Asia Pacific Science Press

Asia Pacific Economic and Management Review
ISSN(O):3005-9275
ISSN(P):3005-9267
Vol. 2 No.1 (2025)

The Impact of Performance Aspiration Surplus on Corporate Innovation Activity: The Moderating Effects of Managers' Risk Traits and Competitive Threats

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Abstract: In the pursuit of industry leadership, innovation activity is considered a crucial driver for high-performing enterprises to transcend to industry leaders. By selecting listed companies on the Shanghai and Shenzhen A-share markets from 2010 to 2022 as the research object, this paper explores the impact of performance aspiration surplus on corporate innovation activity and its boundary conditions. The results show that performance aspiration surplus has an inverted U-shaped relationship with corporate innovation activity; managers' risk traits and competitive threats respectively strengthen and weaken this inverted U-shaped relationship. This paper expands the research boundaries of the impact of performance aspirations on corporate innovation, enriches the application of social comparison theory in the Chinese context, and provides new insights for continuously stimulating corporate innovation vitality.

Keywords: Performance Aspiration Surplus; Corporate Innovation Activity; Managers' Risk Traits; Competitive Threats
Published: Feb 26, 2025
DOI: https://doi.org/10.62177/apemr.v2i1.169

1.Introduction

With the accelerating evolution of economic globalization, China has emerged with a number of enterprises experiencing rapid performance growth. However, after achieving performance growth, how to plan and adjust subsequent strategic directions and development paths constitutes an important issue for the future development of these enterprises. Some enterprises anticipate potential crises and strive to accumulate resources and enhance innovation capabilities to gain a stronger competitive advantage, creating enormous value for both enterprises and society. For instance, Contemporary Amperex Technology Co. Limited (CATL), a leader in the global new energy battery market, held a 36.8% market share in the global power battery market in 2023, ranking fi rst for seven consecutive years. Despite this, CATL invested 4.34 billion yuan in research and development in the fi rst quarter of 2024 alone. Its strong innovation capability not only generated huge profi ts for the enterprise but also reduced society's dependence on traditional energy sources and lowered carbon emissions. In contrast, some enterprises, after experiencing performance growth, become shackled by existing models and successful experiences, neglecting innovation and ultimately disappearing from the market. Kodak, a leader in the fi lm camera era, is an example. Overly reliant on its highly successful fi lm camera and fi lm technology, it ultimately lost in market competition and went bankrupt. In view of this, an in-depth exploration of the impact of performance growth on corporate innovation

undoubtedly holds significant value and importance.

Regarding the impact of performance aspiration surplus (the portion where a company's actual performance exceeds its expected level) on corporate innovation, the academic community holds mixed views. Based on principal-agent theory and performance feedback theory, some scholars argue that performance growth reduces managers' performance pressure, further solidifying their thoughts and behaviors within existing experiences and models. Managers may also develop overconfidence due to the company's successful operations, leading to satisfaction with the status quo and opposition to change, ultimately inhibiting corporate innovation. On the other hand, scholars grounded in threat rigidity theory and organizational behavior theory advocate that the unexpected returns generated by aspiration surplus promote enterprises to engage in innovative activities to establish competitive advantages[1]. In such scenarios, enterprises' confidence in implementing innovative activities increases, and resources such as funds, talent, and materials required for innovation become available, thereby promoting corporate innovation.

The lack of consensus among scholars regarding the impact of performance growth on corporate innovation can be attributed to the following reasons: Firstly, the theories applied in analyzing the relationship between the two in existing literature need further deepening. Most existing studies use prospect theory to explain the mechanism of their interaction, emphasizing individuals' decision-making behavior and psychological mechanisms when facing uncertainty. However, corporate behavior results from the combined effects of multiple forces, thus limiting the explanatory power of prospect theory at the corporate innovation level. Secondly, existing research on the impact of performance aspiration surplus on innovation is either too specific or overly generalized. Scholars have primarily explored the following aspects: specifically studying the impact of performance growth on corporate R&D investment [2] or broadly generalizing its impact on corporate risk-taking or speculative behavior [3,4]. These studies have laid a theoretical foundation for understanding the relationship between performance aspiration surplus and corporate innovation but mainly focus on the intensity of corporate innovation investment, risk behavior, and specific innovation categories, lacking targeted examination of corporate innovation enthusiasm and frequency. Thirdly, most existing studies discuss the relationship between performance aspiration surplus and corporate innovation from a linear perspective, failing to consider their relationship from a nonlinear perspective.

Therefore, instead of using prospect theory to explain the mechanism of action between performance aspiration surplus and innovation, this paper explores their intrinsic logical relationship from a nonlinear perspective based on social comparison theory and upper echelons theory. Additionally, rather than treating corporate innovation specifically or generally, this study selects corporate innovation activity as the research object, allowing for a more direct and targeted discussion of corporate innovation potential and vitality, taking into account both corporate innovation investment and frequency.

In summary, what is the impact of performance aspiration surplus on corporate innovation activity, and what constraining factors exist between them? To address these questions, this paper relies on social comparison theory and upper echelons theory, aiming to make contributions in the following three aspects: Firstly, it explores the relationship between performance aspiration surplus and corporate innovation activity, contributing to the understanding of their relationship, which has yet to reach a consensus. Additionally, by focusing on the indicator of innovation activity, this paper expands the research boundaries of the impact of performance growth on corporate innovation. Secondly, this paper adopts social comparison theory, organizational inertia, and the law of diminishing marginal returns of innovation for mechanism analysis, supplementing and enriching theoretical tools in this field. Thirdly, it analyzes the internal and external factors constraining the impact of performance aspiration surplus on corporate innovation activity, providing theoretical references for a deeper understanding of their relationship and continuously enhancing corporate innovation activity.

2. Theoretical Analysis and Research Hypotheses

2.1 The Impact of Performance Aspiration Surplus on Corporate Innovation Activity

According to social comparison theory, individuals' expectation levels are determined by the performance of similar others[5]. People compare themselves with reference points for self-reflection and improvement, distinguishing between upward and downward social comparisons. In upward social comparison, individuals compare themselves with those who are better than themselves to seek information and strategies that contribute to their growth and improvement, thereby driving self-

motivation and continuously stimulating intrinsic potential to promote their overall development and perfection. Existing research shows that downward social comparison, besides eliciting feelings of superiority and satisfaction, may also generate positive responsive behaviors motivated by a desire to help. At the same time, enterprises may also face considerable pressure to be overtaken by peer enterprises. Both factors drive enterprises to increase their innovation activity to seek further development.

Apart from comparative pressure and the pressure to be overtaken affecting enterprises' risk-taking behavior in surplus scenarios, enterprises' redundancy-driven search behavior is also a crucial factor explaining changes in their innovation activity under aspiration surplus conditions[6]. After generating performance aspiration surplus, enterprises often accumulate redundant resources that, although not necessary for their daily operations, provide additional capital and flexibility for capturing new development opportunities [7]. In the early stages of performance aspiration surplus, managers typically direct accumulated redundant resources towards exploring and experimenting with new innovative initiatives. The existence of these redundant resources effectively reduces costs during the innovation process, significantly enhancing enterprises' ability to withstand the risks of innovation failure [8]. Simultaneously, these redundant resources provide a crucial material and human resource guarantee for innovation activities, ensuring the steady progress of innovation projects. Therefore, in the early stages of performance aspiration surplus, enterprises tend to leverage these redundant resources to drive the search process, thereby enhancing innovation activity and aiming to achieve superior performance and market competitiveness.

When performance aspiration surplus increases to a certain extent, enterprises have already achieved certain accomplishments in the industry, reducing the urgency to align with industry leaders and gradually shedding the pressure to be overtaken. At this point, corporate innovation activity becomes dominated by other factors. Furthermore, as enterprises accumulate performance aspiration surplus, a stable set of successful operating models and inertial thinking gradually forms within the organization [9]. This inertial thinking leads enterprises to rely more on existing successful experiences rather than actively exploring innovative solutions when facing emerging market dynamics or technological revolutions, which is detrimental to corporate innovation activities. Additionally, the path dependence phenomenon of enterprises also plays a crucial role. Past successful experiences often lock enterprises into a "locked-in" state, inclining them to follow existing development trajectories rather than attempting new innovative paths that may bring uncertainty. Therefore, when performance aspiration surplus reaches a certain level, the dual effects of organizational inertia and path dependence reduce enterprises' enthusiasm for innovation, thereby decreasing their innovation activity.

In terms of corporate innovation activities themselves, the law of diminishing marginal returns of innovation is also an important factor influencing changes in corporate innovation activity [10]. This law describes a trend where, despite continuously increasing innovation investments (including funds, human resources, time, and other key elements), the innovation benefits brought by each additional unit of investment (such as improved efficiency in new product development, the depth of technological innovation, and enhanced market competitiveness) exhibit a diminishing return. This means that as innovation activities progress, the effect of new investments on promoting innovation diminishes gradually [11]. Due to the diminishing innovation benefits, managers may be more inclined to reduce innovation investments after a period of innovation investments to maintain existing performance levels, thereby decreasing corporate innovation activity.

Considering the above factors simultaneously, this paper summarizes the relationship between performance aspiration surplus and corporate innovation activity as follows: The social comparison pressure and redundancy-driven search behavior enterprises face lead them to exhibit a profit-seeking tendency. Conversely, factors such as organizational inertia, path dependence, and the law of diminishing marginal returns of innovation make enterprises exhibit a risk-averse tendency. When performance aspiration surplus first appears, enterprises have just entered the ranks of high-performing enterprises, and external pressures and driving forces dominate, making enterprises seek further development and enhance their competitiveness, thereby increasing innovation activity. After performance aspiration surplus reaches a certain level, enterprises have achieved certain accomplishments, and the previously dominant social comparison pressure takes a back seat. Enterprises are now more constrained by internal factors such as organizational inertia and the law of diminishing marginal returns of innovation, leading to a decrease in innovation activity. In summary, this paper proposes hypothesis H1.

H1: There is an inverted U-shaped relationship between performance aspiration surplus and corporate innovation activity.

2.2 The Moderating Effect of Managers' Risk Traits

Upper echelons theory emphasizes that under conditions of incomplete rationality, executives' traits not only shape their decision-making styles and patterns but also influence corporate strategic decision outcomes and innovation performance. Corporate innovation heavily relies on managers' cognitive and judgment abilities. In complex and uncertain situations, differences in managers' risk traits manifest as heterogeneity in their interpretation and response to corporate risks. On the one hand, managers with stronger risk traits have higher risk tolerance and are more optimistic about corporate risk expectations. During upward comparison, they may be more convinced that the enterprise can achieve surpassing results and are more enthusiastic about engaging in high-risk, high-return investment activities. They are also more easily attracted by the characteristics of innovative activities. Compared to managers with weaker risk traits, they are more inclined to invest the enterprise's accumulated resources in innovation activities, resulting in higher corporate innovation activity under the same magnitude of performance surplus. On the other hand, managers with stronger risk traits have higher wealth expectations or reference points [12], which also makes them have higher expectations and satisfaction standards for corporate performance. They tend to seek opportunities that can bring significant wealth growth. Therefore, under the same performance aspiration surplus, managers with higher wealth expectations are more motivated to drive innovation to achieve higher wealth growth targets. In summary, this paper proposes hypothesis H2.

H2: Managers' risk traits strengthen the inverted U-shaped relationship between performance aspiration surplus and corporate innovation activity.

2.3 The Moderating Effect of Competitive Threats

When enterprises engage in upward comparison, a sudden deterioration in the competitive environment not only reduces their confidence in catching up with outstanding competitors but also significantly impacts their survival and performance improvement. Intensified competitive threats are important manifestations of a crisis, such as competition for market share, product and service homogenization, and overcapacity, which may put corporate executives under high pressure [13]. Executives need to allocate a considerable amount of resources and energy to respond to competitive strategies adopted by peers. In high-threat competitive scenarios, it is more difficult for enterprises to stand out and establish unique advantages. Therefore, the pressure generated by such competitive threats may make decision-makers believe that the enterprise faces higher risks, reducing their risk-taking motivation and confidence. In surplus scenarios, enterprises may prioritize allocating all resources to maintain existing operations, aiming to maintain existing business performance as the primary goal, and seek innovation and change only after the competitive threat situation eases. Based on this, this paper proposes the following hypothesis.

H3: Competitive threats weaken the inverted U-shaped relationship between performance aspiration surplus and corporate innovation activity.

3.Research Design

3.1 Data Sources

Based on data availability, this study uses all listed companies on the Shanghai and Shenzhen A-share markets from 2010 to 2022 as the initial sample. This paper excludes years and enterprise data with serious missing values, ultimately constructing an unbalanced panel dataset involving 13,496 observations from 3,245 listed companies. Patent-related data come from the CNRDS database, while financial and basic corporate information data come from the CSMAR database. To avoid the adverse effects of extreme and abnormal values on the results, this paper further screens the data. Specifically, it excludes ST, *ST, and companies about to be delisted; companies with significant missing financial data in some years; and conducts a 1% and 99% quantile tailing process for major continuous variables.

3.2 Variable Measurement

3.2.1 Dependent Variable

Corporate Innovation Activity (Innov). According to the mainstream view in existing research, the number of patent applications during a company's strategic adjustment period is considered the most accurate and direct indicator for comprehensively

measuring the company's innovation investment and frequency during that period. Since the number of patent applications has strong explanatory power for a company's innovation output over a certain period and patent applications also undergo review and verification by national patent departments, their credibility is high. Based on this, this paper uses the number of patent applications as a proxy variable for corporate innovation activity and performs a logarithmic transformation. However, since many companies have zero patent applications, this paper calculates the natural logarithm after adding 1 to the number of patent applications.

3.2.2 Independent Variable

Performance Aspiration Surplus (PAG). Referring to mainstream literature, performance aspiration surplus is calculated as the difference between a company's actual performance (P) and its expected level (A) when P is higher than A. Here, P is measured using ROA from the previous year (t-1), and the expected level (A) is derived by calculating the social expectations of the same industry. Drawing on study uses the average ROA of other companies within the same industry (based on the tertiary SIC industry code of the national economic classification) in the previous year (t-1) to measure industry social expectations.

3.2.3 Moderating Variables

Managers' Risk Traits (Character). Referring to [14], individuals' and companies' financial decisions can reflect managers' risk preferences. Therefore, this paper measures managers' risk traits using the proportion of risk assets in total assets. Based on existing literature and data availability, this paper comprehensively measures managers' risk traits using the following two methods: Firstly, at the company level, the specific calculation formula is as follows:

Secondly, at the individual level, the proportion of managers' personal risk assets to their total wealth is used as an indicator to measure managers' risk preferences. Managers' personal risk assets mainly refer to their shareholding market value, and total wealth includes both their shareholding market value and total compensation. The shareholding market value is calculated by multiplying the number of shares held by executives by the share price for that year. Due to significant fluctuations in share prices over time, this paper calculates the average share price over 365 days of the year to compute executives' shareholding market value and finally obtains Character_r2. To avoid subjectivity in the indicators, this paper uses the entropy method to calculate the weights of the two indicators, with Character_r1 at the company level accounting for 13.58% and Character_r2 at the individual level accounting for 86.42%. The final weighted value is Character.

Competitive Threats (HHI). This paper uses industry competition intensity as a proxy variable for competitive threats, meaning that the more intense the competition within an industry, the greater the competitive pressure and threats faced by enterprises. Referring to existing research methods [15], this study calculates each company's share of the industry market by dividing its main business income by the total main business income of its industry and then squares the calculated market shares and sums them up to obtain the HHI index.

3.2.4 Control Variables

Combining research practice and data availability: At the internal corporate level, we select firm age (Firm-age). Older firms may exhibit organizational rigidity, which could hinder their innovation decision-making processes. We also include equity concentration (Concen) as a control variable. The degree of equity concentration directly influences managers' discretion, which in turn may affect their strategic decisions. Ownership nature (State) is another control variable. According to the institutional-based view, the impact of performance feedback on corporate innovation varies based on the ownership nature of the firm. Compared to non-state-owned enterprises, state-owned enterprises typically possess more key resources and are more likely to receive government support, which may influence their innovation decisions. CEO age (CEO-age) is also considered, as it can reflect differences in mental state, experience, and background, all of which may affect managerial decision-making. Furthermore, we include whether there has been a change in senior management (CEO-alter) as a control variable. Changes in senior management may bring new ideas and corporate cultures, leading to shifts in corporate strategy and operations. At the external corporate level, we incorporate year (Year), industry (Ind), and provincial dummy variables (Province) to mitigate the influence of unobservable factors.

3.2.5 Model construction

To verify the main hypothesis H1 and hypotheses H2 H3,This article constructs the following benchmark regression model:

$$Innov_{i,t} = \alpha_1 PAG_{i,t-1} + \alpha_2 PAG^2_{i,t-1} + \alpha_3 Controls_{i,t-1} + Year + \Pr ovince + \varepsilon_{i,t} \quad (1)$$

To further test the moderating effect of managerial risk characteristics and competitive threats on the main effect, this article will add independent variables and their square terms to the above model, as well as interaction terms between the moderating variable and the independent variables. Then, by observing the positive and negative coefficients of the independent variables and interaction terms, we can test the moderating effect of both on the main effect.

4.Data analysis and research results

4.1 Descriptive statistics and correlation coefficient

To avoid multicollinearity among variables, this article conducted a variance inflation factor (VIF) test on all variables. The test results showed that the highest VIF was 1.34, and the average VIF was 1.11, which was far below 10, indicating that there was no serious multicollinearity among variables. Descriptive statistics and correlation coefficients of variables are shown in Table 1. From Table 1, it can be seen that the correlation coefficients between the main variables are all less than 0.5, indicating that the variable settings are reasonable.

4.2 Analysis and Discussion of Regression Results

4.2.1 Main effect test

To test the impact of performance expectation gap on enterprise innovation activity, this article conducted a regression analysis on the full sample based on Model 1, controlling for year, industry, province, and a series of control variables. The regression results are shown in columns 1 and 2 of Table 2. The results show that when only the explanatory variable is regressed in the first column, the coefficient is significantly positive β=0.126, p<0.01, After adding the quadratic term of the explanatory variable, the results are shown in the second column. The coefficient of the square term of the independent variable is significantly negative β = -0.158, p<0.01, The coefficient of

Table 1 Descriptive statistics and correlation analysis

variables	1	2	3	4	5	6	7	8	9
1Innov	1								
2PAG	0.075***	1							
3Character	0.067***	0.159***	1						
4HHI	-0.113***	0.026***	-0.033***	1					
5Firmage	-0.090***	-0.030***	-0.143***	-0.057***	1				
6State	-0.158***	-0.148***	-0.252***	-0.240***	0.201***	1			
7Concen	-0.0100	0.020**	-0.031***	-0.458***	-0.048***	0.193***	1		
8CEOage	-0.00300	-0.030***	-0.050***	-0.201***	0.060***	0.109***	0.036***	1	
9CEOalter	-0.044***	-0.0130	-0.046***	-0.079***	0.040***	0.081***	0.006	0.030***	1
Max	5.817	2.406	8.065	1	36	33	0.794	72	1
Min	0	0.005	0	0	2	5	0.001	31	0
mean	1.652	0.451	2.644	0.135	18.299	0.268	0.165	49.640	0.104
Std.dev	1.563	0.440	2.603	0.149	5.894	0.443	0.117	8.603	0.306
VIF	—	1.03	1.33	1.01	1.10	1.34	1.07	1.01	1.01

Note: *** p<0.01, ** p<0.05, * p<0.1

the first-order term is significantly positive β=0.405, p<0.01, The goodness of fit increased from 0.292 to 0.293, indicating that using a curve equation to fit the data is more effective. Following the recommendations of [16], this article further tested the nature of the curve. The test results showed that the T value was 3.18, which passed the U-shaped curve hypothesis, and when the performance expectation surplus was small, PAG=0.005. The slope is significantly positive, with a beta value of 0.423, P<0.01, When the performance expectation surplus is large, the slope is significantly negative β = -0.354, P<0.01, The

peak of the curve is PAG=1.284, which falls within the range of 0.050 to 2.406 for the desired performance surplus, meeting the conditions for the existence of a downward-opening parabola. In summary, H1 is supported, that is, as the performance expectation surplus increases, the innovation activity of enterprises gradually increases. When the performance expectation surplus reaches a certain turning point, the innovation activity of enterprises begins to show a downward trend, ultimately resulting in an inverted U-shaped relationship between the performance expectation surplus and the innovation activity of enterprises.

4.2.2 Test of the moderating effect of managerial risk traits. Finally, this article discusses the moderating effect of managerial risk traits and competitive threats on the main effect from the perspective of managers and external environment. To test this effect, this article adds interaction terms between the moderator variable and the independent variable as well as interaction terms between the moderator variable and the independent variable's quadratic term to the basic model. Finally, it compares the significance and positive and negative signs of the interaction terms to determine their moderating effect. The regression model is as follows:

$$Innov_{i,t} = \beta_1 PAG_{i,t-1} + \beta_2 PAG^2_{i,t-1} + \beta_3 PAG_{i,t-1} \times Character + \beta_4 PAG^2_{i,t-1} \times Character + \beta_0 \quad (2)$$

$$Innov_{i,t} = \varepsilon_1 PAG_{i,t-1} + \varepsilon_2 PAG^2_{i,t-1} + \varepsilon_3 PAG_{i,t-1} \times HHI + \varepsilon_4 PAG^2_{i,t-1} \times HHI + \varepsilon_0 \quad (3)$$

Regression results are shown in Table 2. The regression results of the moderating effect of the manager's risk traits are reported in column 3. It can be seen that the coefficient of the quadratic term of the independent variable is negative and significant β = -0.159, p<0.01, The interaction coefficient between the manager's risk traits and the quadratic term of the independent variable is also negative and significant, with a beta value of -0.022, p<0.1, This article further examined the calculation results in Equation 2 and found that the result was significantly positive at 0.000855, indicating a significant difference, indicating that the inflection point of the curve shifted to the right as the adjustment variable increased.

Table 2 Performance expectation surplus and enterprise innovation activity

	(1)	(2)	(3)	(4)
variables	Innov	Innov	Innov	Innov
PAG^2		-0.158***(0.036)	-0.159***(0.036)	-0.346***(-0.048)
PAG	0.126*** (0.027)	0.405***(0.068)	0.402***(0.068)	0.927***(-0.087)
Character×falsePAG			0.061**(0.025)	
Character×falsePAG^2			-0.022*(0.013)	
HHI×falsePAG				-2.570***(-0.300)
HHI×falsePAG^2				0.776***(-0.186)
Firmage	-0.018***(0.002)	-0.018***(-0.002)	-0.018***(0.002)	-0.034***(-0.003)
State	0.029(0.030)	0.036(-0.030)	0.031(0.030)	-0.267***(-0.033)
Concen	0.665***(0.104)	0.643***(-0.104)	0.634***(0.104)	0.197*(-0.114)
CEOage	0.001(0.001)	0.001(-0.001)	0.001(0.001)	0.003**(-0.002)
CEOalter	-0.074*(0.038)	-0.072*(-0.038)	-0.070*(0.038)	-0.092**(-0.042)
Year/ Province/ Ind	yes	yes	yes	yes
_cons	0.255*(0.136)	-1.152***(0.168)	0.204(0.137)	1.218***(-0.109)
N	13174	13174	13174	13174
R2	0.292	0.293	0.294	0.114
Curve testing				
Utest				
T-value		3.18		
Extreme point		1.284		
Slope (PAG-lower)		0.423***		
Slope (PAG-upper)		-0.354***		

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

In summary, H2 is verified. This indicates that the stronger the risk characteristics of managers, the steeper the inverted U-shaped curve between performance expectation surplus and corporate innovation, that is, the risk characteristics of managers strengthen the inverted U-shaped relationship between performance expectation surplus and corporate innovation activity.

4.2.3 Test of the moderating effect of competitive threat

The empirical test results of the moderating effect of competitive threat are reported in column 4 of Table 2. It can be seen that the quadratic coefficient of the independent variable in the model is significantly negative β=-2.570, $p<0.01$, while the interaction coefficient between the independent variable's square term and competitive threat is significantly positive β=0.776, $p<0.01$. Similarly, this article further tests the calculation results in Equation 3, and the result is significantly negative -0.169868, indicating a significant difference, indicating that the inflection point of the curve moves leftward as the moderating variable increases. In summary, H3 is supported. This indicates that the greater the competitive threat, the flatter the inverted U-shaped relationship between the performance expectation surplus and the enterprise's innovation activity. In other words, the competitive threat weakens the inverted U-shaped relationship between the performance expectation surplus and the enterprise's innovation activity.

4.3 Robustness Tests

4.3.1 Changing the Measurement of the Independent Variable

Considering that different performance indicators may yield different performance feedback results, which could influence managerial decisions, this study initially used ROA to measure the efficiency of a company's profit generation from all assets. However, to avoid potential biases arising from the choice of indicators, ROE, which measures a company's ability to generate profits from shareholders' equity, is used to replace the original independent variable. The alternative variable is denoted as PAG-replace. All calculation procedures, lag periods, and models remain unchanged. The regression results are reported in column (1) of Table 3, showing that apart from changes in coefficient magnitudes, the signs and significance of the coefficients remain unaltered.

Given that some scholars consider the number of patent grants as an effective measure of corporate innovation, this study replaces the original dependent variable (number of patent applications) with the number of patent grants for testing. Considering the lag between patent application and grant, this study calculates the average period required for A-share listed companies on the Shanghai and Shenzhen stock exchanges to obtain patents from application to grant over the observation period. The results indicate an average period of 2.67years from 2010 to 2022. Therefore, the number of patent grants is lagged by three periods to replace the original number of patent applications in the model for regression, denoted as Innov-replace. The results are shown in column (2) of Table 3, indicating that the research conclusions remain unchanged.

4.3.2 Changing the Regression Model

To avoid potential impacts of the regression model on the empirical results, considering that OLS regression is suitable for continuous dependent variables and typically assumes that the dependent variable follows a normal distribution, while the number of patent applications in this study may represent count or frequency data, which are non-negative integers, Poisson regression, specifically designed for count data, is used to replace OLS [17]policy reforms have been undertaken in China to gradually promote entrepreneurship of aca demic researchers. Based on manually collected data on academic executives (defined as either chairperson of the board or CEO, who had an academic title. Other parameters and calculation processes remain unchanged. The results are reported in column (3) of Table 3, showing that the research conclusions remain unaltered.

4.3.3 Addressing Endogeneity with the Heckman Two-Stage Model

This study employs the Heckman two-stage model to mitigate potential endogeneity issues caused by sample self-selection bias. In the first-stage selection equation, "whether the company applies for patents (Innov_dum)" is used as the dependent variable. For exogenous variables, this study adopts the industry average performance (Ind-ROE) as an exogenous variable in the model, Industry average performance clearly influences the explanatory variables in this study but is unlikely to affect the innovation of a specific company, thus satisfying both relevance and exogenous requirements. This exogenous variable is included in the main effect regression equation, and the inverse Mills ratio (IMR) is calculated using the first-stage Probit

regression results. Subsequently, the calculated IMR is substituted into the second-stage model for fitting. Columns 5 and 6 of Table 3 report the regression results of the Heckman two-stage model. The significant negative coefficient of the IMR (β=-0.834, p<0.01) indicates the presence of sample self-selection issues that need to be corrected. The regression results in column 6 of Table 3 show that the adjusted model results are consistent with the baseline regression results, suggesting that after controlling for the endogeneity of whether companies apply for patents, the data still support the previous conclusions.

Table 3 Robustness Test

	(1)	(2)	(3)	Heckman two stages	
	OLS	OLS	Poisson	Probit	OLS
variables	Innov	Innov-replace	Innov	Innov_dum	Innov
PAG2-replace	-0.139***(0.012)				
PAG-replace	0.607***(0.043)				
PAG^2		-0.133***(0.051)	-0.168*(0.091)	-0.129***(0.040)	-0.069*(0.039)
PAG		0.284***(0.094)	0.454***(0.168)	0.314***(0.077)	0.270***(0.075)
Firmage	-0.018***(0.002)	-0.008***(0.003)	-0.011**(0.006)	-0.029***(0.003)	0.014***(0.003)
State	0.012(0.030)	0.454***(0.040)	0.434***(0.068)	-0.083**(0.035)	0.324***(0.038)
Concen	0.552***(0.104)	0.561***(0.138)	0.967***(0.252)	0.348***(0.124)	0.563***(0.119)
CEOage	0.001(0.001)	0.005***(0.002)	0.008**(0.003)	-0.000(0.002)	0.001(0.001)
CEOalter	-0.070*(0.038)	-0.007(0.050)	0.068(0.083)	-0.107**(0.042)	0.077*(0.043)
IndROE				-0.643**(0.311)	
IMR					-0.834***(0.128)
Year/ Province/ Ind	yes	yes	yes	yes	yes
_cons	0.035(0.136)	0.568***(0.175)	0.309(0.315)	-0.014(0.210)	0.993***(0.178)
N	13131	8256	2783	13099	8624
R^2	0.303	0.349	0.406	0.280	0.202

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

5.Conclusion

5.1 Main Research Findings

This study focuses on the effect of performance aspiration surplus on corporate innovation activity. After exploring the impact of performance aspiration surplus on innovation activity, further analysis and discussion are conducted from both internal and external dimensions of the firm. Using A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2010 to 2022 as research samples, the following conclusions are drawn: (1) There is an inverted U-shaped relationship between performance aspiration surplus and corporate innovation activity. (2) The stronger the managers' risk-taking propensity, the more likely firms are to engage in innovative activities in the context of a surplus. Managers' risk-taking propensity positively moderates the relationship between performance aspiration surplus and corporate innovation activity; the greater the competitive threat, the more managers face competitive pressures, leading firms to reduce risk-taking behaviors. Competitive threat negatively moderates the relationship between performance aspiration surplus and corporate innovation activity.

5.2 Theoretical Contributions

The main theoretical contributions of this study are as follows: (1) This study focuses on the impact of performance feedback on the level and activity of corporate innovation, expanding the research boundary of the impact of performance aspiration gaps on corporate innovation. Current research on the impact of performance aspiration gaps on corporate innovation primarily concentrates on R&D investment, innovation performance, and collaborative innovation, overly focusing on innovation outcomes and neglecting the direct effects on corporate innovation propensity and vitality. This study expands

the research boundary in this regard. (2) This study introduces social comparison theory, organizational inertia, and the law of diminishing marginal returns on innovation to explain the mechanism of performance aspiration surplus on corporate innovation activity, serving as a supplement to theoretical tools in this research field. Most current research explains managers' cognitive and behavioral changes following the emergence of performance aspiration surplus through prospect theory, subsequently impacting corporate innovation. This study complements existing research by introducing theoretical tools beyond prospect theory, providing a more holistic and systematic perspective. (3) This study analyzes the mechanisms for enhancing corporate innovation activity from both internal and external perspectives, deepening our understanding of the interaction between performance aspirations and corporate innovation and enriching and extending the research content of the performance feedback model. Most current research approaches this issue from a single dimension (either internal or external to the firm). This study adopts a combined internal and external perspective, deepening and expanding existing research and the performance feedback model.

5.3 Managerial Implications

(1) Reshape the performance evaluation system to stimulate continuous innovation momentum during positive performance cycles. Facing increasingly fierce market competition, companies should develop a flexible and forward-looking performance management system that transcends traditional financial indicators and deeply integrates long-term innovation capability and market competitiveness as core evaluation elements. When companies enter a period of favorable performance aspirations, managers should seize this opportunity to increase investment in scientific research, explore cutting-edge technologies, and venture into new markets. By designing innovative incentive mechanisms, such as innovation contribution awards and patent incentive plans, all employees should be motivated to maintain a clear mind during prosperous times, continuously drive the innovation engine, and effectively avoid the "success paralysis" phenomenon, ensuring sustained corporate innovation vitality.

(2) Deepen the cultivation of managers' risk literacy to enhance strategic resilience in uncertain environments. Existing research has highlighted the profound impact of managers' risk-taking propensity on corporate innovation decision-making. Therefore, companies should incorporate manager risk perception education, risk preference shaping, and risk management skills enhancement into strategic talent development plans. Through diversified teaching methods such as real-world case analysis and scenario simulation training, managers' navigation skills in the uncertainty jungle should be enhanced, improving decision-making speed and accuracy. Importantly, during periods of favorable performance, managers should be encouraged to adopt forward-looking and disruptive innovative initiatives, accompanied by a solid risk prevention and control system, to safeguard the innovation journey and ensure the company's steady progress.

(3) Establish a competitive intelligence system to flexibly adapt and drive competitive advantage reshaping through innovation. Given the rapidly changing market dynamics and the underlying threat of competition, companies urgently need to establish an efficient competitive intelligence monitoring and analysis system. This system should be capable of real-time capturing industry trends and accurately analyzing competitor strategies to provide timely and accurate intelligence support for corporate decision-making. Upon detecting increased competitive pressure, companies should swiftly respond and flexibly adjust their innovation strategies, including but not limited to increasing R&D investment in key technologies, accelerating product iterations and upgrades, and exploring new markets, to drive competitive advantage iteration and upgrading through innovation. Simultaneously, leveraging the positive aspects of managers' risk-taking propensity, adopt differentiated or disruptive innovation strategies based on the situation to surpass competitors and stabilize and expand the company's long-term development footprint.

5.4 Limitations and Future Directions

Finally, this study has some limitations: (1) Due to data structure constraints, this study uses secondary data collected and organized from databases, and the measurement of relevant variables may not be highly precise. Future research could use data obtained from surveys and corporate censuses to further test the applicability of the research conclusions. (2) This study only examines the boundary factors influencing the relationship between performance aspiration surplus and corporate innovation activity. The mediation mechanisms between the two remain to be explored, representing one direction for future

research. (3) The sample and data collection in this study may be too broad. Future research could conduct more detailed and targeted studies on specific industries and regions.

Funding

This research is supported by the project of the Education Department of Yunnan Province [Grant No. 2024Y556]

Conflict of Interests

The author(s)declare(s) that there is no conflict of interest regarding the publication of this paper.

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