

Research on the Dynamic Impact and Spatial Spillover Effect of Fiscal Policy on Technological Innovation Output of High-tech Industries

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Abstract

China's economy has entered a new period of development, and the new demand for economic development requires us to break away from the traditional economic development model. Scientific and technological innovation and other factors are important elements of current economic development, and high-quality economic development cannot be separated from the promotion of innovation. The development of technological innovation is inseparable from the role of the government. The fiscal policies adopted by the government help guide and promote the in-depth development of technological innovation, promote the accelerated implementation of technological innovation, and help the healthy and steady development of the economy. This paper studies and analyzes the dynamic impact of fiscal policy on the output of high-tech industries and evaluates the different implementation effects of fiscal policy in China through the methods of GMM and spatial Dubin model. The government should optimize the structure of financial investment in science and technology, increase the scale of financial investment in science and technology, improve the preferential income tax policy for high-tech enterprises, and so on, in order to encourage the development of technological innovation.

Keywords

Fiscal Policy; High-tech Industry; Technological Innovation; Spatial Spillover.

1. Introduction

Innovation is the first driving force for development and the strategic support for building a modern economic system. Technological innovation has the attribute of public goods and is prone to market failure. Therefore, it is necessary for the government to adopt fiscal policies to guide and encourage technological innovation of enterprises. The project first examines the impact mechanism of fiscal policy in the basic innovation stage and application innovation stage of high-tech enterprises. Secondly, the GMM model is used to test the dynamic impact of overall government subsidies and tax incentives on the innovation output of high-tech industries at different stages. Thirdly, we use the spatial Dubin model to empirically analyze the spatial spillover effect of fiscal policy on high-tech industrial innovation output. Finally, put forward countermeasures and suggestions.

At the beginning of the reform, China achieved a wave of rapid economic growth relying on the demographic dividend and huge material base. However, with the arrival of the new normal of the economy, the previous extensive economic development model is no longer applicable. From the current world economic situation, the core of competition among countries is focused

on high-tech industrial technology, and only seeking breakthroughs in technology is the fundamental way to maintain China's sustainable development. As the main body of innovation activities, high-tech industry has been playing a mainstay role in the process of building a high-tech industrial and technological power in China. Accelerating the development of high-tech industries helps to make up for the lack of economic development impetus caused by the disappearance of population dividend, and is an inevitable choice to alleviate the current downward pressure on the economy. However, China's high-tech industry still has problems such as "big but not strong", and still has a large gap with the United States, Britain, Japan and other leading countries in the world. The lack of core technology of independent research and development is the primary reason that shackles the development of China's high-tech industry. So how to improve the ability of independent research and development and effectively improve the output of technological innovation has become the focus of discussion.

Research on the impact of government subsidies on technological innovation of enterprises. Considering the phenomenon of "free riding" in the process of technological innovation of enterprises, the most common way for the government to solve this problem is to provide government subsidies. So, does the government subsidy really promote the technological innovation of enterprises? The academic circles have launched an incentive debate on its effectiveness, which mainly includes the following three views: "crowding in effect" theory, "crowding out effect" theory and uncertainty theory. Tax preference is another way for the government to subsidize the tax objects according to the tax law of our country, which belongs to indirect subsidy. The tax preference is of great significance to the development of China's industry and has also been widely concerned by the academic community. After Anselin and Anil (1996) systematically sorted out the spatial econometrics, a large number of scholars began to put their research perspective on the spatial effects of R&D activities. Bernard í (2017) analyzed the spatial pattern and interregional interdependence of regional innovation in Spain, and learned the spatial effect of regional R&D. The research of the above scholars confirmed that there is a certain spatial spillover effect in R&D activities and technological innovation. Chinese scholars have introduced spatial econometric models into research and development activities since 2006.

All circles have paid close attention to fiscal policy and technological innovation for a long time. Based on the existing research, it can be seen that domestic and foreign scholars have obtained considerable achievements in the research of government subsidies, tax incentives and technological innovation. However, the existing research still has the following deficiencies: First, the existing research mostly talks about the impact of single government subsidies or tax incentives on technological innovation, and due to the differences in research samples, data age span, and model selection, there is no unified conclusion. Second, when studying the relationship between fiscal policy and technological innovation output, the existing literature often regards technological innovation output as a whole and measures it with a single index such as the number of patent applications or the sales of new products. In fact, technological innovation output is an extremely complex process, which includes the initial research and development of enterprises, and then determines the feasibility plan according to the research and development results, and then mass production, Finally, the products produced will be put into the market and eventually converted into the actual profits of the enterprise. Third, although the existing literature has begun to pay attention to the spatial effect of R&D activities, more attention is paid to the spillover effect of R&D investment on regional technological innovation. R&D investment is often used as an internal way to affect enterprise technological innovation. In contrast, financial policy as an external support for enterprise technological innovation capability can effectively make up for the shortage of enterprise innovation resources, It also plays an irreplaceable role in the innovation and development of enterprises,

and the impact of fiscal policy on the spillover effect of technological innovation output of enterprises is often more intuitive to reflect the policy effect.

2. Overview of Fiscal Policies to Promote Technological Innovation in High-tech Industries

2.1. The Meaning of High-Tech Industry

Countries around the world have different views on the definition of high-tech industry. Each country has its own priorities. At present, the most widely used concept of high-tech industry is mainly defined by the World Economic and Trade Organization. At the end of the last century, the OECD put forward indicators for the division of high-tech industries, mainly including the ratio of R&D expenditure to total output, the ratio of R&D expenditure to output value, and the ratio of direct R&D expenditure to added value. At the same time, the most advanced computer office equipment manufacturing industry in the world, aerospace and aviation innovation research, electronic communication equipment research and pharmaceutical product creation industry are all included in the high-tech industry. The state will provide key support and financial support for the development of electronic information, biological medicine, aerospace manufacturing, new material research and development, technical service industry, new energy, energy-saving development, resource and environmental research, and advanced manufacturing automation. In addition, the updated statistical yearbook of China's high-tech industry also added the new high-tech industry of information chemicals manufacturing industry on the original basis. It can be seen that the new technology industry covers a wide range of fields and covers many regions.

2.2. Financial Science and Technology Investment Policy

The financial science and technology funds account for the majority of the total funds for the enterprise's internal innovation and research activities. Because of the uncertainty of technological innovation, these subsidies are a way to compensate for the uncertain risks. The government's financial support has reduced the pressure on the investment cost of enterprises on the original basis, enabling enterprises to reduce the risks they face in the process of innovation, and at the same time stimulating the R&D efforts of the company's internal innovation department. At present, in the source structure of China's science and technology funds, the proportion of national financial allocations is at least 50%. These funds are of great significance to the country's science and technology development. Since the 1980s, the country has been increasing investment in science and technology, promoting the reform of the scientific and technological system, and promoting the development of science and technology.

2.3. Tax Preferential Policies

In addition to the reduction and exemption of the daily income tax for high-tech industries, the tax preferential policies formulated by the state can also be used by some investors to improve their investment willingness when investing in risk returns. So as to reduce the enthusiasm of enterprises in venture capital activities. In the aspect of risk loss deduction, effectively reducing the capital risk faced by investors can make the investment decisions of the organization more precise, and also encourage state-owned enterprises to increase investment in innovation and reduce the organization from taking risks. The more compensation for government risks is, the greater its motivation is. Therefore, special tax policies will affect the diversification of innovation investment in high-tech industries, which is an important way for the government to encourage innovation investment.

Small and medium-sized enterprises in science and technology are market entities with great development potential. Before 2017, the proportion of R&D expenditures of high-tech enterprises and other enterprises is the same, that is, 50%. In order to encourage small and

medium-sized enterprises to increase scientific research funds and support scientific and technological innovation, the State Administration of Taxation issued the Research Report on High-tech Enterprises in 2017, raising its rate of deduction to 75%. In 2021, the state issued a policy to increase the rate of additional deduction of manufacturing enterprises to 100%.

3. Full-sample Regression Analysis based on System GMM Model

3.1. Model Construction

Financial policy is an important factor affecting the technological innovation output of China's high-tech industries. This paper uses the system GMM model to conduct a full sample regression analysis to examine the impact of government subsidies and tax incentives on the two-stage innovation output of high-tech industries. Build the following model (i represents the year):

$$\text{LnPat}_i = \beta_0 + \beta_1 \text{LnPat}_{i-1} + \beta_2 \text{LnSub}_i + \beta_3 \text{LnMad}_i + \beta_4 \text{LnSca}_i + \beta_5 \text{LnEdu}_i + \beta_6 \text{LnFcs}_i + \beta_7 \text{LnSub}_i * \text{LnSca}_i + C_i \tag{1}$$

$$\text{LnPat}_i = \beta_0 + \beta_1 \text{LnPat}_{i-1} + \beta_2 \text{LnTax}_i + \beta_3 \text{LnMad}_i + \beta_4 \text{LnSca}_i + \beta_5 \text{LnEdu}_i + \beta_6 \text{LnFcs}_i + \beta_7 \text{LnTax}_i * \text{LnSca}_i + C_i \tag{2}$$

$$\text{LnRev}_i = \beta_0 + \beta_1 \text{LnRev}_{i-1} + \beta_2 \text{LnSub}_i + \beta_3 \text{LnMad}_i + \beta_4 \text{LnSca}_i + \beta_5 \text{LnEdu}_i + \beta_6 \text{LnFcs}_i + \beta_7 \text{LnSub}_i * \text{LnSca}_i + C_i \tag{3}$$

$$\text{LnRev}_i = \beta_0 + \beta_1 \text{LnRev}_{i-1} + \beta_2 \text{LnTax}_i + \beta_3 \text{LnMad}_i + \beta_4 \text{LnSca}_i + \beta_5 \text{LnEdu}_i + \beta_6 \text{LnFcs}_i + \beta_7 \text{LnTax}_i * \text{LnSca}_i + C_i \tag{4}$$

3.2. Descriptive Statistics of Variables

The descriptive statistics of each explained variable, explanatory variable and control variable are obtained through Stata software, as shown in Table 1 below:

Table 1. Descriptive statistics of variables

Variable	Mame	N	Mean	S.D.	Min.	Max.
LnPat	Number of patent applications	420	6.0314	2.2175	0	11.0803
LnRev	Sales revenue of new products	420	13.7060	2.5587	5.0106	18.8617
LnSub	Government subsidies	420	9.0503	2.0730	2.0794	12.7151
LnTax	Tax preference	420	11.5243	1.7710	5.7893	15.3156
LnMad	Degree of marketization	420	1.7160	0.3000	0.8459	2.2966
LnSca	Enterprise size	420	5.8239	0.3972	4.6198	6.9905
LnEdu	Higher education level	420	0.3970	0.4261	-0.9515	1.2711
LnFcs	Fixed capital stock	420	15.2427	1.1708	12.3760	17.7253
LnSub×LnSca	Government subsidies × enterprise size	420	53.0890	13.8033	9.6067	80.6885
LnTax×LnSca	Tax preference × enterprise size	420	67.3930	12.7887	33.9794	98.6722

It can be seen from Table 1 that the difference between the maximum and minimum values of several main variables LnPat, LnRev, LnSub has exceeded 10, and the difference between the maximum and minimum values of LnTax has also been close to 10, indicating that there is a large gap between the financial subsidies and technological innovation output of China's provinces. The difference between the maximum and minimum values of the remaining four control variables LnMad, LnSca, LnEdu, LnFcs is between 1.45-5.35. In addition, from the perspective of standard deviation, the standard deviation of LnFcs in the four main variables, LnPat, LnRev, LnSub and LnTax, as well as the control variables, is greater than 1, indicating

that the data of these variables are not centralized, thus further highlighting the differences between provinces.

3.3. Regression Analysis

The regression analysis of (1) - (4) equation is performed by GMM method, and the results are shown in Table 2:

Table 2. Regression analysis results

variable	(1)	(2)	(3)	(4)
L.lnPat	0.3267*** (21.38)	0.3364*** (22.02)		
L.lnRev			0.5714*** (28.78)	0.5569*** (48.99)
lnSub	1.2358*** (5.26)		0.7397*** (6.21)	
lnTax		0.0892 (0.18)		1.6867*** (7.69)
lnMad	1.7157*** (5.5)	2.2473*** (5.9)	1.6099*** (10.54)	1.7335*** (11.09)
lnSca	2.3761*** (6.33)	0.9469 (0.91)	1.7726*** (8.33)	3.8435*** (9.57)
lnEdu	1.0890*** (11.29)	1.3557*** (8.94)	0.5692*** (6.88)	0.4224*** (3.41)
lnFcs	-0.0912 (-1.1)	0.1527 (1.21)	0.1669*** (4.14)	0.0270*** (0.58)
lnSub*lnSca	-0.1623*** (-3.99)		-0.1255*** (-5.94)	
lnTax*lnSca		0.0030 (0.04)		-0.2746*** (-7.73)
_cons	-14.3210*** (-6.67)	-9.3841* (-1.79)	-9.8620*** (-7.77)	-20.6491*** (-9.18)
Sargan test	28.7185 0.7241	27.5728 0.7741	23.2771 0.9172	21.6765 0.9498
AR(1)	0.0078	0.0085	0.0107	0.0072
AR(2)	0.0587	0.0573	0.3552	0.3804
sample size	390	390	390	390

Note: ***p<0.01, **p<0.05, *p<0.1.

From equation (1) in the table above, the impact of government subsidies and tax incentives on high-tech innovation: the impact of government subsidies on high-tech innovation is greater than 1, which is significant at the level of 1%, indicating that government subsidies significantly promote the development of high-tech industries; Equation (2) shows the impact of tax incentives on the development of high-tech industries. The impact coefficient is also significant at the level of 1%, which strongly explains the impact of tax incentives on the innovation of high-tech industries; Equation (3) shows that the impact of government subsidies on the application and innovation of high-tech industries is significant at the level of 1%, indicating that government subsidies have an important impact on the application of high-tech industries; Equation (4) shows the effect of tax incentives on the application and innovation of high-tech industries, which can also be seen to be significant at the level of 1%, indicating that the application and innovation of high-tech industries need to play the role of tax incentives.

4. Empirical Analysis of Fiscal Policy to Promote the Development of High-tech Industry by Using Spatial Dubin Model

The support of domestic government departments for high-tech industries in fiscal and tax policies has been fully reflected. This paper will analyze the problems in the process of using fiscal policies for high-tech industries by establishing various data models.

4.1. Model Setting

This paper uses the total output value of high-tech industry as the explanatory variable, and judges the development scale of high-tech industry according to different data comparisons. At present, the subsidy policy of high-tech industry in China is still in the initial stage of development, and the national policy mainly focuses on tax preference. At this stage, the explanatory variables selected by the research mainly include R&D internal expenditure of high-tech industry, scientific and technological expenditure, and tax reduction and exemption of high-tech industry as explanatory variables.

4.2. Descriptive Analysis

The mean, standard deviation, minimum and maximum values of each major variable are listed in Table 3:

Table 3. Descriptive statistical analysis

Variable	N	Mean	S.D.	Min	Max
Total output value of new industries	168	3852	6346	30.90	33308
Science and technology expenditure	168	85.85	88.58	5.967	569.5
ax reduction and exemption for new enterprises	168	196638	268241	567	1313650
R&D expenditure	168	562031	1131756	1174	7691587
Full-time equivalent of R&D personnel	168	21608	39138	227.3	224334

4.3. Analysis of Empirical Results

The following empirical results are obtained by regression analysis of the selected explanatory variables and explanatory variables, as shown in Table 4:

Table 4. Results of empirical analysis

	(1)	(2)	(3)	(4)
Variable	Output	Output	Output	Output
SE	0.771***	0.754***	0.762***	0.768***
	(5.57)	(5.37)	(5.53)	(5.55)
TR		0.44**	0.40**	0.42**
		(1.27)	(1.16)	(1.22)
RDM			0.54**	0.56**
			(2.27)	(1.94)
RDP				0.41**
				(0.59)
Constant	5.498***	5.035***	3.815***	3.380***
	(10.51)	(7.91)	(4.62)	(3.05)
Year FE	YES	YES	YES	YES
Province FE	YES	YES	YES	YES
Observations	168	168	168	168
R-squared	0.988	0.988	0.988	0.988

Note: ***p<0.01, **p<0.05, *p<0.1.

From the regression result of two-way fixed effect, the function coefficient of financial revenue, tax preferential policies, subsidy funds and daily cost expenditure of high-tech industry is greater than zero, and the regression coefficient of high-tech output value and financial investment in science and technology is about 0.768, that is, for every 1% increase in local financial allocation for science and technology, the high-tech output value increases by 0.768%, which shows that the increase of high-tech output value helps to accelerate the pace of growth of science and technology investment. The regression coefficient between the output value of new technology and the amount of corporate income tax deduction is about 0.42, that is, the output value of new technology will increase by 0.42% for every 1% increase in the amount of corporate income tax deduction. It shows that the preferential tax policy of corporate income tax can stimulate the investment of companies in R&D expenditure, which also shows that the government's preferential policies and tax preferences for high-tech industries are very important.

The regression coefficient between the output value of new technology and enterprise R&D expenditure is about 0.56, that is, the output value of new technology increases by 0.56% for every 1% increase in R&D expenditure. Any policy measures taken by the government to increase the capital input of high-tech industries have solved the capital problems faced by enterprises to a certain extent. The regression coefficient between the output value of new technology and the employees is 0.41, and the output value of new technology will increase correspondingly with the enthusiasm of the innovators. Therefore, the government can introduce a large number of high-tech talents, promote the employees to continuously improve their business research and development capabilities through relevant policy incentive systems, and provide effective talent protection for the new technology industry. At the same time, employees can effectively improve the output value of high-tech industries, promote the development of domestic science and technology, and enable the long-term development of domestic innovation path. It can be seen that talents play a pivotal role in high-tech industries.

5. Suggestions

5.1. Optimize the Structure of Financial Investment in Science and Technology

From the perspective of the research and development structure of the government's investment, most of the government's research and development expenses are spent on technology research and development. R&D is the main body of central research and development. Most of the daily project research processes of new industries in the world take research and development as the core part, and the government's policy preference is also more inclined to research and development expenditure. At the same time, the central-level financial science and technology and the central-level government research and development are more inclined to applied research. It can be seen that different R&D entities have different R&D methods, and there are certain differences in the cost of funds invested in various R&D projects.

The local government department where the new technology industry is located] should optimize the structure of science and technology expenditure to a certain extent, reasonably arrange the proportion of research expenditure, guide the long-term development of local innovative industries, encourage investment in creative and disruptive innovation, and enhance the demand for technological solutions. Comprehensive use of various evaluation systems to evaluate the risks in the R&D process of high-tech industries, strengthen the government's support for enterprise innovation, and make important contributions to improving the efficiency of performance evaluation and scientific and technological expenditure. At the same time, the management department of the enterprise should establish an innovative and high-quality evaluation system to continuously optimize the internal

structure system. In view of the current development background of scientific and technological innovation, we can achieve industrial transformation on the basis of effectively improving the efficiency of innovation, and ensure that the government's financial support and tax preferential policies can be widely popularized.

5.2. Increase the Scale of Financial Investment in Science and Technology

Through the research on the financing structure of R&D funds for high-tech industries and high-tech industries, it can be found that at present, China's high-tech industry's scientific and technological investment mainly comes from the investment of enterprises, while the government's R&D base has reached 8%, and other social investment proportion is low. To achieve innovation-based development, we must vigorously increase investment in science and technology. The establishment of a multi-channel science and technology investment system with government investment as the main part, enterprise investment as the main part and social investment as the auxiliary part has realized that the scale of China's financial science and technology investment has continued to expand, but the proportion of its investment in GDP has not increased. Therefore, we should continue to increase the investment in scientific research funds to meet the needs of economic development. The allocation of resources in science, finance, technology and other fields should be fully covered, and the proportion of the allocation of finance and technology in GDP and fiscal expenditure should also be increased. Therefore, we should make the development of science and technology the primary task of the government, provide funds for the development of science and technology, and encourage and develop technological innovation.

5.3. Improve Preferential Income Tax Policies for High-Tech Enterprises

As a special tax policy for high-tech enterprises, there are many corporate income tax policies that still need to be improved and further improved. We also need to expand the scope of pre-tax expenditure and corporate tax relief. It reduces the financing cost of high-tech enterprises and can greatly improve the enthusiasm of enterprises in scientific research and innovation.

China has implemented various preferential policies in the current development process of high-tech industries, and the tax preferential policy is the most feasible measure, which can directly provide corresponding financial support for innovative research and development of enterprises. However, this policy is aimed at a small and medium-sized innovative enterprise, which cannot provide a wide range of financial support, making the R&D enthusiasm of these small and medium-sized enterprises decline. It can be seen that the Ministry of Government] can also formulate more perfect preferential policies to indirectly promote the development of innovation projects of small and medium-sized high-tech companies, formulate a tax system suitable for various types of technology companies, shift the focus of preferential policies to the fields of independent research and development with the greatest risk and the most needed funds, and at the same time give certain preferential policies in the pilot period to improve their comprehensive benefits, According to different R&D links, corresponding standards will be formulated to achieve the effective popularization of preferential policies and promote enterprises to increase innovation and R&D efforts through incentive mechanisms.

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