

Government Incentive and R&D Innovation: Based on the Research of Environmental Protection Listed Companies

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Abstract: We selected the public disclosure data of 158 listed companies in China's environmental protection industry and analyzed the impact of two types of government incentives (government subsidies and tax incentives) on the R&D and innovation activities of companies. The study also analyzed the differences caused by the location and nature of ownership of the companies. The results showed that both government subsidies and tax incentives have a significant effect on R&D and innovation in the environmental protection industry. Furthermore, the impact of government incentives on enterprise innovation is heterogeneous. Compared with the western region, the impact of government subsidies and tax incentives is more significant for the eastern and middle regions. Similarly, compared with state-owned enterprises, the impact of government subsidies and tax incentives is more significant for non-state-owned enterprises.

Keywords: Government subsidies, Tax incentives, Environmental Protection Industry.

1. Introduction

The environmental protection industry is a strategic emerging industry. Under the guidance of the development strategy driven by scientific and technological innovation, it is necessary to maintain core competitiveness through continuous innovation and improvement of technological level. This is of great significance for the industry to achieve sound development and promote the improvement of China's environmental conditions. The government can help enterprises reduce the risks and costs of research and development innovation through incentives, and enterprises can conduct research and development innovation activities.

Government incentives are actions that the government directly or indirectly gives financial support to enterprises to encourage their development. They are mainly divided into two types: government subsidies and tax incentives.

Government subsidies are direct capital investments given by the government to enterprises. Many scholars at home and abroad have carried out research on the impact of government subsidies on enterprise research and development innovation, but the conclusions are different.

On the one hand, government subsidies can ease the resource constraints of enterprises, spread the risks and encourage enterprises to carry out research and innovation activities. Florian[1] studied enterprises in the EU region and found that government subsidies can increase research and development investment of small and medium-sized companies and research-intensive companies. Bai[2] takes energy-intensive enterprises as the research object and finds that government subsidies can motivate enterprises to carry out green innovation. Jia[3] studied the information technology service industry and found that the higher the degree of marketization, the more obvious the promotion of government subsidies on enterprise innovation input.

On the other hand, due to the existence of adverse selection and moral hazard, government subsidies cannot promote enterprise research and development innovation and even

have a crowding-out effect on research and development innovation. Wu[4]'s research confirms this view. Philipp[5] studied listed companies in China from 2001 to 2006 and discussed the allocation of R&D subsidies of enterprises in China during that period and its incentive effect on R&D investment of enterprises. Philipp found that government subsidies crowd out R&D investment in the short term and have no impact on R&D investment of enterprises in the long term.

Tax incentives are a kind of subsidy after the event and a kind of compensation and incentive means after the enterprise obtains economic benefits through research and development innovation. Academic circles also have different views on the impact of tax incentives on enterprise innovation and research and development. Tian[6] studied from the perspective of changes in tax policies and found that tax incentives will promote enterprises to increase investment in innovation. Fabiani[7] studied various policies of the Brazilian government to stimulate R&D and innovation activities and finally clarified the importance of tax incentives for enterprise R&D and innovation activities. Castellacci[8] and other scholars have also drawn the conclusion that tax incentives have a long-term incentive effect on enterprise R&D investment through multiple regression analysis. However, some scholars believe that the incentive effect of tax incentives on corporate R&D innovation is limited.

To sum up, many scholars have done a lot of research on the impact of the two types of government incentives on corporate innovation activities, but the conclusions are quite different.

We selected 158 listed environmental protection enterprises in China. The data provided by CSMAR was used for the sample from 2014 to 2019 because of the lack of relevant data in the research and development innovation of enterprises before 2014. To ensure the validity and stability of the data, we excluded ST and *ST companies and companies with incomplete disclosure of key data indicators. Finally, we obtained a total of 750 listed companies' annual sample data.

2. Research and Design

2.1. Research assumptions

2.1.1. government subsidies and R&D innovation

The research and innovation activities of enterprises are characterized by high investment and high risk. The direct subsidy provided by the government can provide good financial support for enterprises to carry out research and development innovation in the early stage, help to encourage enterprises to carry out innovation activities and enhance the motivation of research and development and innovation enthusiasm. In addition, the financial subsidy given by the government also shows that the enterprise has been approved by the government, which signals to external investors that the enterprise is operating well, reduces the perception of external investment risk and enables the enterprise to have more opportunities to obtain external financing and expand innovation investment. Based on this, we propose hypothesis 1:

Government subsidy can significantly promote the R&D innovation of enterprises.

2.1.2. tax incentives and R&D innovation

Different from government subsidies, tax incentives are post-event subsidies, which are mainly used to reduce the actual cost (after-tax cost) of enterprise research and development investment. The tax obligation of enterprises increases the cost of R&D and innovation activities, and a large amount of capital is required for the early stage of R&D and innovation activities. The tax obligation R&D investment

budget is restricted by the amount and time of tax cash outflow, which, to a certain extent, inhibits the enthusiasm of enterprises for R&D and innovation activities. At this time, the appropriate preferential tax policies can make up for the financing gap of the enterprise to a certain extent and generate incentives for the research and innovation activities of the enterprise. Based on this, we propose hypothesis 2:

Tax incentives can significantly promote the R&D innovation of enterprises.

2.2. Samples and data sources

We select 158 listed environmental protection enterprises in China. The data provided by CSMAR, the data of the sample from 2014 to 2019 are selected for research because of the lack of relevant data in the research and development innovation of enterprises before 2014. In order to ensure the validity and stability of the data, excluding ST and *ST and companies with incomplete disclosure of key data indicators, 158 listed companies, a total of 750 listed companies' annual sample data are finally obtained.

2.3. Definition of variables

The process of R&D innovation in enterprises is complex and diverse. Besides Government subsidy and Tax Incentives, there are other influencing factors. Therefore, this paper selects enterprise size, profitability, financing constraints and capital structure as control variables.

All variables are defined and assigned as shown in Table 1.

Table 1. Variable Definition and Assignment

name	symbol	Description
R&D Investment	RDI	Amount of research and development investment/revenue from main business
Government Subsidy	SUB	Amount of government subsidy/revenue from main business
Tax Incentives	TAX	Tax refund amount/revenue from main business
Scale	SIZE	Assets are logarithmic
Earning Power	ROE	net income/average shareholders' equity
Financing constraints	TIE	Earnings Before Interest /Interest Expense
Capital structure	LEV	liabilities/assets
	ER	Owner's equity/assets

2.4. Model design

This paper constructs the following models based on assumptions hypothesis 1 and hypothesis 2 respectively:

$$RDI_{it} = \alpha_0 + \beta_1 \times SUB_{it} + \lambda_1 \times Control_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

$$RDI_{it} = \alpha_0 + \beta_1 \times TAX_{it} + \lambda_1 \times Control_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

3. Result

3.1. General descriptive statistics.

In order to overcome the influence of extreme values and ensure the robustness of the research results, all continuous variables are winsor-sized at 1% and 99% points. Descriptive statistics of major variables are shown in Table 2.

Table 2. Descriptive Statistical Results of Major Variables

Variable	RDI	SUB	TAX
Mean	3.49	1.39	1.22
Min	0.04	0.00	0.00
Max	3.38	0.78	0.41
Median	11.73	9.70	8.17
Std. Dev.	2.08	1.70	1.76
Full samples, 750 observations			

In the data sample of 158 listed environmental protection enterprises in our country, the average value of research and development investment (RDI) is 3.49%. According to the

EU statistical standard, the research and development investment of enterprises with sufficient research and development competitive advantage should be greater than

5%. Obviously, the research and development investment of listed environmental protection enterprises in our country is far below this level. In addition, the minimum value of research and development investment is 0.04%, the maximum value is 11.73%, and the standard deviation is 2.08, which indicates that the research and development investment of different enterprises in the environmental protection industry is quite different. On the whole, the intensity of government incentives is low, but it does not rule out the possibility that some enterprises enjoy high government subsidies and tax incentives.

3.2. Regression results

In this paper, the Hausman test is carried out on the sample data, and the results are shown in Table 3. The fixed effect model is selected for regression analysis.

Table 3. Hausman Test

	Chi-Sq	Prob	Chi-Sq	Prob
Result	16.26	0.0228	18.75	0.0090
Model	fixed-effect model		fixed-effect model	

Table 4 shows regression results of the impact of government subsidies and tax incentives on innovation inputs separately.

Table 4. Regression results of RDI, SUB and Tax

	(1)	(2)
Variable	RDI	SUB
SUB	0.208*** (5.61)	
TAX		0.206*** (5.55)
Control	-	-
YEAR	-	-
N	750	750
R²	0.151	0.120
***, **, * represent significance levels of 1%, 5% and 10% respectively, with t values in brackets, similarly hereinafter.		

Regression result (1)-(2) respectively show that the significance level of regression coefficient is 5%, both government subsidies and tax incentives have significant promotion effect on enterprise research and development investment, assuming hypothesis 1 and hypothesis 2 are supported.

3.3. Heterogeneity Test

3.3.1. Regional Heterogeneity Test

There are also various heterogeneity differences in the incentive effect of government measures on the innovation activities of enterprises, such as the nature of property rights of enterprises, the regions where they are located, the industries they belong to, etc. We have limited the research object to the environmental protection industry, so we test the heterogeneity of the sample on the nature of region and property rights. The region is based on the division of China's three major economic zones, namely, the eastern, middle and western regions. Regions and property rights are classified separately and classified differently.

Table 5. Heterogeneity Test1: RDI, SUB and Tax

	(3)	(4)	(5)	(6)	(7)	(8)
	East	Mid	West	East	Mid	West
Variable	RDI	RDI	RDI	RDI	RDI	RDI
SUB	0.188*** (4.40)	0.257*** (3.15)	-0.091 (-0.47)			
TAX				0.101* (1.92)	0.346** (2.46)	0.405 (1.63)
Control	-	-	-	-	-	-
YEAR	-	-	-	-	-	-
N	561	97	92	561	97	92
R²	0.135	0.381	0.321	0.104	0.347	0.346

Table 5 is the heterogeneity test results of sample enterprises. Regression result (3)-(5) and (6)-(8) respectively correspond to the impact of government subsidies and tax incentives on enterprise innovation investment in different regions. In the government subsidy incentive effect model, the eastern and middle regions are significant at 1%, while the western regions are not significant. Similar results are also reflected in the tax incentives model.

On the one hand, the environmental protection industry is a strategic emerging industry, which needs to rely on innovation results to maintain its core competitiveness. However, research and development innovation is affected by various factors, and the conditions for enterprises in the eastern and middle regions to conduct research and development innovation are better than those in the western regions. Therefore, the incentive effect of government subsidies on enterprises in the eastern and middle regions may be better.

On the other hand, tax incentives are subsidies after the event, which require enterprises to achieve innovative results before they can obtain subsidies, with a certain lag. The resources and conditions in the eastern and middle regions are better than those in the western regions, and they are more active in carrying out innovative activities. Therefore, the incentive effect of tax incentives is more significant in the eastern and middle regions.

3.3.2. Property Right Heterogeneity Test

The regression results (9)-(10) and (11)-(12) in Table 6 respectively correspond to the impact model of government subsidies and tax incentives on enterprise research and development investment. Regression results (9)-(10) show that in the incentive effect model of government subsidies, the intensity of government subsidies is significantly positive in both state-owned enterprises and non-state-owned enterprises, and the former has a significance level of 10%, the regression coefficient is 0.110, the latter has a significance level of 1%, the regression coefficient is 0.222, the non-state-owned enterprises have a higher significance level, and the absolute value of the regression coefficient is also larger. This shows that the positive impact of government subsidies on the research and innovation investment of non-state-owned enterprises is significantly higher than that of state-owned enterprises. The model of incentive effect of tax incentives also obtains similar results. The regression results (11)-(12) show that in the non-state-owned enterprise group, the tax preference intensity is significant at the significance level of 1%, and the regression coefficient is 0.155. However, the regression coefficient of state-owned enterprises is only 0.084 and has not passed the test of significance level.

Table 6. Heterogeneity Test2: RDI, SUB and Tax

	(9)	(10)	(11)	(12)
	State-owned	Non-state-owned	State-owned	Non-state-owned
Variable	RDI	RDI	RDI	RDI
<i>SUB</i>	0.110*	0.222***		
	(1.66)	(4.73)		
<i>TAX</i>			0.084	0.155***
			(0.82)	(2.75)
<i>Control</i>	-	-	-	-
<i>YEAR</i>	-	-	-	-
<i>N</i>	191	559	191	559
<i>R</i> ²	0.263	0.148	0.252	0.119

4. Conclusion

Taking 158 listed environmental protection enterprises in China as a sample, we analyzed the impact of government incentives on enterprise research and innovation activities. The study found that government subsidies and tax incentives have significant incentive effects on the research and development innovation of environmental listed companies. At the same time, the impact of government incentives on R&D innovation of listed environmental protection enterprises is obviously heterogeneous. Compared with the western region, the government incentive effect of environmental protection enterprises in the eastern and middle regions is more significant; The impact of government incentives on innovation and research of environmental protection enterprises with different property rights is significantly different. Compared with state-owned enterprises, government subsidies and tax incentives play a more significant role in promoting non-state-owned enterprises.

First of all, state-owned enterprises have particularity. Compared with non-state-owned enterprises, they are more likely to obtain policy support and resources. The incentive effect of government subsidies and tax policies may not be optimal. Compared with state-owned enterprises, non-state-owned enterprises are more likely to face difficulties such as lack of funds and resources, which inhibit the enthusiasm of non-state-owned enterprises for research and innovation. Therefore, the government should take measures to publicly disclose all kinds of government subsidy policies. At the same time, the government should take measures to encourage enterprises to disclose the use and destination of government subsidies in detail through annual reports or other means, so as to conduct supervision, ensure the transparency and efficiency of government subsidies, and enable government innovation subsidies to more effectively promote the research and innovation investment of enterprises. At the same time, it is reasonable to formulate a preferential tax policy as a post-event subsidy, or to establish and implement an innovation

achievement award policy to encourage enterprises to increase innovation and research and development in order to obtain incentives, and to continue to invest in research and development and innovation after achieving results, thus forming a virtuous circle.

Secondly, China's eastern, middle and western regions are unbalanced due to regional conditions, industrial layout, institutional environment and other factors, and industrial development is also affected. At present, both government subsidies and tax incentives have less incentive effect on the innovation activities of environmental protection enterprises in the western region than the other two regions. The government should promote environmental protection enterprises in the eastern and middle regions to support and guide enterprises in the western regions, and at the same time, increase the introduction of high-level talents in the western regions to drive the development of the western regions, so as to promote the coordinated development of environmental protection industries in various regions.

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