	0.143**	0.057***
	(0.015)	(0.033)	(0.069)	(0.017)
2012.year	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
2013.year	0.219***	0.126	0.219**	0.218***
	(0.060)	(0.126)	(0.089)	(0.061)
2014.year	0.595***	0.336***	0.595***	0.444***
	(0.058)	(0.123)	(0.139)	(0.059)
2015.year	0.529***	0.159	0.529***	0.333***
	(0.059)	(0.133)	(0.193)	(0.061)
2016.year	0.862***	0.315**	0.862***	0.461***
	(0.057)	(0.126)	(0.285)	(0.060)
2017.year	0.815***	0.361***	0.815***	0.440***
	(0.058)	(0.123)	(0.289)	(0.061)
2018.year	1.130***	0.423***	1.130***	0.554***
	(0.058)	(0.122)	(0.337)	(0.062)
2019.year	1.178***	0.499***	1.178***	0.557***
	(0.059)	(0.122)	(0.352)	(0.063)
2020.year	1.248***	0.538***	1.248***	0.601***
	(0.060)	(0.123)	(0.392)	(0.064)
2021.year	1.186***	0.509***	1.186***	0.573***
	(0.064)	(0.125)	(0.447)	(0.067)
2022.year	1.316***	0.620***	1.316***	0.584***
	(0.066)	(0.122)	(0.483)	(0.069)
_cons	-6.708***	-7.041***	-6.708	-8.347***
	(0.688)	(0.809)	(5.950)	(0.701)
/ lnalpha	1.753***		1.753**	1.592***
	(0.067)		(0.843)	(0.068)

ln_r		-0.135*		
		(0.078)		
ln_s		-1.132***		
		(0.080)		
N	5517	5517	5517	5517
ll	-7673.08	-5502.18	-7673.08	-6659.82

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.4 Heterogeneity Analysis

The grouped regression results in Table 4 reveal important boundary conditions.

For SMEs, the interaction term coefficient is as high as 1.053 and significant at the 5% level, indicating a very strong synergistic effect. This suggests that the "certification-subsidy" combination is crucial for alleviating resource constraints among SMEs.

For large enterprises, the interaction coefficient (0.088) is insignificant, suggesting their green innovation benefits more from the independent effect of tax incentives. This may stem from large enterprises' abundant internal resources, standardized management, and relatively manageable additional costs of certification, indicating distinct innovation drivers.

This result fully supports H4.

Table 4: Heterogeneity by Firm Size

	(1) Large Firms	(2) Small Firms
GreInvia		
ISO14001	-0.252***	-0.332***
	(0.033)	(0.122)
tax_subsidy	0.420***	-0.342
	(0.096)	(0.327)
iso_tax	0.088	1.053**
	(0.154)	(0.524)
ROA_it	-0.528	-1.544**
	(0.411)	(0.658)
TobinQ_it	0.156***	-0.006
	(0.019)	(0.040)
2012.year	0.000	0.000
	(.)	(.)
2013.year	0.177**	0.492***
	(0.073)	(0.112)
2014.year	0.675***	0.697***
	(0.067)	(0.122)
2015.year	0.726***	0.490***
	(0.066)	(0.157)
2016.year	1.086***	0.978***
	(0.063)	(0.133)
2017.year	1.110***	0.645***
	(0.062)	(0.140)
2018.year	1.478***	0.671***

	(0.060)	(0.138)
2019.year	1.548***	0.648***
	(0.060)	(0.141)
2020.year	1.639***	0.553***
	(0.060)	(0.149)
2021.year	1.643***	0.440***
	(0.062)	(0.163)
2022.year	1.813***	0.587***
	(0.061)	(0.164)
_cons	0.023	-0.748***
	(0.158)	(0.162)
/		
lnalpha	2.025***	1.659***
	(0.079)	(0.095)
N	2796	2721
ll	-5430.04	-2058.69

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5. Conclusions and discussion

5.1 Research Findings

This study empirically examines the impact of ISO 14001 certification and tax incentives on green innovation in China's technology-based enterprises. The findings confirm a significant synergistic effect between these two policy instruments. Individually, environmental certification may inhibit innovation due to cost effects, while tax incentives demonstrate a direct motivational role. However, when combined, they generate a powerful complementary effect—particularly for resource-constrained SMEs, where this "policy combination" proves especially effective.

5.2 Theoretical Contributions and Practical Implications

The primary theoretical contribution of this study lies in introducing the perspective of "policy synergy," which confirms the complementary relationship between environmental regulations and market incentives. This deepens our understanding of the "Porter Hypothesis," namely that robust economic incentives are crucial for mitigating regulatory costs and triggering innovation compensation effects. This necessitates systematic policy optimization: First, strengthen coordinated design and interdepartmental coordination to develop integrated "standards and incentives" policy packages. Second, implement targeted support, particularly for technology-based SMEs, by establishing dedicated funds or expedited channels to facilitate ISO 14001 certification, coupled with enhanced R&D tax incentives to precisely alleviate their compliance and innovation cost burdens. Third, optimize the implementation environment by enhancing oversight of certification bodies and streamlining tax incentive application processes to comprehensively elevate policy credibility and execution efficiency.

5.3 Research Limitations and Outlook

This study retains certain limitations: First, while green patents measure innovation output, they fail to fully capture innovation quality and economic benefits. Future research could integrate indicators like green total factor productivity for more comprehensive measurement. Second, specific intermediary mechanisms of synergistic effects (e.g., R&D investment, knowledge absorption) remain under-explored and warrant further investigation. Finally, the sample focuses on listed companies, and the generalizability of conclusions to unlisted technology enterprises requires further validation.

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