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Government Subsidies and Corporate Innovation

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Abstract. Government subsidies play a crucial role in addressing market failures in corporate innovation. Using 2007-2021 data of Chinese A-share listed companies, excluding non-innovation subsidies, this study applies a two-way fixed effects model to analyze government subsidies' impact on enterprises, and uses R&D investment as a mediator to explore its role in the government subsidies-corporate innovation relationship. The research findings are as follows: First, government innovation subsidies can significantly increase enterprises' innovation output. Second, government innovation subsidies have a significant incentive effect on the substantive innovation output of private enterprises and enterprises in the growth and maturity stages. Third, R&D investment exerts a partial mediating effect in the relationship between government subsidies and corporate innovation.

Keywords: Government subsidies; corporate innovation; R&D investment; mediating effect.

1. Introduction

China's economic development has entered a new era, with a tremendous leap in economic strength. To achieve sustained, efficient, and healthy economic development in China in the future, we must focus on breaking through the current innovation level. As the main players in microeconomic activities, enterprises are the backbone of innovation. Enterprise innovation is crucial for the country to achieve independent innovation; however, there remains significant room for improvement in the current level of enterprise innovation in China. How to enhance enterprises' innovation capabilities has not only become a key research topic valued by scholars from all walks of life but also a hot issue of concern to stakeholders such as the government and enterprise managers.

Neoclassical economic theory holds that the positive externalities and high risks of innovation will lead to market failure, reduce enterprises' motivation to innovate, and result in insufficient effective supply in the market. Therefore, government intervention is indispensable. The government needs to use the "visible hand" to address market failures, alleviate the financial pressure faced by enterprises in innovation through supportive policies such as government subsidies, and stimulate enterprises to carry out independent innovation. To encourage enterprise innovation, governments around the world generally use tools such as fiscal subsidies, and China has also implemented a series of large-scale and diverse subsidy policies. Nevertheless, there is still considerable controversy over whether the supportive policies adopted by the Chinese government have exerted an incentive effect on enterprise innovation, and the nature and extent of the impact of government subsidies on enterprises deserve further discussion.

In this paper, enterprise innovation is taken as the dependent variable, government subsidies as the independent variable, and R&D investment as the mediating variable. Based on the data of Chinese A-share listed companies during 2007–2021, a two-way fixed effects model is used for regression analysis. The potential marginal contributions of this paper are as follows: First, most of the existing literature measures government subsidies by the total amount of government subsidies, without excluding the impact of non-innovation-related subsidy items. Specifically, this may introduce noise into the research. This paper divides the total government subsidies obtained into innovation-related subsidy amount and non-innovation-related subsidy amount through manual collection and keyword search. This not only provides relatively reliable empirical evidence for the controversy over the impact of government subsidies on enterprise innovation but also further explores the mechanism of

innovation incentives by comparing the results generated by the two types of subsidies.Second, this paper adopts multiple indicators to measure enterprise innovation and studies the tendency of enterprises to engage in strategic innovation and substantive innovation based on government supportive policies. At the same time, it introduces R&D investment as a mediating variable, incorporates the three research objects into the same framework, and explores the impact of different types of government subsidies on enterprise innovation from multiple dimensions such as ownership differences and corporate life cycles. This provides reasonable suggestions for the Chinese government to optimize innovation support policies and for enterprises to improve their innovation level.

2. Literature review and hypothesis development

An enterprise must possess innovation capabilities to survive in an intensely competitive environment [1]. At present, regarding the influencing factors of enterprise innovation, different literatures focus on different research objects, which include both macro-level influencing factors and micro-level ones such as those related to enterprises and individuals.

From the macro-level perspective, the research objects mainly involve aspects like the economic environment, the government, and the financial market.Financing constraints are not only driven by the enterprises' own innovation level but also exert a negative impact on their innovation activities[2]. Studies have shown that government corruption hinders corporate innovation in the United States[3].Some scholars have also examined whether venture capitalists' tolerance for failure can have a positive effect on corporate innovation. The results show that among IPO companies, the higher the venture capitalists' tolerance for failure, the higher the enterprises' innovation level and output[4]. Additionally, in industries with high R&D costs, high uncertainty, and no barriers to imitation, an increase in concentration is accompanied by a significant rise in R&D investment, which can promote corporate innovation. In contrast, in industries with low R&D costs, low uncertainty, and high barriers to imitation, market concentration tends to inhibit corporate innovation[5].Market concentration restricts enterprises' innovation output, and small enterprises are subject to a higher degree of restriction[6].

From a micro-level perspective, the influencing factors include corporate governance, ownership nature, firm size, managerial characteristics, family control, institutional voids, and so on. From the perspective of corporate governance, capital market pressures such as stock liquidity and financial analyst coverage, as well as external government intervention, constitute the main components of external governance. It is found that analyst coverage hinders firms' investment in long-term innovation projects and exerts a negative causal effect on corporate innovation[7]. Ownership structure, executive compensation incentives, and board composition are the main aspects of internal corporate governance. Studies have shown that an increase in liquidity inhibits corporate innovation through two main channels: first, an increase in acquisition risk, and second, inadequate supervision by institutional investors[8]. It has been discovered that foreign institutions promote corporate innovation by providing financial security for managers in case of failed innovation investments, and at the same time, leverage technology spillovers from countries with high-quality innovation to encourage small and medium-sized enterprises (SMEs) to carry out innovation activities[9]. Research indicates that managerial risk incentives can drive firms to engage in innovation investment activities[10].

Enterprise innovation output has always been inseparable from government support and incentives, and the subsidy policies implemented by the government have either positive or negative effects on the innovation investment activities of different enterprises. Currently, the research findings of scholars from all walks of life on the relationship between government support and enterprise innovation mainly include five effects, namely incentive effect, crowding-out effect, mediating effect, moderating effect, and threshold effect. First, a large number of scholars have empirically verified the promoting role of government support in enterprise innovation activities. Taking the northern region of Italy as the research object, one study examined whether the local government subsidy

programs could promote enterprises to carry out more innovation activities. The test results showed that the subsidy incentives provided by the government to enterprises could increase their number of patent applications to a certain extent[11]. Another study established a binary endogenous switching model to conduct an empirical test on the innovation productivity of Italian enterprises, and found that government subsidies had a negative effect on enterprises' innovation productivity[12]. A research on the innovation performance of China's wind power industry found that from a long-term perspective, enterprises' innovation efficiency showed a U-shaped trend with changes in government subsidies; after reaching the lowest point, enterprises' innovation efficiency could be improved by reducing government subsidies[13].

The main channels through which the government drives enterprise innovation via supportive policies include direct subsidies such as financial subsidies and indirect subsidies such as tax reductions. This paper focuses on the impact of government financial grants-a form of direct subsidy-on enterprise innovation, and its impact mechanism can be explored from the following two perspectives: First, resource supplementation. When enterprises face constraints in both external financing and internal funds, they struggle to independently and sustainably carry out innovative activities. Government financial grants can effectively address the issue of insufficient funds, providing guarantees for enterprises to maintain stable returns and pursue further innovation. Second, signal transmission. The inherent uncertainty of enterprise innovation and the public-good nature of innovation outcomes lead to information asymmetry between enterprises, external investors, banks, and other institutions. Government provision of financial subsidies not only offers policy guarantees to funded enterprises but also sends positive signals to the market. These signals indicate that the R&D capabilities and standards of the relevant enterprises have been recognized by the government, which can attract venture capitalists to support the enterprises' R&D and innovation efforts. Enterprises can then better achieve innovation output by leveraging the innovative resources provided.Numerous domestic and international studies have verified the signal transmission mechanism of government subsidies on enterprise innovation. Therefore, this paper proposes the following hypothesis:

H1: The government's implementation of financial subsidy policies will significantly promote enterprise innovation.

In studies exploring the impact of government support on enterprise innovation, some literatures have found that in addition to having a direct positive impact on innovation output, financial subsidies also involve an indirect transmission path: government support exerts a positive effect on enterprise innovation output by changing enterprises' R&D investment. Through mediating effect analysis, supportive measures such as financial subsidies can indirectly drive enterprises to achieve innovation output by increasing R&D investment intensity. Based on the above analysis, this paper holds that such a mediating effect exists significantly, and thus proposes the following hypothesis:

H2: R&D investment plays a mediating role. Government support can promote enterprise innovation by increasing enterprises' R&D investment.

3. Research design

3.1. Sample selection and data sources

This study selects A-share listed companies from 2007 to 2021 as the research sample. It excludes financial industry enterprises, enterprises with abnormal operating conditions (including ST, *ST, and PT enterprises), and individual companies with missing values for key variables such as R&D investment. Finally, a research sample consisting of 3288 enterprises and 19,939 observations is obtained. The above data are mainly sourced from the CSMAR database and the CNRDS database. To mitigate the impact of outliers, this study performs Winsorization on the 1st and 99th percentiles of key continuous variables.

Among them, since data on government innovation subsidies and non-innovation subsidies of listed companies cannot be obtained directly, this study screens and classifies various items under the

detailed government subsidy accounts through manual collection and “keyword search”. It identifies specific items under the detailed accounts that fall into the categories of innovation subsidies and non-innovation subsidies, respectively, and aggregates these items to obtain the total amount of government innovation subsidies and total non-innovation subsidies for each listed company.

3.2. Measurement of government subsidies

When examining the impact of government support on R&D investment and enterprise innovation level, this paper mainly uses the amount of government subsidies to represent the intensity of government support. Referring to the practices of existing scholars, it adopts the ratio of government innovation subsidy funds to the total assets of funded enterprises to measure the intensity of government innovation subsidies, excluding the interference caused by non-innovation subsidies. For the purpose of comparative research, this paper also takes the ratio of total non-innovation subsidies to total assets as the non-innovation subsidy variable.

3.3. Measurement of corporate innovation

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Existing literature generally uses two types of indicators to measure corporate innovation: R&D expenditures and patent activities. Patent activities can reflect the efficiency with which enterprises make the most of innovative inputs to achieve innovation outputs, while R&D expenditures only represent the quantification of enterprises’ R&D inputs and cannot reflect the quality of innovation. Drawing on the approach of existing scholars, this paper uses the number of patent applications and granted patents to reflect enterprises’ tendency toward strategic innovation, and simultaneously employs the average number of citations per patent and the number of invention patent applications to measure enterprises’ level of substantive innovation. Considering that a large number of enterprises have zero patent data in relevant years, to avoid losing annual corporate observations when enterprises have no patents, this paper takes the natural logarithm of the original values of the above four indicators after adding 1, and uses these transformed values as the dependent variables.

3.4. Empirical model and control variables

The focus of this study is on the impact of government support on corporate innovation. However, corporate characteristic factors such as firms’ financial leverage, profitability, and growth capacity also influence innovation activities. For instance, a higher level of financial leverage—measured by the asset-liability ratio—leads managers to be more inclined to engage in high-efficiency investment activities, which can improve the utilization rate of funds and thereby drive a continuous increase in corporate innovation efficiency. Moreover, when enterprises optimize their profitability, they can provide financial support for better conducting innovation activities; an improvement in corporate profitability is conducive to enhancing firms’ innovation level. Therefore, to avoid estimation errors caused by omitting certain important variables, this study selects firm size, firm age, asset-liability ratio, profitability, the shareholding ratio of major shareholders, and growth indicators as control variables and incorporates them into the regression model.

Table 1. Variable Definitions

Variable	Description
lnpta	Natural logarithm of (annual number of patent applications of the enterprise + 1)
lnptg	Natural logarithm of (annual number of granted patents of the enterprise + 1)
lnita	Natural logarithm of (annual number of invention applications of the enterprise + 1)
lncit	Natural logarithm of (annual average number of citations of the enterprise's applied patents + 1)
rdsub	(Government innovation subsidies obtained by the enterprise in the current year / Total assets) * 100
nrdsub	(Government non-innovation subsidies obtained by the enterprise in the current year / Total assets) * 100
lnrd	Natural logarithm of (annual R&D expenditure of the enterprise + 1)
size	Natural logarithm of total assets at the end of the year
age	Difference between the enterprise's founding year and the year of the sample observation
lev	Asset-liability ratio, equal to the ratio of total liabilities to total assets
roa	Ratio of net profit to total assets
top1	Ratio of the number of shares held by the largest shareholder to the total number of shares
board	Natural logarithm of (number of board directors of the enterprise + 1)
lndep	Ratio of independent directors to the total number of board directors
growth	Ratio of the current period's increase in operating income to the opening value of operating income

Based on the above theoretical analysis, to examine the impact of government support on corporate innovation, this study sets the econometric models in the following forms:

$$y_{it} = \beta_0 + \beta_1 rdsub_{it} + \beta_2 nrdsub_{it} + \sum \beta_k \cdot controls_{it} + \lambda_i + \tau_t + \varepsilon_{it} \quad (1)$$

Among them, *i* represents an enterprise and *t* represents a year. The left-hand side of the equation is the dependent variable: the dependent variable of Model (1) consists of four indicators measuring the enterprise's innovation level, including the number of patent applications, the number of granted patents, the number of invention patent applications, and the average number of citations per patent. The variables on the right-hand side of the equation include the government's innovation-related subsidies obtained by the enterprise, non-innovation-related subsidies, and various control variables (with non-relevant factors excluded). The coefficients preceding the variables can be used to measure the impact of each factor on the enterprise's R&D investment and innovation level. In addition, this study incorporates firm-level fixed effects and year fixed effects, and ultimately chooses to adopt a two-way fixed effects model for the research.

Furthermore, to further explore whether enterprises' R&D investment exerts a mediating effect in the path through which subsidy support policies influence enterprises' innovation level, this study incorporates a mediating effect equation based on the above equations, aiming to analyze the effect of R&D investment as a mediating variable:

$$lnrd_{it} = \alpha_0 + \alpha_1 rdsub_{it} + \alpha_2 nrdsub_{it} + \sum \alpha_k \cdot controls_{it} + \lambda_i + \tau_t + \varepsilon_{it} \quad (2)$$

$$y_{it} = \gamma_0 + \gamma_1 rdsub_{it} + \gamma_2 nrdsub_{it} + \gamma_3 lnrd_{it} + \sum \gamma_k \cdot controls_{it} + \lambda_i + \tau_t + \varepsilon_{it} \quad (3)$$

4. Empirical analysis

4.1. Descriptive statistics

Table 2 presents the descriptive statistics of key continuous variables after winsorization at the 1% level. As shown in the table, the mean values of the number of patent applications and granted patents are 2.995 and 2.736, respectively, both of which are higher than the mean values of the number of invention patent applications and patent citations. The minimum value of the logarithm of enterprises' R&D investment is 13.41, with an average of 17.69, indicating that listed companies generally have a relatively strong willingness to invest in R&D. The proportions of government innovation subsidies and non-innovation subsidies in total assets are 12.3% and 53.2%, respectively. This shows that only

a small part of the total government subsidies granted to enterprises falls into the category of government innovation subsidies, while more than half are non-innovation subsidies, which further confirms the necessity and rationality of excluding the impact of non-innovation subsidies before conducting the study.

Table 2. Descriptive Statistics of Variables

Variable	N	Mean	S.D.	Minimum	Median	Maximum
lnpta	19939	2.995	1.533	0.000	3.045	6.773
lnptg	19939	2.236	1.484	0.000	2.773	6.480
lnita	19939	2.736	1.447	0.000	2.079	6.114
lncit	19939	2.153	1.733	0.000	2.197	6.774
lnrd	19939	17.690	1.473	13.410	17.695	21.529
rdsub	19939	0.123	0.197	0.000	0.048	1.151
nrdsub	19939	0.532	0.632	0.000	0.319	3.595
age	19939	16.584	5.798	4.000	16.000	32.000
size	19939	21.963	1.185	19.940	21.788	25.622
lev	19939	0.392	0.200	0.046	0.380	0.871
roa	19939	0.048	0.062	-0.207	0.045	0.224
top1	19939	0.339	0.142	0.088	0.319	0.719
board	19939	8.511	1.581	5.000	9.000	14.000
indep	19939	0.375	0.053	0.333	0.333	0.571
growth	19939	0.184	0.359	-0.458	0.126	2.158

4.2. Baseline regression results

This study analyzes the impact of government subsidies on corporate innovation levels based on Model (1), with the corresponding regression results presented in Table 3. Among the columns, Columns (1) and (2) correspond to the number of patent applications and patent authorizations, which reflect enterprises' strategic innovation behaviors. It can be seen from the results that government innovation-related subsidies can significantly increase the number of enterprises' patent applications and authorizations, that is, enhance their strategic innovation behaviors; however, non-innovation subsidies have no significant effect on either of the two indicators.Columns (3) and (4) correspond to the number of invention applications and patent citations, which represent the level of enterprises' substantive innovation outputs. The coefficient of government innovation-related subsidies corresponding to these two indicators is significantly positive, indicating that government innovation support policies can effectively promote enterprises to achieve substantive innovation outcomes such as invention applications; non-innovation subsidies have a positive effect on enterprises' substantive innovation outputs but with a relatively weak impact.The above results verify Hypothesis H1: government subsidy behaviors can stimulate enterprises' innovation vitality and improve their innovation levels.

Table 3. The Impact of Government Subsidy Support on Corporate Innovation

Variable	(1) lnpta	(2) lnptg	(3) lnita	(4) lncit
rdsub	0.241***	0.194***	0.235***	0.138***
	(4.93)	(4.16)	(5.06)	(2.97)
nrdsub	0.014	0.027	0.042***	0.035**
	(0.81)	(1.58)	(2.68)	(2.35)
Controls	Yes	Yes	Yes	Yes
Firm & year FEs	Yes	Yes	Yes	Yes
N	19,939	19,939	19,939	19,939
R^2	0.309	0.339	0.299	0.641
F	132.7	120.8	99.76	363.7

4.3. Robustness testing

To enhance the robustness of the research results, this study subsequently conducts a series of robustness tests, and the main conclusions are consistent with those presented earlier.

First, adjusting the sample structure. Considering the differences in the characteristics of industries in which enterprises operate, this study separately extracts samples from the manufacturing industry for regression analysis. As shown in the results in Table 4, the coefficients of government innovation-related subsidies are all significantly positive, while the coefficients of non-innovation subsidies are smaller or their significance is reduced—these results are basically consistent with the previous findings.

Second, adopting the panel Tobit random effects model. This study uses patent data as the measurement indicator for corporate innovation. Since there is a considerable number of zero values in such data, the panel Tobit random effects model can address the aforementioned "zero-value accumulation" issue. The regression results obtained using this model are presented in Table 5. Government innovation-related subsidies have a significant promoting effect on enterprises' R&D investment, as well as on enterprises' strategic innovation and substantive innovation outputs. In contrast, the coefficients of non-innovation subsidies are all relatively low, which is basically consistent with the aforementioned conclusions.

Table 4. Regression Results of Manufacturing Industry Samples

Variable	(1) lnpta	(2) lnptg	(3) lnita	(4) lncit
rdsub	0.228***	0.185***	0.239***	0.174***
	(4.27)	(3.81)	(4.77)	(3.42)
nrdsub	0.028	0.051***	0.048***	0.043**
	(1.38)	(2.68)	(2.64)	(2.55)
Controls	Yes	Yes	Yes	Yes
Firm & year FEs	Yes	Yes	Yes	Yes
N	14,948	14,948	14,948	14,948
R^2	0.334	0.359	0.319	0.659
F	122.2	100.4	84.45	308.7

Table 5. Regression Results of the Tobit Random Effects Model

Variable	(1) lnpta	(2) lnptg	(3) lnita	(4) lncit
rdsub	0.380***	0.300***	0.422***	0.400***
	(9.07)	(7.76)	(10.09)	(7.41)
nrdsub	0.081***	0.066***	0.118***	0.110***
	(5.73)	(5.00)	(8.31)	(6.01)
Constant	-12.462***	-11.466***	-13.526***	-17.469***
	(-40.14)	(-38.90)	(-43.72)	(-42.52)
Controls	Yes	Yes	Yes	Yes
sigma_u	1.256***	1.285***	1.231***	1.743***
	(67.26)	(68.59)	(65.31)	(59.61)
sigma_e	0.866***	0.790***	0.852***	1.068***
	(171.90)	(170.95)	(163.78)	(157.76)
rho	0.678	0.725	0.676	0.727

5. Mechanism discussion

To verify the mediating effect of enterprises' R&D investment on the relationship between government support and corporate innovation, this study constructs a system of simultaneous equations including Models (1), (2), and (3). The regression results are presented in Tables 6 and 7

below. Among them, the explained variables in Table 6 are the number of patent applications and patent authorizations, which are used to measure enterprises' strategic innovation. The coefficients of government innovation-related subsidies in Models (1), (2), and (3) are all significantly positive, while the coefficients of non-innovation subsidies are small or insignificant. When the corporate innovation output is the number of patent applications, the direct positive effect generated by government innovation subsidy support is 20.1%, and the mediating effect and its proportion are 4.03% and 16.72% respectively. Similarly, when the corporate innovation output is the number of granted patents, the direct effect and mediating effect are 16.1% and 3.2% respectively, with the mediating effect accounting for 17.03%.

The two explained variables in Table 7 are the number of invention applications and patent citations, which are used to reflect enterprises' substantive innovation capabilities. The proportions of the mediating effect corresponding to these two variables are 14.47% and 8.30% respectively. The coefficient of government innovation-related subsidies is also significantly positive, while the coefficient of non-innovation subsidies is small or insignificant. The results show that: in addition to having a direct positive impact on corporate innovation levels, government subsidies can also indirectly promote corporate innovation by increasing enterprises' R&D investment. That is, enterprises' R&D investment exerts a partial mediating effect; however, compared with the direct effect, the degree of its impact is smaller. This verifies Hypothesis H2.

Table 6. Mediating Effect Analysis of Enterprises' R&D Investment (I)

Variable	lnpta	lnrd	lnpta	lnptg	lnrd	lnptg
rdsub	0.241***	0.191***	0.201***	0.194***	0.191***	0.161***
	(0.049)	(0.033)	(0.048)	(0.047)	(0.033)	(0.046)
nrdsub	0.014	0.031**	0.008	0.027	0.031**	0.021
	(0.018)	(0.014)	(0.017)	(0.017)	(0.014)	(0.017)
lnrd			0.211***			0.173***
			(0.017)			(0.017)
Constant	-10.952***	-0.730	-10.798***	-9.841***	-0.730	-9.715***
	(0.761)	(0.635)	(0.727)	(0.745)	(0.635)	(0.719)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	19939	19939	19939	19939	19939	19939
R^2	0.309	0.563	0.326	0.339	0.563	0.351

Table 7. Mediating Effect Analysis of Enterprises' R&D Investment (II)

Variable	lnita	lnrd	lnita	lncit	lnrd	lncit
rdsub	0.235***	0.191***	0.201***	0.138***	0.191***	0.127***
	(0.046)	(0.033)	(0.045)	(0.047)	(0.033)	(0.046)
nrdsub	0.042***	0.031**	0.036**	0.035**	0.031**	0.033**
	(0.016)	(0.014)	(0.015)	(0.015)	(0.014)	(0.015)
lnrd			0.178***			0.060***
			(0.015)			(0.014)
Constant	-11.043***	-0.730	-10.913***	-7.211***	-0.730	-7.167***
	(0.748)	(0.635)	(0.719)	(0.721)	(0.635)	(0.720)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	19939	19939	19939	19939	19939	19939
R^2	0.299	0.563	0.313	0.641	0.563	0.642

6. Further analysis

6.1. Corporate ownership

Against China's unique institutional background, government subsidies may have heterogeneous impacts on the innovation activities of enterprises with different ultimate ownership structures. On the one hand, state-owned enterprises (SOEs) are more likely to obtain government support than private enterprises, and the number of subsidies they receive is also larger. This reduces SOEs' own R&D investment; meanwhile, government subsidies increase SOEs' revenue to a certain extent, which inhibits their demand for innovation. On the other hand, the inherent institutional management issues of SOEs may also reduce their motivation to fully allocate the received subsidies to innovation activities.

Therefore, compared with SOEs, government subsidies will more significantly promote the high-quality innovation outputs of private enterprises. In this study, enterprises are divided into SOEs and private enterprises based on their ultimate ownership for subsample analysis. The number of patent citations is used as the explained variable to measure the impact of government subsidies on the significance of innovation outputs of different types of enterprises. The regression results are presented in Table 8 below. It can be observed that the coefficients of both government innovation-related subsidies and non-innovation subsidies are insignificant and small in the SOE subsample. In contrast, the coefficients of these two types of subsidies are significant in the private enterprise subsample, though the coefficient of non-innovation subsidies is relatively small. This indicates that government innovation-related subsidies can significantly enhance the high-quality innovation outputs of private enterprises but have no significant impact on SOEs, which is basically consistent with the theoretical analysis.

Table 8. Group Research Results

Variable	6.2. Corporate ownership			6.3. Corporate Life Cycle		
	State-Owned Enterprises	Private Enterprises		Growth Stage	Maturity Stage	Decline Stage
	(1)	(2)		(3)	(4)	(5)
rdsub	0.080	0.188***		0.137***	0.255***	-0.007
	(0.057)	(0.042)		(0.052)	(0.063)	(0.089)
nrdsub	0.003	0.045***		0.061***	0.021	-0.012
	(0.018)	(0.015)		(0.019)	(0.022)	(0.028)
Constant	-4.822***	-7.386***		-7.923***	-6.968***	-6.455***
	(0.629)	(0.505)		(0.613)	(0.789)	(1.192)
Controls	Yes	Yes		Yes	Yes	Yes
Firm FEs	Yes	Yes		Yes	Yes	Yes
Year FEs	Yes	Yes		Yes	Yes	Yes
N	6404	13535		9785	6758	3396
R^2	0.680	0.632		0.687	0.659	0.624
F	478.110	791.066		615.176	354.535	120.306

6.4. Corporate Life Cycle

Based on the Corporate Life Cycle Theory, it can be observed that enterprises' ability to acquire resources and their level of independent innovation exhibit certain differences depending on the life cycle stage they are in. In this study, enterprises are divided into three stages—growth stage, maturity stage, and decline stage—for subsample analysis, with the division criteria being the positivity or negativity of enterprises' net cash flows from operating, investing, and financing activities. Similarly, the number of patent citations is adopted as the explained variable to measure whether there are differences in the impact of government subsidy funds on the generation of substantive innovation

outputs among enterprises at different life cycle stages. The specific results are presented in Table 8 above.

As can be seen from the results: Government innovation-related subsidies and non-innovation subsidies can both increase the substantive innovation outputs of enterprises in the growth stage, but the promoting effect of non-innovation subsidies is relatively weak; Government innovation-related subsidies have a highly significant promoting effect on the substantive innovation outputs of enterprises in the maturity stage, and their coefficient is larger than that for enterprises in the growth stage, while the effect of non-innovation subsidies is not significant; For enterprises in the decline stage, the coefficients of both government innovation-related subsidies and non-innovation subsidies are negative and insignificant, indicating that government subsidies have no incentive effect on enterprises in the decline stage.

7. Conclusions

Corporate innovation activities are characterized by high risk and uncertainty, which reduce enterprises' enthusiasm for independent innovation. Meanwhile, the positive externality of innovation can lead to market failure, requiring the government to use its "visible hand" of support to make up for market deficiencies. The government's implementation of subsidy policies for enterprises can play a key role in addressing the market failure in corporate innovation. However, there remains considerable controversy over whether government support can truly promote corporate innovation. Based on existing research findings, this study uses data from China's A-share listed companies spanning 2007 to 2021 and adopts a two-way fixed effects model to explore the mechanism of action between government support and corporate innovation. Furthermore, it analyzes whether enterprises' R&D investment exerts a mediating effect on the relationship between government support and corporate innovation.The study mainly draws the following conclusions:

First, the innovation-related subsidies provided by the government to enterprises have a significant positive effect on the increase of their innovation outcomes, such as the number of patent applications and authorizations. Non-innovation subsidies also have a weak positive effect, but it is not significant. This indicates that enterprises tend to have a certain degree of strategic innovation tendency when carrying out innovation activities. In addition, government innovation-related subsidies also have a significant positive impact on enterprises' substantive innovation outcomes, but the overall degree of this impact is lower than that on the first type of innovation output (i.e., strategic innovation outputs). This shows that enterprises, to a certain extent, use the obtained government subsidies for high-quality R&D and innovation, thereby increasing their substantive innovation outcomes, which verifies the first hypothesis (Hypothesis H1).

Second, against China's unique institutional background, government innovation-related subsidies show a stronger incentive effect on the output of substantive innovation level of private enterprises. In addition, for enterprises in the growth stage and maturity stage of their life cycle, government innovation-related subsidies have a significant promoting effect on their high-quality innovation outputs such as invention applications, among which the promoting effect on mature-stage enterprises is stronger. However, for enterprises in the decline stage, government innovation-related subsidies do not have an obvious positive effect.

Third, in the process where supportive measures such as government subsidies affect corporate innovation, enterprises' R&D investment, as an intermediary variable, can play a certain role. Compared with the direct positive effect, the proportion of the mediating effect is not high. This indicates that enterprises' increase in R&D investment can, to a certain extent, enhance the promoting effect of government support on corporate innovation, which verifies the second hypothesis (Hypothesis H2) of this study.

Based on the empirical results, this study puts forward the following suggestions: The government should improve the accuracy of subsidies, abandon the "one-size-fits-all" approach, implement

differentiated policies, and focus on supporting private enterprises that face greater financing constraints and R&D risks. It should accurately select and support enterprises in the growth and maturity stages that have innovation potential and core technology R&D capabilities. Subsidies standards should be adjusted in phases; in the later stage, innovation achievements should be taken as the basis to avoid strategic innovation. A fair market environment should be created, resource allocation should be guided in conjunction with the market, the financing environment should be optimized, and social resources should be integrated to reduce information asymmetry.

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