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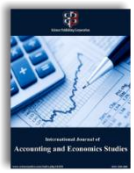

# Female executives and innovation quality: the moderating role of board independence and financing constraints

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**Abstract**

This study investigates the relationship between female executives and corporate innovation quality, with a particular focus on the moderating roles of board independence and financing constraints. Using panel data from Chinese publicly listed firms between 2012 and 2021, I employ Random-effects, Fixed-effects, and Poisson count models to examine the impact of female executives on innovation quality. Our findings reveal a negative effect of female executives on innovation quality. However, this negative relationship is mitigated by higher board independence, suggesting that an independent board provides strategic oversight and support that alleviates the adverse effects of female leadership on innovation outcomes. In contrast, financing constraints exacerbate the negative impact, highlighting the compounding chal-lenges of limited resources on the innovation-related decisions of female executives. These findings offer novel insights into the interplay of gender, governance, and financial constraints in shaping corporate innovation performance, providing valuable implications for firms seeking to optimize governance structures and resource allocation to enhance innovation quality in diverse leadership contexts.

***Keywords***: *Female Executives; Innovation Quality; Corporate Governance; Board Independence; Financing Constraints; China*.

## 1. Introduction

In recent years, the influence of female executives on corporate outcomes has garnered increasing attention, reflecting broader societal shifts toward leadership diversity and inclusivity (e.g., Flabbi et al., 2019; Hyun et al., 2021). Studies have shown that female executives contribute positively to various dimensions of corporate outcomes, including financial performance, environmental, social, and governance (ESG) performance (Yahya, 2023), and organizational culture (Dwyer et al., 2002; Srimulyani & Hermanto, 2022). For instance, firms with higher female representation in leadership positions often demonstrate enhanced ESG performance, driven by a greater emphasis on long-term sustainability and ethical decision-making (Ahmed et al., 2024). Similarly, research highlights that female executives bring unique perspectives to strategic decision-making, which can lead to improved corporate reputation and stakeholder engagement (Amorelli & García-Sánchez, 2019). Despite these advancements, their impact on specific corporate dimensions, particularly innovation quality, remains underexplored.

Innovation quality differs fundamentally from routine or incremental innovation, characterized by its high uncertainty, extended investment cycles, and elevated failure rates (Coccia, 2023). These attributes demand sustained commitment and significant resources, often with uncertain or delayed returns. Prior research highlights that managers, driven by short-term performance targets or personal reputation concerns, may underinvest in innovation, preferring safer, quicker-to-realize projects (Pu & Zulkafli, 2024a). Such short-sighted behaviors may manifest through strategies like cost-cutting in R&D, focusing on incremental improvements over breakthroughs, or diverting resources to immediate financial gains (Pu, 2025; Yang et al., 2023). Female executives, in particular, have been shown to exhibit higher levels of risk aversion compared to their male counterparts, potentially leading to more conservative decision-making in high-stakes innovation environments (Ingersoll et al., 2023). This raises critical questions about how women executives in leadership influence the quality of corporate innovation.

The role of board independence in mitigating managerial short-sightedness has been a prominent topic in corporate governance research. Agency theory suggests that independent boards enhance oversight, align managerial actions with shareholder interests, and curb self-serving behaviors (H. Yang et al., 2023). By providing strategic guidance and robust monitoring, independent directors can counteract the tendency of executives to prioritize short-term objectives over long-term innovation investments (Chen et al., 2023). Previous studies have demonstrated that board independence is associated with increased R&D spending, improved governance quality, and better alignment between corporate goals and innovation strategies (Asad et al., 2023). However, the extent to which board independence can mitigate the risk aversion of female executives in the context of innovation quality remains underexplored.

Financing constraints represent another critical factor influencing managerial behavior in innovation activities. Firms facing limited access to external funding are often compelled to prioritize immediate financial stability over long-term investments in innovation (Liu & Xu, 2024). This pressure is particularly pronounced for female executives, whose risk-averse tendencies may be exacerbated by resource limitations. Under such constraints, female executives may resort to short-sighted measures such as reducing R&D expenditures or focusing

exclusively on low-risk projects (Chu & Oldford, 2022). Despite its practical significance, the interaction between gender, financial constraints, and innovation quality has not been systematically examined, leaving an important gap in the literature with clear implications for corporate governance and financial policy.

To address these research gaps, this study aims to explore the following questions: (1) Does the presence of female executives suppress innovation quality? (2) How does board independence influence the relationship between female executives and innovation quality? (3) How do financing constraints affect the relationship between female executives and innovation quality? By integrating risk aversion theory, agency theory, and financial distress theory, this study seeks to provide a comprehensive framework for understanding these critical issues.

From the perspective of the Risk Aversion View, female executives, on average, exhibit a greater preference for caution in decision-making, which may result in underinvestment in high-risk, high-reward innovation activities (Zhou et al., 2023). While this risk-averse approach may reduce exposure to uncertainty, it can also hinder the pursuit of breakthrough innovations, thereby adversely affecting innovation quality. This theoretical lens provides a foundational explanation for the potential negative impact of female leadership on corporate innovation outcomes.

The Agency View offers insight into how board independence can mitigate the negative effects of risk aversion on innovation quality. Independent directors act as external monitors and strategic advisors, aligning managerial actions with shareholder interests and encouraging long-term value creation (Qiu & Yu, 2023). For female executives, board independence may provide the necessary support and oversight to overcome risk aversion tendencies, enabling them to prioritize innovation quality over short-term considerations (Javaid et al., 2021).

The Financial Distress View emphasizes the exacerbating role of financing constraints in shaping innovation outcomes under female leadership. When resources are scarce, firms are forced to adopt conservative financial strategies (Andersson & Arvidsson, 2023), which may amplify the risk-averse tendencies of female executives. This compounding effect can further restrict investments in high-quality innovation, leading to suboptimal innovation performance. This perspective underscores the critical interplay between resource availability and managerial characteristics in shaping corporate innovation strategies.

Using a comprehensive dataset of publicly listed Chinese firms from 2012 to 2021, this study employs robust empirical methods, including random-effects, fixed-effects, and Poisson count models, to analyze the effects of female executives on innovation quality. The findings reveal that female executives hurt innovation quality, consistent with the risk aversion perspective. Board independence mitigates this negative relationship, aligning with agency theory, while financing constraints exacerbate it, supporting the financial distress perspective.

This study makes several contributions to the literature and practice of corporate governance and innovation. First, it extends the risk aversion literature by empirically demonstrating how female executives influence innovation quality. Second, it enriches agency theory by highlighting the role of board independence in moderating the relationship between female executives and innovation quality. Third, it incorporates financial distress theory into the discussion of gender and innovation, providing new insights into how resource constraints shape innovation outcomes. Lastly, it offers actionable implications for firms and policymakers, emphasizing the importance of aligning governance structures and financial policies with leadership diversity to foster sustainable innovation.

The remainder of this paper is structured as follows. Section 2 outlines the research methodology and analytical framework, including data collection and model specifications. Section 3 presents the empirical results, while Section 4 discusses the findings and their implications. Section 5 concludes with key insights, limitations, and suggestions for future research.

## 2. Materials and methods

This study leverages a meticulously constructed dataset of publicly listed firms on China's A-share market, spanning the period from 2012 to 2021. Executive-level information and financial data were systematically sourced from the CSMAR database, while innovation-related metrics, specifically patent data, were extracted from the CNRDS database.

To ensure the integrity, relevance, and robustness of the data, a rigorous preprocessing protocol was implemented. First, companies within the financial sector were excluded from the sample, as their unique governance frameworks and regulatory requirements could introduce bias and limit comparability with non-financial firms. Second, firms classified as "Special Treatment" (ST) by the China Securities Regulatory Commission, indicating at least two consecutive years of financial distress, were removed to mitigate the undue influence of extreme cases of insolvency. Third, observations with incomplete or missing financial and accounting information were eliminated to maintain data quality and analytical consistency. Finally, a winsorization process was applied to all continuous variables at the first and ninety-ninth percentiles to control for the impact of extreme outliers, thereby enhancing the reliability of the statistical analysis.

In this study, the dependent variable, innovation quality (IQ), is defined following the framework established by Pu and Zulkafli (2024a). Specifically, IQ is measured as the natural logarithm of the number of invention patents filed by the firm. This measure focuses exclusively on invention patents, which are widely recognized as a proxy for high-quality innovation due to their stringent requirements for originality, technical depth, and potential economic impact. By isolating invention patents, the study emphasizes the firm's capacity to generate breakthrough innovations that contribute to its competitive advantage and long-term growth. This approach ensures a precise and consistent assessment of innovation quality, capturing its critical role in reflecting a firm's ability to produce impactful and technically advanced intellectual property.

The independent variable in this study is female executives (FE), representing the degree of female representation in senior management. This variable is defined as the proportion of female executives to the total number of executives within the firm's senior management team. By quantifying the share of women in leadership roles, this measure not only captures the organizational emphasis on gender diversity but also reflects the potential influence female executives may exert on the firm's strategic decision-making and governance processes.

In this study, two moderating variables are examined: board independence and financial constraints, each capturing distinct dimensions of corporate governance and financial limitations.

Board independence (BI) is measured as the proportion of independent directors on the firm's board of directors. This metric reflects the degree to which the board is composed of directors who are free from direct affiliations with the firm's management, ensuring their ability to provide unbiased oversight and strategic guidance.

Financial constraints (FC) are captured using the widely recognized FC index, which provides a comprehensive measure of firms' external financing limitations. The FC index is constructed based on a combination of firm-specific financial characteristics that reflect the degree of difficulty firms face in accessing external capital. Higher values of the FC index indicate greater financial constraints, signaling restricted financial flexibility and heightened reliance on internal resources for investment activities.

To control for firm-specific characteristics that may influence innovation quality, I include several key variables. Firm Size (FS) is measured as the natural logarithm of total assets, providing a consistent basis for comparing firms of varying scales. Firm Age (FA) is calculated

as the natural logarithm of the number of years since the firm's establishment, plus one, capturing the role of organizational experience in shaping innovation outcomes. Return on Assets (ROA), defined as the ratio of net income to total assets, reflects profitability and operational efficiency, which are essential for sustaining innovation. Financial Leverage (FL), expressed as the ratio of total debt to total assets, indicates the extent of reliance on external financing and its implications for risk-taking behavior. Board Size (BS), represented by the natural logarithm of the total number of board members, accounts for the potential impact of board diversity and decision-making capacity on strategic initiatives. Finally, Ownership Concentration (OC), measured as the proportion of shares held by the largest shareholder, highlights governance structure influences that may shape a firm's innovation priorities. These control variables are essential for isolating the primary effects of the study's independent and moderating variables on innovation quality.
To test Questions 1 to 3, I construct the following empirical models:

$$IQ_{i,t} = \alpha_0 + \alpha_1 FE_{i,t} + \alpha_2 FS_{i,t} + \alpha_3 FA_{i,t} + \alpha_4 FL_{i,t} + \alpha_5 ROA_{i,t} + \alpha_6 BS_{i,t} + \alpha_7 OC_{i,t} + Year + Firm + \varepsilon \quad (1)$$

$$IQ_{i,t} = \alpha_0 + \alpha_1 FE_{i,t} + \alpha_2 BI_{i,t} + \alpha_3 FE * BI_{i,t} + \alpha_4 FS_{i,t} + \alpha_5 FA_{i,t} + \alpha_6 FL_{i,t} + \alpha_7 ROA_{i,t} + \alpha_8 BS_{i,t} + \alpha_9 OC_{i,t} + Year + Firm + \varepsilon \quad (2)$$

$$IQ_{i,t} = \alpha_0 + \alpha_1 FE_{i,t} + \alpha_2 FC_{i,t} + \alpha_3 FE * FC_{i,t} + \alpha_4 FS_{i,t} + \alpha_5 FA_{i,t} + \alpha_6 FL_{i,t} + \alpha_7 ROA_{i,t} + \alpha_8 BS_{i,t} + \alpha_9 OC_{i,t} + Year + Firm + \varepsilon \quad (3)$$

In this study, Equation (1) is used to test the direct effect. Equations (2) and (3) aim to examine the moderating role of board independence and financial constraints. Where $\alpha_0$ denotes the intercept, and $\alpha_1 - \alpha_9$ are the coefficients to be estimated. This study added dummy variables that control for year and firm fixed effects (Year and Firm); $\varepsilon$ is the error term; i denotes the cross-sectional dimension for firms; and t denotes the time series dimension.

## 3. Results

Table 1 provides descriptive statistics for the key variables used in this study. The dependent variable, IQ (innovation quality), has a mean value of 1.869 with a standard deviation of 1.532, ranging from 0.000 to 5.974. This measure reflects the varying levels of invention patents across firms, capturing differences in the quality and intensity of innovation efforts within the sample.
The independent variable, FE (female executives), represents the percentage of women in senior management positions. It shows a mean of 19.326 with a standard deviation of 11.408, ranging from 0.000 to 80.000. This indicates substantial variability in gender representation across firms, highlighting diverse organizational commitments to leadership diversity.
For the moderating variables, BI (board independence), defined as the proportion of independent directors on the board, has a mean value of 37.642% and a standard deviation of 5.351%, with a range between 33.330% and 57.140%. This suggests moderate variability in governance oversight. Similarly, FC (financial constraints), measured by the FC index, has a mean of 0.468 with a standard deviation of 0.285, ranging from 0.003 to 0.963, reflecting differences in firms' access to financial resources.
The control variables display diverse characteristics across the sample. FS (firm size), measured as the natural logarithm of total assets, has a mean of 22.274 with a standard deviation of 1.294, indicating a broad range of firm sizes. FA (firm age) averages 2.922 with a standard deviation of 0.319, reflecting a relatively mature sample. FL (financial leverage), calculated as the ratio of total debt to total assets, has a mean of 0.422 and a standard deviation of 0.203, ranging from 0.050 to 0.893. ROA (return on assets), which indicates profitability, averages 0.041 with a standard deviation of 0.063, showing considerable variation in operational efficiency. BS (board size), measured as the natural logarithm of board members, has a mean of 2.123 with a standard deviation of 0.197. Finally, OC (ownership concentration), represented by the percentage of shares held by the largest shareholder, has a mean of 34.245% with a standard deviation of 14.820%, indicating substantial variation in governance structures.

**Table 1:** Descriptive Statistic

| Variable | Obs | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| IQ | 26,694 | 1.869 | 1.532 | 0.000 | 5.974 |
| FE | 26,694 | 19.326 | 11.408 | 0.000 | 80.000 |
| BI | 26,694 | 37.642 | 5.351 | 33.330 | 57.140 |
| FC | 26,694 | 0.468 | 0.285 | 0.003 | 0.963 |
| FS | 26,694 | 22.274 | 1.294 | 19.814 | 26.153 |
| FA | 26,694 | 2.922 | 0.319 | 1.609 | 3.497 |
| FL | 26,694 | 0.422 | 0.203 | 0.050 | 0.893 |
| ROA | 26,694 | 0.041 | 0.063 | -0.239 | 0.222 |
| BS | 26,694 | 2.123 | 0.197 | 1.609 | 2.708 |
| OC | 26,694 | 34.245 | 14.820 | 8.630 | 74.180 |

Table 2 presents the Pearson correlation coefficients for the key variables in this study, providing insights into their interrelationships. The dependent variable, IQ, demonstrates significant correlations with both the independent and control variables. Notably, IQ is negatively correlated with FE (-0.140, $p<0.01$), indicating a potential inverse relationship between female executive representation and innovation quality. In contrast, IQ exhibits positive correlations with FS (0.310, $p<0.01$) and ROA (0.076, $p<0.01$), suggesting that larger and more profitable firms are associated with higher innovation quality. Additionally, IQ is positively correlated with FL (0.071, $p<0.01$), reflecting the potential role of financial stability in fostering innovation.
The moderating variables also reveal important patterns. BI shows a weak but positive correlation with FE (0.076, $p<0.01$), suggesting a potential alignment between board independence and gender diversity. Conversely, FC exhibits strong negative correlations with FS (-0.847, $p<0.01$) and FL (-0.637, $p<0.01$), highlighting the interplay between financial constraints and firm characteristics. Furthermore, FE is negatively associated with structural factors such as BS (-0.181, $p<0.01$), suggesting complex interdependencies between governance structures and gender diversity. These results provide an initial understanding of the relationships among key variables, forming the foundation for the subsequent multivariate analyses.

**Table 2:** Pearson Correlation

| | (1) IQ | (2) FE | (3) FS | (4) FA | (5) LEV | (6) ROA | (7) BS | (8) OC | (9) BI | (10) FC |
|---|---|---|---|---|---|---|---|---|---|---|
| IQ | 1.000 | | | | | | | | | |
| FE | -0.140*** | 1.000 | | | | | | | | |
| FS | 0.310*** | -0.198*** | 1.000 | | | | | | | |
| FA | -0.031*** | 0.040*** | 0.168*** | 1.000 | | | | | | |
| FL | 0.071*** | -0.130*** | 0.519*** | 0.163*** | 1.000 | | | | | |
| ROA | 0.076*** | 0.024*** | -0.004 | -0.081*** | -0.359*** | 1.000 | | | | |
| BS | 0.052*** | -0.181*** | 0.273*** | 0.053*** | 0.154*** | -0.005 | 1.000 | | | |
| OC | -0.023*** | -0.062*** | 0.197*** | -0.090*** | 0.059*** | 0.127*** | 0.027*** | 1.000 | | |
| BI | 0.022*** | 0.076*** | -0.001 | -0.014** | -0.009 | -0.009 | -0.550*** | 0.039*** | 1.000 | |
| FC | -0.211*** | 0.178*** | -0.847*** | -0.182*** | -0.637*** | 0.155*** | -0.258*** | -0.147*** | 0.020*** | 1.000 |

Note: statistical significance is represented by stars, where * denotes p < 0.1, ** represents p < 0.05, and *** corresponds to p < 0.01.

Table 3 presents the baseline regression results, investigating the relationship between FE and IQ using random effects, fixed effects, and Poisson regression models. The analysis consistently reveals a negative and statistically significant relationship between FE and IQ, with coefficients of -0.009 (p<0.01) and -0.006 (p<0.01) in the random effects models (columns 1 and 2), -0.005 (p<0.01) and -0.004 (p<0.01) in the fixed effects models (columns 3 and 4), and -0.002 (p<0.01) in the poisson regression models (columns 5 and 6). These findings indicate that a higher proportion of female executives in senior management is associated with a significant reduction in innovation quality. This result underscores the potential challenges posed by female executive representation in fostering high-quality innovation and provides robust support for the hypothesis grounded in the risk aversion view.

To further test the robustness of these results, I introduce lagged variables of female executives (L. FE) in Table 4. The robustness checks confirm the negative relationship between FE and IQ persists, with coefficients of -0.008 (p<0.01) and -0.005 (p<0.01) in the random effects models (columns 1 and 2), and -0.002 (p<0.01) in the poisson regression models (columns 5 and 6). These results reaffirm the consistency of the negative effect, providing further confidence in the robustness of the initial findings.

This negative relationship between FE and IQ aligns with the risk aversion view, which suggests that female executives, on average, are more likely to adopt conservative decision-making approaches. Innovation, characterized by high-risk, long-time horizons, and uncertain outcomes, may be less prioritized under risk-averse leadership. The findings answer the first research question by empirically demonstrating that female executives may inhibit the pursuit of high-quality innovation, likely due to their cautious approach to strategic decision-making. These results contribute to the broader discourse on gender diversity in leadership by highlighting how inherent risk preferences can shape corporate innovation outcomes, emphasizing the need for complementary mechanisms, such as supportive governance structures, to mitigate these effects.

**Table 3:** Main Results

| | Random Effects Model | | Fixed Effects Model | | Poisson Regression Model | |
|---|---|---|---|---|---|---|
| | (1) IQ | (2) IQ | (3) IQ | (4) IQ | (5) IQ | (6) IQ |
| FE | -0.009*** | -0.006*** | -0.005*** | -0.004*** | -0.002*** | -0.002*** |
| | (-10.56) | (-7.18) | (-5.01) | (-3.81) | (-4.56) | (-4.05) |
| FS | | 0.421*** | | 0.450*** | | 0.246*** |
| | | (37.93) | | (25.64) | | (24.64) |
| FA | | -0.463*** | | 0.029 | | -0.237*** |
| | | (-8.87) | | (0.26) | | (-4.32) |
| LEV | | -0.240*** | | -0.192*** | | -0.136*** |
| | | (-4.51) | | (-3.04) | | (-3.55) |
| ROA | | 0.140 | | -0.046 | | -0.006 |
| | | (1.33) | | (-0.41) | | (-0.10) |
| BS | | 0.039 | | 0.108* | | 0.067** |
| | | (0.85) | | (1.95) | | (2.38) |
| OC | | -0.004*** | | -0.001 | | 0.000 |
| | | (-4.85) | | (-0.51) | | (0.83) |
| Cons | 1.426*** | -6.309*** | 1.970*** | -8.307*** | 0.968*** | -4.002*** |
| | (47.20) | (-24.07) | (103.08) | (-16.47) | (97.71) | (-14.99) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 26694 | 26694 | 26150 | 26150 | 24299 | 24299 |
| Adj. $R^2$ | 0.128 | 0.168 | 0.750 | 0.761 | | |
| Pseudo $R^2$ | | | | | 0.250 | 0.254 |

Note: values in parentheses represent robust t-statistics; statistical significance is represented by stars, where * denotes p < 0.1, ** represents p < 0.05, and *** corresponds to p < 0.01.

**Table 4:** Robustness Checks

| | Random Effects Model | | Fixed Effects Model | | Poisson Regression Model | |
|---|---|---|---|---|---|---|
| | (1) IQ | (2) IQ | (3) IQ | (4) IQ | (5) IQ | (6) IQ |
| L. FE | -0.008*** | --0.005*** | --0.004*** | --0.003*** | --0.002*** | --0.002*** |
| | (-8.67) | (-5.89) | (-3.77) | (-2.88) | (-3.57) | (-3.04) |
| Controls | Omitted | Controlled | Omitted | Controlled | Omitted | Controlled |
| Year FE | Controlled | Controlled | Controlled | Controlled | Controlled | Controlled |
| Firm FE | Controlled | Controlled | Controlled | Controlled | Controlled | Controlled |
| N | 22048 | 22048 | 21833 | 21883 | 20219 | 20219 |
| Adj. $R^2$ | 0.110 | 0.144 | 0.761 | 0.770 | | |
| Pseudo $R^2$ | | | | | 0.249 | 0.251 |

Note: controls refer to all control variables.; values in parentheses represent robust t-statistics; statistical significance is represented by stars, where * denotes p < 0.1, ** represents p < 0.05, and *** corresponds to p < 0.01.

Table 5 presents the results of the moderating role of BI in the relationship between FE and IQ across random effects, fixed effects, and poisson regression models. The interaction term (c.FE#c.BI) is positive and statistically significant in all models, indicating that higher board independence mitigates the negative impact of female executives on innovation quality. The coefficients for FE remain negative and significant across all specifications, with values ranging from -0.655 ($p<0.01$) to -0.253 ($p<0.01$), reinforcing the finding that female executive representation is associated with lower innovation quality. Similarly, BI is negatively and significantly associated with IQ, with coefficients ranging from -0.745 ($p<0.01$) to -0.263 ($p<0.01$), suggesting that higher board independence alone is not sufficient to directly enhance innovation quality. However, the interaction term between FE and BI demonstrates a positive moderating effect, with coefficients of 0.160 ($p<0.05$) to 0.203 ($p<0.01$) in the random effects and fixed effects models and 0.065 ($p<0.1$) to 0.076 ($p<0.05$) in the poisson models. These results indicate that as board independence increases, the negative effect of female executives on innovation quality is alleviated.

These findings align with the agency theory, which posits that independent boards can provide oversight and strategic support, mitigating managerial biases and aligning decision-making with shareholder interests. In the context of female executives, higher board independence appears to counterbalance risk-averse tendencies, enabling a more supportive environment for pursuing high-quality innovation. The positive moderating effect of board independence provides an answer to the second research question, demonstrating that governance structures play a critical role in enhancing the effectiveness of diverse leadership in fostering innovation. This underscores the importance of strong governance mechanisms in leveraging the benefits of gender diversity while minimizing potential constraints.

**Table 5:** The Moderating Role of Board Independence

| | Random Effects Model | | Fixed Effects Model | | Poisson Regression Model | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | IQ | IQ | IQ | IQ | IQ | IQ |
| FE | -0.655*** | -0.787*** | -0.706*** | -0.736*** | -0.253** | -0.291** |
| | (-2.84) | (-3.50) | (-2.65) | (-2.89) | (-1.97) | (-2.39) |
| BI | -0.627*** | -0.640*** | -0.745*** | -0.625*** | -0.311*** | -0.263*** |
| | (-3.39) | (-3.47) | (-3.52) | (-3.00) | (-3.18) | (-2.81) |
| c.FE#c.BI | 0.160** | 0.203*** | 0.184** | 0.195*** | 0.065* | 0.076** |
| | (2.52) | (3.29) | (2.52) | (2.79) | (1.83) | (2.28) |
| Controls | Omitted | Controlled | Omitted | Controlled | Omitted | Controlled |
| Year FE | Controlled | Controlled | Controlled | Controlled | Controlled | Controlled |
| Firm FE | Controlled | Controlled | Controlled | Controlled | Controlled | Controlled |
| N | 26694 | 26694 | 26150 | 26150 | 24299 | 24299 |
| Adj. $R^2$ | 0.128 | 0.168 | 0.750 | 0.761 | | |
| Pseudo $R^2$ | | | | | 0.251 | 0.254 |

Note: controls refer to all control variables.; values in parentheses represent robust t-statistics; statistical significance is represented by stars, where * denotes $p < 0.1$, ** represents $p < 0.05$, and *** corresponds to $p < 0.01$.

Table 6 reports the moderating effects of FC on the relationship between FE and IQ across random effects, fixed effects, and poisson regression models. The interaction term (c.FE#c.FC) is negative and statistically significant across all models, suggesting that greater financing constraints amplify the negative impact of female executives on innovation quality. The coefficients for FE vary across models, with significant negative values in the random effects model, while becoming insignificant in the fixed effects and poisson models. This variation indicates that the direct effect of female executives on innovation quality may weaken under tighter financial constraints. Meanwhile, FC itself shows a strong negative association with IQ in models without control variables, with coefficients ranging from -0.600 ($p<0.1$) in the random effects model to -0.140 ($p<0.05$) in the poisson model. The interaction term (c.FE#c.FC) is consistently negative and significant across all models, with coefficients ranging from -0.063 ($p<0.05$) to -0.086 ($p<0.05$). These results suggest that the combination of higher female executive representation and greater financing constraints exacerbates the challenges in fostering innovation quality. This finding is robust across different econometric specifications, indicating that the presence of financing constraints intensifies the risk-averse tendencies of female executives, leading to further reductions in innovation quality.

These findings align with the financial distress theory, which posits that constrained access to financial resources exacerbates risk aversion and short-term decision-making. In the context of female executives, financing constraints appear to amplify the cautious approach to innovation, further discouraging investment in high-risk, high-reward projects. This result answers the third research question by showing that financing constraints significantly moderate the relationship between female executives and innovation quality, deepening the negative impact. These findings emphasize the need for policies and governance structures that alleviate financial constraints to enable diverse leadership teams to pursue long-term innovation goals effectively.

**Table 6:** The Moderating Role of Financing Constraints

| | Random Effects Model | | Fixed Effects Model | | Poisson Regression Model | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | IQ | IQ | IQ | IQ | IQ | IQ |
| FE | -0.039** | -0.018 | 0.003 | 0.006 | 0.009 | 0.011 |
| | (-2.18) | (-1.02) | (0.14) | (0.31) | (1.03) | (1.26) |
| FC | -0.600*** | 0.090 | -0.431*** | 0.077 | -0.140** | 0.153*** |
| | (-6.29) | (0.90) | (-4.04) | (0.72) | (-2.57) | (2.65) |
| c.FE#c.FC | -0.063** | -0.064** | -0.086** | -0.070** | -0.069*** | -0.062*** |
| | (-2.01) | (-2.07) | (-2.46) | (-2.06) | (-3.85) | (-3.50) |
| Controls | Omitted | Controlled | Omitted | Controlled | Omitted | Controlled |
| Year FE | Controlled | Controlled | Controlled | Controlled | Controlled | Controlled |
| Firm FE | Controlled | Controlled | Controlled | Controlled | Controlled | Controlled |
| N | 26694 | 26694 | 26150 | 26150 | 24299 | 24299 |
| Adj. $R^2$ | 0.139 | 0.168 | 0.753 | 0.761 | | |
| Pseudo $R^2$ | | | | | 0.251 | 0.254 |

Note: controls refer to all control variables.; values in parentheses represent robust t-statistics; statistical significance is represented by stars, where * denotes $p < 0.1$, ** represents $p < 0.05$, and *** corresponds to $p < 0.01$.

## 4. Discussion

The findings of this study provide critical insights into the relationship between female executives and innovation quality, emphasizing the moderating roles of board independence and financing constraints. These results highlight the complex interplay between leadership diversity, governance mechanisms, and financial conditions, offering both theoretical contributions and practical implications for corporate innovation management.

The negative relationship between female executives and innovation quality aligns with the risk aversion view, which posits that female executives tend to adopt more cautious decision-making approaches, particularly in high-risk contexts like innovation. This cautious behavior may limit the pursuit of breakthrough innovation, thereby reducing overall innovation quality. These findings resonate with prior studies that link female leadership with conservative strategies, reflecting the influence of risk preferences on strategic priorities (Armstrong et al., 2023). In the context of China, cultural norms regarding gender roles and leadership may further influence these decision-making tendencies. Additionally, state-owned enterprises (SOEs) in China, where governance and financial conditions differ from privately-owned firms, may face additional challenges or opportunities in fostering innovation under female leadership.

The moderating role of board independence demonstrates its capacity to mitigate the negative impact of female executives on innovation quality, consistent with the agency theory. Independent boards enhance oversight, align managerial actions with shareholder interests, and provide strategic support, enabling female executives to pursue long-term innovation goals more effectively. This finding extends prior research on the role of governance structures in fostering innovation, highlighting how diverse leadership can benefit from robust governance mechanisms (Pu & Zulkafli, 2024b; Zaman et al., 2023). By mitigating managerial biases, board independence is a critical enabler of high-quality innovation, reinforcing the importance of governance design in leveraging leadership diversity. In the Chinese context, state-owned enterprises may face specific challenges related to board composition and independence that can influence the ability of female executives to drive innovation.

Conversely, the moderating effect of financing constraints reveals an exacerbating influence, where resource limitations amplify the challenges faced by female executives in fostering innovation. This aligns with the financial distress theory, which suggests that constrained firms prioritize short-term survival over long-term investments in innovation. Female executives, already predisposed to risk aversion, may face compounded difficulties in resource-constrained environments, further reducing innovation quality. These findings are consistent with previous research on the dual pressures of financial constraints and risk preferences in shaping innovation outcomes (Duréndez et al., 2023; Pu, 2024). In China, where many firms, particularly state-owned enterprises, are subject to strict financial regulations and limited access to external capital, financing constraints may disproportionately impact the ability of female executives to prioritize high-quality innovation.

This study advances the literature by examining how governance structures and financial conditions shape the relationship between female executives and innovation quality. While prior research has largely focused on the direct effects of leadership diversity on firm performance, the findings here provide a nuanced understanding of the contextual factors that influence innovation outcomes. The dual moderating framework offers a more comprehensive perspective, highlighting the critical role of complementary mechanisms in mitigating the challenges of diverse leadership. The positive moderating effect of board independence underscores the importance of governance interventions. In contrast, the negative moderating role of financing constraints reveals the need for financial policies that alleviate resource limitations.

## 5. Conclusions

This study examines the relationship between female executives and innovation quality, focusing on the moderating roles of board independence and financing constraints. Using a comprehensive dataset of publicly listed Chinese firms from 2012 to 2021, the findings reveal that female executives are negatively associated with innovation quality, consistent with the risk aversion view, which posits that risk-averse decision-making may hinder the pursuit of high-risk, high-reward innovation activities. However, the governance and financial environments in which female executives operate significantly influence this relationship, highlighting the critical roles of board independence and financial constraints as moderating factors.

Board independence mitigates the negative impact of female executives on innovation quality. Consistent with agency theory, independent directors enhance oversight and provide strategic support, aligning managerial decisions with long-term innovation objectives. This governance mechanism appears to counterbalance the cautious tendencies of female executives, creating an environment conducive to higher-quality innovation. In contrast, financing constraints exacerbate the negative relationship between female executives and innovation quality. Drawing on financial distress theory, the findings suggest that limited access to financial resources amplifies the risk aversion of female executives, further restricting the capacity for innovation investment in financially constrained firms.

These findings advance the understanding of how leadership diversity interacts with organizational and contextual factors to shape innovation outcomes. The study extends agency theory by illustrating the critical role of board independence in unlocking the innovation potential of diverse leadership teams. At the same time, it enriches financial distress theory by demonstrating how resource constraints amplify the challenges of fostering innovation under risk-averse leadership. The nuanced interplay between these moderating factors underscores the importance of tailoring governance structures and financial policies to optimize innovation outcomes in diverse leadership contexts.

Practically, the findings provide actionable insights for managers and policymakers to enhance innovation outcomes under diverse leadership. For managers, fostering board independence is crucial to mitigating risk-averse tendencies among female executives and creating an innovation-friendly environment. Recruiting independent directors with expertise in innovation and supporting leadership training can help female executives adopt balanced strategies for innovation investment. Addressing financing constraints internally, such as through innovation funds or alternative financing mechanisms, can also support long-term innovation efforts.

Policymakers should focus on reducing systemic financing barriers by promoting equitable access to financial resources through finance policies like innovation grants or subsidized loans. Strengthening governance frameworks to enhance board effectiveness and fostering a culture of inclusivity in leadership can further enable female executives to overcome challenges in innovation management. These strategies collectively ensure that governance and financial systems support diverse leadership teams in achieving sustainable innovation.

Future research should explore additional contextual and mediating factors that may shape the relationship between female executives and innovation quality. For example, organizational culture, leadership styles, or firm-specific innovation capabilities could provide further insights into how diverse leadership affects strategic outcomes. Comparative studies across different institutional and cultural settings could also enhance the generalizability of these findings, offering a broader perspective on the dynamics between leadership diversity, governance

mechanisms, and innovation performance. These avenues of research will deepen the understanding of how to maximize the benefits of diverse leadership while addressing the challenges inherent in fostering innovation.

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