Research on the Driving Role of Environmental Protection Law on Technological Innovation of High-Polluting Enterprises

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Abstract. As an important reform of China's green tax system, the impact of environmental protection fee reform is naturally extensive and far-reaching. Based on the data of A-share industrial listed companies in Shanghai and Shenzhen from 2015 to 2020, this paper uses the difference-in-difference method to investigate the impact of environmental protection fee reform on the technological innovation of high-polluting enterprises. The results show that the change of environmental protection fee to tax significantly reduces the R&D and innovation investment of high-polluting enterprises.

Keywords: sewage charge; R&D innovation; environmental protection tax; Differential Difference.

1 Introduction

While considering how to promote economic growth, the environment is also a key issue that should be considered. General Secretary Xi Jinping once said that "lucid waters and lush mountains are invaluable assets"[4], this concept profoundly reveals that development and environmental protection are dialectical and unified relations, and only by paving the way for green development can there be sustainable and rapid development in the future. In order to protect and improve the environment and reduce pollutant emissions, China officially implemented the Environmental Protection Law of the People's Republic of China on January 1, 2018[7], which mainly taxes four pollutants: air pollutants, water pollutants, solid waste and noise.

The object of environmental protection tax is mainly enterprises, institutions and other producers and operators who directly discharge taxable pollutants into the environment, which is not the same as the sewage fee levied on polluting enterprises in the past. However, after the legislation, the environmental protection tax is imposed on enterprises that emit pollutants, and the local government cannot intervene in this regard[6], which will undoubtedly increase the financial burden of high-polluting enterprises, so enterprises have to think about green transformation.

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2 Literature Review

Industrial and manufacturing enterprises are the main sources of pollution. The early pollution discharge fee system not only had a low legislative level but also lacked sufficient enforcement by local governments[1]. Existing literature on the impact of the environmental protection fee reform to tax on enterprises mainly focuses on the following aspects: The concept of environmental tax was proposed in Arthur Pigou's "Welfare Economics," and based on this, scholars both domestically and internationally have conducted extensive research on the dual dividends of environmental protection tax[2]. The basic meaning of dual dividends refers to the idea that the imposition of environmental taxes can not only effectively curb pollution and improve the ecological environment, thereby achieving the goal of environmental protection, but can also reduce the distortionary effects of existing tax systems on capital and labor through the revenue generated from environmental taxes, which is beneficial for social employment and sustained economic growth. These two effects are referred to as the "green dividend" and the "economic dividend."

Domestic scholars primarily focus their research on the environmental and economic effects of the pollution discharge fee system. Based on the findings of most scholars, the effects brought about by the implementation of the pollution discharge fee system have been unsatisfactory. The main reasons for this are the low legislative level and insufficient enforcement of the pollution discharge fee system. On this basis, the country launched the reform of the environmental protection fee to tax on January1,2018, officially legislating the environmental protection tax. Whether the implementation of the environmental protection tax can perfectly coordinate and unify both the "green dividend" and the "economic dividend" is an important issue of concern going forward. From existing research, it appears that after the implementation of the environmental protection tax law, the environmental quality in various provinces and cities has significantly improved[5]. However, there is insufficient research on the economic effects on enterprises, with most studies focusing on the relationship between environmental protection tax and enterprises total factor productivity and financial performance[8]. This paper primarily investigates the impact of environmental protection tax on enterprises technological innovation, examining whether the reform from environmental protection fee to tax can encourage enterprises to invest more funds in technology.

3 Empirical Study Design

3.1 Model Selection and Setup

The difference-in-difference method is a statistical model that uses a nascent policy as a quasi-experiment to observe the differences between the experimental and control groups before and after its implementation, so as to evaluate the effectiveness of the policy. China officially implemented the environmental protection tax on January 1, 2018, so this paper takes the Environmental Protection Tax Law of the People's

Republic of China as a quasi-experiment to exclude the influence of other factors that do not change with time and are uncontrollable[3],

$$\mathrm{RD}_{i,t} = \alpha_0 + \alpha_1 \ \mathrm{Treat}_{i,t} * \mathrm{Post}_t + \beta_1 \ \mathrm{Year} + \beta_2 \ \mathrm{ID} + \sum \gamma \ \mathrm{Controls}_{i,t} + \varepsilon_{i,t}$$

where i represents the enterprise, t represents the year, represents the innovation and R&D investment of the explanatory variables, represents the interaction term of spatial dummy variables and temporal dummy variables, represents the annual effect, represents the enterprise effect, represents various control variables, and represents the random perturbation term.

3.2 Description of the Variable

In this paper, the natural logarithm of enterprise R&D expenditure is selected to measure the RD investment of enterprise innovation and R&D as the explanatory variable. The explanatory variable is the product of dummy variables, Treat=1 when the firm belongs to the category of high-polluting enterprises, and Treat=0 when the year t is in 2018 and subsequent years, Post=1, and Post=0 on the contrary. On the basis of the existing research, this paper further controls other indicators that may affect the results as control variables: enterprise size (Size), which is the natural logarithm of the total assets of the enterprise; Equity nature (SOE), state-owned enterprises are equal to 1, non-state-owned enterprises are equal to 0; Asset-liability ratio (Tdr), which is the ratio of total liabilities to total assets; Profitability (ROA), measured by the company's operating net profit margin, that is, the ratio of net profit to operating income; Cashrat is measured as the ratio of cash flow from operating activities to total assets.

3.3 Sample Selection and Data Sources

China's environmental protection tax has been officially legislated since January 1, 2018, so this paper selects A-share industrial listed companies in Shanghai and Shenzhen as the research data from 2015 to 2020, and the definition of industrial enterprises refers to the Industrial Classification of the National Economy (GB/T 4754-2017), including mining, manufacturing, electricity, heat, gas and water production and supply. In addition, according to the Guidelines for the Classification of Listed Companies by the China Securities Regulatory Commission in 2012 and the Catalogue of Classified Management of Environmental Protection Verification Industries of Listed Companies formulated by the Ministry of Environmental Protection of the People's Republic of China in 2008, the heavily polluting enterprises include 14 industries, including thermal power, iron and steel, cement, electrolytic aluminum, coal, metallurgy, building materials, mining, chemical, petrochemical, pharmaceutical, light industry, textile and tanning, with heavy polluting enterprises as the experimental group and other industrial enterprises as the control group. At the same time, this paper filters the data as follows: excluding the data of listed companies with abnormal financial status (ST) and facing delisting risk warning (*ST), and excluding the data of companies with missing above variables, a total of 8376 panel data is obtained.

4 Empirical Analysis

4.1 Parallel Trend Test

Before using the difference-in-difference model, it is necessary to satisfy the parallel trend assumption, that is, the trend of R&D and innovation investment in the experimental group and the control group should be the same before the policy is implemented, otherwise the causal effect in the results will contain selective bias. In order to intuitively investigate the impact of environmental protection fee to tax on enterprise R&D and innovation investment, this paper intends to draw a comparison chart of the time trend of R&D and innovation investment between the experimental group and the control group, as shown in the Table 1.

After inspection, the parallel trend test has been passed.

Table 1. Robust standard errors in parentheses

VARIABLES	before2	before3	current_treat	after1	did	Constant
RD	0.0311*	0.00256**	0.0318**	-0.0411**	-0.384***	-1.420***
	(0.0214)	(0.0210)	(0.0202)	(0.0199)	(0.0214)	(0.148)

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

4.2 Simple Regression Analysis

Based on the above data and the established model, this paper empirically tests the relationship between enterprise technological innovation and environmental protection tax through STATA18.0, and according to Table 2, the model (1)~(6) is the result of gradually adding control variables. In general, the net effect coefficient (DID) of the environmental protection fee reform tax on enterprise R&D and innovation investment is significantly negative at the significance level of 1%, which preliminarily indicates that the environmental protection fee to tax will inhibit the R&D and innovation investment of high-polluting enterprises. After adding the control variables one by one, although the regression coefficient changed, the significance level of the DID coefficient remained unchanged, and the regression coefficient size was 0.381, indicating that the R&D and innovation investment of enterprises decreased by 0.381% compared with that before the environmental protection fee was changed to tax, which is in line with the above theoretical analysis.

Table 2. Simple regression analysis

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	RD	RD	RD	RD	RD	RD
did	0.073*	-0.025	-0.012	-0.371***	-0.381***	-0.381***

	(1.68)	(-0.62)	(-0.31)	(-18.16)	(-18.76)	(-18.36)
Trd		2.540***	2.617***	-0.271***	-0.186***	-0.196***
		(40.91)	(41.58)	(-7.26)	(-4.91)	(-5.03)
Roa			0.275***	-0.233***	-0.251***	-0.256***
			(6.85)	(-11.18)	(-12.10)	(-11.95)
size				0.828***	0.817***	0.822***
				(153.64)	(149.55)	(142.88)
cashrat					0.971***	0.955***
					(10.43)	(10.03)
Soe						-0.029**
						(-2.22)
Industry FE	YES	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES	YES

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Simple regression analysis

5 Conclusions and Recommendations of the Study

5.1 Conclusions of the Study

Based on the data of A-share industrial listed companies in Shanghai and Shenzhen from 2015 to 2020, this paper empirically studies the impact of China's environmental protection fee reform on the R&D and innovation investment of high-polluting enterprises by using the difference-in-difference model and the mediating effect test model. The results are as follows: From the perspective of impact effect, the impact of environmental protection fee to tax on high-polluting enterprises is obviously higher than that of non-high-polluting enterprises; From the perspective of the mechanism, the environmental protection fee to tax can promote enterprises to increase investment in R&D and innovation by increasing the pressure of environmental legitimacy, which is conducive to solving the problems of insufficient law enforcement rigidity, loose law enforcement, lax law enforcement and low binding force on enterprises.

5.2 Policy Recommendations

First, optimize tax policies. Tax policy has always been an important means for the government to improve the environment, for heavy polluting enterprises, can appropriately increase the collection standards of environmental protection tax, resource tax and pollution discharge fees, so that enterprises bear more environmental governance and restoration costs, but also play a role in guiding and stimulating enterprises to actively implement environmental protection measures. Second, strengthen industrial policy

guidance. The government should formulate strong industrial policies, strengthen guidance on the research and development and application of environmental protection technologies and industries, encourage enterprises to accelerate industrial upgrading, and promote green transformation. Third, improve the regulatory mechanism. The government should intensify environmental supervision of heavily polluting enterprises, strengthen the supervision of pollution emission sources and emission standards, implement green production methods, and strengthen environmental self-monitoring and self-examination, find problems and rectify them in a timely manner, and regularly accept the assessment and testing of environmental protection departments or third parties, so as to gradually improve the environmental protection quality and completeness of enterprises.

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