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Environmental Protection Tax and Enterprise Total Factor Productivity

-- Empirical Research based on PSM-DID

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Abstract

Based on the panel data of China's A-share listed companies from 2006 to 2019, this paper empirically studies the relationship between environmental protection tax and enterprise total factor productivity using the mediation effect and PSM-DID model. It can promote the improvement of the total factor productivity of enterprises; the test of regional heterogeneity shows that the environmental protection tax has the strongest promotion effect on the total factor productivity of enterprises in the western region, followed by the promotion of enterprises in the central region, and the promotion of enterprises in the eastern region. At the same time, compared with the non-state-owned enterprise environmental protection tax, the promotion effect on the total factor productivity of state-owned enterprises is more obvious.

Keywords

Environmental Protection Tax; Enterprise Total Factor Productivity; PSM-DID Model.

1. Introduction

"Lucid waters and lush mountains are invaluable assets". Environmental problems are closely related to human survival and development. With the continuous development of social economy, environmental problems are becoming increasingly prominent, and economic development cannot be at the expense of the environment. In 2021, China will promote high-quality economic development with the goal of "reducing pollution and carbon dioxide", and realize the transformation of the ecological environment from quantitative change to qualitative change. At this stage, the factor conditions, combination methods, and resource allocation efficiency of China's economic development have changed. The constraints faced by Chinese enterprises in the development have increased, and the constraints of resources and the environment have gradually reached the upper limit. Carbon peaking and carbon neutrality are the keys to achieving green economic and social development. important goal of transformation.

China's development is inseparable from the development of enterprises, and the development of enterprises will also affect all aspects of China's social and economic environment. In order to achieve high-quality development in China, environmental protection tax was launched in China on January 1, 2018. Most of the existing literature explores the relationship between environmental regulation and China's green economy. These are based on urban panel data to explore environmental issues. Explore the relationship between environmental protection tax and total factor productivity of enterprises, and study the impact of environmental protection tax on the enterprise level.

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2. Literature Review

2.1. There is a Positive Relationship between Environmental Regulation and Total Factor Productivity

Some scholars believe that moderate environmental regulation can promote the improvement of total factor productivity. Zhang Pingdan, Zhang Huilin, etc. (2021) based on the quasi-natural experiment of carbon emission trading pilot, using the double difference model to conduct an empirical study on Chinese manufacturing listed companies from 2009 to 2020. The model examines the relationship between environmental regulation and enterprise total factor productivity. The results show that there is a positive relationship between the carbon emission trading pilot and the listed manufacturing enterprises[3]. Guo Tao et al. (2021) conducted an empirical study through the threshold regression model based on the perspective of heterogeneous enterprises and the decomposition of total factor productivity. The results show that moderate environmental regulation has a positive impact on changes in total factor productivity of enterprises [5]. Lin Chun et al. (2019) found through the GMM model that the positive effect of environmental regulation on total productivity in the horizontal effect stems from the promotion of technological progress[9]. At the same time, Liu Hewang et al. (2016) found that appropriate environmental regulation intensity can stimulate the "innovation compensation effect" of enterprises, thereby continuously making up for the "compliance cost" of innovation and improving the total factor productivity of enterprises[10].

2.2. There is a Negative Relationship between Environmental Regulation and Total Factor Productivity

Other scholars believe that the reason for the inhibitory effect of environmental regulation on total factor productivity is the entry of low-productivity firms and the exit of high-productivity firms. Xiao Hanyue, Sun Hui et al. (2021) investigated the impact of environmental regulation intensity gradient on total factor productivity from a macro level. The study found that, on the whole, the expansion of environmental regulation intensity gradient has a negative impact on urban total factor productivity[1]. Zhou Ruihui, Liu Yaobin, etc. (2021) measured the relationship between changes in environmental regulation intensity and total factor productivity in China's industrial four-digit industries from 2004 to 2009, and examined the effect of changes in environmental regulation intensity on companies in four-digit industries from the four-digit industry level. Changes in total total factor productivity, it is found that the increase in the intensity of environmental regulation reduces the total total factor productivity of enterprises in the industry[2]. (2019) used data on Chinese companies and showed that the emission trading system can significantly improve the total factor productivity of listed companies in pilot areas[8]. Lin Chun et al. (2019) found through research that environmental regulation from the perspective of investment has a significant negative growth effect on total factor productivity[9].

2.3. There is a "U"-Shaped Relationship between Environmental Regulation and Total Factor Productivity

Ma Dianyuan, Sun Hui et al. (2021) conducted an empirical analysis on the relationship between dual environmental regulation, government regulation and total factor productivity of heavily polluting enterprises by constructing a fixed effect model. The study found that: formal environmental regulation and total factor productivity of heavily polluting enterprises There is a significant "U"-shaped relationship between productivity, which first decreased and then increased; there was a significant inverted "U"-shaped relationship between informal environmental regulation and the total factor productivity of heavily polluting enterprises, which first increased and then decreased[4]. Wang Jie et al. (2014) verified the relationship

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between environmental regulation and enterprise total factor productivity through an empirical model. The results show that there is an "inverted N-type relationship" between the two [11]. Similarly, Tang Xueliang, Gu Binxian et al. (2019) Using the generalized propensity score matching method (GPSM), this paper empirically studies the relationship between the "energy saving and carbon reduction" policy and the total factor productivity of Chinese industrial enterprises. "N" shaped relationship. That is to say, moderate environmental regulation helps to improve the production factors of enterprises[12]. And Li Jiashu (2020) conducted an empirical test on China's inter-provincial panel data from 2004 to 2018, and also proved that there is a significant "U"-shaped relationship between environmental regulation and total factor productivity[6].

3. Research Design

3.1. Sample Selection and Data Sources

In order to study the impact of the implementation of environmental protection tax on the total factor productivity of enterprises, technological innovation has played a role in it. This article takes all A-share listed companies from 2007 to 2020 as research samples, and according to the "Guidelines for Environmental Information Disclosure of Listed Companies" (Draft for Comment) issued by the Ministry of Environmental Protection on September 14, 2010, 16 types of heavy polluting industries are set as treatment groups , and the less polluting industries served as the control group.

All data of A-share companies in this article come from the CSMAR Guotai'an database. In order to reduce research errors, based on the integrity and continuity of the data, the following sample data observations are excluded: (1) ST, *ST and abnormally listed companies (2) Financial and insurance companies (3) Too many samples of corporate financial indicators are missing. In order to ensure the robustness of the results and remove special values from the analysis of the empirical results, this paper performs 5% abbreviated processing on the samples, and uses Stata15 to analyze the relevant data.

3.2. Variables

3.2.1. The Explained Variable

The explained variable of this paper is the total factor productivity of enterprises, because total factor productivity can reflect productivity more comprehensively than a single input-output indicator. Today's mainstream methods for measuring total factor productivity include the OLS method, the fixed effects method (FE), the OP method and the LP method (Lu Xiaodong et al. 2012) [14]. Total factor productivity is used as the explained variable of the main regression, and the OP method is used as the robustness test of the model.

3.2.2. Explanatory Variables

The environmental protection tax kicked off in my country on January 1, 2018. The policy impact of the 2018 environmental protection tax policy was taken as a policy evaluation. The explanatory variable of this paper is DID. DIDit=treatedi×postt ,where treatedi is the policy object, when the enterprise is a heavily polluting industry, treatedi=1, otherwise it is 0; postt The time effect of environmental protection tax implementation, when the time year is 2018-2020, postt =1, 0 otherwise.

3.2.3. Control Variables

In order to study the impact of environmental protection tax on the total factor productivity of enterprises, this paper selects the controlling shareholder's shareholding ratio (LHR), operating income growth rate (growth), asset-liability ratio (Lev), operating gross profit

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margin (OM), total asset income rate (ROA), controlling for both individual (stkcd) and regional (region) effects. The variables and their definitions are listed in Table 1.

Table 1. Variables and their definitions

variable type	variable code	variable name	variable description
Explained variable	TFP	Total Factor Productivity	Calculated based on the labor, capital, intermediate products and output invested by the enterprise
Explanatory variables	post	Implementation of Environmental Protection Tax	1 for 2018 and later, 0 for other years
	Treated	Whether it is a heavily polluting industry	1 if the company is a heavily polluting industry, 0 otherwise
	DID	double difference variable	The intersection of post and Treated
Control variables	LHR	Shareholding ratio of controlling shareholder	Controlling shareholder's shareholding ratio of listed company
	growth	growth indicator	Current operating income growth rate
	Lev	Assets and liabilities	Total Liabilities/Total Assets
	ROA	return on total assets	Net profit/total asset balance
	OM	Operating gross profit margin	(operating income - operating costs)/operating income
	stkcd	industry	Industry dummy variable
	region	area	region dummy variable

3.3. Model

The double-difference model can avoid the interference caused by endogenous problems to a certain extent, so as to better evaluate the effect of policy implementation, but it is difficult to use the double-difference method simply and directly to test the parallel trend between the experimental group and the control group. Therefore, this paper Based on the research of Zhang Youzhi et al. (2021), the double difference propensity score method (PSM-DID) was selected [13]. Build the model as follows:

$$TFPit=\beta0+\beta1DIDit+ \beta2R\&Dit +Controlsit+\varepsilon it$$

Among them, Controlsit is each control variable, β0 and εit are constant terms and error terms of the model.

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4. Analysis of Empirical Results

4.1. Descriptive Statistics of the Main Variables

Table 2. Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
lntfp	26519	8.091	0.928	6.59	10.009
LHR	26518	35.075	14.024	13.86	62.25
growth	26488	0.295	0.535	-0.328	1.877
Lev	26519	0.439	0.197	0.113	0.782
ROA	26519	0.04	0.041	-0.049	0.125
OM	26519	0.276	0.157	0.059	0.631

4.2. Propensity Score Matching Processing

Since the regression of the entire sample may lead to errors in the results, in order to ensure the robustness of the results, this paper adopts the Logit model, and takes the heavily polluting enterprises that are significantly affected by the environmental protection tax in 2018 as the experimental group, while the enterprises that are almost free from the environmental protection tax are selected as the experimental group. The affected enterprises were taken as the control group, and the propensity score matching method was used to match the enterprises closest to the experimental group in the control group. ROA (return on total assets) and OM (operating gross profit margin) are used as matching variables to match the enterprises in the control group and the experimental group.

Table 3. Propensity score matching balance test

Variable	Unmatched	Mean		%bias	%reduct bias	t-test	
	Matched	Treated	Control			t	p>|t|
LHR	U	36.472	34.478	14.3		10.65	0
	M	36.471	36.552	-0.6	95.9	-0.37	0.714
growth	U	0.154	0.356	-40.7		-28.64	0
	M	0.154	0.153	0.1	99.7	0.1	0.922
Lev	U	0.455	0.432	11.8		8.73	0
	M	0.455	0.454	0.5	96.1	0.29	0.771
ROA	U	0.037	0.041	-9.1		-6.88	0
	M	0.037	0.038	-2.1	77	-1.34	0.182
OM	U	0.228	0.297	-46.1		-33.48	0
	M	0.228	0.229	-0.7	98.5	-0.47	0.635
Ps R^2	U	0.06					
	M	0					

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As shown in Table 3, the absolute value of the deviation of each covariate after matching is within 10%, and it is significantly smaller than the deviation before matching, and the pseudo R2 after matching becomes smaller, indicating the difference in the values of all variables between the two groups before and after matching. are not big, indicating that the PSM-DID method is effective.

4.3. Analysis of Regression Results

For example, model (1) in Table 4 only controls the industry effect, while model (2) controls both industry and regional effects. The regression results show that the DID coefficients of the cross product of models (1) and (2) are positive, and both are within 1 It is significant at the level of %, which verifies the impact of environmental protection tax on the total factor productivity of enterprises, indicating that environmental protection tax can significantly improve the total factor productivity of enterprises.

Table 4. Benchmark regression results

VARIABLES	model(1)	model(2)	model(3)	model(4)
	lntfp	lntfp	tfp_op	tfp_op
did	0.319***	0.319***	0.0533***	0.0534***
	(0.0140)	(0.0140)	(0.0091)	(0.0091)
lhr	-0.00562***	-0.00559***	-0.000032	-0.000039
	(0.0007)	(0.0007)	(0.0005)	(0.0005)
growth	0.0438***	0.0436***	-0.0030	-0.0032
	(0.0112)	(0.0112)	(0.0076)	(0.0076)
lev	1.087***	1.085***	0.451***	0.453***
	(0.0425)	(0.0425)	(0.0286)	(0.0286)
roa	4.227***	4.219***	4.335***	4.340***
	(0.1520)	(0.1520)	(0.1030)	(0.1030)
om	-0.856***	-0.848***	-1.166***	-1.174***
	(0.0686)	(0.0687)	(0.0470)	(0.0471)
Constant	7.876***	7.921***	3.573***	3.533***
	(0.0351)	(0.0418)	(0.0247)	(0.0297)
stkcd	yes	yes	yes	yes
region	no	yes	no	yes
Observations	11399	11399	11746	11746
R-squared	0.1680	0.1690	0.1780	0.1790

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

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4.4. Robustness Test

By changing the accounting method of the total factor productivity of enterprises, this paper uses the OP method to obtain the total factor productivity (tfp_op) of the enterprise for robustness testing. The regression results are shown in models (4) and (5) in Table 4. Both the DID and the passenger transport items have a significant positive effect at the level of 1%, indicating that the environmental protection tax can promote the improvement of the total factor productivity of enterprises. This is consistent with the previous benchmark regression results, indicating that the model passes the robustness test.

5. Heterogeneity Analysis

5.1. Regional Heterogeneity Analysis

Table 5. Heterogeneity test regression results

VARIABLES	Eastern Region (5)	Central Region (6)	Western Region (7)	SOEs (8)	Non-SOEs (9)
	lntfp	lntfp	lntfp	lntfp	lntfp
did	0.284***	0.340***	0.365***	0.329***	0.289***
	(0.0175)	(0.0325)	(0.0320)	(0.0214)	(0.0180)
lhr	-0.00881***	-0.0012	-0.0012	-0.00230**	-0.00868***
	(0.0008)	(0.0017)	(0.0015)	(0.0010)	(0.0009)
growth	0.0486***	0.0668**	0.0004	0.0472***	0.0423***
	(0.0143)	(0.0262)	(0.0244)	(0.0153)	(0.0160)
lev	1.222***	0.870***	0.935***	0.917***	1.138***
	(0.0518)	(0.1060)	(0.0990)	(0.0633)	(0.0576)
roa	3.943***	4.808***	3.912***	4.005***	4.083***
	(0.1900)	(0.3580)	(0.3490)	(0.2220)	(0.2070)
om	-0.584***	-1.230***	-1.155***	-1.370***	-0.465***
	(0.0908)	(0.1610)	(0.1420)	(0.1010)	(0.0948)
Constant	7.927***	7.873***	7.720***	8.319***	7.713***
	(0.0431)	(0.0866)	(0.0821)	(0.0788)	(0.0508)
stkcd	yes	yes	yes	yes	yes
region	no	no	no	yes	yes
Observations	7367	2096	1936	5208	6147
R-squared	0.1830	0.1580	0.1710	0.1440	0.2000

According to the province where the enterprise is located, the enterprise is divided into three groups: the eastern region, the central region and the western region, and the regional heterogeneity test is carried out. The empirical test results are shown in Table 5. It can be seen

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that the DID of the eastern region, the central region and the western region is significant at the 1% level and the coefficient is positive, indicating that the environmental protection tax can promote the improvement of the total factor productivity of enterprises. According to the size of the coefficient, the environmental protection tax has the most obvious promoting effect on the total factor productivity of enterprises in the western region, followed by the promoting effect on the enterprises in the central region, and the promotion effect on the enterprises in the eastern region is obviously smaller than that of the enterprises in the western and central regions.

5.2. Heterogeneity Analysis of Equity Nature

The enterprises are divided into state-owned enterprises and non-state-owned enterprises according to the nature of their equity. Through model (8) and model (9), it can be seen that the dummy variable DID is significant at the 1% level, and the coefficient of model (8) is larger than that of model (9) and both are positive, indicating that compared with non-state-owned enterprises The effect of environmental protection tax on the total factor productivity of state-owned enterprises is more obvious.

6. Conclusions and Implications

This paper conducts empirical research on the relationship between environmental protection tax and enterprise total factor productivity. The main conclusions are as follows: First, environmental protection tax can promote the improvement of enterprise total factor productivity. Second, compared with non-state-owned enterprises, the environmental protection tax has a more significant positive impact on the total factor productivity of state-owned enterprises. At the same time, the environmental protection tax has the strongest promotion effect on the total factor productivity of enterprises in the western region, and the promotion effect on enterprises in the central region. Second, and the weakest promotion effect on enterprises in the eastern region.

Since the environmental protection tax policy has been implemented for a short period of time, it has a certain positive impact on the production efficiency of enterprises and the national economic environment in the short term. Based on the research inspiration of this paper, there are the following points: First, improve the tax preferential policy of environmental protection tax and reduce the cost increase that it brings to enterprises. Considering the particularity of environmental protection tax, the threshold of environmental protection tax should be scientifically set. Second, the government should support the investment of enterprises in innovation, and give certain financial support and subsidies to the innovation behavior of enterprises, so as to promote the technological innovation of enterprises and improve the production efficiency of enterprises. Third, the levy scope of environmental protection tax should be continuously adjusted to adapt to changes, expand the levy scope of environmental protection tax, and establish and improve coordination and supervision among relevant departments.

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