Innovation and Performance, Role of Financing constraints as Moderator

QI WANG

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR MASTER DEGREE OF ACCOUNTANCY
BURAPHA BUSINESS SCHOOL
BURAPHA UNIVERSITY
2026

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This study examines the complex relationship between corporate innovation and firm performance, focusing on the moderating role of financial leverage as a financing constraint. Using data from non-financial firms listed on China's Shanghai and Shenzhen A-share markets (2013–2022), we apply fixed-effects panel models to analyze this interaction. Results show that innovation inputs (R&D expenditure) and outputs (patent citations) positively affect market value (Tobin's Q), while their impact on accounting performance (ROA, ROE) is mixed and often delayed by one year. Importantly, financial leverage significantly weakens the innovation-performance link, with high debt levels reducing the benefits of innovation, especially for capitalized R&D and overall R&D intensity. These findings are robust across alternative performance measures and model specifications. This research underscores the critical role of capital structure, offering insights for managers optimizing innovation financing and policymakers addressing credit constraints for innovative firms.

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Qi Wang

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CHAPTER 1
INTRODUCTION

1.1 Research Background

A country's ability to develop and utilize its innovative capacity is vital for long-term economic performance and sustainable development (Ernst, 2005; Tsai, Lin, & Kurekova, 2009). Aligning with national policy, companies in China increased R&D spending from ¥89.6 billion in 2000 to ¥2.44 trillion in 2020 (China Statistical Yearbook). Innovation is a top priority in China's 14th Five-Year Plan (2021–2025) to become an innovative nation (Xu et al., 2023). Government initiatives boost the manufacturing sector by providing companies with greater competitive advantages (Huang, 2023; Tsai et al., 2009). In 2023, companies continuously investing in R&D could deduct 200% of R&D costs before taxes, reflecting strong government support for innovation (C. Lee, 2024).

A firm's ability to finance R&D is crucial for driving performance. The uncertain outcomes and long investment cycles of innovation increase financing costs (B. H. Hall, 2002). Innovation requires stable financial support, yet internal funds are often unreliable. According to pecking order theory, firms rely on external financing to complete technological innovation, making them dependent on outside funding (Bartoloni, 2013). Compared to market-based equity financing, debt financing—such as short-term bank loans—dominates innovation funding due to its lower capital costs (Acemoglu & Linn, 2004). Financing R&D is vital for firm performance, but innovation's uncertainty and long cycles raise costs (B. H. Hall, 2002). Firms depend on external funding, often favoring debt like short-term loans over equity because of lower capital costs (Acemoglu & Linn, 2004; Bartoloni, 2013)

Debt financing can constrain firms, especially small ones, due to poor creditworthiness. Although it offers lower capital costs, lenders typically require tangible collateral, which R&D projects lack. Additionally, information asymmetry and market imperfections make equity financing more expensive than internal funds. Small firms struggle to secure external funding because investors have limited information (Myers & Majluf, 1984) leading to reliance on internal funds for

investment (Fazzari & Athey, 1987). These financial constraints often force companies to forgo potential projects. The innovation development stage is particularly affected, as it is risky, costly, slow to yield returns, and suffers from high information asymmetry.

Strategic financing allocation for R&D enhances a company's competitiveness through innovation (Alraja, Imran, Khashab, & Shah, 2022). While some studies show innovation improves performance (Nemlioglu & Mallick, 2021) , others highlight risks, noting that failed innovations can harm financially constrained firms(Zhang, Zhu, Zhou, & Zou, 2022) . Negative or no relationships between innovation and performance have been observed in various countries (Cazavan-Jeny & Jeanjean, 2006; Feyzrakhmanova & Gurdgiev, 2016) (Guo & Xie, 2019; Hartmann, Myers, & Rosenbloom, 2006). Although a link exists, mechanisms like time lags, tax shields, and accounting treatments remain unclear. For instance, R&D expensing lowers short-term profits but provides tax benefits, while capitalization matches costs with long-term revenues but risks earnings manipulation (Cazavan-Jeny & Jeanjean, 2006; Lev & Sougiannis, 1996). These trade-offs require deeper analysis of how innovation strategies translate into performance outcomes.

Financial leverage can lower financing costs and boost firms' innovation inputs (Acemoglu & Linn, 2004). Debt financing offers a tax shield effect (B. H. Hall, 2002), and appropriate indebtedness promotes innovation (B. Hall & Van Reenen, 2000). However, excessive leverage increases debt servicing risk, financial distress costs, and hampers performance (Yazdanfar & Öhman, 2015). It also reduces return on equity, equity value, and shareholder wealth (U. Iqbal & Usman, 2018; K. Kim, Patro, & Pereira, 2017). Conversely, leverage reduces free cash flow, encouraging managers to invest in positive NPV projects and allowing external investors to monitor management, thus lowering agency costs (Harris & Raviv, 1990; Hart & Moore, 1994; Jensen, 1986; Zwiebel, 1996). According to trade-off theory, firms must balance the risks and benefits of leverage and regulate it rationally leverage (Meckling & Jensen, 1976; Modigliani & Miller, 1958). Excessive debt limits R&D and weakens firms (García-Gómez et al., 2021), while too little debt reduces innovation funding (K. Chen & Zha, 2018). Firms must balance debt and innovation to protect value (Gao, 2021; N. Iqbal, Xu, Fareed, Wan, & Ma, 2022).

Financial leverage has dual effects on innovative firms. While debt financing reduces tax burdens and provides immediate capital for innovation (B. H. Hall, 2002), excessive leverage increases bankruptcy risk and restricts R&D investments (Yazdanfar & Öhman, 2015). This highlights the need to understand how financial leverage moderates the innovation-performance relationship. Additionally, the impact of R&D accounting methods (expensing vs. capitalization) on firm performance warrants further exploration.

1.2 Research Questions

Is there a relationship between innovation and corporate performance? Does financial leverage moderate the relationship between innovation and corporate performance?

1.3 Research Objectives

To examine the relationship between innovation and corporate performance. To examine how financial leverage moderates the relationship between innovation and corporate performance.

1.4 Research framework

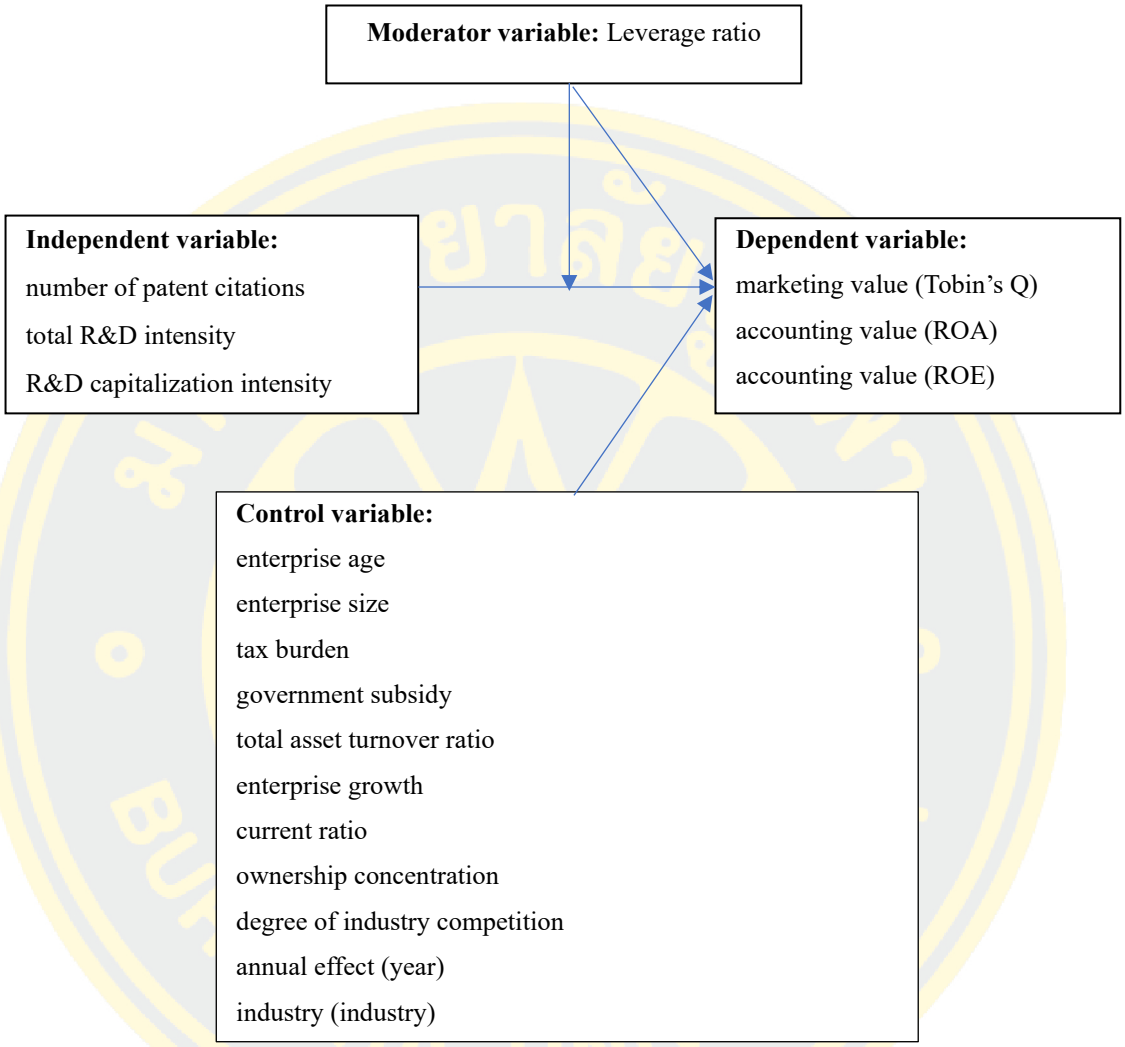

Figure 1 Research framework

1.5 Research significances

This clarifies leverage's dual role as both a driver and constraint in innovation-performance dynamics. It presents evidence on the differing impacts of R&D expensing versus capitalization, enriching accounting policy discussions. The study offers actionable strategies for firms to balance innovation investments with leverage management, especially in high-risk sectors. It combines multiple proxies for innovation (R&D intensity, patent citations) and performance (ROA, Tobin's Q) to improve measurement accuracy.

1.6 Research Scope

The analysis examines A-share non-financial listed companies in China's Shanghai and Shenzhen markets from 2010 to 2022, capturing post-financial crisis innovation trends. Key limitations include reliance on secondary data and inefficiencies in emerging capital markets.



CHAPTER 2
LITERATURE REVIEW

2.1 Theoretical Foundation

Innovation-induced performance theory

Schumpeter and Swedberg (2021) define innovation as recombining production factors to create new functions. Later studies expanded this into two branches: neoclassical growth theory, which integrates technology into economic models, and the network paradigm, which emphasizes external collaboration to reduce innovation uncertainty (Murmann & Frenken, 2006).

Innovation allows firms to develop unique resources and enhance long-term competitiveness. Scholars assess innovation through two dimensions: inputs and outputs. Inputs include financial and human resources dedicated to R&D, such as R&D spending and personnel ratios. Outputs consist of tangible results like patent citations, new product sales, and technology commercialization. This study employs both input and output measures to capture the complete innovation process, with R&D expenditures representing short-term investment and patents indicating long-term success.

Corporate performance is assessed using market-based and accounting-based metrics. Market-based metrics like Tobin's Q compare a firm's market value to asset replacement cost, reflecting investor expectations. Accounting-based metrics such as ROA (return on assets) and ROE (return on equity) measure profitability from financial statements. This paper uses Tobin's Q and ROA to capture both market perception and operational efficiency. However, Tobin's Q can overvalue firms in inefficient markets, and ROA relies on historical data.

Signaling theory explains how individuals or organizations convey information to influence others' perceptions and decisions.

Signaling theory, based on Spence (1978) work, explains how firms use observable actions to reduce information asymmetry with external stakeholders. Ross (1977) highlighted that managers, possessing superior knowledge of operations, send signals through financial decisions. For example, higher debt ratios indicate strong

operational health, as weaker firms avoid debt due to bankruptcy risks. High-quality firms prefer debt financing, while low-quality firms favor equity, leading investors to value debt-heavy firms more. In innovation, firms use costly or verifiable signals to convey unobservable traits like technological competence and growth potential. For instance, choosing debt over equity signals confidence in future cash flows (Ross, 1977), while heavy R&D spending or patent filings serve as credible indicators of innovation capability (C.-J. Chen & Huang, 2009).

Collaborations with universities or research institutions demonstrate a commitment to advanced knowledge and technology (Becker & Dietz, 2004). However, signaling poses challenges. When seeking external innovation funding, firms must balance disclosing project details to attract investment against the risk of intellectual property leakage. Excessive secrecy can undermine investor confidence (Myers, 1984). Effective signaling requires aligning claims with real outcomes, as misleading signals—such as inflated R&D disclosures without results—damage trust and long-term performance. Ultimately, successful signaling lowers capital costs, improves market access, and strengthens stakeholder relationships, thereby enhancing firm performance.

Resource-Based View (RBV)

The resource-based view (RBV), articulated by Barney (1991) and Wernerfelt (1984), asserts that firms are bundles of resources, and competitive advantage arises from resources that are valuable, rare, inimitable, and non-substitutable. Innovation helps firms develop unique resources that competitors cannot replicate, enabling monopolistic profits. For example, proprietary technologies, such as patented manufacturing processes, create barriers to imitation and allow firms to dominate niche markets (Barney, 1991). Human capital—skilled R&D teams and adaptive organizational cultures—is equally vital (Kreps, 1990). These resources transform ideas into market-ready innovations, especially important for SMEs with limited external visibility (Becker & Dietz, 2004; Grant, 1991). Unlike signaling theory's indirect approach, RBV links innovation to performance through direct mechanisms like cost savings and product differentiation. Firms with superior resources innovate faster and commercialize more effectively, securing long-term market leadership.

Leverage-related theory explores the impact of financial leverage on a firm's performance and risk.

Leverage refers to a firm’s use of external funds, such as bonds, loans, or equity issuance, to enhance its financial capacity. It indicates the proportion of debt in the capital structure and highlights two key aspects: financial risk—where higher debt increases repayment obligations and bankruptcy risk—and debt-servicing capacity, or the ability to meet interest and principal payments. For example, highly leveraged firms can invest more in growth but face stricter creditor oversight and potential liquidity constraints (B. H. Hall, 2002). The leverage ratio measures a firm’s access to finance.

Various theories explain firms' financing choices. The Pecking Order theory states firms prefer internal financing, then debt, and finally equity to minimize costs and avoid negative market signals (Myers, 1984). Modigliani and Modigliani and Miller (1958) argue that capital structure does not affect firm value if taxes are ignored. However, with corporate taxes, debt financing offers tax benefits through interest deductions, reducing overall capital costs and increasing financial leverage (Gordon, 1963; Modigliani & Miller, 1958). Non-debt tax shields, such as depreciation and R&D expenses, also lower taxable income without default risk (DeAngelo & Masulis, 1980). The tax shield from non-debt sources is calculated as NDTS = (Depreciation + Amortization + R&D Expenses) / Total Assets.

While debt financing offers benefits, high debt levels increase default or especially during economic downturns. Firms may cut R&D investments to meet debt obligations, weakening long-term competitiveness. Signaling theory suggests that information asymmetry between firms and investors leads to capital structure signaling: high debt can indicate growth potential but may deter investors if information is withheld (Myers, 1984). Additionally, high debt brings creditor oversight and monitoring costs (Jensen & Meckling, 2019). However, Agency Cost Theory posits that creditor intervention can reduce conflicts between managers and shareholders. Thus, firms must balance debt advantages, like tax savings, against disadvantages, such as bankruptcy risk, to find an optimal capital structure. Trade-off theory states that excessive debt causes financial instability, while too little debt limits tax benefits.

2.2 Review of Related Studies

The relationship between innovation and performance.

The relationship between innovation and firm performance has been widely studied, but empirical findings remain inconclusive across different contexts and measurement methods. Generally, innovation is believed to improve firm performance over the long term, despite potential short-term financial costs. Early studies Damanpour and Evan (1984); Lev and Sougiannis (1996) showed that technological and managerial innovations lead to delayed gains in profitability and market value. Likewise, Artz, Norman, Hatfield, and Cardinal (2010) and Hirshleifer, Hsu, and Li (2013) found that R&D efficiency and patent metrics enhance long-term shareholder value. These results support resource-based and knowledge-based views that see innovation as a driver of sustained competitive advantage.

However, some studies present conflicting findings. Cazavan-Jeny and Jeanjean (2006) and Keung, Lin, and Shih (2010) argue that R&D capitalization may be seen by investors as earnings manipulation, damaging market trust and short-term stock prices. Artz et al. (2010) note that although R&D investment boosts patent counts, patents do not always lead to improved accounting performance, possibly due to strategic patenting and delayed commercialization. These discrepancies indicate that the innovation–performance relationship depends on firm strategy, industry traits, and external financing.

A key reason for inconsistencies is the time-lag effect of innovation outcomes. Studies in developed and emerging markets (Liu et al., 2019; Nieto & Santamaría, 2010; Usman, Shaique, Khan, Shaikh, & Baig, 2017) show that R&D investment often reduces short-term profitability (ROA, ROE) but increases market value after one to three years. This reflects the cumulative and uncertain nature of innovation, where benefits emerge only when research matures into commercial products. However, other research Rao, Yu, and Cao (2013) suggests that the positive impact may decline after prolonged delays, indicating that overly long innovation cycles can reduce returns.

Non-linear effects frequently appear in research. Studies Y.-S. Chen and Chang (2010); Guo and Xie (2019); Ho, Tjahjapranata, and Yap (2006) reveal inverted U-shaped relationships between R&D intensity and performance, indicating

that moderate innovation spending maximizes efficiency, while excessive investment leads to diminishing or negative returns. Additionally, knowledge spillover effects Y.-S. Chen and Chang (2010) complicate this dynamic, as patents cited beyond a certain threshold may advantage competitors more than the original innovator.

Contextual factors like industry maturity, financing structure, and governance mechanisms significantly influence the innovation–performance relationship. For instance, Yin and Sheng (2019) showed that executive compensation boosts innovation in Chinese firms, while Nemlioglu and Mallick (2021) found that strong management quality reduces financial constraint risks in Turkish companies. Financing sources also matter: equity financing enhances innovation capacity (J. Feng, Yao, & Yang, 2022), whereas debt financing can hinder it due to repayment pressures (Miao, Fang, Sun, Luo, & Yu, 2018)

The literature converges on several key points.Innovation typically boosts long-term market performance but can reduce short-term accounting profits.The effect varies over time, showing delayed and possibly non-linear patterns.

The strength and direction of this relationship differ across industries, financing conditions, and national institutions.

Despite extensive research, gaps remain in understanding how innovation time lags interact with financing structures to impact firm value, especially in emerging markets like China. Most studies focus on linear or immediate innovation effects, neglecting dynamic lag structures and contextual factors.

H1: Innovation positively influences firm performance.

H1.1: Innovation's impact on firm performance is delayed, with positive effects appearing only after some time following the investment.

The relationship between leverage, innovation, and firm performance.

Hsu (2013)shows that excessive debt diminishes the positive impact of R&D on profitability in Taiwanese technology firms, suggesting financial pressure limits managerial freedom and short-term innovation gains. This indicates that while leverage enforces discipline, it also creates rigidity, leading firms with high debt to prefer incremental or low-risk projects over exploratory innovation.

O’Connell, AbuGhazaleh, Tahat, and Whelan (2022) find that successful, capitalized R&D projects reduce the negative impact of leverage on future innovation investment, turning debt from a constraint into a catalyst by boosting creditor and investor confidence. Similarly, Cuevas-Vargas, Cortés-Palacios, and Lozano-García (2022) demonstrate that capital structure influences performance indirectly through innovation, showing that well-managed financial leverage can enhance innovation-driven performance.

JEURISSEN (2020) shows that in highly leveraged U.S. firms, innovation increases financial risk, leading to a negative leverage–performance relationship. This supports the view that innovation outcomes are uncertain and debt amplifies return volatility. Ibhagui and Olokoyo (2018) add that this relationship varies by firm size: larger firms better absorb financial risk, so leverage’s impact differs based on financial resilience. Kijkasiwat and Phuensane (2020) highlight the importance of financial capital availability, similar to leverage capacity, in turning innovation into performance gains, especially for SMEs with limited internal funds.

These findings collectively support a key theoretical proposition central to this study. Leverage influences how innovation impacts performance by affecting firms’ financial constraints and risk tolerance. Moderate leverage signals financial discipline and resource availability, boosting innovation efficiency, while excessive leverage hinders experimentation and raises performance volatility. Thus, understanding leverage’s moderating role is essential to explain the varied innovation–performance relationships across firms and markets, supporting

Hypothesis H2.

H2: Leverage moderates the relationship between innovation and performance.

Control variables

To improve the model's explanatory power and reduce omitted-variable bias, this study incorporates three control variable categories—firm heterogeneity, financial and governance characteristics, and external environmental factors—based on prior research (Hsu, 2013) (O’Connell et al., 2022) (Cuevas-Vargas et al., 2022) (JEURISSEN, 2020) (Kijkasiwat & Phuensane, 2020) (Ibhagui & Olokoyo, 2018).

These variables are theoretically and empirically linked to firm performance and innovation.

Firm heterogeneity includes age, size, growth, and liquidity. Older firms have more experience and networks but may innovate less. Controlling for age accounts for life-cycle differences. Larger firms have more resources and access to finance but may face bureaucratic inertia that stifles innovation (JEURISSEN, 2020; O'Connell et al., 2022). High-growth firms invest more in innovation but face greater performance volatility (Kijkasiwat & Phuensane, 2020). The current ratio reflects liquidity; while higher liquidity lowers financial risk, it may also signal idle capital and reduced investment efficiency (JEURISSEN, 2020).

Financial and governance factors significantly impact firm performance. Higher tax rates reduce profits, limiting R&D and investment, while tax incentives promote innovation (N. Iqbal et al., 2022; Modigliani & Miller, 1958) ; Government subsidies ease financing constraints and encourage R&D (Cuevas-Vargas et al., 2022; Hsu, 2013). Total asset turnover measures operational efficiency, with higher turnover enhancing performance (Ibhagui & Olokoyo, 2018). Ownership concentration affects governance and agency costs; increased concentration improves monitoring but may harm minority shareholders if control is excessive (Hsu, 2013).

External environmental factors include the degree of industry competition (HHI_D), which reflects market structure and innovation incentives. The Schumpeterian hypothesis suggests moderate competition fosters innovation, while excessive competition deters investment (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005). Year dummies control for macroeconomic shocks, policy changes, and temporal fluctuations (O'Connell et al., 2022). Industry dummies account for technological and capital-structure differences across sectors, preventing industry-specific traits from distorting results (Cuevas-Vargas et al., 2022).

These control variables—based on firm characteristics, financial governance, and environmental conditions—remove non-core influences on the relationships among leverage, innovation, and firm performance, enhancing the robustness and validity of the empirical results.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Sample Construction

This study analyzes fixed effects unbalanced panel data from the CSMAR database, focusing on non-financial firms listed on China's A-share market from 2010 to 2022. Using Stata, financial data, ownership structure, R&D expenditures, patent citations, government subsidies, and industry information are merged. Continuous variables are winsorized at 1% to reduce outlier effects. Firm performance is measured by ROA and Q; innovation by R&D intensity and patent citations; leverage by the debt-to-asset ratio. Control variables include firm size, age, tax burden, government subsidies, and current ratio. Calculated but unnecessary variables are dropped, and observations with missing values are removed.

A fixed effects regression model estimates innovation's impact on firm performance, incorporating one-, two-, and three-period lags to capture long-term effects. Leverage and its interaction terms are added to test moderating effects. Robustness checks include substituting performance with ROE and performing subgroup regressions. A fixed effects model with lagged innovation terms evaluates its long-term impact on firm performance. Leverage and interaction terms test moderation, followed by robustness checks using ROE and subgroup regressions.

Selecting Shanghai and Shenzhen A-share listed firms suits this study well. Under China's accounting rules (CAS 2006 No. 6), these firms must separately report expensed and capitalized R&D, allowing clear distinction between ERD and CRD. The unified regulatory and disclosure framework by the CSRC ensures comparability across firms. Many A-share companies operate in technology, manufacturing, and emerging industries, where innovation is active and leverage varies, making the sample ideal. Additionally, financial, patent, leverage, and R&D data are readily available through the CSMAR database, which offers consistent, continuous, and comparable data over time.

Previous studies show that substituting ROE for ROA does not significantly change empirical results (Karna, Mavrovitis, & Richter, 2022). Saharti (2025) used

both ROA and ROE as complementary measures of firms' financial health and innovation capacity. Thus, using ROE instead of ROA in this study's robustness test is theoretically justified.

Panel-level unobserved heterogeneity often correlates with explanatory variables in corporate innovation–performance models. Bell, Fairbrother, and Jones (2019) offer a framework for selecting between fixed effects (FE) and random effects (RE), noting that FE is preferable when individual effects correlate with regressors. Clark and Linzer (2015) demonstrate through simulations that FE typically provides more reliable estimates when RE assumptions are violated. In finance, C.-F. Lee, Chen, and Lee (2019) also endorse FE for firm-level panel studies.

3.2 Variable Definitions

Table 1 variable measurement

variable	proxy	description
performance	marketing value (Tobin's Q)	market value (book value of liabilities + market value of equity capital) of assets at the end of year) divided by book value of assets (book value of liabilities +book value of equity capital) (Agrawal & Knoeber, 1996; J. Kim, Kim, & Lee, 2011)
performance	accounting value (ROA)	net profit / total asset
performance	accounting value (ROE)	net profit / equity
innovation	innovation influence (Number of patent citations)	NCited i,t = Ln(Number of patent citations i,t +1) (Azim Khan, 2023)
innovation	R&D intensity (TRD)	(R&D investment) / total asset (N. Iqbal, Xu, Fareed, Wan, & Ma, 2020)
innovation	R&D capitalization intensity (CRD)	R&D capitalization/ total asset (Y. Feng, Ma, Wang, & Ma, 2022)
innovation	R&D expensing intensity (ERD)	R&D expensing/ total asset (Y. Feng et al., 2022)
leverage	leverage ratio (lev)	total debt / total asset

Table 1 (Cont.)

variable	proxy	description
control variables (N. Iqbal et al., 2022; Shahzad, Luo, & Liu, 2023)		
enterprise age (Age)	Ln (observation year - establishment year + 1)	
enterprise size (size)	Ln (total assets+1)	
tax burden (TAX)	the tax payable /operating income	
government subsidy (lnGRANT)	Ln (government subsidies +1)	
total asset turnover ratio (turnover)	operating income/ total asset	
enterprise growth (growth)	(the operating income of the year -operating income of the previous year)/operating income of the previous year	
current ratio (current)	current assets/current liabilities	
ownership concentration	Percentage of shares held by controlling shareholders/100	
degree of industry competition	Herfindahl-Hirschman index (HHI_D): HHI_Djt = $\Sigma i \in \Delta j(salei, t/salej, t) \wedge 2$where saleit represents the operating income of enterprise i in year t, and salejt is the industry j's operating income in year t.	
annual effect (year)	time dummy variable	
industry (industry)	industry dummy variable	

3.3 Estimation Model

Based on the literature review and chosen proxy variables, we propose preliminary hypotheses and a model to analyze the relationship between leverage, innovation, and performance in non-financial listed companies.

To test H1—the relationship between innovation and performance—a fixed-effects regression model is constructed to analyze the link between corporate innovation and performance, as follows:

$$Performance_{i,t} = \beta_0 + \beta_1 Inno_{i,t} + \gamma Control_{i,t} + Indus + year + \epsilon_{i,t} \quad (1)$$

To test H2—the moderating role of leverage—the interaction between leverage and innovation on firm performance is examined using cross terms, leading to the development of Model 2.

$$Performance_{i,t} = \beta_0 + \beta_1 Inno_{i,t} + \beta_2 Inno_{i,t} * LEV_{i,t} + \gamma Control_{i,t} + Indus + year + \epsilon_{i,t} \quad (2)$$

Performance is measured by quality (Q), return on assets (ROA), and return on equity (ROE) for robustness testing.

Innovation is measured by four proxies: 1) Ncited, 2) TRD, 3) ERD, and 4) CRD.

Innovation is classified into four categories by examining innovation inputs, outputs, and variations in accounting treatments for R&D inputs under accounting standards.

Additionally, we analyze the potential for dynamic relationships per H1.1 by including lagged innovation variables in equation (1.1), expressed as follows:

$$Performance_{i,t} = \beta_0 + \sum_{j=1}^{3} \beta_1 Inno_{i,t-j} + \gamma Control_{i,t} + Indus + year + \epsilon_{i,t} \quad (3)$$

CHAPTER 4
RESULTS

4.1 Regression Results

Table 2 Innovation's Impact on Performance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Q	Q	Q	Q	ROA	ROA	ROA	ROA
NCited	0.051***				-0.002***			
	(9.020)				(-7.974)			
ERD		7.367***				0.187***		
		(13.143)				(6.900)		
CRD			22.520***				-0.412***	
			(12.938)				(-4.902)	
TRD				12.617***				0.087***
				(29.263)				(4.139)

_cons	10.560***	10.118***	10.097***	9.718***	-0.253***	-0.226***	-0.231***	-0.231***
	(60.746)	(62.230)	(62.119)	(60.457)	(-30.207)	(-28.866)	(-29.441)	(-29.452)
size	-0.415***	-0.396***	-0.395***	-0.379***	0.015***	0.014***	0.014***	0.014***
	(-50.002)	(-50.545)	(-50.464)	(-48.995)	(37.562)	(36.531)	(37.167)	(37.120)
lev	0.022	0.015	0.025	0.088*	-0.167***	-0.167***	-0.167***	-0.166***
	(0.414)	(0.286)	(0.469)	(1.688)	(-65.487)	(-65.250)	(-65.357)	(-64.967)
Age	0.244***	0.279***	0.257***	0.304***	-0.008***	-0.008***	-0.009***	-0.009***
	(19.890)	(22.993)	(21.252)	(25.303)	(-13.632)	(-14.325)	(-14.968)	(-14.542)
SOE	-0.118***	-0.136***	-0.117***	-0.104***	0.002*	0.001	0.002*	0.002*
	(-6.350)	(-7.316)	(-6.290)	(-5.695)	(1.753)	(1.287)	(1.743)	(1.892)
ContrshrP	-0.057	-0.102*	-0.034	0.002	0.042***	0.042***	0.042***	0.043***
	(-1.084)	(-1.942)	(-0.654)	(0.036)	(16.384)	(16.439)	(16.374)	(16.892)
HHI_D	0.019	0.038	0.045	0.218***	-0.017***	-0.015***	-0.017***	-0.015***
	(0.335)	(0.674)	(0.789)	(3.875)	(-6.268)	(-5.651)	(-6.274)	(-5.398)
LnGRANT	-0.026***	-0.022***	-0.024***	-0.035***	0.001***	0.000***	0.000***	0.000**
	(-8.362)	(-7.187)	(-7.858)	(-11.190)	(3.798)	(2.678)	(2.953)	(2.097)

TAX	4.908***	4.846***	4.749***	5.057***	0.125***	0.132***	0.131***	0.132***
	(22.575)	(22.368)	(21.923)	(23.607)	(11.929)	(12.630)	(12.522)	(12.638)
turnover	0.224***	0.202***	0.242***	0.140***	0.027***	0.027***	0.027***	0.027***
	(10.654)	(9.611)	(11.503)	(6.685)	(26.995)	(26.240)	(26.565)	(26.058)
current	0.080***	0.078***	0.079***	0.077***	0.000	0.000	0.000	0.000
	(17.556)	(17.073)	(17.473)	(17.174)	(0.464)	(0.457)	(0.600)	(0.566)
growth	0.328***	0.322***	0.318***	0.295***	0.074***	0.075***	0.075***	0.075***
	(12.947)	(12.725)	(12.586)	(11.797)	(61.069)	(61.283)	(61.311)	(61.059)
N	27993	27993	27993	27993	27993	27993	27993	27993
R^2	0.285	0.288	0.288	0.305	0.358	0.358	0.357	0.357

TRD, CRD, and ERD all significantly and positively influence Q, indicating market approval of corporate innovation. TRD has the strongest effect on Q (coef. 29.263), while ERD (13.143) and CRD (12.938) have similar impacts, suggesting minimal market differentiation between R&D expensing and capitalization.

NCited positively correlates with Q (9.02, $p<0.01$) but negatively impacts ROA (-7.974), indicating a gap between market perception and financial performance. Similarly, TRD positively affects both Q (29.263) and ROA (4.139), with a stronger influence on market value than on financial results.

Notably, ERD boosts ROA by 6.9, while CRD reduces it by 4.902. However, CRD's negative impact is less than both NCited's effect and ERD's positive influence.

Table 3 Regression Analysis of Leverage's Moderating Effect

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Q	Q	Q	Q	ROA	ROA	ROA	ROA
NCitedlev	-0.121***				-0.004***			
	(-5.881)				(-4.385)			
NCited	0.107***				-0.000			
	(9.696)				(-0.363)			
ERDlev		-0.928				-0.045		
		(-0.319)				(-0.318)		
ERD		7.715***				0.203***		
		(6.298)				(3.440)		
CRDlev			-25.931***				-0.816**	
			(-3.083)				(-2.009)	

CRD			32.468***				-0.099	
			(8.857)				(-0.559)	
TRDlev				-12.158***				-0.845***
				(-6.655)				(-9.471)
TRD				17.226***				0.407***
				(21.121)				(10.232)
_cons	10.354***	10.115***	10.077***	9.641***	-0.260***	-0.227***	-0.232***	-0.237***
	(58.429)	(62.107)	(61.960)	(59.867)	(-30.488)	(-28.836)	(-29.499)	(-30.104)
size	-0.410***	-0.396***	-0.395***	-0.380***	0.015***	0.014***	0.014***	0.014***
	(-49.160)	(-50.529)	(-50.439)	(-49.075)	(37.826)	(36.530)	(37.187)	(37.118)
lev	0.266***	0.019	0.057	0.279***	-0.158***	-0.166***	-0.166***	-0.153***
	(3.951)	(0.354)	(1.063)	(4.682)	(-48.874)	(-63.316)	(-63.706)	(-52.494)
Age	0.237***	0.279***	0.256***	0.308***	-0.008***	-0.008***	-0.009***	-0.008***
	(19.293)	(22.971)	(21.213)	(25.617)	(-13.975)	(-14.280)	(-14.994)	(-14.086)
SOE	-0.111***	-0.136***	-0.115***	-0.104***	0.002**	0.001	0.002*	0.002*
	(-5.982)	(-7.310)	(-6.199)	(-5.701)	(2.018)	(1.292)	(1.800)	(1.892)

ContrshrP	-0.053	-0.102*	-0.036	0.007	0.042***	0.042***	0.042***	0.043***
	(-1.009)	(-1.937)	(-0.682)	(0.135)	(16.444)	(16.442)	(16.356)	(17.058)
HHI_D	0.026	0.038	0.052	0.230***	-0.017***	-0.015***	-0.017***	-0.014***
	(0.451)	(0.672)	(0.925)	(4.093)	(-6.183)	(-5.653)	(-6.179)	(-5.095)
LnGRANT	-0.027***	-0.022***	-0.025***	-0.035***	0.001***	0.000***	0.000***	0.000*
	(-8.595)	(-7.190)	(-7.889)	(-11.438)	(3.621)	(2.675)	(2.933)	(1.747)
TAX	4.885***	4.845***	4.725***	5.042***	0.124***	0.132***	0.130***	0.131***
	(22.480)	(22.364)	(21.799)	(23.552)	(11.853)	(12.627)	(12.440)	(12.554)
turnover	0.225***	0.202***	0.241***	0.150***	0.027***	0.027***	0.027***	0.027***
	(10.708)	(9.616)	(11.466)	(7.179)	(27.038)	(26.228)	(26.540)	(26.746)
current	0.083***	0.077***	0.079***	0.073***	0.000	0.000	0.000	-0.000
	(18.196)	(17.006)	(17.399)	(16.019)	(1.048)	(0.433)	(0.553)	(-0.835)
growth	0.323***	0.322***	0.318***	0.292***	0.074***	0.075***	0.075***	0.074***
	(12.746)	(12.728)	(12.572)	(11.688)	(60.903)	(61.282)	(61.304)	(60.981)
N	27993	27993	27993	27993	27993	27993	27993	27993
R^2	0.286	0.288	0.288	0.306	0.358	0.358	0.357	0.359

The interaction coefficients of leverage with NCited, CRD, and TRD are significantly negative, while the coefficient of Q slightly exceeds that of ROA. This indicates that market investors disfavor corporate debt financing for innovation, revealing a negative moderating effect of leverage on the link between innovation investment and performance. Specifically, the interaction between leverage and CRD is -2.009 and significant at the 0.05 level, whereas the interaction with ERD is -0.318 but not significant. This suggests debt financing facilitates expensing R&D and reduces interest costs via the tax shield. However, capitalized borrowing costs and R&D are non-deductible, increasing current tax liabilities and negatively impacting firms' financial performance. In short: Leverage negatively moderates the relationship between corporate innovation investment and performance, as shown by significant negative interactions with NCited, CRD, and TRD. Debt financing aids R&D expensing and lowers interest costs through tax shields, but non-deductible capitalized borrowing costs and R&D raise taxes, harming financial performance.

Table 4 regression results between lagged innovation and performance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Q	Q	Q	Q	ROA	ROA	ROA	ROA
TRD	9.503***				-0.748***			
	(7.557)				(-12.112)			
lTRD	2.379				0.881***			
	(1.496)				(11.277)			
l2TRD	2.164*				0.112*			
	(1.714)				(1.804)			
ERD		10.665***				-0.201*		
		(4.376)				(-1.695)		
lERD		-1.411				0.667***		
		(-0.469)				(4.549)		

l2ERD		-0.017				-0.153		
		(-0.007)				(-1.276)		
CRD			18.528***				0.720***	
			(4.864)				(3.871)	
lCRD			-4.502				-1.210***	
			(-0.922)				(-5.078)	
l2CRD			13.244***				-0.170	
			(3.415)				(-0.901)	
NCited				0.038***				-0.000
				(2.909)				(-0.143)
lNCited				0.034*				-0.002**
				(1.834)				(-2.059)
l2NCited				-0.018				-0.001
				(-1.154)				(-1.113)
_cons	11.147***	11.590***	11.570***	12.032***	-0.258***	-0.251***	-0.259***	-0.291***
	(56.556)	(58.122)	(58.033)	(55.107)	(-26.623)	(-25.752)	(-26.617)	(-27.361)

size	-0.376***	-0.392***	-0.393***	-0.413***	0.015***	0.015***	0.015***	0.016***
	(-39.545)	(-40.777)	(-40.841)	(-39.914)	(31.552)	(30.973)	(31.768)	(32.307)
lev	0.095	0.035	0.039	0.030	-0.174***	-0.174***	-0.174***	-0.175***
	(1.450)	(0.523)	(0.587)	(0.458)	(-54.078)	(-53.859)	(-53.935)	(-54.097)
Age	0.115***	0.058***	0.051***	0.047**	-0.003***	-0.004***	-0.004***	-0.003***
	(5.997)	(3.012)	(2.635)	(2.370)	(-3.162)	(-4.625)	(-4.660)	(-3.420)
SOE	-0.075***	-0.105***	-0.087***	-0.091***	0.001	0.000	0.000	0.001
	(-3.301)	(-4.570)	(-3.788)	(-3.946)	(0.836)	(0.032)	(0.425)	(0.521)
ContrshrP	0.291***	0.162**	0.267***	0.239***	0.049***	0.046***	0.046***	0.046***
	(4.450)	(2.439)	(4.030)	(3.592)	(15.142)	(14.177)	(14.297)	(14.233)
HHI_D	0.305***	0.088	0.107	0.065	-0.016***	-0.017***	-0.020***	-0.020***
	(4.073)	(1.177)	(1.422)	(0.868)	(-4.229)	(-4.736)	(-5.461)	(-5.518)
LnGRANT	-0.036***	-0.021***	-0.024***	-0.025***	0.000	0.000**	0.000**	0.001***
	(-8.766)	(-5.055)	(-5.791)	(-6.122)	(1.017)	(2.114)	(2.475)	(3.262)
TAX	5.084***	4.845***	4.694***	4.883***	0.118***	0.118***	0.115***	0.105***
	(19.401)	(18.292)	(17.728)	(18.343)	(9.132)	(9.108)	(8.886)	(8.103)

turnover	0.157***	0.220***	0.270***	0.249***	0.026***	0.026***	0.026***	0.027***
	(5.949)	(8.332)	(10.229)	(9.438)	(20.160)	(19.976)	(20.290)	(20.786)
current	0.105***	0.109***	0.108***	0.109***	-0.000	0.000	0.000	0.000
	(16.571)	(16.967)	(16.903)	(16.983)	(-0.333)	(0.169)	(0.265)	(0.026)
growth	0.310***	0.325***	0.321***	0.334***	0.077***	0.077***	0.077***	0.076***
	(10.058)	(10.416)	(10.312)	(10.694)	(51.190)	(50.578)	(50.428)	(49.995)
N	19108	19108	19108	19108	19108	19108	19108	19108
R^2	0.319	0.303	0Q.302	0.299	0.362	0.356	0.355	0.355

The coefficients of innovative activities on Q in the current period are positive and significant at the 0.01 level, but they gradually decrease and become insignificant as the number of lagged periods increases.

The coefficient of current total R&D (TRD) on ROA is -12.112, and the one-period lag coefficient is 11.277, both significant at the 0.01 level. The two-period lag coefficient is 1.804, significant at the 0.1 level. The negative current effect reflects ongoing innovation activities, while R&D yields delayed revenue benefits. The positive impact of one-period lagged R&D on firm performance diminishes with additional lags, with the two-period lag significant only at the 0.5 level. The current coefficient of external R&D (ERD) on ROA is -1.695, significant at the 0.5 level. In short: Current total R&D negatively affects ROA (-12.112, $p<0.01$), while one-period lagged R&D positively impacts ROA (11.277, $p<0.01$), with effects weakening over time. Two-period lagged R&D is marginally significant (1.804, $p<0.1$). Current external R&D shows a slight positive effect (-1.695, $p<0.5$).

The coefficient of the one-period lagged ERD on ROA is 4.549, significant at the 0.01 level. The current-period CRD coefficient on ROA is 3.871, also significant at 0.01, while the lagged-period CRD coefficient is -5.078, significant at 0.01. The two-period lag effect is not significant. For NCited on Q, the current-period coefficient is 2.909, positive and significant at 0.01, and the one-period lagged coefficient is 1.834, positive and significant at 0.05. The positive effect and significance decrease over time. The current-period coefficient is -0.143 but not significant. In short: The one-period lagged ERD positively affects ROA (4.549, $p<0.01$). Current CRD also positively impacts ROA (3.871, $p<0.01$), while its lagged effect is negative (-5.078, $p<0.01$). Two-period lag effects are insignificant. NCited positively influences Q in the current (2.909, $p<0.01$) and lagged (1.834, $p<0.05$) periods, with effects diminishing over time. The current-period effect is negative but not significant (-0.143).

The coefficient of NCited on ROA is -2.059, significant at the 0.1 level, indicating that frequent citations negatively impact firms' financial performance. This suggests technological spillovers, where competitors use the innovations to improve their own products, potentially rendering the original innovations obsolete. However, investors still perceive firms as innovative despite spillovers, as current and one-period lagged NCited positively affect Q. After two periods, investor confidence in the firm's innovation declines. In short: NCited negatively affects ROA (-2.059, $p<0.1$), implying technological spillovers harm financial performance. Yet, investors view current and one-period lagged citations positively for firm value (Q), though confidence fades after two periods.

4.2 Robustness check

Table 5 robustness test of the regression of firm innovation and performance

	(1)	(2)	(3)	(4)
	ROE	ROE	ROE	ROE
NCited	-0.002***			
	(-3.065)			
ERD		0.504***		
		(7.275)		
CRD			-0.787***	
			(-3.656)	
TRD				0.169***
				(3.128)
_cons	-0.539***	-0.508***	-0.519***	-0.519***
	(-25.100)	(-25.274)	(-25.807)	(-25.815)
size	0.029***	0.028***	0.029***	0.029***
	(28.702)	(28.881)	(29.468)	(29.437)
lev	-0.279***	-0.279***	-0.279***	-0.278***
	(-42.696)	(-42.620)	(-42.706)	(-42.422)
Age	-0.014***	-0.014***	-0.015***	-0.014***
	(-9.303)	(-9.116)	(-9.814)	(-9.502)
SOE	0.002	0.001	0.002	0.002
	(0.916)	(0.408)	(0.898)	(1.010)

ContrshrP	0.088***	0.087***	0.088***	0.090***
	(13.580)	(13.439)	(13.465)	(13.855)
HHI_D	-0.028***	-0.025***	-0.029***	-0.024***
	(-3.991)	(-3.529)	(-4.098)	(-3.444)
LnGRANT	0.001*	0.001	0.001*	0.000
	(1.951)	(1.518)	(1.728)	(1.088)
TAX	0.307***	0.317***	0.314***	0.317***
	(11.454)	(11.854)	(11.720)	(11.806)
turnover	0.053***	0.052***	0.053***	0.052***
	(20.627)	(19.932)	(20.348)	(19.961)
current	-0.003***	-0.003***	-0.003***	-0.003***
	(-5.119)	(-5.239)	(-5.078)	(-5.103)
growth	0.146***	0.146***	0.147***	0.146***
	(46.742)	(46.873)	(46.881)	(46.693)
N	27993	27993	27993	27993
R^2	0.213	0.214	0.213	0.213

Table 6 robustness test for the analysis of the moderating effect of the leverage ratio

	(1)	(2)	(3)	(4)
	ROE	ROE	ROE	ROE
NCitedlev	0.004			
	(1.509)			
NCited	-0.004***			
	(-2.875)			
ERDlev		2.072***		
		(5.775)		
ERD		-0.273*		
		(-1.803)		
CRDlev			-3.239***	
			(-3.115)	
CRD			0.456	
			(1.006)	
TRDlev				-0.838***
				(-3.663)
TRD				0.486***
				(4.763)
_cons	-0.532***	-0.501***	-0.521***	-0.525***
	(-24.310)	(-24.914)	(-25.914)	(-26.018)
size	0.029***	0.028***	0.029***	0.028***

	(28.395)	(28.786)	(29.501)	(29.419)
lev	-0.287***	-0.288***	-0.275***	-0.265***
	(-34.548)	(-42.798)	(-41.278)	(-35.439)
Age	-0.014***	-0.014***	-0.015***	-0.014***
	(-9.130)	(-9.450)	(-9.856)	(-9.314)
SOE	0.002	0.001	0.002	0.002
	(0.822)	(0.322)	(0.988)	(1.009)
ContrshrP	0.088***	0.087***	0.087***	0.090***
	(13.559)	(13.353)	(13.439)	(13.911)
HHI_D	-0.028***	-0.025***	-0.028***	-0.023***
	(-4.020)	(-3.508)	(-3.956)	(-3.323)
LnGRANT	0.001**	0.001	0.001*	0.000
	(2.009)	(1.570)	(1.698)	(0.951)
TAX	0.308***	0.319***	0.311***	0.315***
	(11.480)	(11.906)	(11.600)	(11.769)
turnover	0.053***	0.051***	0.053***	0.053***
	(20.615)	(19.665)	(20.312)	(20.187)
current	-0.003***	-0.003***	-0.003***	-0.003***
	(-5.275)	(-4.813)	(-5.150)	(-5.588)
growth	0.146***	0.146***	0.147***	0.146***
	(46.767)	(46.828)	(46.872)	(46.632)
N	27993	27993	27993	27993
R^2	0.213	0.215	0.214	0.214

Table 7 robustness regressions of lagged innovation activity on performance

	(1)	(2)	(3)	(4)
	ROE	ROE	ROE	ROE
TRD	-1.962***			
	(-12.177)			
lTRD	1.961***			
	(9.625)			
l2TRD	0.468***			
	(2.894)			
ERD		-0.689**		
		(-2.225)		
lERD		1.646***		
		(4.307)		
l2ERD		-0.161		
		(-0.518)		
CRD			1.331***	
			(2.747)	
lCRD			-2.806***	
			(-4.518)	
l2CRD			0.117	
			(0.238)	
NCited				0.001

				(0.534)
lNCited				-0.001
				(-0.237)
l2NCited				-0.004**
				(-2.050)
_cons	-0.594***	-0.579***	-0.599***	-0.642***
	(-23.515)	(-22.834)	(-23.617)	(-23.162)
size	0.031***	0.030***	0.031***	0.033***
	(25.249)	(24.834)	(25.574)	(25.124)
lev	-0.317***	-0.316***	-0.317***	-0.318***
	(-37.847)	(-37.626)	(-37.710)	(-37.762)
Age	-0.001	-0.004*	-0.004*	-0.002
	(-0.552)	(-1.686)	(-1.801)	(-0.882)
SOE	0.002	-0.000	0.001	0.001
	(0.641)	(-0.073)	(0.292)	(0.344)
ContrshrP	0.104***	0.097***	0.099***	0.099***
	(12.340)	(11.542)	(11.721)	(11.771)
HHI_D	-0.024**	-0.025***	-0.032***	-0.031***
	(-2.471)	(-2.647)	(-3.298)	(-3.237)
LnGRANT	0.000	0.001	0.001	0.001
	(0.261)	(0.993)	(1.276)	(1.543)
TAX	0.270***	0.275***	0.267***	0.252***
	(8.029)	(8.155)	(7.917)	(7.458)

turnover	0.052***	0.051***	0.052***	0.053***
	(15.524)	(15.031)	(15.357)	(15.756)
current	-0.004***	-0.003***	-0.003***	-0.004***
	(-4.712)	(-4.258)	(-4.176)	(-4.337)
growth	0.156***	0.155***	0.154***	0.153***
	(39.621)	(39.162)	(38.944)	(38.653)
N	19108	19108	19108	19108
R^2	0.233	0.228	0.226	0.226

To ensure the reliability of our findings, we conducted robustness tests using ROE as an alternative performance metric, presented in Tables 6 and 7. The key coefficients' signs and significance remain consistent. Innovation inputs continue to positively impact market value, while financial leverage's negative moderating effect persists. These results confirm that our conclusions are robust across performance measures and reinforce that financing constraints significantly hinder the innovation–performance relationship.

CHAPTER 5
CONCLUSIONS AND DISCUSSION

5.1 Key Conclusions

(1) Innovation activities significantly improve firm performance, though their impact varies between financial and market outcomes.

Total R&D investment (TRD) is positively and significantly linked to both ROA and Tobin's Q, indicating that sustained innovation investment enhances profitability and market value. This aligns with Damanpour and Evan (1984) and Deng, Lev, and Narin (1999) supporting the Resource-Based View (RBV) that innovation is a crucial strategic resource for sustainable performance growth.

R&D expensing (ERD) is positively and significantly linked to both ROA and Tobin's Q, indicating that expensed R&D boosts current profitability and market value through knowledge accumulation and technological progress. This aligns with B. H. Hall (2002) and Hirshleifer et al. (2013), showing that timely R&D recognition signals positively to the market and enhances accounting returns. Theoretically, this supports the information-asymmetry argument that transparent R&D reporting lowers capital costs by signaling managerial confidence in innovation.

Third, R&D capitalization (CRD) has a significantly positive impact on Tobin's Q but a significantly negative effect on ROA. Investors see capitalized R&D as a reliable indicator of long-term growth potential, aligning with Lev and Sougiannis (1996) and Cazavan-Jeny and Jeanjean (2006). However, from an accounting perspective, capitalization raises asset values and defers expense recognition, increasing amortization costs and temporarily lowering ROA. This discrepancy between market and financial effects highlights the time lag and cost deferral inherent in capitalized R&D.

Patent citations (NCited) positively impact Tobin's Q but negatively affect ROA, suggesting that high-quality innovation boosts market valuation while potentially lowering short-term profitability due to knowledge spillovers, consistent with Hirshleifer et al. (2013).

The baseline regression results reveal a dual impact of innovation. R&D investment, expensing, and high-impact innovation enhance market value, while capitalization and knowledge spillovers may limit short-term accounting performance. These findings emphasize the long-term, phased nature of innovation returns and the need for firms to balance R&D structure and accounting practices to align short-term profits with long-term growth.

Technology spillover occurs when competitors develop new products or technologies by citing an original patent, aiming to capture or replace its market share, which reduces the original enterprise's profits. The more a patent is cited, the stronger the spillover effect and the greater the negative impact on the enterprise (Bloom, Schankerman, & Van Reenen, 2013).

The results indicate that leverage has a significantly negative moderating effect overall.

（2）The interaction terms between leverage and patent citations (NCited), R&D capitalization (CRD), and total R&D investment (TRD) are significantly negative, with a stronger adverse effect on Tobin’s Q than on ROA. This suggests that higher debt levels diminish the positive impact of innovation on financial performance and market valuation. These results align with Yazdanfar and Öhman (2015) and U. Iqbal and Usman (2018), indicating that excessive leverage raises financial distress costs and repayment pressure, reducing innovation efficiency. This supports the Pecking Order Theory, which states that firms prefer internal financing for innovation, as high leverage limits managerial flexibility and risk-taking.

The interaction between leverage and R&D expensing (ERD) is negative but insignificant, indicating that debt financing does not significantly reduce expensed R&D. This may be due to the tax shield effect, where interest expenses on debt offset taxable income, easing financing pressure and lessening leverage's negative impact. This partially supports (B. H. Hall, 2002), who suggested that debt financing can lower capital costs and encourage R&D investment.

The interaction between leverage and R&D capitalization (CRD) is significantly negative, indicating that debt financing for capitalized R&D intensifies its adverse effect on firm performance. Because borrowing costs tied to capitalized R&D are included in asset values rather than deducted from taxable income, the tax

shield effect weakens, increasing tax burdens and reducing profitability. This aligns with Cazavan-Jeny and Jeanjean (2006) and Lev and Sougiannis (1996), suggesting that under high leverage, the short-term financial costs of capitalized R&D outweigh its potential long-term benefits. In short: Leverage combined with capitalized R&D (CRD) worsens firm performance, as debt-financed R&D reduces tax shields and raises tax burdens, lowering profitability. This supports findings that under high leverage, short-term costs of capitalized R&D exceed long-term gains (Cazavan-Jeny & Jeanjean, 2006; Lev & Sougiannis, 1996).

These findings align with Agency and Trade-Off Theories. Excessive leverage increases financial risk, leading managers to adopt conservative innovation strategies to avoid bankruptcy. Interest obligations also reduce resources for innovation, decreasing capital allocation efficiency. While moderate debt can improve financial discipline and resource use (Jensen, 1986), in Chinese A-share firms, leverage's suppressive effect on innovation prevails.

Leverage negatively moderates the innovation–performance relationship. High leverage weakens innovation's positive effects on market value and financial performance, especially for R&D capitalization and high-quality innovation outputs. This indicates that Chinese listed firms' debt financing structures do not yet effectively support innovation, and excessive debt reliance may hinder innovation efficiency and firm performance.

The results confirm that R&D investment follows a first, gain later benefits appearing after a delay and profits increasing only when delayed returns surpass initial costs.

Current R&D significantly boosts Tobin's Q, indicating investor expectations of future growth from innovation. However, this effect diminishes over time, supporting the Innovation Cycle Theory that innovation's market impact peaks early and fades as competitors catch up.

R&D investment negatively impacts current-year ROA, as innovation demands ongoing spending before yielding returns. The first-year lag of R&D positively correlates with performance, though this effect diminishes in subsequent years due to limited patent life and increased competition. The second-year lag shows

only weak significance, indicating firms should shorten R&D cycles to avoid competitors surpassing them and reducing the value of late-stage R&D.

（3）Among accounting treatments, R&D expensing (ERD) has the strongest positive effect on ROA in the first lag, indicating that past R&D efforts begin generating income, consistent with the Knowledge Accumulation Effect. Conversely, R&D capitalization (CRD) negatively impacts ROA in the lag stage. Once capitalized, R&D becomes an intangible asset subject to amortization and impairment, increasing tax burdens since tax rules often disallow impairment deductions before disposal. The strongest negative effect occurs in the first lag, suggesting a short economic life for these assets or competitive pressures limiting returns. This aligns with Path Dependence Theory, which posits that innovation value declines without ongoing renewal. In short: R&D expensing (ERD) positively affects ROA in the first lag, reflecting income from past R&D consistent with the Knowledge Accumulation Effect. In contrast, capitalized R&D (CRD) negatively impacts ROA due to amortization, impairment, and tax burdens, with the strongest effect in the first lag. This supports Path Dependence Theory, indicating innovation value declines without continuous renewal.

Patent citations (NCited) currently have a negative but insignificant effect on ROA, while lagged effects are significantly negative. This supports the knowledge spillover effect, where competitors use cited patents to improve technology, reducing the originator’s profits after about a year. Meanwhile, the positive impact of patent citations on Tobin’s Q diminishes over time, becoming insignificant by the second lag, indicating that investor confidence in the firm’s innovation lasts only one or two cycles. In short: Patent citations initially have a negative but insignificant effect on ROA, with significant negative effects appearing after a year due to knowledge spillover. The positive impact on Tobin’s Q fades by the second lag, showing investor confidence in innovation lasts only briefly.

The lag test reveals that innovation unfolds in short- and long-term phases. Market gains occur immediately, while financial benefits arise later but diminish over time. Firms should manage R&D duration and enhance project management to reduce the delay between investment and returns.

5.2 Recommendations

Strengthening research and development (R&D) management and accounting discipline is essential.

The findings reveal that R&D expensing and capitalization differently impact accounting and market performance. Expensed R&D boosts short-term financial metrics (ROA, ROE) via immediate recognition and tax benefits, while capitalized R&D enhances market value (Tobin's Q) by signaling long-term growth. However, excessive capitalization increases amortization and impairment costs, reducing future profitability. Firms should balance short-term financial gains with long-term innovation signaling.

Managers must strictly adhere to accounting standards, avoiding blurred lines between expensing and capitalization that could manipulate earnings or reduce apparent leverage. Shareholders can enhance oversight by tying executive incentives to long-term innovation results instead of short-term profits. Firms should plan R&D projects considering debt costs, cash flow stability, and innovation life cycles. Proper allocation between expensed and capitalized R&D optimizes short-term tax benefits and supports sustainable long-term returns.

Before launching innovation projects, firms should assess R&D feasibility, potential spillovers, and industry competition to select projects with clear investment benefits. Managers must monitor R&D timeliness to speed commercialization, increase patent self-citations(Suh, 2015), and avoid excessive costs from low-value patents. Enhancing post-R&D evaluation and lifecycle management helps maximize innovation returns and reduce delayed financial losses.

Supporting SMEs through credit access and disclosure policies.

The results indicate that excessive leverage weakens the relationship between innovation and performance, especially for capitalized R&D. Financial regulators and policymakers should create credit policies that promote innovation-focused lending while preventing over-leveraging. For small and medium-sized enterprises (SMEs), which often face financing constraints, banks could offer "innovation credit lines" linked to verified R&D expenses or patent results, enabling lower collateral and interest rates.

Regulators can set differentiated disclosure standards for innovation activities, such as requiring firms to report the ratio of expensed versus capitalized R&D, amortization schedules, and innovation-related tax incentives. Transparent disclosures reduce information asymmetry, enabling investors and lenders to better assess innovation quality and financial risk.

Credit and reporting frameworks would improve funding flow to innovative yet financially constrained SMEs and support the government’s broader innovation-driven development strategy.

Strengthening the link between innovation and finance in policy design. From a policy perspective, the findings highlight innovation's dual nature: R&D investment fuels market growth, but debt financing can hinder innovation efficiency if financial risks are mismanaged. Policymakers should coordinate innovation and financing systems through targeted measures.

Establishing national R&D insurance or guarantee programs to lower lenders' perceived credit risk.

Offering tax deductions for verified innovation expenses, particularly for SMEs involved in high-risk technological research.

Promoting innovation bonds and technology-backed financing instruments to diversify funding sources beyond traditional bank loans.

Targeted measures can enhance the capital environment for innovation without causing excessive financial leverage, enabling firms to balance innovation-driven growth with financial stability.

5.3 Limitations and Future Research

This study examines only linear relationships. Future research should explore non-linear or threshold effects to determine optimal ranges.

Operating leverage also plays a role: H. Chen (2020) found that financial leverage negatively impacts performance, while operating leverage has a positive moderating effect.

Various indicators of capital structure, innovation, and performance—such as equity ratio, R&D investment, patent quality, EVA, and EPS—can be compared to ensure robustness.

The 2013–2022 A-share sample is limited; broader, longer data may reveal cyclical differences (Narayan, Narayan, & Tran, 2023). Future research could use actual rather than book leverage to better capture hidden debt behaviors (Amore, Schneider, & Žaldokas, 2013; Benfratello, Schiantarelli, & Sembenelli, 2008).

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