

The Impact of Fiscal Science and Technology Expenditures on Corporate Innovation in China——Empirical evidence from high-tech industries

Tang Qirong

Business School, Beijing Technology and Business University, Beijing, China

Abstract: *The degree of innovation in high-tech industries plays a significant role in national innovation and has a direct impact on the competitiveness of the nation in the world market as well as its possibilities for future growth. According to this study, spending on science and technology in the budget positively impacts businesses in high-tech industries' capacity for innovation. The essay employs an empirical method to investigate this relationship in order to gain a deeper understanding of it. The results demonstrate that company innovation is indeed encouraged by fiscal S&T investments. To further confirm the validity of the results, the paper also performs a robustness test and a heterogeneity discussion. Therefore, in order to support the enhancement of businesses' capacity for innovation and the nation's overall capacity for innovation and industrial upgrading, the government ought to augment its funding in science and technology for high-tech industries. In addition to giving businesses a competitive edge in the global market, this will provide a strong basis for the nation's future growth.*

Keywords: *Fiscal S&T Expenditures, Corporate Innovation, High-tech Industries*

1. Introduction

The nation's overall strength is enhanced through technical innovation, which is the primary driving force behind the uninterrupted, seamless operation of the economic "double cycle" and has been shown through both historical precedent and practical application. Enhancing the innovation potential of high-tech industries and creating global competitive advantages are crucial in the context of the new of scientific and technological revolution and industrial change. These factors will help China's grow at a high rate, establish itself as a global leader in science and technology, and achieve scientific technological independence and autonomy^[1]. The new high-tech generation has been quickly and thoroughly infiltrating all spheres of the economy and society in recent years, changing the structure of the productive forces system not only in the traditional domains, where workers, objects of labor, labor tools, means of production, and means of production are involved. Simultaneously, significant shifts have occurred in the relations of production, encompassing the ownership structure of the means of production, the institutional socio-cultural context, the roles and relationships of individuals in the production process, and the distribution channels for goods^[2]. It is evident that China's economic model is currently undergoing a transitional phase. The conventional economic growth and model must be modified in order to adapt to the nation's changing development circumstances^[3]. Furthermore, one significant breakthrough in the theory and practice of economic development can be attributed to China's innovation-driven practices.

Following a protracted era of growth, China's high-tech sector has developed into a crucial hub for supply-side reform movement and an essential platform for the execution of the innovation-driven strategy. Its leading and supporting roles in the economy have also grown in prominence. We urgently need to increase the industrial chain's operational efficiency and innovation capacity because China's autonomous innovation capability is still insufficient for forward research and development and independent control, and because the country imports a significant amount of essential and core technologies and components. By continuously releasing innovative products, a company is able to sustain its competitive advantage and hold a leading position in the market. A company's level of innovation also plays a direct role in its ability to recognize and seize opportunities to emerge in the global marketplace. Furthermore, the ability of firms to innovate plays a critical role in determining the

future development prospects of associated industries in China, since they are the driving force behind the nation's efforts to become an inventive one. Not only is the impact extensive, but it is also closely linked to the area and possibility for these businesses to grow in the future. Thus, fostering China's economy's quality development and achieving the nation's construction of an innovative nation depend heavily on businesses' ongoing efforts to enhance their capacity for innovation^[4]. It is especially critical to keep providing high-quality innovation support for high-tech businesses in light of the nation's ongoing, excellent economic growth and efforts to position it as a leader in innovation. Scientific and technological innovation has emerged as a key tactic for national development with the advent of a new wave of scientific and technological revolution. The government has focused heavily on the growth of high-tech companies in recent years in an effort to address China's "necking" problem in essential technology and components. Businesses are essential to independent R&D and innovation, thus the government must have a clear plan for allocating R&D subsidies and exercise extreme caution to prevent market failures brought on by technology spillovers. The government has stepped up its support for corporate innovation every year in an attempt to quicken the transition from "Made in China" to "Created in China", but business innovation output is still sluggish. Consequently, it is imperative to conduct comprehensive research and provide clarification on the relationship between government R&D spending and business innovations^[5].

Researchers nationwide as well as worldwide are currently investigating the connection between corporate innovation and fiscal S&T expenditures. The majority of research came to the conclusion that fiscal S&T investments positively affect businesses' innovation efforts, which is primarily seen in the following two areas: First, a lot of academics looked into how government subsidies directly affect businesses' R&D. According to some academics, technology and financial science subsidies can boost an organization's capacity for innovation^[6]. The rationale behind government R&D subsidies is that they provide capital to businesses, improving their cash flow and, consequently, the efficiency of their R&D and innovation^{[7][8]}. These subsidies not only help businesses become more risk-tolerant, but they also significantly increase the incentives for their creative endeavors. Second, through mediating effects, academics have also examined the process of government investment on R&D by businesses. The study demonstrates that government assistance policies have a noteworthy impact on state-owned firms' R&D investment, and they have an even more notable impact on non-state-owned enterprises' innovation efficiency. Government subsidies and R&D deduction laws can work together to raise businesses' R&D expenditures and foster innovation in a more market-oriented setting. Nevertheless, the R&D plus deduction policy by itself still has a sizable mediating effect in the situation of low marketization. This further demonstrates the requirement for a supportive market environment in order for STI policies to be implemented effectively and R&D plus deduction policies to have widespread applicability. However, other academics continue to maintain a different perspective, contending that government R&D spending has little influence on listed companies' innovation initiatives. This is mostly due to the possibility that the market process failed in choosing the aim and amount of subsidies, which made it challenging for the government to find truly creative businesses. This failure creates a vacuum for certain businesses to engage in rent-seeking, which allows them to pose as creative enterprises and collect subsidies through unethical means. As a result, there is still no consensus among academics regarding the connection between business innovation and government spending on research and technology.

Compared with the established research results, the marginal contribution of this study is mainly reflected in the following two aspects: First, this analysis offers a more comprehensive viewpoint on how fiscal S&T spending affects enterprises' innovation. Academics are divided at the moment regarding the effectiveness of government R&D subsidies in fostering enterprise innovation. This study offers compelling evidence to back up the idea that government R&D subsidies can foster corporate innovation and advance academic research in this field through thorough analysis and empirical testing. Second, in order to delve deeper into the subject, our study starts with the high-tech sector. This study broadens the focus on the subject by investigating how government support policies affect enterprise innovation in high-tech sectors and at varying levels of marketization. It also offers valuable policy insights for implementing comprehensive market-oriented reforms and for resource allocation that is both reasonable and effective in fostering substantive innovation by enterprises. This study is a helpful resource for government decision-making in addition to encouraging more conversation within the academic community.

2. Empirical Design

2.1 Model

The purpose of this paper is to study the impact of financial science and technology expenditures on corporate innovation and construct the following econometric model:

$$\text{Patent}_{it} = \beta_0 + \beta_1 \text{RD}_{it} + \rho \text{Controls}_{it} + \lambda_i + \gamma_t + \varepsilon_{itrt}$$

In the above formulation, Patent_{it} is the explanatory variable, which represents the innovation performance of high technology industry in region i in year t . In addition, RD_{it} serves as the key explanatory factor of this paper, which represents the scale of expenditure on financial science and technology in region i in year t . Controls_{it} is a series of control variables, including the level of urbanization, infrastructure development, the level of human resources, the level of development of the secondary sector, and regional GDP. In addition to this control for province fixed effects and year fixed effects, λ_i and γ_t , respectively, and ε_{ijrt} is a randomized perturbation term. i represents the 30 provinces in the country and t is from 2005 to 2021; The β_1 coefficient, which is the focus of this paper, reflects the net impact of fiscal S&T expenditures on indicators related to innovation in high-tech industries. In addition, in order to smooth out the data fluctuations, the innovation performance of high-tech industries, the level of financial expenditure on science and technology, and the related control variable indicators are logarithmized.

2.2 Variables and data

2.2.1 Explained variables

Corporate innovation (Patent): In existing studies, two main ways are usually used to assess the innovation capacity of enterprises, enterprise innovation input and enterprise innovation output^[9]. In order to quantify the innovation output of the enterprise, we use the patent application volume of the enterprise in the current year as a criterion, which is because the patent application volume is one of the important indicators reflecting the enterprise's innovation results and innovation capability.

2.2.2 Core explanatory variables

Fiscal Science and Technology Expenditure (RD): measure the proportion of fiscal science and technology expenditure in fiscal expenditure^[10], as a reflection of the intensity of regional government R&D funding, which can reasonably reflect the structural differences in regional innovation investment.

2.2.3 Control variables

The control variables selected in this paper mainly include some important regional characteristics, in order to exclude the interference of other factors on the regression analysis, the following control variables are set: Urbanization level (Urb), measured by the proportion of regional urban population to the total population; Infrastructure area (Infra), measured by the per capita ownership of the road area^[11], Talent support (Tal), measured by the number of students enrolled in colleges and universities in the natural logarithmic value is measured^[12], Industrial structuring level (Fn), measured by the share of secondary industry; Economic development (Pgdp), measured by the level of regional GDP per capita, in order to better test the impact of government R&D subsidies on corporate innovation.

2.3 Sample selection and data sources

After comprehensive consideration of the scientificity and availability of the data, the time range of the study selected for this paper is from 2005 to 2021. After this selection, our study finally covers 30 provinces (municipalities and autonomous regions) in China and yields 510 observations. The data on regional characteristics come from the China Statistical Yearbook, China Macroeconomic Database-Annual Data (National), and are organized by the EPS data platform.

2.4 Descriptive statistics

Table 1 Descriptive statistics

Variables	Mean(1)	Sd(2)	Min(3)	Max(4)
RD	0.0200	0.0140	0.0038	0.0720
Patent	5189.7180	14141.3600	1.0000	147321.0000
Urb	0.5576	0.1399	0.2687	0.8960
Infra	14.5825	4.9559	4.0400	26.7800
Tal	186.9185	63.4518	55.4300	424.8747
Fn	0.4455	0.0875	0.1580	0.6150
Pgdp	46539.1600	29865.8600	5051.9600	183980.0000

3. Analysis of empirical results

3.1 Baseline test results

The financial investment in science and technology is positively correlated with the innovation vitality of businesses at the 1% level, according to Table 2's regression analysis, where the coefficient is 0.4872. The stability of the regression result holds true even when additional control variables are added. This suggests that funding for research and technology has a positive impact on innovation in high-tech sectors. The national and local governments have paid close attention to the innovative activities of high-tech businesses since the introduction of China's innovation-driven growth plan. The nation is persuaded that science and technology are the main drivers of economic and social progress as well as the cornerstone of national wealth. The ongoing increase in government spending on research and technology has significantly sparked businesses' drive for innovation and provided a powerful boost to long-term economic growth. In response, governments at all levels have developed unique preferential policies, optimized industrial layouts, and achieved optimal resource and talent allocations in an effort to fully enhance innovation capacity and foster an environment that is conducive to the flourishing of innovation activities. Upon examination of additional determinants, we discover a noteworthy affirmative association between the degree of urbanization, the advancement of infrastructure, and the industrial configuration, and the inventiveness of businesses. Nonetheless, a few other control factors, such economic development and talent assistance, have no discernible relationship with the high-tech enterprises' entrepreneurial zeal.

Table 2 Baseline test results

	(1)	(2)	(3)	(4)	(5)
RD	0.4872***(5.09)	0.4447***(4.71)	0.5167***(5.13)	0.5167***(5.13)	0.4963***(4.59)
Urb		1.8844***(4.47)	1.4718***(2.24)	1.4718***(2.24)	1.3387*(1.93)
Infra			0.6639***(3.20)	0.6639***(3.20)	0.6482***(3.08)
Tal				-0.3106(-1.00)	-0.3309(-1.06)
Fn					1.1869****(3.04)
Pgdp					-0.4014(-1.40)
Province fixed effects	Control	Control	Control	Control	Control
Year fixed effects	Control	Control	Control	Control	Control
R ²	0.8265	0.8337	0.8373	0.8373	0.8406
Obs	510	510	510	510	510
constant term (math.)	6.9937***(16.57)	8.3563***(16.27)	8.2749***(8.78)	8.2749***(4.59)	12.9789***(3.76)

Note: ***, **, * indicate significant at the 1%, 5%, and 10% levels, respectively.

3.2 Heterogeneity discussion

The results in Table 3 demonstrate the regional heterogeneity of the impact of financial science and technology expenditure on the transformation of high-tech industrial innovations. Specifically, the results show that financial science and technology expenditures significantly increase the level of industrial innovation transformation in the central and western regions; in contrast, the impact of these expenditures on the transformation of industrial innovations is less evident in the eastern region.

First of all, the middle and western regions lag behind the eastern regions in terms of economic

foundation and development level. As a result, the drive from more financial spending on science and technology will more clearly encourage and improve the innovation of high-tech industries in these locations. These funding can support the transformation of industrial innovation results and more effectively make up for the shortage of resources for innovation in the western and central regions. Particularly for the central and western areas, there are clear and immediate effects from the current inputs of fiscal S&T investments being promptly converted into results of industrial innovation. In the eastern region, due to the stronger innovation foundation, the current impact of fiscal S&T expenditures may be relatively small, and is more reflected in laying the foundation for future innovation activities. Second, significant elements influencing regional heterogeneity include the level of marketization and the growth of intermediary organizations. A more effective system for the distribution and transfer of innovative resources is implied by the eastern region's greater level of marketization and the more developed intermediary organization sector. Since the market mechanism has been able to effectively support innovative activities, an increase in fiscal S&T expenditures may not have a substantial impact on the transformation of industrial advances in this situation. Finally, variations in regional development strategies and legislative contexts may also impact how effective fiscal S&T investments are. A number of state-implemented regional development policies that enhance the effectiveness of the use of fiscal S&T expenditures and so greatly foster innovation in high-tech businesses may prove advantageous to the central and western regions. On the other hand, because the eastern region already has a strong economic foundation and ability for innovation, the policy influence there might be less significant.

Therefore, the central and western regions and the eastern regions show heterogeneity in the impact of financial science and technology expenditures on innovation in high-tech industries^[13]. This is mainly due to the differences in the economic foundation, the degree of marketization, the development of intermediary organizations and the policy environment.

Table 3 Heterogeneity analysis table

	Eastern region(1)	Central and Western region(2)
RD	0.1619(1.02)	0.5362***(3.48)
Urb	2.9984***(4.12)	-0.1698(-0.15)
Infra	0.2113(0.89)	0.2640(0.47)
Tal	-0.1493(-0.45)	-0.5109(-1.08)
Fn	0.4173(0.70)	1.4407***(2.72)
Pgdp	0.7712**(2.43)	-0.5857(-1.30)
Province fixed effects	Control	Control
Year fixed effects	Control	Control
R ²	0.9213	0.8253
Obs	187	323

3.3 Robustness testing

Considering that there may be a mutual causal relationship between the fiscal science and technology expenditure situation of a region and the innovation-driven development of high-tech enterprises in the current period, this paper refers to the endogeneity test experience of Dong M and Han X^[14], and based on it, the model of the core explanatory variable - fiscal science and technology expenditure is re-estimated with a lag of one period. The coefficient of column (1) in the table is 0.5416, and it is significantly positive at 1% confidence level, indicating that the positive impact of fiscal S&T expenditures on the innovation-driven development of high-tech enterprises still exists significantly; the model is re-estimated for the core explanatory variable, fiscal S&T expenditures, with a lag of two periods. Column (2) in the table shows that the coefficient is 0.4208 and significantly positive at 1% confidence level, and the positive impact of fiscal S&T expenditures on innovation-driven development of high-tech enterprises is still positive and effective on the whole. This result is similar to Table 4, and after such validation, we can prove that the model output has weakened the effect of endogenous disturbances to some extent.

By drawing on the experience of scholars at home and abroad, this paper decides to use the instrumental variable method for estimation in order to facilitate more robust conclusions^{[15][16]}. In this paper, the first-order lagged value of fiscal science and technology expenditures is selected as an instrumental variable, and the regression experience is carried out using the instrumental variable method, and the regression and test results are shown in Column (3), and the coefficient of Column (3) is 0.7459, and it is significantly positive at the 1% confidence level. The result remains robust.

Table 4 Robustness test list

	Phase I lag(1)	Phase II lag(2)	instrumental variable approach(3)
RD	0.5416***(5.23)	0.4208***(4.17)	0.7459***(4.68)
Urb	1.0233(1.41)	1.5904**(2.10)	0.6939 (0.86)
Infra	0.9987***(4.37)	0.8989***(3.52)	1.1099***(3.78)
Tal	-0.2452(-0.74)	-0.3660(-1.03)	-0.1456(-0.39)
Fn	1.3475***(3.40)	1.2480***(3.10)	1.1898***(3.15)
Pgdp	-0.4735*(-1.70)	-0.4111(-1.52)	-0.6799**(-2.49)
Province fixed effects	Control	Control	Control
Year fixed effects	Control	Control	Control
Cragg-D			642.1800
R ²	0.8363	0.8211	0.9512
Obs	480	450	480

4. Conclusions and recommendations

4.1 Conclusions

This paper uses panel data at 30 provincial levels from 2005 to 2021 as a research sample to deeply explore the impact of fiscal S&T expenditures on Corporate innovation in China's high-tech industries. The research results show that:

First of all, there is a positive correlation between government spending on research and technology and the development of company innovation potential. By boosting the financial investment made by local governments in the field of science and technology, increasing S&T expenditures can indirectly support the sustained development of innovation in high-tech industries in addition to directly promoting the innovation-level growth of China's high-tech industries. This is due to the fact that fiscal S&T expenditures offer significant government subsidies for the high-tech businesses' innovative endeavors across a range of locations. These subsidies serve to strengthen the local S&T innovation environment, which in turn raises the level of innovation within high-tech companies.

In addition, the stimulating effect of financial S&T expenditures on innovation in high-tech industries has significant differences among different geographical regions. Especially in the central and western regions of China, the incentive effect of financial expenditure on science and technology is more obvious. Comparatively speaking, in the eastern region, this incentive effect is slightly weaker. This is mainly due to the differences between the two regions in terms of economic foundation, degree of marketization, development of intermediary organizations and policy environment. The development of high-tech industries in the central and western regions is relatively lagging behind, and the period of effect of investment in science and technology innovation is shorter. In contrast, in the eastern region, the development of high-tech fields has been relatively mature due to better economic conditions. As a result, the economic and social benefits brought about by financial S&T expenditures in these regions are more prominent in the central and western regions.

4.2 Policy recommendations

Raising financial support for scientific and technological innovation and fully utilizing the guiding function of financial policies and funds are essential for advancing scientific and technological innovation and stimulating and advancing the innovative activities of businesses. Governments at all levels should place a high priority on funding science and technology, and they should use their financial resources to support and boost businesses' capacity for innovation as well as their own. This will strongly assist the continued and healthy growth of the economy and society in addition to fostering the quick advancement of science and technological innovation^[17].

To make sure that fiscal science and technology spending can more precisely and successfully support enterprise innovation, it must be optimized. It is vital to ensure the constant expansion of financial expenditure on science and technology since empirical studies have demonstrated that the government's financial investment in these fields significantly influences the level of corporate innovation. During this procedure, the fiscal S&T financial support focus for the eastern, central, and western areas should be logically determined based on their distinct economic conditions and stages of development. Fiscal subsidy incentives, in particular, should be used cautiously for businesses in the eastern region's mature and declining industries. Instead, more diverse policy tools, like tax incentives,

innovation incentives, and rebates, should be investigated in order to more accurately support the growth and innovation of these businesses. In addition to increasing the effectiveness of how tax dollars are used for science and technology, this will help the economy better respond to the demands of various regions for economic development and will encourage the modernization and optimization of the economy as a whole^[18].

Governments and businesses must cooperate to create coordinated initiatives in order to foster technological innovation. To lessen the financial strain that businesses place on scientific research, the government should aggressively encourage them to engage in R&D and offer them tax breaks. Businesses should embrace the government's request that they prioritize technological innovation and take advantage of the tax breaks available to them by appropriately disclosing expenditures associated with research and development. Simultaneously, in order to lower the cost of scientific research, firms must also improve policy sensitivity, raise R&D expenditure, and pay closer attention to changes in government policies^[19]. Developing and rewarding scientific research expertise is also essential to businesses' ability to innovate technologically. Businesses should support the development of scientists with research aptitude, encourage researchers' zeal and inventiveness, and positively impact their potential to innovate in technology. We can encourage the growth of technological innovation and make it easier for the economy to expand sustainably and for social progress if businesses and the government work together^[20].

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