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Ownership Structure and Innovation Quality: Evidence from Patenting Activities

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Abstract

High-quality innovation can provide companies with a competitive advantage in the market, enabling them to become leaders and effectively respond to challenges from competitors. This paper aims to offer recommendations to Chinese policymakers on enhancing innovation quality. It adopts a corporate governance perspective to examine the impact of ownership structure (ownership concentration, state ownership, institutional ownership, and managerial ownership) on innovation quality. Using patent data from Chinese listed companies from 2012 to 2021, the study reveals that innovation quality is influenced by different ownership structures. State ownership, institutional ownership, and managerial ownership positively affect innovation quality. Contrary to expectations, ownership concentration leads to a decline in innovation quality. This approach differs from previous research in two key aspects. First, it identifies ownership factors that enhance innovation quality, addressing the limitations of earlier studies that focused solely on single ownership types. Second, by focusing on invention patent information, it captures innovation quality, providing a more accurate assessment of firms' true innovative capabilities in a transitional economy.

Keywords: ownership structure, ownership concentration, state ownership, institutional ownership, managerial ownership, innovation quality

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Introduction

Corporate innovation is a key factor in achieving competitive advantage for enterprises. Technological advancements have been proven to create jobs and increase income, thereby significantly promoting macroeconomic growth [1–3]. Consequently, innovation is often considered a potent tool for enhancing national competitiveness [4–5]. High-quality innovation typically leads to breakthrough products, services, or processes, providing sustainable competitive advantages that are difficult for competitors to replicate, thus ensuring a more enduring market position [6–9]. However, high-quality innovation also increases the risk of failure, potentially depleting resources and damaging the company's reputation [10–12]. Conversely, firms that emphasize quantity of innovation, even at the expense of quality, often view this approach as a risk mitigation strategy: if some high-quality innovations fail, others may succeed, balancing the overall outcome. Unfortunately, an excessive focus on quantity can dilute resources, reduce overall innovation quality, and lead to long-term strategic disadvantages [13].

While many transitional countries and regions have policies that encourage firms to increase innovation activities, these policies often place relatively less emphasis on the quality of innovation [14–15]. Previous studies have debated the extent to which ownership structure can influence overall innovation [16]. While the importance of overall innovation quantity is undeniable, exploring the relationship between ownership structure and innovation quality can help to better assess the true "innovation value" of ownership. The Anglo-American model, characterized by dispersed ownership, and the German-Japanese model, characterized by bank-based financing, concentrated ownership, and insider ownership, are specific to developed countries [17]. These established models may not accurately describe the unique institutional differences in transitional economies. For instance, Chinese firms have distinct characteristics in their equity structures, including more concentrated ownership, prevalent family ownership, and a growing trend of state ownership [18]. However, existing literature lacks a comprehensive assessment of the relationship between ownership structure and innovation quality in these transitional economies. Addressing this gap is crucial as equity structure influences the incentive mechanisms for both internal and external stakeholders. Understanding these relationships can help firms allocate resources more effectively, directing them toward high-value innovation activities.

This paper aims to fill this gap. Firstly, we provide a thorough analysis and comparison of ownership structures. Specifically, we examine the impact of ownership concentration, state ownership, institutional ownership, and managerial ownership on innovation quality. Secondly, we measure the quality of innovation by utilizing invention patent information from Chinese listed companies. By examining the technological content of patents, we differentiate high-quality invention patents from other categories of lower-quality patents within China's patent applications. This approach allows us to identify high-quality patents within the scope of corporate innovation activities. China, as a significant economic power with a transitional economy, offers an interesting context for examining the relationship between ownership structure and innovation quality, given its distinctive corporate governance models compared to developed countries. Our sample comprises data from 3,837 Chinese listed firms from 2012 to 2021. The results indicate that state, institutional, and managerial ownership positively influences innovation quality, while ownership concentration has a negative impact.

This paper makes several contributions. Firstly, it examines the relationship between ownership structure and innovation quality from multiple perspectives, addressing the limitations of previous research that focused solely on the impact of a single type of ownership on innovation. Secondly, it extends the literature on the relationship between equity structure and innovation quality, a topic that has been underexplored, particularly in transitional economies. By utilizing invention patent information, this study offers new insights, which are valuable for emerging economies seeking to improve their innovation governance mechanisms and achieve economic transformation.

The remainder of this paper is structured as follows. Second section reviews the existing literature and develops the hypotheses. Third section describes the data, main variables, and research methods used in this study. Fourth section presents the empirical results, while Fifth section concludes the paper.

Theoretical Foundations and Hypothesis Development

Agency Theory

Agency theory, a fundamental component of institutional economics and contract theory, primarily focuses on the principal-agent relationship [19]. This relationship involves one or more principals hiring agents under a contractual agreement, granting the agents certain decision-making authority to manage the firm. As companies grow and evolve, corporate governance mechanisms also change, with the separation of ownership and control being a prominent indicator of this transformation [20].

Agency theory posits that agents typically possess more information than principals, and this information asymmetry adversely affects the principals' ability to effectively monitor whether the agents are acting in the principals' best interests [21–22]. Conflicts of interest and differing priorities, such as attitudes towards innovation risk, lead to agency conflicts when agents act on behalf of principals [23]. These principal-agent problems arise when the interests of the two parties diverge and when there is information asymmetry, with agents having more information. Principals cannot directly ensure that agents always act in their best interests, especially when activities beneficial to the principals involve high costs and risks for the agents, such as innovation activities [20; 24].

Institutional Theory

Institutional theory focuses on the interaction between institutions and organizations, emphasizing that corporate behaviour is largely influenced by specific social and institutional contexts or frameworks [25–27]. These institutions include social, economic, and political organizations, as well as informal social norms and rules. When formulating and implementing business strategies, companies need to consider their external environment and institutional norms [28]. This is particularly important in transitional economies, where firms must adapt to different institutional constraints to acquire necessary resources and support [29].

The institutional dimension of firms allows scholars to better understand corporate decisions regarding the adaptation to the institutional logic of developing new or internal resources. Many Chinese scholars have observed that institutional factors alter the application of agency theory assumptions in state-owned enterprises (SOEs) [30–31]. Due to path dependence, Chinese SOEs are subject to extensive government intervention, including ownership control and the recruitment system for senior managers [32]. Specifically, although SOEs enjoy privileges conferred by government agencies, the links between the government and SOEs create institutional pressures that compel SOEs to use resources to attain public goals set by the government, including economic growth and national innovation strategies [30; 32].

Hypothesis Development

Ownership Concentration and Innovation Quality

The relationship between ownership concentration and innovation can be predicted by considering the role of information asymmetry in the corporate innovation process. Generally, managers tend to focus more on short-term financial returns than long-term innovation benefits. This myopic behaviour can lead to reduced investment in innovation activities [33].

From an agency theory perspective, ownership concentration serves as a monitoring mechanism to reduce information asymmetry [34]. When ownership is concentrated among large shareholders, these shareholders have a stronger incentive to oversee information relating to innovation investments and influence management [35]. This mitigates the problem of dispersed ownership, where small shareholders are neither willing nor able to bear the costs of monitoring managers. Furthermore, the value of the shares held by large shareholders depends on the commercial value of the company, and successful innovation often leads to an increase in stock prices [36]. Given their focus on the company's stock price, large shareholders are more motivated to oversee investments in high-quality innovation activities and promote R&D processes that have a potential to yield significant innovation benefits, thereby ensuring the enhancement of innovation quality in the firm. Thus, our first hypothesis may be formulated as follows:

H1: Ownership concentration positively influences the quality of innovation.

State Ownership and Innovation Quality

In emerging markets, institutional factors significantly influence firms' R&D activities [37–40]. These factors include social, economic, and political organizations, as well as informal social norms and rules. The innovation process is seen as a dynamic accumulation of learning and innovation, intricately linked with the country's economic structure and institutional environment [41]. Therefore, when formulating and implementing corporate strategies, SOEs in transition economies must prioritize external environment considerations and their own institutional norms.

The managers of Chinese SOEs exhibit distinct institutional characteristics, being more akin to bureaucrats than to typical private entrepreneurs [42]. This unique group frequently rotates positions with government officials. Notably, within this specific institutional context, SOE managers, acting as agents of the government shareholder, are driven by political motives and often adhere to public economic goals set by the government. These political motives overweigh general short-term profit considerations [43]. Indeed, higher political ranks typically lead to rapid increases in income and reputation, far beyond what short-term corporate performance can achieve. The Chinese government tends to adopt long-term strategies to promote high-quality innovation and industrial upgrading. Consequently, the underlying political motivations drive SOEs to increase R&D investment and enhance innovation quality. This leads to our second hypothesis:

H2: State ownership positively influences the quality of innovation.

Institutional Ownership and Innovation Quality

Institutional investors have emerged as major players in the field of corporate governance. Prior research indicates that they positively impact corporate performance and strategic decision-making by monitoring and constraining managers' self-serving motives. Institutional investors also contribute to reducing agency costs by exerting pressure on managers to focus on company performance and competitive potential [44–45].

Unlike dispersed small shareholders, institutional investors typically hold significant stakes, which motivate them to oversee managers' innovation decisions. This oversight can reduce managerial opportunism and ensure that corporate resources are genuinely directed toward improving innovation quality [46]. Furthermore, institutional investors play a crucial coordinating role among internal and external stakeholders, including the government, board of directors, employees, and suppliers [47]. As both major shareholders and key participants in the national economy, these institutional investors exert pressure on firms to pursue long-term innovation outcomes associated with high-quality innovation rather than merely short-term performance. Therefore, we hypothesize:

H3: Institutional ownership positively influences the quality of innovation.

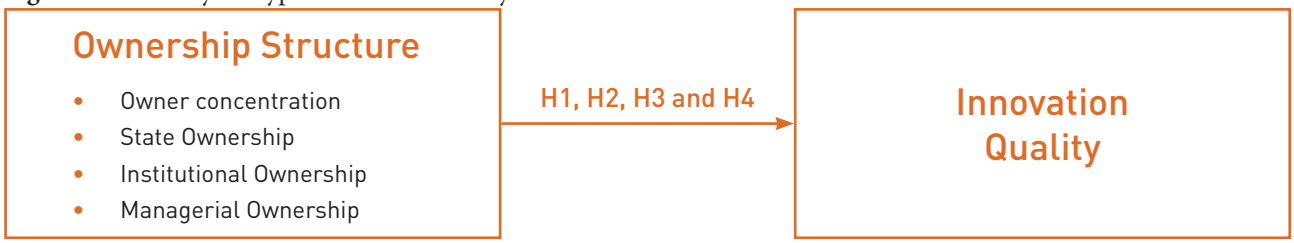
Managerial Ownership and Innovation Quality

In the realm of corporate governance, innovation is characterized by its long-term and high-risk nature [48]. Due to information asymmetry, managers possess more information than shareholders [49]. When acting on behalf of shareholders, managers may prioritize their personal short-term interests, fearing the potential failure of innovative projects. This can lead them to make decisions that favour their interests rather than the company's long-term success. Unlike shareholders, who typically pursue long-term gains and acknowledge the inherent risks of innovation, managers may be less inclined to invest in innovation due to its potential negative impact on short-term performance.

However, when managers hold significant ownership stakes in the company, their interests align more closely with those of shareholders [50]. This alignment mitigates the agency problem, as managers are more likely to act in the best interests of the company, focusing on long-term value creation through innovation. Equity incentives provide managers with a vested interest in pursuing high-reward innovation strategies. Since their personal wealth is tied to the company's innovation performance, managers are motivated to ensure the success of innovation initiatives, thus improving the quality of innovation activities. Based on this rationale, we propose the following hypothesis:

H4: Managerial ownership positively influences the quality of innovation.

Figure 1. Summary of Hypotheses in this Study



Methodology

Sample and Data

Using the CSMAR database, we constructed a comprehensive dataset covering the ownership and financial information of Chinese listed companies from 2012 to 2021. Patent information related to innovation was sourced from the CNRDS database. The data underwent the following pre-processing steps: 1) financial firms (e.g., banks, insurance companies, and mutual funds) were excluded due to their distinct governance structures; 2) companies that experienced consecutive losses for two years and faced delisting risks were removed, as these firms are marked as "Special Treatment" by the China Securities Regulatory Commission, indicating severely abnormal financial conditions; 3) companies with missing data were excluded to minimize the impact of incomplete data on the results; and 4) all continuous variables were winsorized at the 1st and 99th percentiles.

Variable Measurement and Model Specification

The dependent variable in this study is innovation quality (IQ), measured as the natural logarithm of the number of invention patents filed by the company. Invention patents typically involve new technical solutions, reflecting high levels of technological innovation and R&D investment. Obtaining an invention patent requires a rigorous examination process, including evaluations of novelty, inventiveness, and utility. Therefore, invention patents often point to a company's breakthroughs in technological innovation and high-quality R&D outcomes. In China, invention patents must meet the requirements of "novelty, inventiveness, and utility" to pass the examination. In contrast, design patents or utility model patents only require the absence of prior similar applications. Thus, invention patents demonstrate a higher degree of technological advancement and quality. Additionally, IQ_A, defined as the natural logarithm of the number of granted invention patents, is used as a robustness check indicator. These are two of the most commonly used measures of innovation quality in previous research [51].

This study focuses on four key test variables. First, ownership concentration (TOP1) is measured by the total percentage of shares held by the largest shareholder. In China, the prevalent phenomena of cross-holdings and pyramid structures have long complicated ownership frameworks, making calculations of state ownership percentages potentially inaccurate, as the degree of control might not be fully reflected in direct shareholdings. To examine the impact of state ownership (SOE), we created a dummy variable, where 1 indicates that a firm is controlled by a government entity, and 0 otherwise. Institutional ownership (INST) refers to the proportion of shares held by institutional investors. Similarly, managerial ownership (Mshare) denotes the percentage of the company's shares held by its managers. These measures align with those used in prior literature [30; 32].

Additionally, we included several control variables that potentially affect IQ, consistent with prior research (e.g., Beyer et al., 2012; Choi et al., 2011; Pu & Zulkafli, 2024 [17; 32; 35]). These variables include firm size (logarithm of total

assets), firm age (natural logarithm of years since establishment plus one), financial leverage (total debt divided by total assets), sales growth (ratio of current to previous year's operating revenue), and board size (natural logarithm of the total number of directors on the board). The measurements of these variables are given in Table 1.

To mitigate the impact of unobserved industry heterogeneity and temporal variations on IQ, we included industry and year fixed effects. This ensures that the observed relationship between ownership structure and innovation quality is not confounded by industry-specific or time-specific factors. The basic empirical model is as follows:

$$IQ_{i,t} = \alpha_0 + \alpha_1 OS_{i,t} + \alpha_2 Size_{i,t} + \alpha_3 FirmAge_{i,t} + \\ + \alpha_4 Lev_{i,t} + \alpha_5 Growth_{i,t} + \alpha_6 Board_{i,t} + Year + \\ + Industry + \varepsilon, \quad (1)$$

where α_0 denotes the intercept, and $\alpha_1 - \alpha_6$ are the coefficients to be estimated. OS refers to the four ownership structure variables – TOP1, SOE, INST, and Mshare; ε is the error term; i denotes the cross-sectional dimension for firms; and t denotes the time series dimension.

Table 1. Summary of Variable Descriptions and Measurements

Measurement	
Panel A: Dependent Variables	
IQ	The natural logarithm of the company's applied invention patents plus one.
Panel B: Independent Variables	
TOP1	The percentage of firm shares owned by the largest shareholder.
SOE	Dummy variable equal to 1 if the company is a state-owned entity and 0 otherwise.
INST	The percentage of company shares owned by institutional investors.
Mshare	The percentage of company shares owned by top management.
Panel C: Control Variables	
Size	The logarithm of total assets.
FirmAge	The natural logarithm of the number of years since the firm's establishment plus one.
Lev	The book value of total debts divided by total assets.
Growth	The ratio of the change in operating income to the operating income in the previous year.
Board	The natural logarithm of the total number of directors on the firm's board.

Source: prepared by the author.

Findings and Discussion

Descriptive Statistics and Correlation Matrix

The descriptive statistics for the key variables in our study are presented in Table 2; they include the mean, standard deviation, and minimum and maximum values. From Table 2, we see that the mean innovation quality (IQ) for 3,837 listed firms in China during 2012–2021 is 1.873. The mean number of granted patents (IQ_A) is slightly lower at 1.231, indicating that the actual number of granted patents is generally lower than the total number of patent applications. This aligns with the reality of patent activities, as not all applications are ultimately accepted.

Regarding the test variables, the average ownership concentration (TOP1), measured by the largest shareholder's holding percentage, is 34.015%, with a standard deviation of 14.757%, and ranges from 8.630% to 74.180%. The mean value of state ownership (SOE) is 0.343, with a standard deviation of 0.475, and ranges from 0.000 to 1.000. Institutional ownership (INST) has a mean of 43.909%, with a standard deviation of 25.036%, and ranges from 0.321% to 94.529%. Managerial ownership (Mshare) averages 13.834%, with a standard deviation of 19.572%, and ranges from 0.000% to 68.955%. These statistics provide an overview of the ownership structures within our sample, highlighting the diversity in ownership concentration, state involvement, institutional investments, and managerial stakes in the firms.

For the control variables, the sample firms have an average company size (log of total assets) of 22.256, an average firm age (log of years since establishment plus one) of 2.920, a financial leverage (total debt to total assets) of 0.420, a sales growth rate of 0.169, and an average board size (log of the number of directors) of 2.122.

The industry distribution data in Table 3 shows that the manufacturing industry accounts for the largest share, with 66% of total firm observations, followed by the information transmission, software, and information technology services industry at 6.99%. The wholesale and retail industry and real estate industry contribute 4.98 and 3.89%, respectively. Several industries, including agriculture, forestry, animal husbandry, and fishery as well as mining, represent smaller shares, around 1 to 3% each. A few sectors, such as residential services and education, account for less than 0.5%. The cumulative distribution indicates that over 90% of observations come from the top eight industries, reflecting a concentration in manufacturing and information-related sectors.

Table 2. Descriptive Statistics

Variable	N	Mean	Std. dev.	Min	Max
IQ	25940	1.873	1.526	0.000	5.974
IQ_A	25940	1.231	1.251	0.000	5.063
TOP1	25940	34.015	14.757	8.630	74.180
SOE	25940	0.343	0.475	0.000	1.000
INST	25940	43.909	25.036	0.321	94.529
Mshare	25940	13.834	19.572	0.000	68.955
Size	25940	22.256	1.282	19.814	26.153
FirmAge	25940	2.920	0.319	1.609	3.497
Lev	25940	0.420	0.202	0.050	0.893
Growth	25940	0.171	0.388	-0.544	2.445
Board	25940	2.122	0.197	1.609	2.708

Source: calculated by the author.

Table 3. Industry Distribution

No.	Industry Code	Industry Name	Freq.	Percent	Cum.
1	A	Agriculture, forestry, animal husbandry, and fishery	301	1.16	1.16
2	B	Mining	570	2.2	3.36
3	C	Manufacturing	17,120	66	69.36
4	D	Electricity, heat, gas, and water production and supply	835	3.22	72.58
5	E	Construction	664	2.56	75.13
6	F	Wholesale and retail	1,293	4.98	80.12
7	G	Transportation, storage, and postal	741	2.86	82.98
8	H	Accommodation and catering	69	0.27	83.24
9	I	Information transmission, software, and information technology services	1,814	6.99	90.24
10	K	Real estate	1,009	3.89	94.12
11	L	Leasing and business services	298	1.15	95.27
12	M	Scientific research and technical services	294	1.13	96.41
13	N	Water conservancy, environment, and public facilities management	343	1.32	97.73
14	O	Residential services, repairs, and other services	4	0.02	97.74
15	P	Education	35	0.13	97.88
16	Q	Health and social work	59	0.23	98.11
17	R	Culture, sports, and entertainment	335	1.29	99.4
18	S	Comprehensive industry	156	0.6	100
	Total		25,940	100	

Note: The first column represents the industry number, the second column shows the industry code, the third column lists the industry name, the fourth column provides the frequency of firm observations in each industry, while the fifth and sixth columns display the frequency proportion and cumulative proportion for each industry, respectively.

The Pearson correlation analysis in Table 4 indicates that ownership structure influences IQ in distinct ways. INST and Mshare show positive and significant correlations with IQ, suggesting that the oversight and vested interests of these stakeholders support higher innovation quality. In contrast, TOP1 is negatively correlated with IQ, implying that high ownership concentration may not incentivize innovation. Meanwhile, SOE has a weak positive but non-significant correlation with IQ, indicating a potentially complex relationship that requires further exploration. Additionally, Table 5 shows the Variance Inflation Factor (VIF) values for the primary variables in this study, ranging from 1.03 to 2.92, indicating that multicollinearity is not a concern in our model.

Table 4. Pearson Correlation

	(1) IQ	(2) TOP1	(3) SOE	(4) INST	(5) Mshare	(6) Size	(7) FirmAge	(8) Lev	(9) Growth	(10) Board
(1)	1.000									
(2)	-0.026***	1.000								
(3)	0.007	0.223***	1.000							
(4)	0.057***	0.493***	0.412***	1.000						
(5)	0.017***	-0.090***	-0.481***	-0.650***	1.000					
(6)	0.307***	0.186***	0.354***	0.444***	-0.360***	1.000				
(7)	-0.027***	-0.089***	0.197***	0.062***	-0.246***	0.178***	1.000			
(8)	0.069***	0.057***	0.286***	0.211***	-0.312***	0.525***	0.168***	1.000		
(9)	0.036***	-0.010	-0.085***	0.028***	0.071***	0.038***	-0.044***	0.026***	1.000	
(10)	0.054***	0.020***	0.273***	0.232***	-0.203***	0.273***	0.058***	0.156***	-0.023***	1.000

Note: this table shows the correlation coefficients for the key variables defined in Table 1. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, respectively.

Table 5. Variance Inflation Factor Analysis

Variable	VIF	1/VIF
INST	2.92	0.34
Mshare	2.40	0.42
Size	1.73	0.58
TOP1	1.57	0.64
SOE	1.49	0.67
Lev	1.46	0.68
Board	1.15	0.87
FirmAge	1.12	0.89
Growth	1.03	0.97
Mean VIF	1.65	

Multivariate Results

The main regression results in Table 6 reveal the effects of the independent variables – ownership concentration (TOP1), state ownership (SOE), institutional ownership (INST), and managerial ownership (Mshare) – on innovation quality (IQ) (columns 1–4). Additionally, a combined model including all four independent variables is conducted as a sensitivity test (column 5). Each model incorporates industry and year fixed effects, ensuring that variations due to these factors are controlled.

First, ownership concentration negatively impacts innovation quality. The results in columns 1 and 5 of Table 6 contrast with previous studies on overall innovation, which suggest that dispersed ownership in developed economies enables shareholders to diversify investment risks, benefitting overall innovation (e.g., Chatterjee & Bhattacharjee; Choi et al. [16; 17]). Our study, rooted in the context of China's transition economy, does not guarantee the applicability of these conclusions in other settings. Research by Shleifer and Vishny (1986) [52] suggests that large shareholders often prioritize immediate returns over long-term investments, potentially limiting firms' innovation incentives. This effect may be more pronounced when concentrated ownership fosters risk aversion, as large shareholders may avoid investing in uncertain, innovation-driven projects. In fact, Minetti et al. [36] indicate that, in transitional economies, concentrated ownership can result in entrenched large shareholders, causing conflicts of interest with minority shareholders and possibly hindering complex, long-term investments into aspects like innovation.

Second, state ownership has a positive impact on innovation quality. The results in columns 2 and 5 of Table 6 support findings by Aoki et al. [53], who note that SOEs often receive government support for innovation to achieve national development goals. Studies of SOEs in emerging economies have similarly highlighted increased R&D investment, resources, and political backing for innovation projects. Due to institutional differences, managers of Chinese SOEs, unlike their private-sector counterparts, face

less pressure to meet performance targets; instead, improving innovation quality serves as a political performance indicator. This institutional setting encourages effective oversight of innovation quality by managers and signals active engagement in innovation.

Third, institutional ownership positively influences innovation quality. The results in columns 3 and 5 of Table 6 are consistent with the findings of Aghion et al. [54], who argue that institutional investors are generally oriented toward long-term performance and may therefore support innovation investments. Institutional investors typically possess extensive resources and expertise to monitor and evaluate their investments. Our findings support the view that active involvement by institutional investors improves corporate governance, including decisions related to enhancing innovation quality. This enhanced monitoring mitigates managerial opportunism and promotes investment in high-quality innovation projects.

Fourth, managerial ownership is positively correlated with innovation quality. The results in columns 4 and 5 of Table 6 indicate that managerial ownership as a governance mechanism can mitigate adverse factors in innovation activities. Managers holding company shares directly benefit from the success of the firm's innovation, aligning their interests with those of shareholders, consistent with the perspective of Jensen and Meckling (1976) [20]. With equity stakes, managers may be more inclined to pursue long-term innovation strategies that enhance firm value. Additionally, some publications, such as Karácsony et al. (2023) [55], suggest that managers with ownership stakes may take appropriate risks in innovation to enhance the firm's reputation and competitiveness. Thus, equity incentives provide managers with greater motivation to pursue high-return innovation projects.

Among the control variables, firm size shows a positive effect on innovation quality, consistent with the view of Herrera and Sánchez-González (2012) [56] that larger firms typically have more R&D resources, enabling a higher share of innovation projects. Conversely, firm age is negatively associated with innovation quality, possibly due to the inertia and resistance to change often observed in older firms, as noted by Coad et al. (2015) [57]. Additionally, leverage negatively impacts innovation quality, supporting the view that high debt levels constrain firms' financial flexibility, potentially limiting R&D investment [58]. Finally, board size positively impacts innovation quality, as board members provide oversight and strategic direction for innovation, consistent with the findings of Zona et al. (2012) [59].

In summary, our results reinforce existing theories regarding the impact of ownership structure on innovation quality, with distinct effects observed for different ownership types. These findings underscore the complexity of ownership governance mechanisms in shaping corporate innovation strategies, suggesting that policies tailored to ownership structure could further optimize the quality of corporate innovation outcomes.

Table 6. Main Regression Results

	(1) IQ	(2) IQ	(3) IQ	(4) IQ	(5) IQ
TOP1	-0.001*				-0.004***
	(-1.84)				(-6.52)
SOE		0.117***			0.164***
		(6.43)			(8.45)
INST			0.001**		0.004***
			(2.03)		(7.40)
Mshare				0.002***	0.005***
				(3.58)	(9.44)
Size	0.609***	0.599***	0.601***	0.612***	0.592***
	(79.01)	(77.41)	(74.65)	(78.67)	(73.45)
FirmAge	-0.116***	-0.141***	-0.111***	-0.093***	-0.112***
	(-4.53)	(-5.46)	(-4.39)	(-3.59)	(-4.24)
Lev	-0.355***	-0.379***	-0.346***	-0.328***	-0.317***
	(-7.99)	(-8.55)	(-7.80)	(-7.34)	(-7.04)
Growth	0.010	0.020	0.009	0.006	-0.000
	(0.52)	(1.05)	(0.46)	(0.29)	(-0.02)
Board	0.174***	0.146***	0.173***	0.190***	0.112***
	(4.37)	(3.61)	(4.30)	(4.74)	(2.76)

	(1) IQ	(2) IQ	(3) IQ	(4) IQ	(5) IQ
_cons	-11.529***	-11.241***	-11.441***	-11.753***	-11.238***
	(-63.97)	(-60.78)	(-61.66)	(-62.46)	(-58.18)
P value of F test	0.000	0.000	0.000	0.000	0.000
P value of Hausmann test	0.000	0.000	0.000	0.000	0.000
Year FE	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y
N	25 940	25 940	25 940	25 940	25 940
Adj. R^2	0.439	0.440	0.439	0.440	0.442

Note: values in parentheses are robust t-statistic. * p < 0.1, ** p < 0.05, *** p < 0.01, respectively.

Source: calculated by the author.

Robustness Check

The regression results in the previous section reveal a nuanced relationship between ownership structure and innovation quality. In this section, we employ three methods to ensure the robustness of these results.

First, we use an alternative dependent variable. To address potential measurement errors related to IQ, we introduce an alternative dependent variable: the natural logarithm of the total number of patents granted to a firm plus one (IQ_A), following the methodology of Chen and Zhang [60]. Unlike previous studies that rely on patent applications as an innovation indicator, the number of granted patents represents the actual number recognized and certified by government intellectual property agencies. The first column of Table 6 shows the robustness test results based on the alternative dependent variable. The estimated coefficients of the four test variables (TOP1, SOE, INST, and Mshare) are similar in magnitude and direction, confirming the robustness of the baseline regression.

Second, we conduct a subsample test. Removing post-2019 COVID-19 samples tests the robustness of the baseline regression by controlling for the abnormal disturbances and external shocks caused by the pandemic, ensuring the validity and reliability of the analysed results. The COVID-19 pandemic had a profound impact on the global economy and business operations, potentially causing significant variations in firms' innovation activities, financial performance, and innovation decisions. The results in the second column of Table 7 indicate that the relationship between TOP1 and IQ is negative and significant, while SOE, INST, and Mshare continue to positively influence firms' innovation quality. These findings are consistent with previous results, confirming the consistency of our conclusions.

Third, we employed two alternative estimation methods to enhance the robustness of our results. On the one hand, given the count nature of patents, fixed-effects model estimates may be misleading. Therefore, we re-estimated model (1) using a Poisson model and a maximum likelihood estimation to address this concern. On the other hand, while IQ is largely continuously distributed across positive values, it includes a subset of observations with zero values, making the Tobit model particularly appropriate under these conditions. Thus, we reran model (1) using the Tobit specification. The results from both alternative models (see Table 6, columns 3 and 4) align with the conclusions of our main regression model, further confirming the robustness of our findings.

Table 7. Robustness Checks

	(1) IQ_A	(2) IQ	(3) IQ	(4) IQ
TOP1	-0.003***	-0.004***	-0.002***	-0.004***
	(-4.74)	(-5.78)	(-5.07)	(-6.48)
SOE	0.145***	0.160***	0.066***	0.150***
	(8.67)	(7.06)	(6.38)	(7.73)
INST	0.002***	0.003***	0.002***	0.003***
	(4.38)	(5.12)	(8.20)	(7.00)
Mshare	0.002***	0.005***	0.004***	0.005***
	(3.89)	(6.67)	(12.66)	(9.38)

	(1)	(2)	(3)	(4)
	IQ_A	IQ	IQ	IQ
Size	0.483***	0.576***	0.293***	0.602***
	(67.34)	(59.57)	(74.90)	(75.46)
FirmAge	-0.070***	-0.113***	-0.075***	-0.062***
	(-3.10)	(-3.73)	(-5.48)	(-2.48)
Lev	-0.356***	-0.331***	-0.158***	-0.336***
	(-9.18)	(-6.21)	(-6.23)	(-7.45)
Growth	-0.048***	0.016	-0.008	-0.033
	(-2.97)	(0.70)	(-0.81)	(-1.72)
Board	0.127***	0.131***	0.104***	0.096***
	(3.61)	(2.75)	(4.95)	(2.36)
_cons	-9.502***	-10.893***	-5.880***	-12.404***
	(-56.24)	(-47.45)	(-60.26)	(-58.73)
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
N	25 940	18 891	25 940	25 940
Pseudo R^2			0.166	0.156
Adj. R^2	0.388	0.444		

Note: values in parentheses are robust t-statistic. * p < 0.1, ** p < 0.05, *** p < 0.01, respectively.

Source: calculated by the author.

Conclusion

Using patent data from Chinese listed companies between 2012 and 2021, this study addresses the current confusion surrounding the impact of four types of ownership structures on innovation quality. Unlike previous research that treats patents as a holistic phenomenon, we examine technologically significant invention patents from the perspective of patent quality, empirically testing the impact of ownership structure on innovation quality in China's transitional economy. Drawing on agency theory, we find that ownership concentration is detrimental to innovation quality, while institutional ownership and managerial ownership are two corporate governance mechanisms that drive improvements in innovation quality. We incorporate institutional theory into the framework of state ownership and innovation quality, confirming that state-owned enterprises with institutional support have an inherent advantage in enhancing innovation quality. Through a series of checks, including alternative dependent variables, subsample tests, and Poisson models, the results are found to be robust.

These findings suggest that in transitional economies like China, innovation quality is closely linked to ownership structure. Excessive ownership concentration is not beneficial; instead, state ownership, institutional ownership, and managerial ownership enable firms to access resources and innovation advantages that are difficult to obtain in traditional centralized institutional forms.

This study adds to the literature on ownership structure and innovation quality in transitional economies. Previous research has emphasized the critical role of ownership in enhancing holistic innovation. Our results demonstrate that ownership structure is a vital means for firms to acquire scarce resources and address institutional gaps from corporate governance mechanisms. We provide empirical evidence from a transitional economy, highlighting that high ownership concentration negatively impacts innovation quality due to risk aversion and short-term profit motives, thereby challenging the traditional belief in its governance benefits. Conversely, our findings indicate that state ownership positively influences innovation quality, countering the inefficiency narrative often associated with SOEs, while institutional ownership enhances corporate governance and innovation by leveraging investor resources and expertise. Additionally, managerial ownership aligns managers' interests with those of shareholders, promoting high-quality innovation and mitigating agency problems, which offers a comprehensive understanding of internal stakeholder equity participation in innovation outcomes.

This study offers several policy implications for promoting high-quality innovation through balanced ownership

structures. Policymakers should encourage broader share ownership and protect minority shareholder rights to mitigate the risks of ownership concentration. Supporting SOEs by providing resources and fostering autonomy can leverage their potential for high-quality innovation. Attracting institutional investors through favourable regulatory frameworks can enhance governance and strategic decision-making, while incentivizing managerial ownership through stock options and performance-based rewards can align managerial interests with long-term innovation goals. Tailoring policies to the unique characteristics of transitional economies, particularly by recognizing the roles of state ownership and institutional investors, is essential for promoting sustainable and high-quality innovation.

However, this study also has limitations. First, the sample selection is limited to Chinese listed companies. While this sample provides sufficient and reliable data given China's status as the largest transitional economy, it excludes non-listed companies and other transitional economies, potentially causing sample selection bias. Future research could consider cross-national comparisons and include non-listed firms. Second, the identification of innovation quality is based solely on invention patents, which, although reflective of technological innovation, may not capture the full spectrum of innovation quality. Future studies could collect more detailed high-tech patent information to deepen research on innovation quality. Lastly, while this study examines the impact of four ownership structures on innovation quality, it does not test moderating effects. Future research could explore other corporate governance mechanisms as moderating variables to further investigate the mitigating and promoting roles of corporate governance.

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