The Impact of Tax Incentives on the Intensity of Firm's R&D Investment

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Abstract

Under the innovation-driven development strategy, this study employs data from A-share listed companies during the period 2012–2023 to empirically examine the impact of tax incentives on the intensity of corporate R&D investment. The findings reveal that tax incentives significantly enhance R&D investment intensity, with the effect being more pronounced in large-scale enterprises, mature-stage firms, and enterprises facing high financing constraints. Mechanism analysis indicates that tax incentives promote R&D investment primarily by alleviating financing constraints. These results confirm that tax incentives can substantially reduce financial pressure on enterprises, thereby effectively stimulating R&D activities. Based on these findings, this study recommends establishing a "three-dimensional targeted" incentive framework tailored to firms' size, life cycle stage, and financing capacity, so as to maximize the supportive role of tax policy in fostering innovation activities.

Keywords

Tax incentives, R&D investment, firm life cycle, internal financing constraints.

1. Introduction

Since the 18th National Congress of the Communist Party of China, the country has vigorously implemented the innovation-driven development strategy, designating enterprises as the core actors in technological innovation. The 20th National Congress further underscored the need to strengthen the principal role of enterprises in innovation and to promote self-reliance and self-strengthening in science and technology. In this context, enterprise R&D investment has become a critical indicator for assessing the effectiveness of the national innovation system. tax incentives, as a key policy instrument to stimulate innovation vitality, play an important role by reducing R&D costs and guiding resource allocation.

In recent years, China's tax incentives framework has been continuously refined, with measures such as the R&D expense super deduction and preferential policies for high-tech enterprises being progressively reinforced. Official statistics show that in 2023, the country's total R&D expenditure reached 3.3 trillion yuan, and the R&D intensity increased to 2.65%, both reaching record highs. These developments suggest that tax incentives have become a crucial lever for promoting industrial upgrading. Nevertheless, their actual effectiveness and underlying mechanisms warrant further investigation.

The existing literature presents divergent views regarding the incentive effects of tax incentives. On the one hand, many scholars contend that tax incentives can effectively promote corporate R&D investment. For instance, Tassey (2007) noted that tax incentives may stimulate innovation by reducing costs[31], while Thomson (2010), using firm-level data from Australia, found that tax incentives play a positive role in easing financing constraints[32]. Wang et al. (2021) further argued that tax incentives improve corporate investment, R&D innovation, and operational performance[34]. On the other hand, some studies raise concerns. Chen and Gupta

(2017), examining emerging economies such as India, found that due to the difficulty of directly profiting from R&D, the policy effects of tax incentives may be weakened[21]. Similarly, Guceri and Liu (2019), using a quasi-natural experiment, demonstrated that policy effects may be only short-lived if the design lacks precision[25]. Most prior studies focus on the average effects of tax incentives while paying insufficient attention to firm-level heterogeneity-such as differences in size, life cycle stage, and financing constraints-and lacking long-term tracking of their dynamic effects. Against this backdrop, this study addresses the following core research questions: (1) Do tax incentives significantly increase corporate R&D investment? (2) Do policy effects vary according to firm size, life cycle stage, and internal financing capacity? (3) Do internal financing constraints serve as a mediating mechanism in the relationship between tax incentives and R&D investment?

The marginal contributions of this study are reflected in the following three aspects. First, in the heterogeneity analysis, unlike prior studies that primarily adopted classification frameworks based on ownership structure, this paper systematically depicts firm heterogeneity from three dimensions: firm size, corporate growth cycle, and internal financing constraints. This enables a more in-depth identification of the differentiated effects of tax policies across various types of enterprises, particularly providing a targeted analytical perspective for growth-stage firms, small-scale firms, or firms with low financing constraints. Second, regarding mechanism testing, by constructing a mediation effect model, this study examines the transmission mechanism through which tax incentives influence R&D investment from the perspective of internal financing constraints, systematically unveiling the logical chain of "policy incentive policy-capital release-R&D investment." Third, in terms of causal identification, the study introduces the one-period lagged Tax Refund indicator as an instrumental variable, effectively addressing potential endogeneity concerns.

2. Literature Review

The sensitivity of corporate R&D activities to tax policies has long attracted sustained scholarly attention, generating a substantial body of empirical evidence based on various research methods. This paper reviews the evolution of relevant literature from two perspectives: research themes and research approaches.

2.1. Verification of Policy Effects

Early studies predominantly focused on the incentive effects of tax incentives, examining their actual impacts on promoting corporate R&D investment and enhancing innovation output. For instance, Bronwyn Hall et al. (2000), using OECD country data, confirmed the positive impact of tax credits on R&D investment[25]. Based on panel data from OECD countries covering the period 1979–1998, Nick Bloom et al. (2002)[26] found that tax incentives significantly stimulate corporate R&D expenditure[18]. Similarly, Dirk Czarnitzki et al. (2011), using a sample from the Canadian manufacturing sector, demonstrated that tax incentives substantially enhance firms' innovation output[23]. In the Chinese context, Zhu Pingfang and Xu Weimin (2023), employing panel data on large and medium-sized industrial enterprises in the late 1990s and using a simultaneous equation model, found a synergistic effect between tax reductions and government science and technology grants-when implemented concurrently, the increase in R&D investment reached 1.5 times the effect of either policy alone[16]. Cheng Yao and Yan Huihui (2018) contributed by applying the propensity score matching (PSM) method, precisely quantifying an increase of 0.8 percentage points in R&D intensity attributable to the super deduction policy[1]. Nonetheless, a minority of scholars argue that the actual effects of tax incentives may fall short of policy expectations. For example, Qi Y et al. (2020), employing text analysis and other methods, examined the impact of various fiscal and tax policies implemented by Chinese provinces and municipalities on corporate and regional innovation vitality[30]. Their

results indicate that reductions in corporate income tax and value-added tax may, to some extent, hinder or even suppress the development of corporate and regional innovation vitality. Based on these insights, this paper proposes the following hypothesis:

Hypothesis 1: tax incentives can significantly increase the R&D intensity of enterprises.

2.2. Heterogeneity Analysis of Policy Effects

As research has advanced, scholars have found that the effects of tax incentives vary depending on firm characteristics or the design of expenditures, with increasing attention paid to the differentiated manifestations of these effects. Some studies focus on differences in ownership structure and firm size. For instance, Jiang Jing (2011) found that tax incentives exert a stronger innovation-stimulating effect on enterprises from Hong Kong, Macao, and Taiwan[5]. Based on an analysis of China's capital market, Junxue Jia (2017) reported that private enterprises respond more significantly to tax incentives[27]. Marc Cowling (2016) confirmed that the R&D investment of small and medium-sized enterprises (SMEs) is more responsive to tax incentives[22]. Yohei Kobayashi (2014), using the propensity score matching (PSM) method, reached similar conclusions[28], while Busom et al. (2014), from the perspective of financing constraints, demonstrated that micro and small enterprises benefit more substantially from tax incentives[20]. Other studies emphasize differences stemming from policy design. For example, Feng Haihong et al. (2015) proposed that tax incentives exhibit a "threshold effect," whereby policy effectiveness is maximized only when the incentive intensity falls within a specific range[2]. Research grounded in firm life cycle theory indicates that, as Liu Shiyuan et al. (2020) found, tax incentives have the most pronounced effect on the R&D investment of mature enterprises, whereas their impact on firms at other development stages is comparatively limited[10]. Accordingly, this paper further proposes:

Hypothesis 2: The effects of tax incentives differ significantly across firm types, with large-scale enterprises, mature enterprises, and firms facing high internal financing constraints deriving greater benefits.

2.3. Mechanisms of Policy Effects

Recent studies have identified multiple channels through which tax incentives influence corporate behavior. For example, Wang Xi and Liu Meng (2020) found that the super-deduction policy promotes innovation investment both directly and indirectly-by reducing R&D costs and improving cash flow-thereby affecting corporate decision-making through dual channels[14]. Li Y et al. (2022) argued that various tax incentives provide enterprises with additional cash flow, which in turn enhances productivity[29]. However, some scholars have offered alternative perspectives. Scott J. Wallsten (2000) [29] suggested that tax incentives might crowd out existing R&D expenditure, thereby limiting their actual effectiveness[33]. In light of these findings, this paper further proposes:

Hypothesis 3: tax incentives positively affect the R&D intensity of enterprises by alleviating internal financing constraints.

3. Research Design

3.1. Sample Selection and Data Sources

The data used in this study are primarily sourced from the financial statements of A-share listed companies in China from 2012 to 2023, as reported in the CSMAR (China Stock Market & Accounting Research) database. To ensure data reliability, the following preprocessing steps were applied: financial, insurance, and real estate-related firms were excluded; ST and *ST firms during the sample period were removed; missing values for key variables were

appropriately supplemented. To mitigate the influence of extreme values, a 3% winsorization was applied to the upper and lower tails of selected variables.

3.2. Variable Selection

(1) Dependent Variable

R&D intensity is defined following Tong Jinzhi et al. (2018) as the ratio of R&D expenditure to total assets[13]. This measure reflects the extent to which firms allocate resources to technological innovation and effectively captures the impact of tax incentives on corporate R&D behavior. Compared with revenue-based measures, the asset-based indicator better represents overall firm resources and is suitable for cross-sectional comparisons across firms of different types and life cycle stages. Following Long Xiaoning and Lin Zhifan (2018)[17], firms that did not report R&D expenditures were assigned a value of zero, based on the distribution characteristics of the disclosed sample[11].

(2) Independent Variable

Tax Refund is measured following Zhen Hongxian et al. (2023) as the ratio of "tax refunds received" to the sum of "tax refunds received" and "taxes and fees paid" from the cash flow statement[16]. This indicator objectively reflects the actual benefits firms obtain under the tax system, accounting for both the absolute amount of refunds and the firm's overall tax payment scale. Unlike using the names of tax incentives (e.g., super-deduction) or dummy variables, this measure provides continuity and financial comparability, making it suitable for both cross-industry and longitudinal analyses.

(3) Control Variables

Based on prior literature, the study introduces firm-level control variables, including: Assets : measured as net profit divided by total assets. Ownership: coded as 1 for state-owned enterprises and 0 for non-state-owned enterprises. Profit: measured as net profit divided by total revenue in the previous year. Growth: measured as the growth rate of operating revenue, calculated as $(Revenue_t - Revenue_{t-1})/Revenue_{t-1}$. Power: measured as the logarithm of the ratio of operating revenue to operating costs.

3.3. Descriptive Statistics

Table 1 presents descriptive statistics for the main variables. The mean R&D intensity is 0.014, with a standard deviation of 0.018, ranging from 0 to 0.068. The mean Tax Refund intensity is 0.168, with a maximum value of 0.734, indicating substantial heterogeneity in the extent to which firms benefit from tax incentives. Firms with high-tech enterprise certification or dedicated tax planning departments are more likely to systematically receive tax refunds. Additionally, differences across industries in R&D reliance and regional variations in fiscal pressure and tax administration efficiency may affect the actual implementation of tax incentives.

Table 1. Descriptive Statistics of Variables

	Variable	Observations	Mean	Variance	Min Median	Max
R&D intensity	38,294	0.014	0.018	0	0.005	0.068
Tax Refund	38,294	0.168	0.208	0	0.073	0.734
Asset	38,294	0.094	0.116	-0.201	0.089	0.356
Ownership	38,294	0.307	0.461	0	0	1
Profit	38,286	0.08	0.122	-0.269	0.073	0.357
Growth	35,465	0.235	0.502	-0.383	0.109	2.076
Power	38,284	0.39	0.302	0.041	0.305	1.339

3.4. Model Specification

Based on empirical facts and theoretical analysis, the following model is specified to examine the impact of tax incentives on corporate R&D intensity:

$$RDintensity_{i,t}=\beta_0+\beta_1 TaxRefund_{i,t}+\beta_2 Control_{i,t}+\alpha_i+\lambda_t+\varepsilon_{i,t}$$

where i represents firm and t denotes year. $RDintensity_{i,t}$ is the R&D intensity of firm i in year t. $TaxRefund_{i,t}$ represents the intensity of tax incentives received by firm i in year t. $Control_{i,t}$ is a vector of firm-level control variables, including return on assets, ownership structure, prior-year profitability, firm growth, and market power. α_i and λ_t denote firm fixed effects and year fixed effects, respectively, and $\varepsilon_{i,t}$ is the stochastic error term.

4. Empirical Analysis

4.1. Baseline Regression

Based on the theoretical framework and research design, this study empirically examines the relationship between tax incentives and corporate R&D intensity. The baseline regression results are presented in Table 2. To mitigate potential endogeneity, firm and year fixed effects are included in columns (1) and (2). Column (1) includes only the core explanatory variable, Tax Refund intensity, while column (2) further incorporates a set of control variables. The coefficients of the core explanatory variable are significantly positive at the 5% and 10% levels, indicating that tax incentives have a significant promoting effect on corporate R&D intensity. This finding confirms that tax incentives can effectively stimulate firms to increase R&D investment, thereby contributing to industrial upgrading and technological progress at the macro level.

Table 2. Baseline Regression Results

	(1) R&D intensity	(2) R&D intensity
Tax Refund	0.001**	0.001**
	(2.25)	(2.29)
Controls	No	Yes
Firm FE Year FE	Yes Yes	Yes Yes
Observations	37,736	34,799
R^2	0.813	0.821

Note: *, **, *and* *** *denote significance at the 10%, 5%, and 1% levels, respectively. Values in parentheses are t-statistics. The same applies to subsequent tables.*

4.2. Mechanism Test: Mediating Role of Internal Financing Constraints

To verify whether tax incentives affect corporate R&D intensity by alleviating internal financing constraints, internal financing constraint is selected as the mediating variable. Following Jiang Ting (2022), a two-step method is employed for the mechanism test[6]. The first-step regression results are shown in Table 3. Preliminary analysis indicates a significant negative relationship between Tax Refund intensity and the internal financing constraint measure, providing initial evidence that tax incentives ease firms' financial pressure. Previous studies (Ju Xiaosheng, 2013; Borisova & Brown, 2013) suggest that internal funds are the primary source driving corporate

innovation investment, further supporting the logical chain that internal financing constraints affect R&D intensity, thereby validating the proposed mechanism[7][19].

Table 3. First-Step Regression: Internal Financing Constraint

	(1)	(2)
	Fincon	R&D intensity
Tax Refund	-0.051***	0.001**
	(-3.45)	(2.29)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	34,799	34,799
R^2	0.688	0.821

4.3. Heterogeneity Analysis

(1) Heterogeneity by Firm Size. This study adopts the measurement approach of Huang Shoufeng and Zhao Yan (2023), using the natural logarithm of total assets as a proxy for firm size and dividing the sample into groups based on the annual median[4]. Columns (1) and (2) of Table 4 present the results of the heterogeneity analysis by firm size. The findings indicate that tax incentives significantly promote R&D investment in large firms, whereas the policy does not effectively stimulate R&D in small firms. This phenomenon can be explained from two perspectives. On one hand, large firms, owing to abundant financial reserves, substantial technological accumulation, and well-established innovation systems, are better positioned to leverage tax incentives, thereby significantly increasing the scale and intensity of R&D investment. On the other hand, small firms, constrained by limited technological resources and insufficient innovation capacity, face difficulties in translating tax incentives into actual R&D expenditure.

Table 4. Heterogeneity Analysis: Firm Size

	(1)	(2)
	Large Firms	Small Firms
Tax Refund	0.002***	-0.000
	(3.16)	(-0.10)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	18,211	16,100
R^2	0.817	0.860

(2) Heterogeneity by Firm Life Cycle. Following Dickinson (2011), this study classifies sample firms into growth-stage and mature-stage enterprises to examine life cycle heterogeneity[24]. Regression results in Table 5 show significant differences in the effects of firm characteristics on R&D intensity across life cycle stages. Specifically, tax incentives exert a significant positive effect on mature firms but are not significant for growth-stage firms. This may be because mature firms have stronger profitability and larger tax bases, allowing them to benefit more from policies. Variables such as asset size and market power are also significant only for mature firms, indicating that they have established resource advantages and market positions, making them more sensitive to external policy changes. In contrast, growth-stage firms are still in the

expansion phase, with profitability and scale not yet stabilized, leading to limited observable effects of most variables.

Table 5. Heterogeneity Analysis: Firm Life Cycle

	(1) Growth Stage	(2) Mature Stage
Tax Refund	0.001	0.001**
	(1.08)	(2.23)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	10,258	22,918
R^2	0.844	0.830

(3) Heterogeneity by Internal Financing Constraint. Following Liu Shiyuan and Lin Zhifan (2023), this study measures internal financing constraints using the ratio of cash holdings to total assets, where higher values indicate lower constraints[9]. To control for industry-specific effects, the sample is divided using the industry median as the threshold: firms above the median are classified as low internal financing constraint firms, and those below as high internal financing constraint firms. Regression results in Table 6 show that tax incentives significantly promote R&D investment in high internal financing constraint firms, whereas the effect is not significant for low constraint firms. This suggests that for cash-constrained firms, tax incentives can meaningfully stimulate R&D through channels such as reducing marginal R&D costs and signaling policy support. In contrast, for financially unconstrained firms, the incentive effect is limited due to threshold effects in R&D investment and alternative financing channels.

Table 6. Heterogeneity Analysis: Internal Financing Constraint

	(1) Low Constraint	(2) High Constraint
Tax Refund	0.001	0.002**
	(0.80)	(2.45)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	16,490	16,868
R^2	0.858	0.833

4.4. Endogeneity Test

(1) Instrumental Variable Approach

To mitigate potential endogeneity concerns associated with Tax Refund, this study adopts the one-period lagged Tax Refund_lag as an instrumental variable and applies the two-stage least squares (2SLS) method. Specifically, the instrumental variable captures the institutional inertia and continuity of tax incentives from the previous period, thereby exhibiting strong exogeneity and explanatory power. Column (1) of Table 7 reports the first-stage regression results, indicating that the coefficient of the instrumental variable is significantly positive at the 1% level. Furthermore, the weak instrument F-statistic is 1507.82, which substantially exceeds the Stock–Yogo critical value of 16.38, suggesting that weak instrument bias is not a concern. Column (2) presents the second-stage regression results, showing that the intensity of Tax

Refund continues to exert a significantly positive effect on R&D intensity at the 1% level (coefficient = 0.0091). These findings remain robust after accounting for endogeneity, further confirming the role of tax incentives in promoting firms' R&D investment.

Table 7. Instrumental Variable Estimation

	(1) Tax Refund	(2) R&D intensity
Tax Refund_lag	0.235*** (22.05)	
Tax Refund		0.00908***
	Yes	(4.13)
Controls		Yes
Firm Fe	Yes	Yes
Year Fe	Yes	Yes
Observations	31,674	31,674
F值	486.1	38.01

(2) Robustness Tests

The baseline regression results suggest that tax incentives effectively enhance firms' R&D investment. To ensure the robustness of this conclusion, several additional tests are conducted: ① Alternative measurement of the dependent variable: Following Hu and Wu (2018), R&D intensity is redefined as the ratio of R&D expenditure to operating revenue[3]. ② Exclusion of municipalities and provincial capitals: Consistent with Shao et al. (2024), considering that municipalities and provincial capitals possess inherent advantages in policy resources, fiscal support, and innovation environments-which may amplify the effects of tax incentives and bias the representativeness of the results-the sample excludes firms located in these cities[12]. ③ Exclusion of high-technology industries: Following Li and Zheng (2016), industries such as general equipment, special equipment, transportation equipment, electrical machinery and apparatus, computers and other electronic equipment, communication equipment, instruments, and cultural/office machinery are classified as high-tech sectors[8]. To avoid potential estimation bias, regressions are conducted only on non-high-tech firms. As presented in Table 8, the results of these robustness checks consistently support the reliability of the study's main conclusions.

Table 8. Robustness Tests

	(1)	(2)	(3)
	R&D ratio Alternative DV	R&D intensity Excluding Municipalities/Provincial Capitals	R&D intensity Excluding High-Tech Industries
Tax Refund	0.757***	0.002***	0.003***
	(6.83)	(3.34)	(6.45)
Controls	Yes	Yes	Yes
Firm Fe	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes
Observations	34,799	18,927	19,730
R^2	0.900	0.786	0.824

5. Conclusion and Recommendations

5.1. Research Conclusion

Drawing on data from A-share listed companies between 2012 and 2023, this study demonstrates that tax incentives significantly promote firms' R&D investment. The effect is particularly pronounced for large enterprises, firms in the maturity stage, and those subject to high financing constraints. The primary mechanism operates through the mitigation of financing constraints, thereby fostering innovation. These findings provide robust evidence for the design of differentiated tax incentives.

5.2. Policy Recommendations

Based on the above conclusions, this paper offers the following policy recommendations: (1) Establish a differentiated system of tax incentives that delivers targeted support to small and medium-sized enterprises (SMEs) as well as firms with low financing constraints. (2) Strengthen the precision and dynamic adaptability of policies by integrating instruments such as the corporate life cycle. (3) Enhance policy transparency and information disclosure, and improve regulatory mechanisms. (4) Develop a performance evaluation framework for tax incentives to ensure periodic assessment and optimization. (5) Guide enterprises in building endogenous incentive mechanisms oriented toward R&D. Looking ahead, policy design should balance inclusiveness with precision in order to maximize the effectiveness of tax incentives.

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