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Research on Corporate Financial Performance and Green Technology Innovation Effect under Carbon Trading Policy

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Abstract— *This article uses carbon trading pilot control companies as the research object, based on the panel data of China's A-share listed companies from 2009 to 2018, and uses DID and PSM-DID methods to evaluate the impact of carbon trading policies on corporate financial performance and green technology innovation. The policy effects of carbon trading policies on enterprise performance and green technology innovation of different implementing entities are discussed, and empirical research evidence is provided for the government to optimize carbon trading policies and the direction of corporate green development.*

Keywords— *Carbon emissions trading; Green technology innovation; Financial performance; Differences-in-Differences.*

I. Introduction

In response to environmental problems caused by carbon emissions, a variety of carbon regulations and carbon control policies have been applied to management practices, among which carbon trading policies have proven to be a low-cost and high-efficiency market-based environmental policy (Peng Wang et al. 2015). The carbon trading policy is an important mechanism to deal with global climate change, internalizing the external environmental costs of enterprises through market transactions, and solving carbon emissions problems by market-based means.

Regarding the impact of carbon trading on corporate financial performance, Zhang et al. found through research that carbon trading reduces the financial performance of non-ferrous metal companies and reduces the market value of high-carbon-intensive companies, which is not conducive to the long-term value of the company. Promote. However, another group of experts held the opposite view. He Shengbing used matching estimation and PSM-DID to explore the relationship between carbon trading and corporate performance, and found that carbon trading promotes the operating performance of thermal power companies and cement companies, and can effectively improve corporate value and financial performance. Therefore, carbon trading has different effects on the financial performance of different types of enterprises, so the policy effect of carbon trading on financial performance needs to be considered from the perspective of enterprise heterogeneity. In terms of research on carbon trading and corporate green technology innovation, Daniel examined the relationship between green technology innovation and carbon emission reduction, and found that carbon trading can stimulate corporate innovation by guiding green technology innovation represented by green patents. Reduce carbon emissions and promote green economic growth.

The effectiveness of carbon trading policies should be reflected in two aspects. One is to encourage enterprises to save energy and reduce carbon emissions through market-based means; the other is to force enterprises to innovate in green technology, improve their financial performance, and ultimately achieve continuous environmental improvement and green economy. Win-win development (Qi Hongqian et al. 2020). Enterprises are microscopic entities that can reflect the effectiveness of carbon trading policies. Their profit-seeking nature determines that the financial performance improvement brought about by carbon trading is the key to stimulating the internal motivation of enterprises to reduce emissions. Therefore, studying the policy effectiveness of carbon trading on green technology innovation and corporate financial performance has important theoretical significance for ensuring the sustainability of carbon trading policies and the high-quality growth of the Chinese economy.

II. Research Design

Industry Division

In order to study the impact of corporate financial performance and the effectiveness of green technology innovation under the carbon trading policy on corporate heterogeneity, this article draws on the classification of resource-intensive and industry-intensive enterprises by Wang Fengzheng et al. and Yang Ligao et al. As a standard for the classification of enterprise heterogeneity, combined with the 2012 edition of the China Securities Regulatory Commission's industry classification, the resource-intensive and technology-intensive industries are classified as follows, as shown in Table 1.

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TABLE 1. Industry classification and code

Resource-intensive	Technology-intensive
B06 Coal mining and washing industry	C27 Pharmaceutical manufacturing
B07 Oil and gas extraction industry	C35 Special equipment manufacturing
B08 Ferrous metal mining and dressing industry	C36 Automotive Manufacturing
B09 Non-ferrous metal mining and dressing industry	C37 Railway, shipbuilding, aerospace and other transportation equipment manufacturing
B10 Non-metallic mining and dressing industry	C38 Electrical machinery and equipment manufacturing
C25 Petroleum Processing and Coking Industry	C39 Computer, communications and other electronic equipment manufacturing
C26 Chemical raw materials and chemical products manufacturing	C40 Instrumentation Manufacturing
C30 Non-metallic mineral products industry	
C31Ferrous metal smelting and rolling processing industry	
C32 Non-ferrous metal smelting and rolling processing industry	
C33 Metal products industry	
D44 Electricity and heat production and supply industry	

Sample and Data

On the basis of ensuring the availability of data, this article uses the panel data of A-share listed companies from 2009 to 2018, and sets 2014 as the time point for the policy shock, 2009-2013 as the time before the policy shock, and 2014-2018 as The time after the policy is implemented. According to the list of controlled companies released by each pilot, the companies involved in carbon trading in the seven pilot regions of Shenzhen, Shanghai, Beijing, Guangdong, Tianjin, Hubei, and Chongqing will be used as the processing group, and the remaining A-share listed companies will be the control group. The rules for sample selection are: ①Exclude listed companies in the financial and insurance industries; ②Exclude ST and *ST companies; ③Exclude companies whose subsidiaries or holding companies are not controlled companies and are not in the pilot provinces and cities, but whose subsidiaries or holding companies are controlled companies, Such companies may be affected by their subsidiaries or holding companies, and thus do not have the conditions to serve as a control group.

TABLE 2. Variables and data description

	variable	definition	Calculation method
Explained variables	*tobinq*	tobinq value	Market value/total assets
	patent	Number of green invention patent applications	Manual statistics
Explanatory variables	*firm*	Whether it is a pilot enterprise	Carbon trading pilot control enterprises=1; otherwise=0
	time	Whether to implement carbon trading	2008-2013=0; 2014-2018=1
Control variable	*size*	Enterprise size	Logarithm of total assets
	lev	Assets and liabilities	Assets/liabilities
	rdex	R & D spending	Logarithm of R&D expenditure
	lratio	Current ratio	Current assets/current liabilities
	cratio	Quick ratio	Quick assets/current liabilities

DID Model

The Double Difference Model (DID) is an important research method for testing the effect of policy implementation at home and abroad. The advantage of this model is that it can avoid the endogenous problem of policy as an explanatory variable, and effectively control the mutual influence between the explained variable and the explanatory variable. Therefore, this paper uses a double difference model to study the impact of carbon trading policies on corporate financial performance and green technology innovation.

$$Tobinq = \alpha_0 + \alpha_1 post + \alpha_2 treat + \alpha_3 (post \times treat) + \alpha_i \sum Control_i + \lambda + \mu + \varepsilon \quad (1)$$

Among them, Formula 1 is an empirical model to test the impact of carbon trading policies on corporate financial performance. The explained variable is tobinq representing the financial performance of the enterprise; post×treat represents the interaction item of the double-difference model, which is the core variable of the double-difference analysis method; post represents the time dummy variable, and treat represents the regional dummy variable; $\sum Control_i$ is a set of control variables, including enterprise size (*size*), asset-liability ratio (*lev*), R&D expenditure (*r&d*), current ratio (*lratio*), quick ratio (*cratio*), λ represents industry fixed effectiveness, μ represents time fixed effectiveness, ε represents the random disturbance term.

$$Patent = \beta_0 + \beta_1 post + \beta_2 treat + \beta_3 (post \times treat) + \beta_i \sum Control_i + \lambda + \mu + \varepsilon \quad (2)$$

Formula 2 is a model for testing the impact of carbon trading on corporate green technological innovation. Except for the dependent variable *Patent*, the meaning of other variables is similar to Model 1.

$$Tobinq = \alpha_0 + \alpha_1 \sum_{2015}^{2018} (post \times treat) + \alpha_2 post + \alpha_3 treat + \alpha_i \sum Control_i + \lambda + \mu + \varepsilon \quad (3)$$

$$Patent = \beta_0 + \beta_1 \sum_{2015}^{2018} (post \times treat) + \beta_2 post + \beta_3 treat + \beta_i \sum Control_i + \lambda + \mu + \varepsilon \quad (4)$$

In addition, in order to capture the dynamic effects of the carbon trading policy after the implementation of the carbon trading policy, based on Formula 1 and Formula 2, this article adds 4 interaction terms from 2015 to 2018, and establishes Formula 3 and Formula 4 to reflect the dynamics of companies after participating in carbon trading. influences.

III. RESULTS

According to Table 3, we have the following two important findings: First, as shown in column (1) of Table 3, carbon trading policies have a negative policy effect on corporate financial performance, which means that carbon trading policies are not being realized. While reducing carbon emissions, it also brings economic efficiency to enterprises. This may be because the main participants in China's carbon

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trading market are high-energy-consuming companies, which generally have problems with relatively low technical efficiency, production and profit, and are accompanied by high pollution, high energy consumption and resource waste. Second, as shown in column (2), carbon trading has a significant positive policy effect on corporate green technological innovation. This may be because carbon trading policies can encourage regulated companies to innovate green production technologies and production processes, resulting in an "innovation compensation" effect, partially or even completely offsetting compliance costs, and enhancing industrial competitiveness (Porter, 1995).

TABLE 3. Benchmark regression results

	(1) *tobinq*	(2) *patent*
post×treat	-0.275***	0.047 1***
	(0.060 5)	(0.090 6)
time	-0.403***	0.473***
	(0.048 3)	(0.072 2)
size	-0.196***	0.018 1
	(0.017 0)	(0.025 4)
lev	0.062 1	0.294**
	(0.077 0)	(0.115)
rdex	-0.026 0***	0.003 57***
	(0.007 91)	(0.011 8)
lratio	-0.005 45	0.024 8
	(0.023 5)	(0.035 1)
cratio	-0.036 4***	-0.025 9***
	(0.025 0)	(0.037 5)
_cons	6.929***	-0.300***
	(0.383)	(0.574)
Industry effectiveness	YES	YES
Time effect	YES	YES
N	19 762	19 762
R2	0.251	0.19

**** p<0.01, ** p<0.05, * p<0.1;The value in brackets is t value*

The following discusses whether the effectiveness of this policy has industry heterogeneity. The results are shown in Table 4.

TABLE 4. The impact of industry heterogeneity

	(1) *tobinq*	(2) *patent*	(3) *tobinq*	(4) *patent*
post×treat	-0.571**	0.075 7*	-0.058 8**	-0.311*
	(0.249)	(0.363)	(0.115)	(0.164)
time	-0.566***	0.551***	-0.204**	0.659***
	(0.099 8)	(0.146)	(0.099 5)	(0.142)
size	-0.081 7**	0.053 9	-0.210***	0.020 2
	(0.033 2)	(0.048 5)	(0.036 0)	(0.051 2)
lev	0.270*	-0.010 2	-0.209	0.505**
	(0.162)	(0.236)	(0.167)	(0.237)
rdex	-0.029 2*	-0.025 0	-0.028 2	-0.012 0
	(0.016 1)	(0.023 5)	(0.017 2)	(0.024 5)
lratio	-0.042 8	0.139*	0.056 3	0.008 24
	(0.052 5)	(0.076 8)	(0.054 5)	(0.077 6)
cratio	0.003 08	-0.157*	-0.112*	0.015 9
	(0.056 2)	(0.082 2)	(0.058 1)	(0.082 8)
_cons	4.466***	-0.569	7.273***	-0.352
	(0.759)	(1.108)	(0.807)	(1.149)
Industry effect	YES	YES	YES	YES
Time effect	YES	YES	YES	YES
N	4 110	4 110	4 628	4 628
R2	0.222	0.18	0.256	0.33

The results in Table 4 show that for resource-intensive companies, carbon trading has a significant inhibitory effect on the financial performance of companies measured by tobinq. On the other hand, carbon trading has significantly promoted the green technological innovation of resource-intensive companies. The idea that strict environmental regulations can lead to innovation proposed by the "Hypothesis" is supported by China's resource-intensive enterprises.

For technology-intensive companies, the effectiveness of carbon trading policies has a significant negative correlation with corporate financial performance, and it is also significantly negatively correlated with corporate green technological innovation. The research results show that the coefficient of the key interaction term post×treat is negative and significant at the level of 10%, indicating that carbon trading has significantly inhibited the green technological innovation of technology-intensive enterprises.

In order to capture the dynamic effects of carbon trading, based on formulas (3)(4), this paper sets the policy implementation time as 2015, 2016, 2017, and 2018 respectively to examine the time trend of the impact of carbon trading and obtain the effect of carbon trading policies. The regression results of the dynamic impact of corporate financial performance and green technology innovation are shown in Table 5.

TABLE 5. Dynamic regression results

	(1) *tobinq*	(2) *patent*
post×treat（2015）	-0.374***	0.077 9
	(0.092 1)	(0.138)
post×treat（2016）	0.053 0	-0.048 1
	(0.114)	(0.171)
post×treat（2017）	0.155	0.111
	(0.112)	(0.168)
post×treat（2018）	0.132	0.160
	(0.109)	(0.163)
size	-0.196***	0.018 3
	(0.017 0)	(0.025 4)
lev	0.060 5	0.294**
	(0.077 0)	(0.115)
rdex	-0.026 0***	0.003 47
	(0.007 90)	(0.011 8)
lratio	-0.006 17	0.024 6
	(0.023 5)	(0.035 1)
cratio	-0.035 7	-0.025 7
	(0.025 0)	(0.037 5)
_cons	6.924***	-0.303
	(0.383)	(0.574)
Industry effectiveness	YES	YES
Time effect	YES	YES
N	19 762	19 762
R2	0.252	0.19

Combined with Table 3, it can be seen that the impact of carbon trading policies on corporate financial performance has not yet stabilized, with greater volatility, and the impact has gradually changed from a significant suppression in 2014 and 2015 to a positive effect. The carbon trading policy may lead to a relative increase in the cost of controlling emissions, resulting in carbon trading having a significant inhibitory

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effect on the financial performance of the company in the first two years of its implementation.

According to Table 3 and Table 5, it can be seen that the impact of carbon trading on corporate green technology innovation was only positively significant in 2014, indicating that carbon trading policies are difficult to promote corporate green technology innovation for a long time.

IV. Discussion

Based on the above research results, this article believes that the following measures should be taken: ① Guide enterprises to actively participate in carbon emission reduction, and stimulate their inherent enthusiasm for emission reduction. Actively adjust the industrial structure according to the nature of the industry, improve the efficiency of low-carbon technology, innovate to promote the transformation of enterprises, enhance the competitiveness of the industry, and promote the development of low-carbon economy. ②Improve the carbon trading market and its guiding role in corporate green technological innovation. Through subsidies and special funds, companies covered by carbon trading are guided to implement green innovation activities, and relevant companies are forced to reduce carbon emissions through green technological innovation. ③Expand the radiation scope of the carbon trading market. Accelerate the construction of the national carbon trading market and encourage all regions to join the carbon trading market in order to reduce the cost of carbon trading and improve the efficiency of carbon trading. Improve the transparency of all entities and ensure the fairness of carbon market transactions.

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