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Innovators or Risk-Avoiders? The Role of Female Executives in Enterprise Innovation in China

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ABSTRACT

The author examines the relationship between female executives and enterprise innovation in Chinese A-share listed companies. **The subject** of the study is the impact of female executive representation on research and development (R&D) investment and innovation output in firms. **The purpose** of the research is to determine whether female executives inhibit innovation performance and to explore the mediating role of R&D investment while also assessing the variation of effects between state-owned and non-state-owned enterprises. **The relevance** lies in the growing international interest in understanding how gender diversity in top management affects firm-level strategic outcomes, especially in emerging markets with distinct institutional and cultural contexts. **The scientific novelty** lies in the empirical identification of the mechanism through which female executives affect innovation, using a panel dataset of 3,920 Chinese listed companies over the period 2012 to 2021. As part of the study, the author used **the methods** of two-way fixed effects, mediation analysis to assess indirect effects through R&D investment, and heterogeneity analysis to compare state- versus non-state-owned enterprises. Based on the **results**, it was found that female executives are significantly associated with reduced innovation output, primarily due to lower R&D investment. **The author concluded** that gender-based differences in risk-taking behavior influence innovation outcomes and that these effects may also be shaped by institutional settings and ownership structures.
Keywords: female executives; gender diversity; corporate leadership; enterprise innovation; R&D investment; social roles; China

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Новаторы или стремящиеся избежать риск? Роль женщин-руководителей в инновационной деятельности предприятия в Китае

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АННОТАЦИЯ

Автор исследует взаимосвязь между работой женщин-руководителей и корпоративными инновациями в китайских компаниях, акции которых А-класса котируются на фондовых биржах. **Предметом** исследования является влияние представительства женщин-руководителей на инвестиции в исследования и разработки (НИОКР) и выпуск инновационной продукции в компаниях. **Цель исследования** — выяснить, сдерживают ли женщины-руководители инновационную деятельность, и изучить опосредующую роль инвестиций в НИОКР, а также оценить различия в эффекте между государственными и негосударственными предприятиями. **Актуальность** заключается в растущем международном интересе к пониманию того, как гендерное разнообразие в высшем руководстве влияет на стратегические результаты на уровне фирм, особенно на развивающихся рынках с различным институциональным и культурным контекстом. **Научная новизна** состоит

в эмпирическом выявлении механизма, с помощью которого женщины-руководители влияют на инновации, с использованием панельного набора данных из 3920 китайских компаний, зарегистрированных на бирже, за период 2012–2021 гг. В рамках исследования автор использовал **методы** двухсторонних фиксированных эффектов, опосредованного анализа для оценки косвенных эффектов от инвестиций в НИОКР и анализа неоднородности для сравнения государственных и негосударственных предприятий. **Результаты** исследования показали существенную связь между представительством женщин-руководителей и сокращением инновационного выпуска, в первую очередь из-за более низких инвестиций в НИОКР. **Автор пришел к выводу**, что гендерные различия в поведении, связанном с принятием риска, влияют на результаты инноваций и что эти эффекты также могут быть обусловлены институциональными особенностями и структурами собственности.
Ключевые слова: женщины-руководители; гендерное разнообразие; корпоративное лидерство; корпоративные инновации; инвестиции в НИОКР; социальные роли; Китай

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Introduction

Over the past few decades, the impact of gender diversity among top executives on corporate decision-making and performance has emerged as a significant topic in corporate governance research. A wealth of studies has demonstrated that female executives often exhibit stronger risk aversion in decision-making processes, a characteristic that has been empirically validated in various fields. For instance, research shows that female executives tend to limit corporate risk-taking [1], which, while reducing financial risk, simultaneously enhances corporate performance [2]. Moreover, female executives are more compliance-focused on earnings management, demonstrating higher transparency and lower tendencies for accounting manipulation [3]. In the realm of corporate social responsibility, female executives generally exhibit a stronger commitment to social responsibility, driving companies to engage more deeply in socially responsible activities [4]. These findings highlight the distinct influence of female executives on multiple dimensions of managerial decision-making. However, despite extensive research on the roles of female executives in risk management, financial decisions, and social responsibility, there is still a notable gap in understanding the relationship between female executives and enterprise innovation. To explore this relationship more effectively, it is essential to situate the analysis within a context where both innovation and executive gender dynamics are undergoing rapid institutional evolution.

China provides a particularly relevant empirical setting for this study. As one of the fastest-growing economies and a leading force in global innovation output, China has witnessed substantial increases in research and development (R&D) expenditure, patent filings, and high-tech entrepreneurship in the past two decades. The Chinese government has launched multiple policy initiatives — such as the National Medium- and Long-Term Science and Technology Development Plan and the Made in China 2025 strategy — that prioritize technological self-reliance and innovation-led growth. Meanwhile, China has also promoted gender equity in leadership roles through state-level advocacy and regulatory guidance, yet female representation in senior executive positions remains relatively limited. These conditions present a valuable opportunity to examine how the behavioral tendencies of female executives, particularly their risk preferences, influence innovation in a rapidly developing institutional and economic environment. Furthermore, the coexistence of state-owned and non-state-owned enterprises within China's corporate ecosystem allows for rich heterogeneity analyses under varying governance and resource dependence conditions.

Enterprise innovation is a key driver of long-term competitiveness and sustainability for firms [5]. However, innovation is inherently risky, with uncertain returns, and often does not yield immediate economic benefits, potentially negatively impacting short-term performance [6]. Existing research suggests that female executives, given their more conservative approach to risk, may be less inclined to endorse high-uncertainty projects, particularly those that could affect short-term financial outcomes and their own professional reputation [7]. As women remain underrepresented in top management, they face greater pressures in their careers, leading them to avoid decisions that could potentially harm their professional standing [8]. Furthermore, female executives, given their heightened focus on corporate

stability and compliance, may adopt more cautious strategies when it comes to investment decisions [9], which could reduce the allocation of resources to high-risk innovation projects, thereby suppressing enterprise innovation activities.

To verify these hypotheses, this study introduces R&D investment as a mediating factor and investigates the pathways through which female executives influence enterprise innovation. I hypothesize that female executives reduce enterprise innovation by limiting R&D investment. Additionally, the study examines how this effect varies across different ownership structures, with particular attention to state-owned enterprises (SOEs) versus non-state-owned enterprises (non-SOEs). Previous studies suggest that SOEs face more intense political and social pressures, and their innovation motivations may differ from those of market-oriented firms [10]. Based on this, I propose the following research questions: (1) Do female executives suppress enterprise innovation? (2) Is R&D investment the mediating factor through which female executives negatively impact enterprise innovation? (3) Is the suppressive effect of female executives on innovation more pronounced in non-SOEs?

This study utilizes data from China's A-share listed firms from 2011 to 2021 to empirically analyze the impact of female executives on R&D investment and enterprise innovation. First, I use regression analysis to examine the direct relationship between female executives and enterprise innovation (measured by the number of patent applications). Next, I introduce R&D investment as a mediating variable to explore how female executives indirectly influence corporate innovation through their effect on R&D allocation. Finally, I divide firms into SOEs and non-SOEs to investigate the varying effects of female executives on R&D investment and innovation in different ownership structures. The results indicate that female executives significantly inhibit enterprise innovation, and this effect is primarily achieved through the suppression of R&D investment. Moreover, the suppressive effect of female executives on innovation is more pronounced in non-SOEs. These findings support the theoretical perspectives of social role theory and resource dependence theory proposed in this study.

This paper makes two key contributions to both theory and practice. First, from the perspective of social role theory, the study reveals the conservative tendencies of female executives in innovation decisions, addressing the research gap concerning the impact of female executives on enterprise innovation. Although extensive literature has examined the effects of female executives on risk-taking, corporate performance, earnings management, and CSR [1–3], there is relatively little research on how female executives indirectly reduce innovation by suppressing R&D investment. This study not only uncovers this mechanism but also shows that the suppressive effect of female executives on innovation is more significant in non-SOEs, enriching our understanding of the relationship between ownership structure and top management behavior. Second, by introducing resource dependence theory, this research elucidates how female executives play a critical role in resource allocation and investment decisions. Given that R&D investment is a major driver of innovation, the conservative investment strategies of female executives restrict R&D funding, leading to a reduction in innovation activities. This finding extends the application of resource dependence theory to the innovation domain, offering new insights into how firms balance resource allocation between short-term performance and long-term innovation.

In the sections that follow, this paper will first review the relevant literature and present the hypotheses. Next, I describe the data and methodology. Then, I report the empirical results. Finally, I conclude with a discussion of the findings, highlighting both theoretical and practical implications.

Theoretical foundations and hypothesis development

Social role theory

Social role theory posits that societal expectations and norms regarding gender lead to differences in behavior between men and women in the workplace [11]. The theory suggests that traditional gender roles often portray men as more confident, adventurous, and assertive, while women are expected to exhibit traits such as greater focus, collaboration, and an emphasis on risk management [12]. These socially constructed roles shape individual behaviors in professional environments and influence decision-making processes within organizations. Specifically, research has shown that female executives tend to exhibit higher lev-

els of risk aversion and adopt a more cautious approach when faced with high-risk decisions [11–12].

Innovation, by nature, is closely tied to high levels of uncertainty and the potential for failure, as it often involves significant financial commitments with unpredictable outcomes [13]. This inherent risk of innovation may conflict with societal expectations placed on women, which prioritize organizational stability and safety [14]. Consequently, female executives may feel a heightened sense of responsibility to protect the company from the financial and performance risks associated with innovation failure. This increased sense of responsibility could lead female leaders to adopt a more conservative stance in their decision-making, particularly when allocating resources to risky or uncertain projects [15]. Moreover, female executives may face additional scrutiny and expectations from external stakeholders, such as shareholders and investors, who may exert greater pressure on them to avoid risk in innovation-related decisions [16]. Such external pressures may reinforce their socially influenced risk-averse tendencies.

Therefore, social role theory provides a critical framework for understanding how societal expectations and norms regarding gender influence the behavior of female executives, particularly in the context of risky innovation decisions. This perspective highlights the constraints that these expectations place on female decision-makers.

Resource dependence theory

Resource dependence theory, introduced by Jeffrey Pfeffer and Gerald Salancik, posits that organizations are not fully autonomous entities but are instead reliant on the acquisition of critical resources from their external environment [17]. This dependence on external resources, such as capital, technology, raw materials, talent, and market access, is essential for the survival and development of any organization [18]. Since companies cannot fully generate all the resources they need internally, they must engage in exchange relationships with other organizations or individuals like suppliers, customers, governments, and investors. These relationships play a pivotal role in shaping organizational decisions, including strategic choices that affect the firm's direction. The theory emphasizes that access to external resources impacts not only the firm's day-to-day operations but also its long-term competitiveness and strategic decision-making [19].

The core logic of resource dependence theory is that firms must manage their relationships with external resource providers to secure and maintain control over these vital inputs [17, 19]. A company's ability to obtain and control resources directly affects its survival and growth potential, influencing its competitive advantage and its capacity to innovate. Firms facing resource scarcity may find themselves in a vulnerable, reactive position, while those with abundant resources are more capable of making bold, strategic investments, such as in innovation or technological advancement. To mitigate dependency risks, firms typically adopt strategies such as diversifying their resource sources, thus avoiding over-reliance on a single provider, or integrating resource providers through acquisitions or vertical integration to exert greater control over essential inputs [20]. Additionally, firms may form long-term partnerships with key stakeholders, solidifying their access to critical resources through contracts, equity investments, or joint ventures [21].

Hypothesis development

Direct effect hypothesis: Female executives and enterprise innovation

Social role theory suggests that gender roles and societal expectations shape the behaviors and decision-making tendencies of individuals, particularly in professional settings [22]. According to this theory, traditional gender roles often portray men as more risk-taking, assertive, and innovation-driven, while women are expected to exhibit greater caution, cooperation, and risk aversion [23]. These socially constructed expectations can influence how female executives approach organizational decisions, particularly those involving high levels of uncertainty, such as innovation [24].

Additionally, social role theory implies that female executives may exhibit behaviors aligned with societal expectations of risk aversion and caution [25]. Innovation, by nature, involves high uncertainty and the potential for failure, as it often requires significant resource commitment without guaranteed success [26]. Given this, female executives may prioritize organizational stability and security over pursuing aggressive innovation strategies, thereby reducing corporate

innovation efforts. Empirical studies support this notion, showing that women in leadership positions tend to adopt more conservative approaches when faced with high-risk decisions, such as those related to innovation [27]. Therefore, based on social role theory and existing literature, I propose:

H1: Firms with female executives are more likely to reduce enterprise innovation.

Mediating effect hypothesis: Female executives, R&D investment and enterprise innovation

R&D investment is one of the key drivers of innovation, as it directly contributes to the generation of new products, processes, and technologies [28]. However, R&D investment also carries significant risk due to its uncertain outcomes and long-term nature [29]. Given the societal expectations that female executives should focus on stability and risk minimization [30], they may be more inclined to reduce R&D expenditures as a means of avoiding risky investments that could jeopardize the firm's financial stability. Prior studies have shown that female leaders often exhibit higher levels of risk aversion, leading to more conservative financial strategies [31]. Thus, I propose:

H2: All else being equal, female executives are more likely to reduce R&D investment.

Building on the previous hypotheses, R&D investment plays a critical mediating role in the innovation process, as firms that allocate fewer resources to R&D tend to produce fewer innovative outcomes [32]. If female executives reduce R&D expenditures due to their risk-averse behavior, this reduction in R&D investment is likely to lead to a corresponding decrease in corporate innovation output. Therefore, I posit that the reduction in R&D investment serves as a mediating mechanism through which female executives' risk aversion impacts corporate innovation. This mediating effect is consistent with the resource allocation view, which holds that decreased R&D investment limits a firm's ability to innovate [33]. Accordingly, I propose:

H3: All else being equal, female executives reduce enterprise innovation output by decreasing R&D investment, with R&D investment serving as a mediator in the relationship between female executives and enterprise innovation.

Heterogeneous effect hypothesis: State-owned enterprises vs. non-state-owned enterprises

Resource dependence theory posits that firms rely on external resources for their survival and growth, and their strategic decisions are influenced by the expectations and pressures from external resource providers, such as shareholders, investors, and banks [34]. These external parties hold significant sway in shaping a firm's decisions, especially those involving high-risk initiatives like innovation [35]. For female executives, the pressure from external resource providers can be even greater due to gender stereotypes that cast women as more risk-averse and focused on stability [21]. Stakeholders may expect female executives to prioritize risk minimization and short-term financial performance over long-term innovation strategies, intensifying their tendency toward conservative decision-making. This pressure is especially pronounced in firms that are heavily dependent on external funding and resources, such as non-state-owned enterprises (SOEs), where external stakeholders exert greater scrutiny on female leaders to mitigate innovation-related risks [36].

Innovation inherently involves substantial resource commitments and high uncertainty. In non-SOEs, which rely heavily on external capital and market support, innovation decisions are more closely monitored by external resource providers [37]. Female executives in these firms may respond to heightened external pressure by curbing innovation investments to avoid failure and preserve stakeholder confidence. This behavior aligns with the conservative decision-making tendencies traditionally associated with women in leadership roles. In contrast, SOEs often have more secure access to government-backed resources, reducing their dependence on market-driven external capital [38]. As a result, female executives in SOEs face less external pressure and are more likely to engage in innovation without the fear of external stakeholder push-back. This leads to a weaker inhibitory effect of female executives on innovation in state-owned firms. Therefore, I propose:

H4: Compared to state-owned enterprises, female executives have a stronger inhibitory effect on enterprise innovation in non-state-owned enterprises.

Methods

Sample and data

This study focuses on Chinese A-share listed companies, which constitute the largest and most actively traded segment of China's capital markets. Listed on the Shanghai and Shenzhen stock exchanges, these firms are subject to rigorous regulatory oversight from the China Securities Regulatory Commission (CSRC), including stringent requirements for information disclosure, financial auditing, and corporate governance. Spanning a broad array of industries — such as manufacturing, technology, healthcare, and services — A-share companies are widely regarded as representative of the formal and innovation-driven sector of the Chinese economy.

Compared to other types of firms, such as B-share companies (which are denominated in foreign currencies and primarily serve foreign investors) or unlisted private enterprises, A-share firms operate under greater capital market scrutiny and bear higher performance expectations from public shareholders. These firms typically face stronger innovation incentives, particularly in high-tech industries, where R&D investment is closely linked to valuation and market positioning. Accordingly, A-share companies provide an ideal context to examine how top executives — especially female leaders — shape strategic innovation decisions under institutional and market pressures.

Based on this rationale, I construct a comprehensive dataset comprising A-share listed firms from 2012 to 2021. Executive and financial data are obtained from the China Stock Market & Accounting Research (CSMAR) database, while innovation-related indicators are sourced from the China Research Data Services Platform (CNRDS) database. To ensure the quality and reliability of the data, we apply several preprocessing steps: financial firms are excluded due to their distinctive regulatory frameworks; «ST» firms flagged for financial distress by the CSRC are removed; and companies with missing core variables are eliminated. I also winsorize all continuous variables at the 1st and 99th percentiles to mitigate the influence of outliers.

Variable measurement and estimation techniques

In this study, the dependent variable, enterprise innovation (EI), is operationalized based on the framework established by Yuan and Wen. Specifically, EI is measured through the total number of invention patents, utility models, and design patents filed by the firm, with a log transformation with a "+1" applied to enhance the normality of the distribution. This comprehensive approach captures a broad spectrum of innovation activities within the firm, reflecting not only the firm's output of novel ideas but also its ability to translate these ideas into formal intellectual property. By including invention patents, utility models, and design patents, I encompass various dimensions of innovation, which collectively represent the firm's inventive capability.

Additionally, to ensure the robustness of our findings, I employ an alternative measurement of EI (EI-A) based on the total number of patents that have been ultimately authorized, again applying a log transformation with a "+1" adjustment to account for zero counts. This secondary measure serves as a verification check, as it directly reflects the successful translation of innovative efforts into protected intellectual property, thereby providing a more conservative estimate of the firm's innovative performance. The use of both the total number of filed patents and the number of authorized patents strengthens the validity of our analysis and offers a nuanced understanding of the firm's innovation dynamics.

The independent variable in this study is female executives, which serves as a critical indicator of the female executive level. Specifically, this variable is operationalized as the percentage of female executives relative to the total number of executives in the senior management team. This measure provides insight into the extent to which women are represented in leadership roles, reflecting both the organizational commitment to gender diversity and the potential influence of female executives on strategic decision-making processes.

The mediating variable in this study is R&D investment, quantified by the ratio of a firm's R&D expenditure to its total assets. This measure reflects the extent to which a company allocates its financial resources toward R&D activities relative to its overall asset base, providing insight into its commitment to innovation. This operationalization is grounded in the work of Pu and Zukafli (2024) [5], which underscores the significance of R&D investment as a critical driver of corporate

innovation outcomes. By analyzing the proportion of R&D expenditure to total assets, I can effectively assess how resource allocation decisions influence a firm's innovation capabilities and, consequently, how female executives may impact these decisions. This approach enables us to explore the potential mediating effects of R&D investment on the relationship between the presence of female executives and firm innovation outcomes.

Moreover, I include several control variables to account for factors that may influence firm innovation outcomes. Firm Size (Size) is measured by the natural logarithm of total assets, which provides a standard metric for comparing companies of different scales. Firm Age (FirmAge) is quantified as the natural logarithm of the number of years since the firm's establishment, plus one, allowing us to capture the effect of organizational experience on innovation. Return on Assets (ROA) is calculated by dividing the book value of net income by total assets, serving as an indicator of a firm's profitability and operational efficiency. Financial Leverage (Lev) is measured by the ratio of total debts to total assets, reflecting the extent to which a firm relies on borrowed funds to finance its operations. Additionally, Board Size (Board) is assessed through the natural logarithm of the total number of directors on the firm's board, as a larger board may bring diverse perspectives that influence strategic decision-making. Finally, Ownership Concentration (TOP1) is represented by the percentage of shares owned by the largest shareholder, providing insights into the governance structure and potential influence over firm decisions. Collectively, these control variables allow for a more nuanced analysis of the relationship between female executives and enterprise innovation.

To test hypothesis H1 to H4, I construct the following empirical models:

$$EI_{i,t} = \alpha_0 + \alpha_1 Female_{i,t} + \alpha_2 Size_{i,t} + \alpha_3 FirmAge_{i,t} + \alpha_4 Lev_{i,t} + \\ + \alpha_5 ROA_{i,t} + \alpha_6 Board_{i,t} + \alpha_7 TOP1_{i,t} + Year + Firm + \varepsilon, \quad (1)$$

$$RD_{i,t} = \alpha_0 + \alpha_1 Fele_{i,t} + \alpha_2 Size_{i,t} + \alpha_3 FirmAge_{i,t} + \alpha_4 Lev_{i,t} + \\ + \alpha_5 ROA_{i,t} + \alpha_6 Board_{i,t} + \alpha_7 TOP1_{i,t} + Year + Firm + \varepsilon, \quad (2)$$

$$EI_{i,t} = \alpha_0 + \alpha_1 Female_{i,t} + \alpha_2 RD_{i,t} + \alpha_3 Size_{i,t} + \alpha_4 FirmAge_{i,t} + \\ + \alpha_5 Lev_{i,t} + \alpha_6 ROA_{i,t} + \alpha_7 Board_{i,t} + \alpha_8 TOP1_{i,t} + Year + Firm + \varepsilon. \quad (3)$$

In this study, Equation (1) is used to test the direct effect and the heterogeneity effect. Building on Equation (1), Equations (2) and (3) represent the remaining two steps of the three-step mediation test, aimed at examining the mediating role of R&D investment.

The presence of a mediation effect is verified by observing the change in the coefficient and significance of α_1, which indicates whether R&D investment acts as a mediator in the relationship being tested.

Where α_0 denotes the intercept, and $\alpha_1 - \alpha_8$ are the coefficients to be estimated. This study added dummy variables that control for year and firm fixed effects (Year and Firm); ε is the error term; *i* denotes the cross-sectional dimension for firms; and *t* denotes the time series dimension.

Findings

Descriptive statistics and correlation matrix

Table 1 provides descriptive statistics for the variables used in the study, based on 26,694 observations. Enterprise Innovation (EI) has a mean of 2.649, with a standard deviation of 1.734, ranging from 0 to a maximum of 6.690, indicating variability in firms' innovation output. An alternative measurement of EI (EI-A) has a slightly lower mean of 2.476 and a standard deviation of 1.660, with a minimum of 0 and a maximum of 6.409. The variable Female, representing the percentage of female executives, has an average value of 19.326%, with significant variation across firms

Table 1
Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
EI	26,694	2.649	1.734	0.000	6.690
EI-A	26,694	2.476	1.660	0.000	6.409
Female	26,694	19.326	11.408	0.000	80.000
RD	26,694	0.020	0.020	0.000	0.101
Size	26,694	22.274	1.294	19.814	26.153
FirmAge	26,694	2.922	0.319	1.609	3.497
Lev	26,694	0.422	0.203	0.050	0.893
ROA	26,694	0.041	0.063	–0.239	0.222
Board	26,694	2.123	0.197	1.609	2.708
TOP1	26,694	34.245	14.820	8.630	74.180

Source: calculated by authors.

(standard deviation of 11.408), ranging from 0 to 80%.

R&D investment (RD) has a mean of 0.020, with a relatively low standard deviation of 0.020, and values ranging from 0 to 0.101, indicating that firms on average allocate about 2% of their resources to R&D.

In terms of control variables, Firm size (Size) shows a mean logarithm of total assets of 22.274 with a standard deviation of 1.294, while firm age (FirmAge) averages 2.922, with a relatively small variation (standard deviation of 0.319). Leverage (Lev) averages 0.422, suggesting that, on average, firms finance 42.2% of their assets through debt, with a standard deviation of 0.203. Return on Assets (ROA) has a mean of 0.041, indicating a 4.1% average profitability, but also shows some variability (standard deviation of 0.063), with negative values at the minimum (–0.239) and a maximum of 0.222. Board size (Board) has a mean of 2.123 (logarithm of the number of board members), with values ranging between 1.609 and 2.708. Lastly, the shareholding of the largest shareholder (TOP1) has a mean of 34.245%, with significant dispersion (standard deviation of 14.820), ranging from 8.630% to 74.180%, reflecting varying degrees of ownership concentration. These statistics highlight significant variability across the sample firms in terms of innovation output, R&D investment, corporate governance characteristics, and financial performance.

Table 2 presents the Pearson correlation coefficients between the key variables in the study. The results indicate significant relationships across most variables at the 1% level (***). Enterprise Innovation (EI) is positively correlated with R&D intensity (RD) (0.342***) and firm size (Size) (0.294***), indicating that larger firms and those with higher R&D investments tend to have more innovation output. However, the correlation between EI and the proportion of female executives (Female) is negative (–0.144***), suggesting that firms with a higher percentage of female executives may exhibit lower levels of innovation.

Other notable correlations include a positive relationship between RD and EI (0.342***), indicating that firms with more R&D investment tend to have more innovation. The correlation between firm size and leverage (Lev) is strong (0.519***), showing that larger firms tend to have higher levels of leverage. In contrast, the negative correlation between RD and size (–0.232***) suggests that larger firms may allocate a relatively lower proportion of their resources to R&D.

Moreover, the results show a negative relationship between female executives and firm size (–0.198***), suggesting that larger firms tend to have fewer female executives in leadership positions. Additionally, the proportion of female executives is negatively correlated with leverage (–0.130***), indicating that firms with higher leverage may have fewer female executives. Finally, there are some weaker but significant correlations between variables such as ROA, board size, and ownership concentration (TOP1), although none exhibit multicollinearity issues based on their low correlation values.

Table 2
Pearson correlation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
EI	**Female**	**RD**	**Size**	**FirmAge**	**Lev**	**ROA**	**Board**	**TOP1**
1.000								
−0.144***	1.000							
0.342***	0.030***	1.000						
0.294***	−0.198***	−0.232***	1.000					
−0.043***	0.040***	−0.129***	0.168***	1.000				
0.073***	−0.130***	−0.254***	0.519***	0.163***	1.000			
0.075***	0.024***	0.149***	−0.004	−0.081***	−0.359***	1.000		
0.045***	−0.181***	−0.122***	0.273***	0.053***	0.154***	−0.005	1.000	
−0.006	−0.062***	−0.144***	0.197***	−0.090***	0.059***	0.127***	0.027***	1.000

Source: calculated by authors.
Note: *** $p < 0.01$.

Table 3
Variance inflation factor (VIF) analysis

Variable	VIF	1/VIF
Lev	1.68	0.593834
Size	1.63	0.61521
ROA	1.25	0.802959
RD	1.13	0.88658
Board	1.11	0.90343
TOP1	1.10	0.912439
FirmAge	1.07	0.93469
Female	1.07	0.935074
Mean VIF	1.25	

Source: calculated by authors.

Table 3 shows the variance inflation factor (VIF) analysis to check for multicollinearity among the independent variables. The VIF values for all variables are well below the commonly accepted threshold of 10, indicating no severe multicollinearity concerns in the model. The mean VIF is 1.25, suggesting that multicollinearity is not an issue in this dataset.

The highest VIF is for leverage (Lev) at 1.68, followed by firm size (1.63). These values are still low, showing that the variance of each predictor is not inflated significantly due to the presence of other variables. The lowest VIF is for female executives (Female) and firm age (FirmAge) at 1.07, further supporting that multicollinearity is not problematic in this analysis. In conclusion, the Pearson correlation analysis indicates significant relationships between key variables, while the VIF analysis confirms that multicollinearity does not affect the robustness of the regression results.

Baseline results

The baseline regression results provide a comprehensive understanding of the factors influencing EI. In column (1) of *Table 4*, the key explanatory variable, Female, is negatively correlated with EI at a high significance level ($\alpha_1 = -0.022$, $p < 0.01$). This negative relationship persists across all specifications, even after including firm and year fixed effects in columns (2) and (4). Moreover, the introduction of additional control variables in columns (3) and (4) reveals the stability of this negative association, albeit with varying magnitudes. These findings suggest

Table 4
Baseline regression results

Variable	(1)	(2)	(3)	(4)
	EI	**EI**	**EI**	**EI**
Female	−0.022***	−0.006***	−0.015***	−0.005***
	(−10.827)	(−3.891)	(−7.316)	(−3.158)
Size			0.489***	0.486***
			(19.904)	(15.820)
FirmAge			−0.481***	−0.135
			(−6.526)	(−0.745)
Lev			−0.703***	−0.261***
			(−4.974)	(−2.706)
ROA			1.462***	0.024
			(5.239)	(0.166)
Board			−0.449***	0.114
			(−3.629)	(1.417)
TOP1			−0.011***	0.001
			(−6.340)	(0.678)
Cons	3.072***	2.778***	−4.988***	−7.861***
	(61.590)	(92.936)	(−9.499)	(−9.199)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
N	26 694	26 694	26 694	26 694
adj. R 2	0.021	0.762	0.121	0.772

Source: Calculated by authors.

Note: *** $p < 0.01$. The t-statistics (in brackets) are calculated from standard errors adjusted for clustering at the firm level.

a consistent pattern: firms with higher proportions of female executives tend to exhibit lower levels of EI, a result that calls for further exploration into potential underlying causes.

The negative impact of female executives on EI may be linked to several factors. First, it is possible that gender biases or structural barriers within firms prevent female leaders from fully contributing to innovation strategies [39]. Another plausible explanation is that female executives may adopt more risk-averse management styles, leading to a reduction in risk-taking behaviors [40], which are often crucial for driving EI. Prior studies have highlighted that women in leadership positions may focus more on stability and long-term sustainability rather than aggressive innovation strategies [30, 31, 40]. This conservative approach may, in turn, result in lower EI, especially in industries where bold, high-risk innovation is necessary for competitive advantage.

The control variables included in the regression models provide further insights into the determinants of EI. Size consistently shows a positive and highly significant relationship with EI, indicating that larger firms tend to innovate more, possibly due to their access to more resources and economies of scale. In contrast, Lev negatively impacts EI, suggesting that high debt levels impose financial constraints, limiting firms' ability to allocate resources to innovation. FirmAge, while significant in column (3), becomes insignificant in the fixed effects model, implying that the age-related decline in innovation may be context-dependent. Similarly, ROA has a strong positive effect on EI in the unrestricted model but loses significance when firm-specific factors are controlled. These findings largely align with previous research, such as Hadlock and Pierce (2010) [41] and Hoegl et al. (2008) [42], reinforcing the idea that financial constraints, firm size, and profitability play critical roles in shaping a firm's innovation capacity. The mixed results for other control variables, such as Board and TOP1, reflect

the nuanced and sometimes context-specific nature of these factors' influence on EI.

Robustness check

This section offers further support for the main findings by employing various alternative specifications and adjustments. Each robustness test is carefully designed to ensure the consistency and reliability of the results, addressing potential concerns related to variable selection, sample periods, and standard error clustering.

First, the dependent variable is replaced with enterprise innovation adjusted (EI-A) in column (1). This adjustment is made to assess whether alternative measures of innovation affect the core findings. The rationale behind replacing EI with EI-A is to account for any potential discrepancies in the definition or measurement of innovation, which could influence the observed relationship between female executives and enterprise innovation. The coefficient for Female remains negative and significant ($\alpha = -0.005$, $p < 0.01$), which is consistent with the baseline results. This finding suggests that regardless of the specific innovation metric used, female executives continue to exhibit a significant dampening effect on innovation, thereby reinforcing the robustness of the original conclusions.

Second, the sample period from 2020 to 2021, which corresponds to the COVID-19 pandemic, is excluded in column (2). This step is necessary because the pandemic may have introduced external shocks that could distort the normal operations and innovation strategies of firms. By removing these outliers, the analysis can focus on more stable periods to ensure that the results are not driven by extraordinary circumstances. The results remain robust, as the coefficient for Female remains significantly negative ($\alpha = -0.005$, $p < 0.01$), demonstrating that the pandemic did not materially affect the relationship between female executives and innovation. This finding highlights the resilience of the results across different time periods, confirming that the impact of female executives on innovation is stable over time.

Third, the clustering of standard errors is adjusted to the industry level in column (3). This adjustment is essential to address potential intra-industry correlations that may bias the standard error estimates. By clustering at the industry level, the model accounts for shared industry-specific factors that might influence innovation across firms in the same sector. The negative coefficient for Female ($\alpha = -0.005$, $p < 0.01$) remains significant, indicating that the results are not sensitive to the level of clustering. This confirms the robustness of the findings even when accounting for potential industry-wide effects.

Fourth, additional fixed effects, including industry, province, and city fixed effects, are incorporated in column (4). This approach controls for unobserved heterogeneity at different geographical and industry levels that may influence firm-level innovation. By accounting for these extra layers of fixed effects, the model further isolates the effect of female executives on innovation from any location-specific or industry-specific influences. The results remain consistent, with Female still exerting a significant negative effect on innovation ($\alpha = -0.004$, $p < 0.01$). This robustness check strengthens the argument that the observed relationship is not confounded by external regional or industry factors.

Fifth, firms with negative financial performance (loss-making firms) are excluded in column (5). Loss-making firms may face significant financial constraints that could hinder their ability to invest in innovation, potentially biasing the results. By removing these firms from the sample, the analysis ensures that the findings are not driven by firms in poor financial health. The coefficient for Female remains significantly negative ($\alpha = -0.005$, $p < 0.01$), further affirming the robustness of the results. This indicates that even when financially troubled firms are excluded, the negative relationship between female executives and innovation persists.

In conclusion, across all robustness checks, the main findings hold steady, demonstrating the consistency and reliability of the relationship between female executives and enterprise innovation. The negative impact of female executives on innovation remains significant in all alternative models, underscoring the robustness of the initial conclusions.

The mediating role of R&D investment

The mediation effect analysis, as presented in *Table 6*, illustrates the mediating role of R&D

Table 5
Robustness check

Variable	(1)	(2)	(3)	(4)	(5)
	EI-A	**EI**	**EI**	**EI**	**EI**
Female	−0.005***	−0.005***	−0.005***	−0.004***	−0.005***
	(−3.303)	(−2.734)	(−4.177)	(−2.682)	(−3.188)
Size	0.446***	0.471***	0.486***	0.492***	0.485***
	(15.334)	(12.710)	(11.920)	(16.871)	(14.568)
FirmAge	0.020	−0.029	−0.135	−0.033	−0.094
	(0.120)	(−0.138)	(−0.851)	(−0.189)	(−0.490)
Lev	−0.112	−0.088	−0.261**	−0.264***	−0.266**
	(−1.214)	(−0.790)	(−2.450)	(−2.927)	(−2.483)
ROA	−0.373***	0.203	0.024	−0.008	−0.118
	(−2.751)	(1.139)	(0.165)	(−0.052)	(−0.455)
Board	0.079	0.080	0.114	0.103	0.112
	(1.052)	(0.896)	(1.045)	(1.377)	(1.290)
TOP1	0.001	−0.002	0.001	0.001	0.002
	(0.368)	(−1.013)	(0.677)	(0.657)	(0.971)
Cons	−7.573***	−7.772***	−7.861***	−8.286***	−7.937***
	(−9.520)	(−7.525)	(−7.686)	(−10.108)	(−8.556)
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	Yes	No
Province FE	No	No	No	Yes	No
City FE	No	No	No	Yes	No
N	26150	19353	26150	26149	23373
adj. R 2	0.791	0.791	0.772	0.775	0.777

Source: Calculated by authors.

Note: *** $p < 0.01$. The t-statistics (in bracket 1, 2, 4 and 5) are calculated from standard errors adjusted for clustering at the firm level, and the t-statistics (in bracket 3) are calculated from standard errors adjusted for clustering at the industry level.

investment (RD) in the relationship between Female and EI through a three-step regression model.

In the first step, regression model (1) reveals a significantly negative coefficient for Female (−0.00461) in relation to EI, indicating that the presence of female executives significantly inhibits innovation ($p < 0.01$). This result aligns with our main findings, suggesting that female executives may adopt more risk-averse strategies or exhibit different management styles that lead to a reduction in innovation efforts.

In the second step, model (2) examines the impact of Female on RD, showing a significantly negative coefficient of −0.00004 ($p < 0.05$). This suggests that female executives also significantly suppress R&D investment, which is a crucial driver of innovation. Thus, female executives indirectly affect innovation by reducing R&D expenditures.

In the third step, model (3) incorporates the mediating variable, R&D investment, and the results demonstrate a significant positive effect of RD on corporate innovation, with a coefficient of 10.72179 ($p < 0.01$). This finding confirms that R&D investment substantially enhances innovation. While the negative effect of female executives remains significant, with a coefficient of −0.00423 ($p < 0.01$), the magnitude of the effect is smaller

compared to model (1). This reduction suggests that part of the negative impact of female executives on innovation is transmitted through the reduction in R&D investment, indicating a partial mediation effect.

In conclusion, the mediation effect analysis confirms that female executives not only exert a direct negative influence on innovation but also indirectly suppress innovation by reducing R&D investment. The significant positive effect of R&D as a mediator underscores its critical role in this relationship, affirming the existence of a partial mediation effect between female executives and enterprise innovation. These results are consistent with prior academic studies, such as those by Adams and Funk (2011) [43] and Amore and Garofalo (2020) [44], which highlight that female executives tend to adopt more risk-averse strategies, potentially leading to lower innovation levels due to reduced R&D allocation.

Heterogeneity test

The heterogeneity analysis in *Table 7* compares the impact of female executives on EI across state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs).

In column (1), which represents SOEs (SOE = 1), the coefficient for female executives is –0.003, but it is not statistically significant. This suggests that the presence of female executives does not have a significant impact on enterprise innovation within SOEs. One possible explanation is that SOEs, often benefiting from government support and a less competitive environment, may be less

Table 6
Mediating effect

Variable	(1)	(2)	(3)
	EI	**RD**	**EI**
Female	–0.00461***	–0.00004**	–0.00423***
	(–3.158)	(–2.252)	(–2.930)
RD			10.72179***
			(8.763)
Size	0.48593***	–0.00225***	0.51009***
	(15.820)	(–6.119)	(16.592)
FirmAge	–0.13520	–0.00148	–0.11930
	(–0.745)	(–0.647)	(–0.668)
Lev	–0.26070***	–0.00060	–0.25423***
	(–2.706)	(–0.526)	(–2.690)
ROA	0.02419	0.00264	–0.00409
	(0.166)	(1.286)	(–0.028)
Board	0.11376	0.00194**	0.09299
	(1.417)	(2.449)	(1.170)
TOP1	0.00124	–0.00002	0.00144
	(0.678)	(–0.768)	(0.806)
Cons	–7.86100***	0.07206***	–8.63364***
	(–9.199)	(7.035)	(–10.170)
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
N	26150	26150	26150
adj. R 2	0.772	0.857	0.774

Source: calculated by authors.

Note: ** $p < 0.05$, *** $p < 0.01$. The t-statistics (in brackets) are calculated from standard errors adjusted for clustering at the firm level.

Table 7
Heterogeneity test

Variable	SOE = 1	SOE = 0
	(1)	(2)
	EI	EI
Female	−0.003	−0.004**
	(−1.196)	(−2.489)
Size	0.515***	0.483***
	(8.397)	(13.027)
FirmAge	0.183	−0.007
	(0.579)	(−0.029)
Lev	−0.184	−0.223**
	(−0.899)	(−2.089)
ROA	0.074	−0.177
	(0.247)	(−1.037)
Board	0.116	0.120
	(0.864)	(1.195)
TOP1	−0.005	0.002
	(−1.483)	(1.079)
Cons	−9.682***	−8.027***
	(−5.609)	(−7.631)
Year FE	Yes	Yes
Firm FE	Yes	Yes
N	9356	16 709
adj. R 2	0.826	0.735

Note: ** $p < 0.05$, *** $p < 0.01$. The t-statistics (in brackets) are calculated from standard errors adjusted for clustering at the firm level.

Source: calculated by authors.

influenced by the risk-averse behavior commonly associated with female executives, thereby diluting the impact on innovation.

In contrast, column (2) shows that for non-SOEs (SOE = 0), the coefficient for female executives is −0.004 and is statistically significant ($p < 0.05$). This indicates that female executives have a significantly negative effect on enterprise innovation in non-SOEs. Non-SOEs generally face higher competitive pressures and rely more heavily on innovation for growth and survival, making the risk-averse strategies of female executives more detrimental to innovation outcomes in these firms.

Overall, the heterogeneity analysis suggests that the negative impact of female executives on corporate innovation is more pronounced in non-SOEs, likely due to the greater reliance of these firms on innovation to maintain competitiveness, while SOEs appear to be more insulated from this effect.

Discussion

This study finds that the presence of female executives is associated with lower levels of R&D investment and innovation output, especially in non-state-owned enterprises. While our results are consistent with prior literature emphasizing the risk-averse behavior of female leaders [16, 3], it is important to situate these findings within the broader scholarly debate on gender and innovation.

A number of studies suggest that female executives may, under certain conditions, positively contribute to innovation outcomes. For example, Expósito et al. (2021) [27] find that female CEOs in Spanish SMEs are positively associated with innovativeness, especially when organizational cultures

support collaborative leadership. Similarly, Shropshire et al. (2021) [31] argue that although women may exhibit higher risk aversion, this can translate into more deliberate, process-driven innovation practices. These alternative perspectives suggest that the relationship between gender and innovation is not deterministic but context-dependent.

Furthermore, we acknowledge that resistance to innovation is a common behavioral tendency that can affect all employees, regardless of gender or position. Fear of change, loss aversion, and status quo bias are well-documented psychological mechanisms that influence strategic decision-making in high-uncertainty environments. Our study does not claim that women inherently resist innovation but rather posits that social role expectations may amplify risk aversion among female executives, especially in public-facing leadership roles. This interpretation is grounded in social role theory, not biological essentialism.

In addition, a more gender-sensitive interpretation must recognize that women's innovation behavior may be influenced by distinct motivational and structural factors. For instance, studies have shown that women often place greater emphasis on work–life balance, which can shape their strategic priorities in leadership roles [25]. Moreover, women frequently face structural disadvantages in accessing financial resources, market intelligence, and professional networks — factors that are critical for pursuing high-risk innovation projects [4]. These limitations may reduce their observable engagement in R&D-driven innovation, not because of individual-level aversion to innovation, but due to external constraints.

Importantly, the value of cautious decision-making should not be dismissed. Excessive risk-taking can lead to innovation failures or wasted investments, and the conservative strategies adopted by some female executives may reflect rational responses to both institutional expectations and resource constraints [45]. In fact, several studies have found that women entrepreneurs are particularly active in innovation within trade and service sectors, where innovation often takes non-technological forms such as business model redesign or customer experience improvements [27]. These findings suggest that innovation should be assessed not only in terms of R&D intensity but also across diverse industry-specific forms of value creation.

Finally, the complexity of innovation behavior necessitates consideration of multiple influencing factors beyond executive gender. These include workforce skill levels, access to government subsidies, organizational incentives, political and economic uncertainty, and regional development disparities. Although this study controls for many such variables, future research should incorporate them more explicitly to develop a deeper and more contextualized understanding of innovation dynamics.

Conclusion

Utilizing data from publicly listed Chinese firms from 2012 to 2021, this study provides new insights into the relationship between female executives and corporate innovation, with a specific focus on the mediating role of R&D investment. The findings reveal that female executives tend to have a significant negative impact on corporate innovation, both directly and indirectly, by reducing R&D investment. This suggests that the presence of female executives in top management positions may lead to more conservative investments in innovation-driven activities, such as R&D, which in turn constrains the firm's innovation capacity. These results align with prior literature, which indicates that female executives tend to be more risk-averse, often adopting strategies that prioritize stability over high-risk, high-reward initiatives. Given that R&D is widely recognized as a key driver of innovation, this study emphasizes the critical importance of maintaining sufficient R&D investment to sustain long-term innovation efforts, even when firms are led by more risk-averse executives.

Moreover, heterogeneity tests suggest that the negative effect of female executives on innovation is more pronounced in non-state-owned enterprises (non-SOEs), where competitive pressures and the need for innovation are typically higher. In contrast, state-owned enterprises (SOEs) appear to be less affected, possibly due to their relatively monopolistic market positions and reduced reliance on innovation for maintaining competitive advantage.

This study makes several theoretical contributions. First, from the perspective of leadership and innovation, it demonstrates that while female executives contribute to the diversification of

top management teams, they may adopt more conservative approaches to innovation, particularly by curtailing R&D expenditures. This finding adds nuance to the ongoing debate on gender diversity in corporate leadership and its impact on firm performance. Second, by exploring R&D investment as a mediating factor, the study highlights the intricate dynamics between leadership decisions and innovation strategies, offering a more detailed understanding of how leadership characteristics influence corporate innovation.

Our findings have practical implications for corporate leaders and policymakers alike. For firms, particularly those led by female executives, it may be critical to cultivate a balanced approach that encourages risk-taking in innovation while maintaining prudent management practices. For policymakers, fostering an environment that supports R&D investment, especially in non-SOEs, could help mitigate the conservative tendencies of female-led firms and stimulate greater innovation. Additionally, initiatives that encourage female executives to pursue innovation-oriented strategies could further enhance their contribution to corporate growth and competitiveness.

However, this study has certain limitations. First, the sample is restricted to publicly listed Chinese firms, which limits the generalizability of our findings to other institutional or cultural contexts. While our results provide useful insights into the behavioral and structural mechanisms through which female executives may influence corporate innovation, these patterns may be shaped by characteristics specific to the Chinese market. These include the governance structure of Chinese listed firms, state influence on executive appointments, and cultural norms regarding gender roles and managerial behavior. As such, the theoretical implications of our study should be interpreted within the bounds of this national context. Future research could address this limitation by conducting comparative studies across different countries, ownership systems, and cultural settings to assess whether the observed gender-innovation dynamics hold in varied environments. Moreover, future work may examine additional moderating variables — such as internal corporate governance structures, financial constraints, or regional development differences — to further unpack the complexity of this relationship.

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