Can Government Innovation Subsidies Really Unlock Innovation? An Empirical Study of A-Share Listed Companies in China

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Firm Innovation Output; Executive Compensation Incentives; Government Innovation Subsidies; Crowding Out Effect; Incentive Effect

Abstract

Enterprises play a central role in innovation but face challenges like low R&D willingness and output due to R&D externalities and uncertainties. While government innovation subsidies aim to alleviate financial pressures and boost innovation, their efficacy remains debated. Critics highlight subsidy-driven R&D investment "crowding-out" or "over-investment" from information asymmetry, whereas proponents argue subsidies counter market failures. This study analyzes how government subsidies affect corporate R&D output by integrating executive compensation incentives and R&D intensity into a theoretical framework. Empirical tests using 2008-2015 A-share listed company data reveal two key findings: (1) High corporate R&D intensity weakens subsidies' positive impact on innovation (crowding-out effect), and (2) Executive compensation incentives amplify subsidies' effectiveness (incentive effect). Policy implications suggest targeting subsidies to low-R&D-intensity firms, maintaining high executive incentives under intense R&D, and enhancing compensation structures to optimize subsidy-driven innovation outcomes.

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1.Introduction

Modern macroeconomic theory identifies technological development and scientific progress as the endogenous drivers of economic growth and sources of vitality (Z. Li et al., 2020). As a crucial component of the economic structure, enterprises undertake the core responsibilities of knowledge production and technological expansion. Moreover, as the primary agents of innovation activities, enterprises can enhance their R&D capabilities through innovation tasks, transforming technological advantages into product advantages to strengthen their competitiveness.

However, the long-term nature of R&D, uncertain expected returns, substantial capital investment, and instability in the external innovation environment often lead enterprises to face significant challenges when making innovation decisions (Werner & Souder, 1997). These difficulties result in low enthusiasm for independent innovation, creating obstacles to achieving tangible innovation outputs. To address these challenges, governments often resort to direct fiscal interventions, such as providing innovation subsidies. Prominent examples include China's National High Technology Research and Development Program (the 863 Program), enterprise-specific innovation grants, and the Torch Program. These initiatives aim to encourage enterprises to engage in R&D activities through government funding.

Nevertheless, the actual effectiveness of government innovation subsidies remains a contentious issue in academic research (Y. Li et al., 2020). According to neoclassical economic theory, the innovation challenges faced by enterprises stem from market failures caused by externalities and uncertainties (Li et al., 2021). To address these market failures, governments can and should intervene through fiscal policies, such as subsidies or tax incentives, to lower the costs of innovation for enterprises. In contrast, the Austrian school of economics, led by Hayek, argues that governments should avoid direct intervention in market processes (Guest, 1997; Hayek, 2014). They contend that externalities are inherent to market mechanisms and should be addressed through improved patent systems and intellectual property protections, thereby internalizing these externalities.

In recent years, the development of quantitative methods has led to a surge in empirical studies based on real-world data. However, these studies have not resolved the debate over the effectiveness of government subsidies; rather, they have intensified the polarization of views. For instance, Bérubé et al., using data on government innovation funding in Canada from 2002 to 2004, demonstrated that firms receiving government subsidies achieved significantly higher innovation outputs than non-subsidized firms, effectively mitigating market failures and negative externalities.

However, opposing evidence has emerged. Some scholars have highlighted the potential for government subsidies to crowd out enterprise innovation efforts, becoming a "trap" in the innovation process (Sykes, 2010). Research in the Chinese context has shown that excessive government subsidies might incentivize firms to allocate substantial resources toward rent-seeking rather than R&D, leading to a crowding-out effect on innovation resources (Du & Mickiewicz, 2016). Furthermore, studies have revealed that information asymmetry between policymakers and enterprises often results in firms sending false signals to secure government funding, which is then diverted away from R&D activities, creating adverse incentives for innovation outputs (Jiahui & Naysary, 2021). In summary, these conflicting findings demonstrate that there is no consensus in academic discourse on whether governments should implement innovation subsidy programs or how to design such policies effectively. This study holds both theoretical and practical significance. From a theoretical perspective, there is considerable divergence in the academic literature regarding the effectiveness of government innovation subsidies. These discrepancies are primarily due to differences in cultural contexts, government policies, subsidy details,

regulatory frameworks, industrial sectors, and the degree of information asymmetry within the field. Additionally, factors such as historical limitations, data collection methods, and empirical testing techniques may also contribute to these divergent findings.

In response to this, the present study aims to reassess the necessity and design of government innovation subsidy programs. By examining the potential omitted variable biases in previous research, this study applies a more advanced parallel moderation model to mitigate endogeneity issues. It also includes key variables—such as enterprise innovation intensity and executive compensation incentives—that have been the subject of considerable academic debate, thus improving the robustness of the analysis. Moreover, the study utilizes a longer time span of data from Chinese listed companies and refines the handling of time-series data, addressing the model specification biases often associated with short-panel data in prior studies. This approach aims to provide fresh perspectives and contribute new insights to the ongoing academic debate on this issue, offering valuable theoretical guidance for the design and implementation of government innovation subsidy programs.

From a practical perspective, this study offers a detailed examination of how government innovation subsidies affect enterprise R&D outputs, helping to reduce resource misallocation and subsidy distortion. Given that innovation inherently involves externalities, effective government intervention is crucial in supporting the promotion and implementation of innovation. The findings of this study will assist policymakers in formulating more targeted innovation incentive policies, particularly by considering differences in internal organizational factors, such as executive compensation structures. By aligning policies with the specific needs of firms, the government can more effectively incentivize substantial innovation that enhances competitive advantage while mitigating issues like rent-seeking behavior.

Furthermore, by investigating the mechanisms of innovation subsidy outcomes, this study provides practical recommendations for the optimal allocation of subsidies to firms that need them most. It also explores how innovation outcomes can be translated into tangible results, thereby improving policy efficiency and reducing unnecessary costs. Ultimately, the research offers empirical evidence to support the reform of the technological innovation system, strengthens the role of the market in resource allocation, and provides a solid foundation for the government's role in guiding and facilitating technological progress, which in turn will promote healthy industrial development and scientific advancement.

2. Literature Review

2.1 Government Innovation Subsidies and Their Impact on Firms' Innovation Output

In line with the national strategic directives, the Fourth Plenary Session of the 19th Central Committee of the Communist Party of China advocated establishing "a new nationwide system for tackling key and core technologies under socialist market economy conditions." Furthermore, China's 2020 "14th Five-Year Plan" highlights the central importance of innovation in the country's modernization drive, strengthens the role of enterprises as primary innovation agents, and promotes the flow of innovation resources toward firms. In response, the government has introduced fiscal support to enterprises undertaking R&D and innovation projects, along with various policy measures—such as tax incentives and direct subsidies—to encourage advancements in technology and elevate firms' innovative capabilities. According to a State Council press conference in February 2021, total R&D expenditure in China increased from RMB 1.42 trillion in 2015 to RMB 2.4 trillion in 2020. Over the same period, the annual number of patent

applications rose to 68,720 in 2020. Both trends are inextricably linked to the government's innovation subsidy programs.

Many scholars argue that these subsidies exert a positive incentive effect on firms' R&D outputs. Since a firm's innovation output stems from multiple factors, funding is crucial in enabling and sustaining R&D activities. Government subsidies help alleviate the financial constraints that firms often face during R&D, thereby reducing innovation costs. An empirical study confirmed that such technology incentive policies have a favorable impact on firms' R&D output (Guan & Yam, 2015).

However, as the scope and scale of government innovation subsidies continue to expand, assessing their actual effectiveness has become a prominent concern in both academic and industry circles. Some domestic studies have pointed out potential shortcomings in China's current subsidy policies. Scholars remain divided on whether these subsidies indeed steer corporate R&D behavior toward the government's overarching goal of fostering innovation output. According to some researchers, enterprises may engage in rent-seeking or pursue "goal-oriented innovation" primarily to secure larger subsidies, thereby spurring "compliance-driven innovation" behaviors that ultimately diminish the effectiveness of government subsidies (Xulia et al., 2005). In addition, some researchers suggest a nonlinear relationship between government subsidies and firms' innovation output. Academic research has revealed nuanced patterns in subsidy effectiveness. For instance, empirical evidence suggests an inverted U-shaped relationship, where moderate subsidy levels stimulate R&D investment, whereas excessive support may crowd out firms' intrinsic motivation for innovation (Howell, 2017). Cross-national studies further identify threshold effects, demonstrating that subsidies only significantly enhance patent productivity when recipient firms surpass certain R&D capability thresholds (Croce & Bianchini, 2022). Additionally, contingency factors such as firm size and industry characteristics moderate this relationship – subsidies appear more effective in capital-intensive sectors than in service-oriented industries according to panel data analyses (Manso, 2011). These mixed findings underscore the methodological importance of distinguishing between subsidy types (e.g., direct grants vs. tax credits) and employing dynamic models that account for temporal lags in innovation outcomes.

2.2 Factors Influencing Firms' R&D Output

R&D activities, with their significant contributions to the creation of new knowledge and technologies, have become a critical determinant of whether firms can achieve sustainable growth and surpass their competitors. The intensity of a firm's R&D efforts largely determines its innovative capacity. Empirical studies have uncovered complex temporal dynamics in R&D outcomes. Research has confirmed a significant correlation between R&D intensity and firms' innovation output (Savrul & Incekara, 2015). Meanwhile, findings suggest that while heightened R&D investment may temporarily suppress innovation performance in the short term, it contributes positively to innovation outcomes over extended periods (Anzola-Román et al., 2018). While the academic consensus recognizes R&D intensity as a pivotal factor influencing firms' innovation output, there is still no agreement on the underlying mechanisms of its influence.

In addition to R&D intensity, the role of executive incentives in shaping firms' R&D and innovation activities has also garnered considerable attention. Scholars have highlighted the critical role of governance mechanisms, showing that executive incentives significantly enhance corporate innovation capabilities (Cai et al., 2021). According to the rational economic agent hypothesis, executives are motivated by self-interest and personal goals, which inevitably influence their strategic decisions. As key

decision-makers with comprehensive knowledge of a firm's operations, executives' strategies significantly impact the company's future trajectory. Aligning executives' personal objectives with corporate goals—integrating their aspirations into the firm's strategic framework—has thus become an essential component of modern corporate governance. To this end, many firms have implemented executive incentive systems.

Specifically, different types of executive incentives exert varying effects on firms' R&D output. The two main types of incentives studied in literature are monetary compensation and equity-based incentives. Monetary compensation incentives focus on whether executives achieve innovative performance targets within a given timeframe, while equity-based incentives are long-term mechanisms aimed at fostering team collaboration to achieve sustained goals, though they are characterized by a lagged effect. Meanwhile, equity-based incentives were found to exhibit an inverted U-shaped relationship with firms' R&D output efficiency. Further research revealed that the specific patterns of these relationships are not fixed but are influenced by factors such as industry characteristics and market conditions.

3. Hypothesis

3.1 Government Innovation Subsidies and Corporate R&D Output

Government innovation subsidies refer to funds provided by the government to enterprises engaged in technological innovation activities without requiring repayment. The innovative output of enterprises may depend on the level of government subsidies. According to neoclassical innovation theory, government innovation subsidies alleviate financial constraints and reduce the costs associated with innovation activities, thereby incentivizing enterprises to engage in innovation. In addressing the externality characteristics of R&D activities, government subsidies can also mitigate issues like insufficient R&D motivation. Furthermore, considering the signaling effect of government subsidies, receiving such funds sends positive signals to external investors about an enterprise's reputation and technological capabilities, thereby attracting external funding, enhancing innovation capacity, and improving R&D output efficiency. Based on the above discussion, the following hypothesis is proposed:

Hypothesis 1a: Government innovation subsidies have a significant impact on corporate R&D output.

3.2 Executive Compensation Incentives and Corporate R&D Output

Executive incentive systems are an integral part of internal corporate governance mechanisms. Grounded in agency theory and information asymmetry, providing compensation incentives to executives effectively motivates them to work diligently, reduces inherent conflicts with shareholders, enhances their autonomy in innovation, and aligns their objectives with those of the enterprise. Previous studies have shown that higher executive compensation positively stimulates innovation efforts and increases corporate innovation efficiency, with more pronounced effects in state-owned and high-tech manufacturing enterprises.

Based on this, the following preliminary hypothesis is proposed:

Hypothesis 1b: Executive compensation incentives significantly impact corporate R&D output.

3.3 Corporate R&D Intensity and R&D Output

Many studies use patent counts as a key measure of corporate R&D output. Existing research has identified a unidirectional causal relationship between corporate R&D intensity and R&D output. For instance, R&D intensity is found to be positively influences patent counts. Considering the high risk, uncertainty, and delayed returns of R&D activities compared to general investment behaviors, enterprises rely heavily on tangible resource inputs, such as R&D funding. Greater financial investment in R&D

facilitates the accumulation of innovative achievements.

Based on the above analysis, the following hypothesis is proposed:

Hypothesis 1c: Corporate R&D intensity has a significant impact on corporate R&D output.

3.4 The Moderating Role of Corporate R&D Intensity on Executive Compensation Incentives

R&D intensity plays a critical role in influencing corporate output, particularly in the field of technological innovation. From a resource-based perspective, enterprises require sufficient funding to operate effectively. Given the high-risk and high-investment characteristics of R&D activities, enterprises seek government support to sustain long-term interests. Receiving government innovation subsidies significantly motivates enterprises to increase R&D efforts, improving innovation output levels. However, R&D intensity may also have a crowding-out effect on the efficiency of government subsidies. While government subsidies facilitate macro-level resource allocation, excessive R&D intensity could lead enterprises to prioritize high-output projects for short-term government approval, neglecting long-term innovation, resulting in inefficient resource allocation and reduced innovation output.

Based on the multifaceted impact of government innovation subsidies on corporate R&D output, the following hypothesis is proposed:

Hypothesis 2: Corporate R&D intensity weakens the positive effect of government innovation subsidies on corporate R&D output.

Considering the long cycle and sunk costs associated with corporate R&D activities, government innovation subsidies may support high-risk innovation tasks that are unlikely to yield immediate profits. According to agency theory, executives might prioritize short-term projects or even pursue personal gains at the expense of long-term innovation. However, offering compensation incentives aligns executives' interests with those of the enterprise and fosters a convergence of objectives. Such incentives encourage executives to focus on innovation projects beneficial for the enterprise's long-term development. Furthermore, these incentives cultivate a sense of mission and responsibility among executives, contributing to the advancement of innovative R&D activities.

Based on the above analysis, the following hypothesis is proposed:

Hypothesis 3: Executive compensation incentives enhance the positive effect of government innovation subsidies on corporate R&D output.

4. Measures

4.1 Data

The research subjects of this study are A-share listed companies in China. The data collection process integrates information from three authoritative databases: the Wind Financial Terminal, CSMAR Database, and iFinD Financial Database, to mitigate potential data discrepancies or omissions. To ensure comparability with existing studies on A-share listed companies, the study period was set from 2008 to 2015. Following conventional practice in this research domain, we excluded companies with special treatment status (ST, *ST, and PT) from our sample to eliminate potential distortions caused by financially distressed or operationally abnormal enterprises. Additionally, all continuous variables were winsorized at both ends (1% level) to reduce the influence of outliers and extreme values. The final dataset comprises comprehensive operational and innovation-related data from 2,131 listed companies.

4.2 Variable Definitions

The core variables in this study include government innovation subsidies, corporate innovation output, executive compensation incentives, corporate R&D intensity, and other control variables. Their operational definitions are as follows:

4.2.1 Government Innovation Subsidies

The measurement of innovation subsidies is derived from the "Government Subsidy Details" section in corporate annual reports. Due to inconsistent disclosure formats, we employed data mining techniques to extract project names and corresponding amounts from these details. Following Guo Yue's methodology, we identified innovation-related subsidies by screening entries containing keywords associated with technological innovation (e.g., innovation achievements, government innovation policies, R&D collaboration, innovation talent programs, and specialized terms in high-tech or emerging fields) (郭玥, 2018). All qualifying amounts were aggregated. Data processing was implemented using Python 3.8 and Stata 17.0, resulting in a sample of 2,075 companies receiving government innovation subsidies.

4.2.2 Corporate Innovation Output

We measure innovation output using the total number of patents applied by a firm within a given period, including invention patents, utility models, and design patents (Brouwer & Kleinknecht, 1999). To address zero-inflation and sparse distributions in patent counts—common in innovation studies—we adopted the standard practice of applying a natural logarithm transformation to patent counts after adding 1.

4.2.3 Corporate R&D Intensity

Consistent with Guo Yue et al., R&D intensity is defined as the ratio of R&D expenditures to total assets. While alternative measures (e.g., R&D-to-revenue ratios) exist, we retain this widely accepted proxy for comparability.

4.2.4 Executive Compensation Incentives

Following Guo Yue et al.'s definition, executives encompass directors, supervisors, and senior management. Compensation incentives are proxied by the natural logarithm of total annual executive remuneration.

4.2.5 Other Control Variables

We include nine conventional controls following established practices in innovation economics: (1) firm age (years since incorporation), (2) natural logarithm of total assets (in 10,000 CNY), (3) fixed asset ratio (percentage of fixed assets to total assets), (4) growth capacity measured by annual revenue growth rate, (5) ownership concentration expressed as the largest shareholder's equity ratio, (6) market power calculated as revenue-to-cost ratio (log-transformed), (7) executive R&D background (binary indicator), (8) state-owned enterprise status (binary indicator), and (9) high-tech industry affiliation (binary indicator). Continuous variables (total assets and market power) undergo logarithmic transformation to normalize distributions.

4.3 Model Specification

To examine the effect of government innovation subsidies on corporate innovation output, we develop a multiple moderation model that simultaneously incorporates two contentious moderators in this research domain: R&D intensity and executive compensation incentives. The baseline specification positions government innovation subsidies as the independent variable, innovation output as the dependent

variable, with both R&D intensity and executive compensation serving as concurrent moderators. This framework allows us to test how these organizational factors condition the transformation process from policy inputs (subsidies) to innovation outcomes.

The multiple moderation methodology, formally established by Hayes, extends conventional moderation analysis by evaluating multiple moderators within a unified linear regression framework. While prior studies in this field frequently examine moderators separately through sequential models, such piecewise approaches risk omitted variable bias when moderators exhibit interdependencies. Our simultaneous estimation strategy mitigates this endogeneity through full covariate conditioning, consistent with modern causal inference principles.

5. Empirical Results

5.1 Descriptive Statistics and Temporal Aggregation

To address potential temporal aggregation bias inherent in annualized innovation analyses, we construct a seven-year averaged panel (2008–2015) that captures the cumulative nature of innovation conversion processes. This approach aligns with the multi-year R&D cycles characteristic of technological transformation (Hall & Rosenberg, 2010).

Table 1 summarizes the distributional properties of 2,131 A-share listed firms, with key variables demonstrating consistency with prior studies on Chinese enterprises. Innovation output averages 16.81 patent applications annually, exhibiting significant variation across firms (SD = 20.47). Government subsidies display a right-skewed distribution (mean = ¥0.30 million vs. median = ¥0.16 million), reflecting concentrated financial support for a subset of firms. Executive compensation, after logarithmic transformation, approximates a normal distribution (mean = 14.92, SD = 0.64), consistent with standardized disclosure practices in financial reporting. R&D intensity averages 1.86% of total assets, with extreme values ranging from 0.01% to 9.44%, underscoring divergent strategic priorities in innovation investment among sampled firms.

Control variables reflect China's institutional context: 51% of sample firms operate in high-tech sectors, consistent with national industrial upgrading initiatives; 32% are state-owned enterprises (SOEs), mirroring A-share market ownership structures; 89% of executives possess R&D backgrounds, suggesting talent concentration in technology-driven industries. Continuous controls show expected variation – firm age ranges from 2 to 36 years (mean = 13.27), while fixed asset ratios average 21.9% (SD = 13.8%), capturing firms at different lifecycle stages.

Table 1. Descriptive Statistics

Table 1 Descriptive Statistics

Variable	Mean	Median	SD	Min	Max
Innovation Output (patent applications	16.81	9.5	20.47	0	99.59
Government Innovation Subsidies (million CNY)	0.3	0.16	0.38	0	2.82
R&D Intensity (% of total assets)	1.863	1.63	1.58	0.01	9.44
Executive Compensation Incentives	14.92	14.9	0.64	10.77	17.97

Total Assets (million CNY)	21.57	21.36	1.109	18.35	26.89
Firm Age (years)	13.27	12.5	4.99	2	36
Fixed Asset Ratio	0.219	0.196	0.138	0.002	0.841
Growth Capacity (revenue growth rate)	0.147	0.128	0.162	-0.51	1.519
Ownership Concentration (% largest shareholder)	36.32	34.75	14.4	4.8	83.35
Market Power (revenue/cost ratio)	0.38	0.3	0.29	0.001	1.62
Executive R&D Background	0.89	1	0.26	0	1
State-owned Enterprise	0.32	0	0.45	0	1
High-tech Industry	0.51	1	0.5	0	1

5.2 Baseline Estimation Results

Table 2 presents coefficient estimates from our multiple moderation model, employing heteroskedasticity-robust standard errors (Wooldridge, 2015). The model explains 13.55% of innovation variance ($F = 23.68$, $p < 0.001$), comparable to similar studies in emerging markets (Aghion et al., 2015).

Table 2. Multiple Moderation Model of Innovation Output

*(Maintain original table format with APA-style significance markers: ***p<0.01, **p<0.05, *p<0.1)*

Innovation Output	**Coefficient**	**Std. Error**	**95% CI Lower**	**95% CI Upper**
Government Innovation Subsidies	0.089***	0.028	0.034	0.143
R&D Intensity	0.062*	0.025	0.014	0.111
Executive Compensation Incentives	0.23***	0.026	0.181	0.284
Gov. Subsidies × Exec. Compensation	0.079***	0.023	0.033	0.125
Gov. Subsidies × R&D Intensity	-0.066***	0.015	-0.097	-0.035
Total Assets	0.139***	0.026	0.088	0.191
Firm Age	-0.205***	0.004	-0.028	-0.012
Fixed Asset Ratio	-0.003	0.161	-0.319	0.313
Growth Capacity	0.148	0.132	-0.111	0 407
Ownership Concentration	0.001	0.001	-0.001	0.004
Market Power	-0.331***	0.078	-0.484	-0.178
Executive R&D Background (1=Yes)	0.238**	0.081	0.079	0.397
State-owned Enterprise (1=Yes)	-0.16**	0.053	-0.264	-0.057
High-tech Industry (1=Yes)	0.215***	0.046	0.124	0.305
Intercept	-2.917***	0.562	-4.018	-1.815
N	2131			
R_square	0.1355			
F	23.68***			

Root MSE	0.933

Three principal findings emerge from the empirical analysis. First, government subsidies exert a significant direct effect on innovation output: a one-standard-deviation increase in subsidies corresponds to an 8.9% rise in patent production ($\beta = 0.089$, 95% confidence interval [0.034, 0.143], $p < 0.001$), thereby confirming Hypothesis 1. This effect magnitude aligns with meta-analytic evidence on Chinese industrial policy efficacy (Mutlu et al., 2018). Second, we identify a counterintuitive substitution effect in R&D investment. While higher R&D intensity independently predicts innovation gains ($\beta = 0.062$, [0.014, 0.111], $p < 0.05$), its negative interaction with subsidies ($\beta = -0.066$, [−0.097, −0.035], $p < 0.001$) suggests that firms with established R&D capabilities may divert subsidized resources toward non-innovation activities, a pattern consistent with Hypothesis 2's crowding-out mechanism. Finally, the results underscore the critical role of managerial incentives. The positive subsidy-compensation interaction ($\beta = 0.079$, [0.033, 0.125], $p < 0.005$), coupled with the direct effect of executive pay ($\beta = 0.230$, [0.181, 0.284], $p < 0.001$), validates Hypothesis 3 by demonstrating that performance-aligned compensation structures enhance the efficiency of subsidy conversion into innovation outcomes.

The control variables exhibit patterns consistent with theoretical expectations and prior empirical work. Firm size demonstrates a positive association with innovation output ($\beta = 0.139$, $p < 0.001$), aligning with the scale economies inherent in R&D-intensive activities. State-owned enterprises (SOEs) underperform their private counterparts ($\beta = -0.160$, $p < 0.01$), likely reflecting bureaucratic inefficiencies and misaligned incentives characteristic of state-controlled innovators. Furthermore, high-tech firms generate 21.5% greater innovation output than non-high-tech firms ($p < 0.001$), a finding that substantiates the effectiveness of China's targeted industrial policies in strategic sectors. These results collectively reinforce the model's construct validity while contextualizing the core relationships within China's institutional landscape.

6. Conclusion

Drawing on panel data from 2,131 A-share listed firms, this study yields three principal findings that advance our understanding of innovation dynamics in China's corporate sector.

First, government innovation subsidies, corporate R&D intensity, and executive compensation incentives collectively demonstrate statistically significant impacts on innovation output. This tripartite influence aligns with China's national innovation strategy emphasizing external policy support and internal governance mechanisms. While subsidies provide critical external funding, our results confirm that internal resource allocation (R&D investments) and incentive alignment (executive pay structures) constitute equally vital determinants of innovation productivity.

Second, we identify a paradoxical substitution effect: higher R&D intensity attenuates the positive impact of government subsidies on innovation output ($\beta = -0.066$, $p < 0.001$). This crowding-out phenomenon echoes prior findings and may reflect China's evolving subsidy allocation mechanisms. As firms demonstrate greater innovation quantity, policymakers appear to reallocate subsequent subsidies toward quality-driven projects, creating a perverse incentive structure. Firms with established R&D capabilities consequently face "mission creep" – pressured to undertake complex, long-term initiatives that delay measurable outputs while cultivating over-reliance on public funding. This unintended consequence underscores the need for subsidy policies that balance quality mandates with sustainable innovation ecosystems.

Third, performance-linked executive compensation emerges as a critical catalyst for subsidy effectiveness. The positive interaction between subsidies and compensation incentives ($\beta = 0.079$, $p < 0.005$) supports agency theory predictions: by aligning managerial interests with long-term value creation, equity-based incentives mitigate short-termism in R&D allocation. Our results suggest that properly structured compensation packages help channel subsidized resources toward innovation activities rather than managerial self-dealing, particularly when combined with China's unique institutional pressures for technological upgrading.

These findings carry important policy implications. First, subsidy allocation mechanisms should incorporate safeguards against diminishing marginal returns in R&D-intensive firms. Second, regulatory frameworks could mandate compensation structures that tie executive rewards to multi-year innovation metrics rather than short-term financials. Methodologically, our multiple moderation approach advances beyond conventional single-moderator models, providing a template for analyzing complex policy-organization interactions.

Future research should explore dynamic subsidy effects across industries and ownership types, particularly under China's evolving "dual circulation" economic strategy (Yifu & Wang, 2022). Comparative studies across emerging economies could further disentangle universal innovation drivers from China-specific institutional factors.

7. Discussion

This study investigates the impact of government innovation subsidies, corporate R&D intensity, and executive compensation incentives on innovation output in China's A-share listed companies. The findings provide critical insights into the design of innovation subsidy policies and highlight the complex interaction between policy interventions and organizational factors.

The results confirm that government innovation subsidies positively influence corporate innovation output, which aligns with the notion that government support helps alleviate financial constraints and stimulates innovation activities. Specifically, a one-standard-deviation increase in subsidies results in an 8.9% increase in patent applications. This confirms that government subsidies serve as a vital source of funding for firms, particularly in high-tech sectors, where innovation comes with substantial financial risks (Wu & Hu, 2020). Moreover, these subsidies not only reduce immediate innovation costs but also signal a firm's technological capability to external investors, thereby attracting additional resources and fostering a cycle of innovation.

However, our study also reveals that government subsidies can have a "crowding-out effect" on firms with high R&D intensity, which was not expected initially. Firms that already possess a strong innovation capacity may divert the additional funds provided by subsidies toward less productive uses, such as rent-seeking or short-term innovation projects, instead of long-term strategic R&D. This suggests that for firms with established R&D capabilities, over-reliance on government subsidies can lead to inefficient allocation of resources and diminish the effectiveness of such policy interventions (Sun et al., 2024). Policymakers should consider the level of R&D intensity when designing subsidy programs, ensuring that support is targeted at firms that genuinely need it for innovation rather than firms that might become overly dependent on external funding.

The interaction between corporate R&D intensity and government subsidies reveals a substitution effect, as firms with high R&D intensity tend to see a weakened impact of subsidies on innovation output. This result highlights the importance of balancing the quantity and quality of innovation subsidies. While

government support is crucial for firms with low R&D intensity, it may not be as effective for those with high innovation capacity, where subsidies may simply add to existing resources without significantly enhancing output. Therefore, it is essential for subsidy policies to be tailored to the needs of different firms, promoting innovation that is both sustainable and impactful over the long term.

Additionally, the study underscores the crucial role of executive compensation incentives in enhancing the effectiveness of government subsidies. When executive pay is aligned with long-term innovation goals, the firm is more likely to utilize government subsidies efficiently, channeling them into productive R&D activities. The positive interaction between subsidies and executive compensation confirms that well-structured incentive systems help align managerial goals with organizational innovation objectives. This finding suggests that companies should not only focus on providing government subsidies but also ensure that their executive compensation schemes are designed to incentivize sustained, high-quality innovation.

In light of these findings, policymakers should focus on directing innovation subsidies toward firms with low R&D intensity and ensure that the subsidies are not misallocated to firms that would benefit more from other forms of support. Government subsidies should be used as a tool to complement firms' innovation efforts, with a focus on stimulating high-quality, long-term innovation rather than short-term gains (Reshid et al.). At the same time, firms should establish robust executive incentive systems that align managers' personal goals with the company's innovation objectives, maximizing the effectiveness of both internal and external resources.

Despite the valuable insights offered, this study has some limitations. The data is limited to China's A-share listed companies, and further research could extend the analysis to firms across different sectors and ownership types. Additionally, the use of patent counts as a measure of innovation output may not fully capture the diversity and quality of innovations. Future research could explore alternative measures of innovation, such as product development, technological collaborations, or revenue generated from new products, to provide a more comprehensive understanding of the impact of government subsidies on innovation.

This study provides a deeper understanding of how government innovation subsidies and corporate governance structures influence innovation outcomes, offering practical recommendations for both policymakers and corporate managers. Future studies could explore the dynamic effects of innovation subsidies across industries and ownership types, particularly in the context of China's evolving economic strategies.

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