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Impact of Financial Support on Technology Innovation in High-tech Industry

-- Take the Central Region as an Example

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Abstract

Based on the panel data of key industries of Government R&D subsidies in high-tech industries in six central provinces from 2008 to 2019, this paper empirically tests the impact of government capital subsidies and tax incentives on the efficiency of technology innovation. The results show that financial subsidies have a negative impact on the technological innovation of high-tech industries in the long term, while tax preference plays a positive role and shows industrial differences in different high-tech industries. Therefore, this paper proposes that we should make overall use of financial subsidies and tax incentives to implement differentiated financial support policies in different high-tech industries and different development stages of high-tech industry.

Keywords

Financial Subsidy; Tax Preference; High-Tech Industry; Technology Innovation.

1. Introduction

Since the State Council proposed to give priority to supporting high-tech industries in 1995, various regions in our country have actively promoted the innovative development of high-tech industries with their own resource endowments and high-tech industrial development zones as carriers. The 19th National Congress Report proposed that China should build an innovative country. In the current process of high-quality development, it is particularly important to promote technological innovation in high-tech industries. This paper will take the central region as an example to analyze the impact of financial subsidies and tax incentives on technological innovation in high-tech industries, and provide decision-making basis for government departments to implement differentiated support policies based on the characteristics of various industries.

2. Literature Review

As the main tool of the government's incentive policy, financial subsidies and tax incentives can not only stimulate technological innovation but also promote the development of emerging industries. However, financial subsidies and preferential tax policies, as financial policy instruments with different implementation methods, have obvious differences in regulating the technological innovation of high-tech industries. Financial subsidies mainly refer to the government's direct increase in research and development subsidies for high-tech enterprises. For example, the government encourages high-tech enterprises to carry out technological innovation by giving free financial capital, increasing financial capital incentives, and making up for corporate losses. Tax incentives mainly refer to tax authorities at all levels using tax breaks and preferential tax rates to reduce the enterprise's tax payment costs or to extend the enterprise's tax payment time [1].

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2.1. Financial Subsidy and Technological Innovation

Scholars at home and abroad have paid more attention to the relationship between government financial subsidies and technological innovation. Some foreign scholars think that government subsidies may promote or crowd out technological innovation of enterprises. Government subsidies can increase the R&D expenses of enterprises and promote their R&D production activities [2]. While Wallsten(2000) thinks that government subsidies will squeeze out the R&D funds of enterprises, and will not promote the technological innovation of enterprises themselves [3]. Gupta(2013) thinks that although public subsidies can bring innovation to production technology, if there are not enough financial investment incentives and patent protection policies, enterprises will usually underinvest in the socially optimal level of supporting technology, which means that enterprises will consume exhaustible natural resources for a long time [4]. Yina Li et al. (2020) studied the optimal government green subsidy scheme under different environments from the perspective of social welfare maximization, and found that when the cost of green technology innovation is particularly low, the government green subsidy is not always a good choice, and the environmental improvement effect of green innovation is not significant [5]. Relevant domestic research generally believes that government financial support can directly promote the growth of research and development investment of high-tech enterprises and expand R&D investment, which is beneficial to promote the improvement of technological innovation ability and attract more external private investment [6]. At the same time, government financial support will accelerate industrial agglomeration by affecting the cost of labor, land and other factors and changing the relative gap of competitiveness, thus indirectly affecting technological innovation [7]. However, Feng Zongxian and others (2011) believe that the government departments have too much interference in the innovation activities of enterprises, and the existence of rent-seeking behavior in the economic system has reduced the motivation for innovation activities within enterprises [8].

2.2. Tax Preference and Technological Innovation

Mc Alliste et al. (2012) based on the R&D growth model to describe the channels through which tax and technology policies affect the productivity growth of technological innovation. they believe that even when facing significant negative (crowded) externalities of research and development, very high research and development subsidies are the best [9]. The role of preferential tax policies in encouraging technological innovation of enterprises in our country is increasing, but the overall effect needs to be further improved. Yang Xiaomei and others (2018) study that tax incentives have a more significant impact on the innovation behavior of large and medium-sized enterprises, and have a positive guiding effect, but the impact on small industrial enterprises is weak, especially the substantive innovation effect is difficult to highlight [10]. Tan Yuanyuan (2021) found that the collection of environmental tax can broaden the depth and width of innovation, and urge enterprises to implement green technological innovation [11]. He Lingyun et al. (2020) [12] believe that most enterprises lack the motivation of green technological innovation when they invest in technological innovation after meeting the standard of tax incentives, which results in the inverted "U" relationship between tax incentives and green technological innovation.

It can be seen that the existing literature mostly analyzes the impact of government policy support on technological innovation ability from a single perspective, and less literature systematically studies from the perspectives of government financial subsidies and tax incentives, and does not analyze the heterogeneity characteristics of various industries in high-tech industry in detail [13]. In view of this, this paper attempts to compare and analyze the differences between financial subsidies and tax incentives on the technological innovation of

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high-tech industries in the central region, which has similar economic development stages and needs to improve its technological innovation capabilities.

3. Model Setting and Description

3.1. Model Setting

In order to explore the relationship between government financial subsidies, preferential tax policies and technological innovation in high-tech industries, based on the panel data of six provinces in the central region, and considering the differences of individuals and time, this paper establishes the following two-way fixed effect regression model. Among them, techin is the interpreted variable, sub and tax are the two main explanatory variables, and con is the control variable. β1, β2 and β3 are the regression coefficients of each variable, μi is the individual effect, t is the time effect and εit is the random error term.

$$techin_{it} = \partial + \sum_{j} \beta_1 sub_{jit} + \sum_{j} \beta_2 tax_{jit} + \sum_{k} \beta_3 con_{kit} + \mu_i + \phi_t + \varepsilon_{it} \quad (1)$$

3.2. Variable Selection and Data Sources

Explained variable: techin. The agency indicators of technological innovation capability usually include the number of patents applied and sales revenue of new products. Considering the low conversion rate of patents in China, compared with other indicators, the sales revenue of new products can better reflect the economic effect and innovation efficiency of technological innovation. Therefore, this paper refers to the research of Guo Yanqing and others (2018), selects the sales revenue of new products as an indicator to measure technological innovation and takes logarithm processing [14].

Explanatory variables: financial subsidies (sub), tax incentives (TAX). This paper measures the fiscal subsidy policy by the proportion of government funds to the internal expenditure of R&D funds. Compared with the financial subsidy policy, tax incentives are diversified, involving a large number of industry sectors, and the data is difficult to obtain comprehensively. Therefore, this paper uses virtual variables to measure tax incentives, and combines with the "Notice of the Ministry of Finance and State Taxation Administration of The People's Republic of China on Policy Issues Concerning Pre-tax Deduction of Research and Development Expenses" to take the value of the virtual variable of tax incentives before 2013 as 0 and after 2013 as 1.

Control variables: (1) labour. This paper refers to the practice of Li Wanhong (2015), taking the logarithm of R&D personnel input as the control variable to measure the innovation human resources input in high-tech industry [15]. (2) ratio of research and development enterprises. This paper measures the proportion of the number of enterprises with R&D activities in the total number of high-tech industries. (3) profitability. The gross profit of high-tech industry is used to express the profit status. (4) R&D intensity (rd). This is measured by the proportion of new product development expenditures to R&D internal expenditures.

Based on the principle of data availability, this paper selects five typical industries such as pharmaceutical manufacturing in the high-tech industries in six central provinces of Shanxi, Henan, Anhui, Hubei, Hunan and Jiangxi provinces from 2008 to 2019 for research. The relevant data are from the Statistical Yearbook of High-tech Industries of China, and the missing data are supplemented by interpolation method. Descriptive statistics of variables are shown in Table 1.

From Table 1, we can see that there are great differences among different industries in the high-tech industry in the six provinces in the central region of our country. The maximum value of technological innovation level in the electronic and communication equipment manufacturing industry is 8.34, the minimum value is 4.456, and the average value is 6.745; The maximum value of the aviation, spacecraft and equipment manufacturing industry is 5.075, the minimum

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value is -1.253, and the average value is only 3.117, indicating that there is a great difference in the level of technological innovation in various industries. At the same time, there are great differences in government subsidies among various industries, among which the maximum value of subsidies for computer and office equipment manufacturing industry is 2.689, with an average value of 0.139; The maximum value of capital subsidy for pharmaceutical manufacturing industry is 0.995, and the average value is only 0.0782, which indicates that the capital subsidy obtained by different industries of high-tech industry is quite different, and may have certain impact on the improvement of technological innovation level.

Table 1. Variable descriptive statistics

		techin	sub	tax	profit	rd	ratio	labour
Pharmaceutical manufacturing industry	average	6.289	0.0782	0.583	65.86	149.3	0.357	8.336
	standard deviation	0.858	0.136	0.496	47.5	64.4	0.151	0.61
	minimum	4.187	0.0185	0	5.1	36.63	0.0623	6.94
	maximum	7.726	0.995	1	204.8	287.3	0.68	9.326
Aviation, spacecraft and equipment manufacturing industry	average	6.289	0.0782	0.583	65.86	149.3	0.357	8.336
	standard deviation	0.858	0.136	0.496	47.5	64.4	0.151	0.61
	minimum	4.187	0.0185	0	5.1	36.63	0.0623	6.94
	maximum	7.726	0.995	1	204.8	287.3	0.68	9.326
Electronic and communication equipment manufacturing industry	average	6.289	0.0782	0.583	65.86	149.3	0.357	8.336
	standard deviation	0.858	0.136	0.496	47.5	64.4	0.151	0.61
	minimum	4.187	0.0185	0	5.1	36.63	0.0623	6.94
	maximum	7.726	0.995	1	204.8	287.3	0.68	9.326
Computer and office equipment manufacturing industry	average	6.289	0.0782	0.583	65.86	149.3	0.357	8.336
	standard deviation	0.858	0.136	0.496	47.5	64.4	0.151	0.61
	minimum	4.187	0.0185	0	5.1	36.63	0.0623	6.94
	maximum	7.726	0.995	1	204.8	287.3	0.68	9.326
Medical equipment and instrument manufacturing industry	average	6.289	0.0782	0.583	65.86	149.3	0.357	8.336
	standard deviation	0.858	0.136	0.496	47.5	64.4	0.151	0.61
	minimum	4.187	0.0185	0	5.1	36.63	0.0623	6.94
	maximum	7.726	0.995	1	204.8	287.3	0.68	9.326

4. Empirical Result Analysis

It can be seen from Table 2 that the influence of government financial subsidies and tax incentives on technological innovation in different industries of high-tech industries is different. There is a negative correlation between government subsidies and the technological innovation level of different industries in high-tech industries, which is far from the traditional understanding. The reason may be that although government subsidies play a positive role in alleviating the plight of R&D funds shortage and reducing R&D risks of high-tech enterprises in a short period of time, it is undeniable that government subsidies will squeeze out R&D investment of high-tech enterprises to some extent. There may also be some problems such as strong lag and high error rate when choosing specific funded projects for high-tech industries. In addition, in the face of the huge temptation to get government subsidies, there may also be the phenomenon of enterprises seeking rent from government departments and the resulting

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market distortion. The existence of these unfavorable factors may make financial subsidies unable to play their positive role in the long run.

Table 2. Regression results of two-way effect model

	T1	T2	T3	T4	T5
variable quantity	Pharmaceutical manufacturing industry	Aviation, spacecraft and equipment manufacturing industry	Electronic and communication equipment manufacturing industry	Computer and office equipment manufacturing industry	Medical equipment and instrument manufacturing industry
sub	-0.218**	-0.063*	-0.086	-0.296	-0.280***
	(-1.80)	(-0.18)	(-0.44)	(-1.66)	(-2.73)
tax	0.118***	0.242	0.233***	0.135***	0.107***
	(7.23)	(0.86)	(9.75)	(4.21)	(4.73)
profit	0.02	0.051	0.006***	0.056***	0.01
	(1.50)	(1.55)	(7.61)	(2.74)	(0.07)
ratio	-0.015	-0.394**	-0.899**	-0.384	-1.169***
	(-0.06)	(-2.41)	(-2.05)	(-0.93)	(-2.70)
rd	-0.002**	-2.150***	-14.000**	-14.069***	-11.978***
	(-2.33)	(-7.79)	(-2.63)	(-4.99)	(-3.30)
labour	0.345***	0.340***	0.188***	0.058	0.304***
	(2.71)	(3.70)	(2.80)	(0.73)	(4.01)
Constant	2.645**	0.814	3.917***	2.599***	2.321***
	(2.68)	(1.46)	(8.44)	(6.31)	(4.31)
Observations	72	72	72	72	72
R-squared	0.971	0.808	0.983	0.859	0.929
Individual fixation	YES	YES	YES	YES	YES
Fixed time	YES	YES	YES	YES	YES

Note: * * *, * * and * respectively represent the significance level of 1%, 5% and 10% of T statistics, the same below.

There is a positive correlation between preferential tax policies and technological innovation in five high-tech industries, such as pharmaceutical manufacturing, and there are industry differences in their roles in different industries. The high concentration of knowledge and technology in high-tech industries determines that continuous technological innovation is an important means for high-tech enterprises to gain competitive advantage. Tax incentives can significantly reduce the R&D cost of high-tech enterprises, and form the expectation of encouraging R&D in the long term, which has a better incentive effect for enterprises to increase R&D investment, thus more effectively promoting the technological innovation capability of high-tech enterprises.

From the control variables whose regression coefficient passed the significance test, profitability has a positive impact on technological innovation, which is consistent with the expected results. The regression coefficient of R&D ratio of enterprises to technological innovation in high-tech industries is negative, which may be due to the fact that small and medium-sized enterprises (SMEs) are an important engine to stimulate economic growth and an important subject and component of technological innovation in the new era. The flexible, specialized and refined development goals of SMEs make technological innovation, concept innovation and management innovation continuously run through the life course and innovation cycle of enterprise development, and accumulate competitive advantages for the in-

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depth development of technological innovation. The influence coefficient of human resources on technological innovation is positive, which indicates that technological innovation is carried out by "people" in the final analysis, and it is the innovation of "people". The higher the quality of workers, the higher their professional knowledge and innovation ability, the better they can guide the improvement of technological innovation ability of high-tech industries. The regression coefficient of R&D investment intensity to technological innovation in high-tech industries is negative, and it is significantly negative at the level of 1%, which indicates that with the increase of R&D investment intensity, technological innovation does not produce the optimization speed that matches it. The main reason is that high-tech enterprises take a long time to develop technology, have high R&D expenses, have a high probability of failure, and take higher risks than general R&D activities, which to some extent is not conducive to the continuous improvement of technological innovation level of high-tech industries.

5. Robustness Test

In order to further explore the influence of financial subsidies and tax incentives on the technological innovation of high-tech industries, taking into account the internal structure and distribution characteristics of technological innovation in different industries of high-tech industries, this paper tests the stability of the model by quantile regression. The principle is to set the corresponding regression points of 0.25, 0.5 and 0.75 of the explanatory variable and the control variable to obtain different quantile equations of the explained variable. The results are shown in Table 3.

Table 3. Robustness test result

Explained variable	industry	fractile	Explanatory variable			Control variable		
			Financial subsidies	Preferential profitability	Profitability	Proportion of R&D enterprises	Research and development intensity	human resources
technical innovation	Pharmaceutical manufacturing industry	q25	-0.525**	0.019	-0.07	0.69	-0.0271**	0.804***
		q50	-0.101	0.209*	0.053**	0.629	-0.0458**	0.721**
		q75	-0.149	0.336***	0.0644***	0.379	0.034	0.443**
	Aviation, spacecraft and equipment manufacturing industry	q25	0.798***	0.0466	0.100***	-0.810**	-2.492	0.487***
		q50	-0.361***	0.242**	0.0711**	-0.645**	-2.144***	0.513***
		q75	0.213	0.0877	0.0729**	-0.759***	-2.193***	0.531***
	Electronic and communication equipment manufacturing industry	q25	-0.304	0.997***	0.0711***	-0.819*	-16.17**	0.416***
		q50	-0.729*	0.743**	0.0087***	-0.426	-8.346	0.329**
		q75	-0.921***	0.381***	0.0073***	0.144	-11.27*	0.366**
	Computer and office equipment manufacturing industry	q25	-1.081*	0.11	0.132***	-2.482***	-14.7	0.485***
		q50	-0.087**	0.597*	0.104***	-2.980***	-14.6	0.440***
		q75	0.112	0.660*	0.102***	-3.200***	-12.22***	0.545***
	Medical equipment and instrument manufacturing industry	q25	-1.145**	0.294**	0.0136**	-0.0594	-22.70***	0.647***
		q50	-0.372	0.371	0.0219*	-0.181	-15.45***	0.582***
		q75	-0.445	0.195**	0.0303***	-0.185	-13.68**	0.491**

On the whole, the coefficients of the impact of financial subsidies on technological innovation at the three quantiles of 0.25, 0.5 and 0.75 show a negative correlation trend. The coefficients of the impact of tax incentives on technological innovation show a positive correlation trend at these three quantiles, which indicates that tax incentives have a positive effect on improving

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the level of technological innovation, while the impact of financial subsidies is on the contrary. This also verifies the robustness of the conclusions in this paper on the other hand.

6. Conclusion and Suggestions

From the above analysis, it can be seen that financial subsidies have a negative impact on technological innovation of high-tech industries, while tax incentives have a positive impact on technological innovation of high-tech industries, and financial subsidies and tax incentives show obvious industry differences. Based on this, this paper puts forward the following three suggestions on how to use financial subsidies and preferential tax policies to promote the technological innovation level of high-tech industries:

First, implement differentiated fiscal and taxation incentive policies for different industries in high-tech industries and at different stages of their development. Financial subsidies can directly relieve the pressure of R&D funds of high-tech enterprises in a short period of time and enhance their own risk-taking ability, while tax incentives focus on conveying the information that the government actively promotes technological innovation to the market, attracting more market funds to inject, which is more conducive to promoting the technological innovation ability of high-tech enterprises in the long run. We should combine the characteristics of financial subsidies and tax incentives to give full play to their respective advantages and coupling effects.

Second, improve the way to realize preferential tax policies. According to the national strategic development direction, we should formulate tax preferential policies with different industries, different regions, key points and different levels in taxation, and adopt tax preferential policies and measures that combine industry inclination with regional inclination according to the time and situation. At the same time, we should increase the preferential efforts of R&D deduction for high-tech enterprises, and appropriately increase the proportion and scope of application of R&D deduction.

Third, constantly improve the financial support policies of high-tech enterprises. Define the threshold of enterprise high-tech qualification, set up the evaluation standard of high-tech enterprises' technological innovation capability, and focus financial support on related high-tech enterprises with development potential and good incentive effect, such as electronics and communication equipment manufacturing industry, and guide enterprises to increase R&D investment, so as to further promote the overall improvement of technological innovation capability of high-tech industries.

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