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"Double Carbon" Background, Carbon Emissions Trading and Enterprise Total Factor Productivity

-- Evidence from A-share Listed Companies

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Abstract

In order to effectively deal with global warming and improve the ecological environment, China has made a solemn commitment to the world to "achieve carbon peak by 2030 and carbon neutrality by 2060". In 2011, China identified seven pilot provinces and cities for carbon emission trading, namely Shanghai, Guangdong, Shenzhen, Chongqing, Beijing, Tianjin, and Hubei, and officially launched carbon trading in 2013. As the main body of environmental protection and economic development, improving the total factor productivity of enterprises is of great significance to promoting the high-quality development of China's economy. Based on the quasi-natural experiment of carbon emissions trading, this paper uses the micro-panel data of A-share companies from 2008 to 2020 to establish a double-difference model to investigate the impact of carbon emissions trading on the total factor productivity of enterprises in pilot provinces and cities, the mechanism of action, and the impact of carbon emissions trading on the total factor productivity of enterprises in different provinces and cities. the heterogeneity of the situation. The study found that: first, carbon emissions trading can significantly improve the total factor productivity of enterprises; second, carbon emissions trading can promote the total factor productivity of enterprises by improving technological innovation and capacity utilization; third, through heterogeneous Based on the analysis, carbon emission trading has a greater role in promoting the total factor productivity of non-state-owned enterprises, coastal areas, and areas with strong law enforcement.

Keywords

High Quality Economy; Environmental Regulation; Carbon Emission Trading; Total Factor Productivity.

1. Introduction

At the 75th United Nations General Assembly in 2020, China put forward the goal of "achieving carbon peak by 2030 and carbon neutrality by 2060", aiming to cope with global warming, improve the ecological environment, and promote high-quality economic development in China. In recent years, most of the environmental regulations implemented in our country are of the command type, and if the supervision of the command type environmental regulation is not in place, it will be difficult to exert its effect [1]. In order to encourage enterprises to take the main responsibility for environmental protection, with the continuous exploration of the government, China has created a carbon emission trading system. In 2011, the National Development and Reform Commission issued the "Notice on Carrying out the Pilot Work of Carbon Emissions Trading", and at the same time identified seven pilot provinces and cities for carbon trading. Among them, Shenzhen City took the lead in completing the construction of the carbon trading market in 2013 and started it that year, and other provinces and cities also

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started carbon trading successively. In 2021, according to the 14th Five-Year Plan, the carbon emission trading system is an important means to achieve "carbon peaking", and China will improve and promote the carbon emission trading system. The first implementation period of the national carbon trading market (power generation industry) was launched that year, and China began to enter the era of carbon emissions trading. Carbon emissions trading has achieved significant emission reduction effects both at the provincial level and at the enterprise level. Based on the panel data of provincial units, some scholars have found that the carbon dioxide emissions of provinces and cities have dropped significantly, but the emission reduction effect is heterogeneous in each province and region [2][3]. Some scholars have verified the Porter effect of the emission trading mechanism based on the data of industrial enterprises. The research found that although the emission trading cannot achieve the long-term Porter effect, it can bring a huge energy saving and emission reduction effect [4]. Obviously, carbon emission trading has become an important measure for the low-carbon and high-quality development of China's economy.

The report of the 19th National Congress of the Communist Party of China clearly pointed out that promoting the improvement of total factor productivity is the source of driving force for realizing the transformation of China's economy from extensive to high-quality development. Total factor productivity can reflect the efficiency and quality of production more comprehensively, and is an important indicator to measure economic quality [5]. Enterprises are the main body of the economy and society. Promoting the total factor productivity of enterprises is of great significance to promote high-quality economic growth. As a market-based and incentive-based environmental regulation, whether carbon emissions trading can force companies to intensify technological innovation, eliminate outdated production capacity, and then promote their total factor productivity, there is still a lack of practical experience and evidence. In view of this, based on the quasi-natural experiment of carbon emission trading in 2013, this paper uses the panel data of A-share listed companies from 2008 to 2020, and uses the double-difference method to examine the impact and role of carbon emission trading on the total factor productivity of enterprises. This paper further analyzes the heterogeneity of the impact of carbon emissions trading on the total factor productivity of enterprises under different circumstances.

The marginal contributions and innovations of this paper are as follows: First, most of the existing research on environmental regulation is based on provincial panels, and there are few studies on micro-enterprises. From the perspective of micro-enterprises, this paper broadens the scope of carbon emissions trading. Second, this paper deeply studies the impact and mechanism of carbon emission trading on total factor productivity, enriching the theory of market-oriented environmental regulation; The experience and evidence of productivity help China's economy develop in a high-quality direction. Fourth, this paper analyzes the heterogeneity of the impact of carbon emission trading on the total factor productivity of enterprises, and provides experience for the government to promote the total factor productivity of enterprises according to local conditions.

2. Theoretical Analysis and Research Hypotheses

Carbon emission trading is an effective way to solve the externalities generated in the production process of enterprises. It can convert the environmental pollution caused by enterprises into internal costs of enterprises, thereby restraining enterprises' polluting behavior and reducing enterprises' pollution emissions [6][7]. Under carbon emission trading, when an enterprise has exhausted the specified carbon allowances, in order to ensure continued production, it is necessary to purchase excess carbon allowances from other enterprises in the carbon trading market, which will increase the cost of the enterprise; After

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completing the production task, if there are excess carbon allowances, the carbon allowances can be sold in the carbon trading market to obtain additional profits [8]. Driven by profit maximization, enterprises will adjust the input of production factors and improve production technology, thereby promoting the improvement of production quality and efficiency. In view of this, this paper proposes the following assumptions:

H1: Carbon emissions trading can significantly improve the total factor productivity of enterprises.

The impact of environmental regulation on the total factor productivity of enterprises is mainly achieved through two aspects: "following cost effect" and "innovation compensation effect"[9][10]. First, because enterprises are constrained by environmental regulations, their pollutant discharge behaviors will be punished, which will increase the cost of enterprises. Under the impetus of "following the cost effect", enterprises will adjust production methods, optimize the allocation of production factors, and eliminate backward enterprises. production capacity in order to meet compliance requirements, and in the process, the capacity utilization rate of enterprises has been improved. Second, under the incentive of environmental regulation, in order to meet compliance requirements, enterprises will increase investment in technological innovation and improve production technology. Under the impetus of "innovation compensation effect", enterprises can find new sustainable profit points and realize profits. maximize. In view of this, this paper proposes the following assumptions:

H2: Carbon emission trading can promote technological innovation of enterprises and improve the utilization rate of enterprise capacity, and improve the total factor productivity of enterprises through technological innovation and capacity utilization rate.

3. Research Design

3.1. Sample Selection and Data Sources

2008 to 2020, and the micro data comes from the CNRDS database. This paper deals with the micro sample data as follows: First, companies with continuous losses, namely ST, ST * companies and companies with serious data missing, are excluded; second, because the accounting standards of the financial industry are different from other industries, the industry code in the excluded sample is J66 Again, due to the small carbon trading market in Chongqing and the low compliance rate, this paper does not consider the sample of enterprises in Chongqing; finally, the continuous variables in the sample data are abbreviated by 1% and 99% . Obtained 21427 observations.

3.2. Empirical Model and Variable Description

3.2.1. Model Design

In order to investigate the impact of carbon emission rights trading on total factor productivity, this paper uses the double difference method to estimate the effect of carbon emission rights on total factor productivity based on the quasi-natural experiment of carbon emission rights trading in 2013. The double difference model set in this paper is used. as follows:

$$\mathrm{lntfp}_{cit} = \alpha_0 + \alpha_1 DID + \alpha_2 X + \lambda_c + \gamma_{\mathrm{t}} + \mu_{\mathrm{i}} + \varepsilon_{\mathrm{cit}} \quad (1)$$

where lntfp_{cit} represents the total factor productivity of I firms in industry C in period T; the treatment effect DID is the interaction term of the grouping dummy variable DU and the time dummy variable DT, and its coefficient is used to represent the size of the treatment effect. X

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represents the control variable. λ_c represents the industry fixed effect, γ_t represents the time fixed effect, μ_i represents the individual fixed effect, and ε_{cit} represents the random error term.

In order to examine the impact mechanism of carbon emission rights on the total factor productivity of enterprises, this paper uses the three-step method to test the impact mechanism [11], and constructs the following models (2) and (3). Among them, the RD_{cit} and CU_{cit} is the mediating variable, namely technological innovation and capacity utilization rate, and the interpretation of other variables is consistent with the above. If both are satisfied, the interaction term coefficient in model (1) is significant, the interaction term coefficient in model (2) and model (3) is significant, and the interaction term coefficient in model (4) and model (5) is significant, then there is a mediation effect.

$$RD_{cit} = \chi_0 + \chi_1 DID + \chi_2 X + \lambda_c + \gamma_t + \mu_i + \varepsilon_{cit} \tag{2}$$

$$\ln tfp_{cit} = \eta_0 + \eta_1 DID + \eta_2 RD_{it} + \eta_3 X + \lambda_c + \gamma_t + \mu_i + \varepsilon_{cit} \tag{3}$$

$$CU_{cit} = \theta_0 + \theta_1 DID + \theta_2 X + \lambda_c + \gamma_t + \mu_i + \varepsilon_{cit} \tag{4}$$

$$\ln tfp_{cit} = \delta_0 + \delta_1 DID + \delta_2 CU_{it} + \delta_3 X + \lambda_c + \gamma_t + \mu_i + \varepsilon_{cit} \tag{5}$$

3.2.2. Variable Description

Explained variable. Selecting total factor productivity as the explained variable, the current methods for measuring total factor productivity at the enterprise level mainly include the OP method [12]and LP method [13], but because the OP method leads to a sample with an investment of 0 not being estimated, it will lead to a large number of the sample is missing, so this paper uses the LP method to estimate the total factor productivity of enterprises.

Explanatory variables. Taking the interaction term DID of the grouping dummy variable DU and the time dummy variable DT as the core explained variable, it is used to express the impact of carbon emission rights on the total factor productivity of enterprises. If the registered address of the enterprise is located in the 6 pilot provinces and cities, the DU is 1, otherwise it is 0. For the time dummy variable, this paper uses 2013 as the benchmark for policy shocks, and DT takes 0 before 2013 and 1 in 2013 and after.

Mediating variable. Select technological innovation RD and capacity utilization CU as mediating variables. In addition to examining the impact of carbon emissions trading on the total factor productivity of enterprises, this paper also examines the mechanism of action, that is, improving the total factor productivity of enterprises by promoting technological innovation and resolving capacity utilization. For the measurement of technological innovation, this paper uses the proportion of enterprise R&D expenditure to total enterprise assets to represent technological innovation. For the measurement of capacity utilization rate, this paper uses the total asset turnover rate to represent the enterprise capacity utilization rate [14].

Control variables. This paper controls the following variables: enterprise age, enterprise scale, asset-liability ratio, enterprise growth, enterprise ownership, and the shareholding ratio of the largest shareholder [15].

Descriptive statistics of the variables are listed in Table 1 below.

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Table 1. Descriptive statistics

Variable	Definitions	Average	SD	Min	Max
TFP	Calculation by LP method	9.082	1.070	6.988	12.081
CU	Operating Income/Total Assets	0.668	0.409	0.117	2.456
RD	R&D investment/total assets	0.022	0.018	0.000	0.089
Size	ln (total assets at the end of the period)	22.124	1.257	19.983	26.181
Lev	Total Liabilities/Total Net Assets	0.411	0.196	0.056	0.862
Age	ln (year - year of establishment + 1)	2.809	0.358	1.609	3.466
Top1	Number of shares held by shareholders with the most shares/total shares of the company	0.341	0.145	0.088	0.730
Growth	Operating income for the current period / operating income for the previous period	0.167	0.353	-0.479	2.079

4. Empirical Analysis

4.1. Benchmark Regression

Table 2. Regression results of total factor productivity

	TFP	TFP	TFP	TFP
	(1)	(2)	(3)	(4)
DID	0.1567 ***	0.0943 ***	0.1382 ***	0.0780 ***
	(4.1600)	(6.1083)	(4.3021)	(4.2896)
Size		0.6820 ***		0.5582***
		(52.9292)		(30.6901)
Lev		0.4459***		0.1912**
		(4.5276)		(2.3627)
Age		0.0585*		0.2363***
		(1.8589)		(3.1046)
Top1		0.3227***		-0.0139
		(6.0183)		(-0.2525)
Growth		0.2257***		0.2417***
		(11.5652)		(17.6925)
_cons	9.0367 ***	-6.5279 ***	9.0420 ***	-4.0659 ***
	(818.8075)	(-20.0007)	(964.8637)	(-9.0719)
individual fixation	NO	NO	YES	YES
time fixed	YES	YES	YES	YES
Industry fixed	YES	YES	YES	YES
N	21601	21601	21427	21427
adj. R^2	0.2465	0.7873	0.8917	0.9415

Note: The significance levels of 1%, 5%, and 10% are represented by "***", "**", and "*" respectively; the t value is in brackets, and the t value is calculated by the cluster standard error. Same below

Benchmark regression results of the impact of carbon emission rights on the total factor productivity of enterprises are shown in Table 2. The coefficient regression results of the interaction term DID of (1)-(3) are all significant at the 1% level and greater than 0; according to (4) In the regression results of the column, the coefficient of the interaction term is 0.078, which is still significant at the 1% level, and the corresponding adjusted R^2 is also larger than the first 3 columns, the model fitting effect is better, and the results are more robust. Finally, according to the regression results, carbon emission trading has a significant promoting effect on the total factor productivity of enterprises, so it is assumed that H1 is established.

4.2. Robustness Test

The above regression results show that the carbon emission right has a significant positive effect on the total factor productivity of enterprises. This paper will conduct a robustness test through the parallel trend test, the placebo test, and the method of replacing the explained variable to make the research results more convincing and robust.

4.2.1. Parallel Trend Test

The premise of using the double difference method is to satisfy the parallel trend test. In this paper, the interaction term of the time dummy variable before and after the policy and the policy variable is set, and the following double difference dynamic model is designed [16]. year_t^n represents the interaction term of the policy variable and the year dummy variable.

$$\text{lntfp}_{\text{it}} = \sigma_0 + \sum_{n=-5}^{5} \sigma_1 \text{year}_{\text{t}}^n + \sigma_2 \overline{X}_{it} + \gamma_{\text{t}} + \mu_{\text{i}} + \varepsilon_{\text{it}} \tag{6}$$

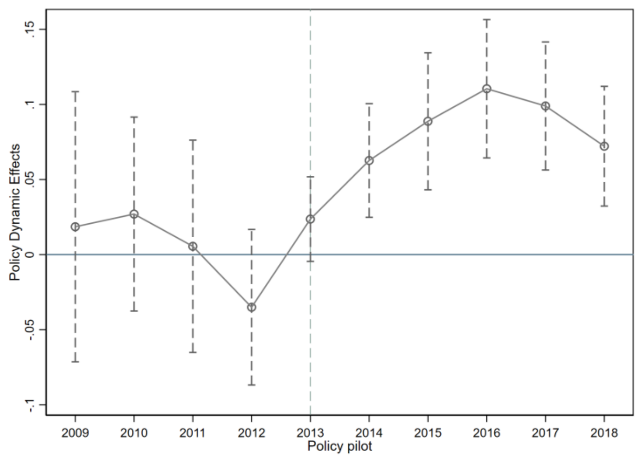

Figure 1. Parallel trend test results

Parallel trend test is shown in Figure 1 above. In the year and before the policy was implemented , the confidence interval of the interaction coefficient in model (6) σ_1 included 0, indicating that there was no significant difference in total factor productivity between the treatment group and the control group; the confidence interval of the interaction term coefficient σ_1 is different from 0 and is significantly positive, indicating that there is a significant difference in the trend of total factor productivity between the policy post-treatment group and the control group . Therefore, the parallel trend test is passed.

4.2.2. Placebo Test

Although the above empirical analysis has proved that carbon emissions trading will have a positive impact on the total factor productivity of enterprises, it does not rule out the impact of other unobservable factors on the total factor productivity of enterprises. In view of this, this paper conducts a placebo test of 500 random samples [17]. The results of the placebo test are shown in Figure 1 below. According to the regression results in column (4) of Table 1, the estimated value of the DID estimated coefficient of the interaction term is 0.078 , which corresponds to the right end of Figure 1, indicating that the interaction in model (1) The term coefficient at the 1% level is significantly a small probability event, excluding the influence of other unobservable factors on the total factor productivity of the enterprise, and from the graph, Figure 2 approximately obeys a normal distribution. Therefore, the improvement of the total factor productivity of enterprises is indeed caused by carbon emission trading.

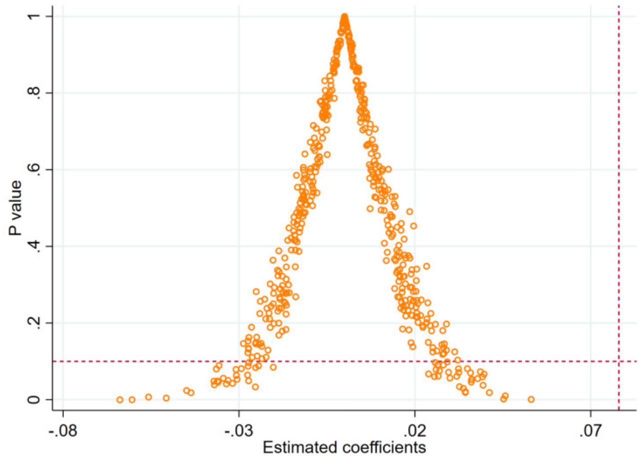

Figure 2. Placebo test

4.2.3. Replace the Explained Variable

In order to prevent the error caused by the LP method to measure the total factor productivity of enterprises from affecting the empirical results of this paper, this paper uses the GMM method, the generalized estimation of moments method, to re-measure the total factor productivity of enterprises [18], and then uses model (1) to test the robustness. Significant means that the empirical results of this paper are credible. The benchmark regression of TFP re-measured by the GMM method is shown in Table 3 below. According to the column (4), the regression coefficient of the interaction term is 0.0607, which is significant at the level of 5 %, indicating that carbon emissions trading is significant Promote the total factor productivity of enterprises, indicating that the empirical results of this paper are robust.

Table 3. Benchmark regression results of GMM

variable	TFP
DID	0.0607 **
	(2.5651)
_cons	-0.1872
	(-0.3694)
control variable	YES
individual fixation	YES
time fixed	YES
Industry fixed	YES
N	21427
adj. R^2	0.8232

4.3. Analysis of the Impact Path

Based on the above empirical evidence, carbon emission rights, as an incentive-based and market-based environmental regulation, have significantly improved the total factor productivity of enterprises, and whether carbon emission rights trading can trigger the "Porter effect"[19], which can improve the overall efficiency of enterprises by promoting technological innovation of enterprises. factor productivity? In addition, incentive-based environmental regulation can help resolve excess capacity and improve capacity utilization. With the increase in capacity utilization, the production factors of enterprises can be reasonably allocated, production technology is improved, and production methods are improved, then whether carbon emission rights can pass Increase capacity utilization to affect the total factor productivity of enterprises? In view of this, this paper will conduct a mechanism analysis to examine the impact path of carbon emission rights on total factor productivity.

Mediation effect of technological innovation and capacity utilization are shown in Table 4 below. Columns (1)-(5) are the regression results of models (1)-(5). For the mediating effect of technological innovation, according to the regression results in the following table (3), the coefficient of interaction term is 0.0709, which is significant at the 1% level, and the coefficient of RD is 7. 1854, which is significant at the 1% level, so There is a mediation effect. For the mediating effect of capacity utilization, as shown in Table (5) below, the coefficient of interaction term is 0.0342, which is significant at the 5 % level, and the coefficient of CU is 1.1511, which is significant at the 1% level, so there is a mediation effect. Therefore, carbon emission trading is to promote the total factor productivity of enterprises by promoting technological innovation and improving capacity utilization.

Table 4. Regression results of the mediating effect

	TFP	RD	TFP	CU	TFP
	(1)	(2)	(3)	(4)	(5)
DID	0.0780 ***	0.0010 *	0.0709 ***	0.0381 ***	0.0342 **
	(4.2896)	(1.8811)	(4.1120)	(2.7060)	(2.4926)
RD			7.1854 ***		
			(7.4345)		
CU					1.1511 ***
					(23.8174)
_cons	-4.0659 ***	0.1136 ***	-4.8819 ***	1.8257 ***	-6.1675 ***
	(-9.0719)	(6.8025)	(-12.3709)	(5.3517)	(-31.3388)
control variable	YES	YES	YES	YES	YES
individual fixation	YES	YES	YES	YES	YES
time fixed	YES	YES	YES	YES	YES
N	21427	21427	21427	21427	21427
adj. R^2	0.9415	0.7980	0.9445	0.8272	0.9749

4.4. Heterogeneity Analysis

4.4.1. Differences in Corporate Attributes

This paper divides the sample into two sub-samples of non-state-owned enterprises and state-owned enterprises according to the different attributes of enterprises, and conducts regressions on the two sub-samples respectively to study the difference in the impact of carbon emission trading on the total factor productivity of enterprises under different enterprise

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attributes. The heterogeneity regression results of enterprise attributes are shown in Table 5 below. Columns (1) and (2) are the regression results of non-state-owned enterprises and state-owned enterprises, respectively. Carbon emission trading significantly improves the total factor productivity of both types of enterprises. However, according to the size of the interaction term regression coefficient, the interaction term regression coefficient of column (1) is 0.1097, which is significant at the 1% level, while the interaction term regression coefficient of column (2) is 0.048, which is significant at the 5% level, indicating that the promotion role of non-state-owned enterprises is significantly higher than that of state-owned enterprises. The reason is that, due to the particularity of state-owned enterprises, they are not sensitive to the market environment and environmental regulations, and they are supported by government finances, rather than state-owned enterprises that are responsible for their own profits and losses. The incentive effect of rights is greater for non-state-owned enterprises.

Table 5. Firm attribute heterogeneity

	TFP	TFP
	(1)	(2)
DID	0.1097 ***	0.0480 *
	(5.2263)	(1.6887)
_cons	-3.7551 ***	-3.9059 ***
	(-7.4210)	(-5.9081)
control variable	YES	YES
individual fixation	YES	YES
time fixed	YES	YES
N	14516	6844
adj. R^2	0.9275	0.9509

4.4.2. Regional Differences in Enforcement Efforts

Table 6. Law enforcement heterogeneity

	TFP	TFP
	(1)	(2)
DID	0.0689 ***	0.0973 ***
	(2.8071)	(3.2042)
_cons	-3.8289 ***	-4.8564 ***
	(-7.6369)	(-6.5034)
control variable	YES	YES
individual fixation	YES	YES
time fixed	YES	YES
N	16527	4894
adj. R 2	0.9401	0.9483

This paper draws on Fan Dan et al. (2022) to estimate the law enforcement intensity of each province, divides the sample into two sub-samples with high law enforcement intensity and low law enforcement intensity, and conducts regressions respectively. The results are shown in Table 6 below. Column (1) is the heterogeneity regression result in areas with weak law enforcement, and column (2) is the heterogeneity regression result in areas with strong law enforcement. According to the regression results, it can be seen that carbon emission trading has a significant positive impact on the total factor productivity of enterprises in regions with high and low law enforcement. The coefficient of the term is 0.073, indicating that carbon emissions trading plays a greater role in areas with high law enforcement. The reason may be that in areas with low law enforcement efforts, due to insufficient supervision, enterprises avoid environmental penalties, while areas with high law enforcement efforts have great environmental pressure on enterprises, so incentive-based environmental regulations have an incentive effect on enterprises in areas with high law enforcement efforts. Better, it can force enterprises to increase technological innovation and eliminate backward production capacity, thereby promoting total factor productivity.

4.4.3. Coastal and Inland Differences

The large differences in the degree of enterprise development between coastal and inland provinces, this paper divides the sample into two subsamples for regression according to the registered place of the enterprise in coastal or inland provinces. The results are shown in Table 7 below. (1) is listed as the heterogeneity regression result for inland provinces, and (2) is listed as the heterogeneity regression result for coastal provinces. According to the table below, the coefficient of the interaction term in column (1) is 0.1057, which is significant at the 1% level; the coefficient of the interaction term in column (2) is 0.0535, which is significant at the 1% level. Obviously, carbon emission trading has a greater effect on promoting the total factor productivity of enterprises in inland provinces. The reason is that the economic development of the coastal provinces is higher than that of the enterprises in the inland provinces, so the total factor productivity of the enterprises in the inland provinces will be greater. Therefore, under the influence of carbon emission trading, the total factor productivity of enterprises in inland provinces increases faster than that in coastal provinces.

Table 7. Geographical heterogeneity of firms

	TFP	TFP
	(1)	(2)
DID	0.1057 ***	0.0535 ***
	(3.0634)	(3.4639)
_cons	-4.0363 ***	-3.9764 ***
	(-5.4960)	(-8.2303)
control variable	YES	YES
individual fixation	YES	YES
time fixed	YES	YES
N	8218	13197
adj. R 2	0.9449	0.9407

5. Conclusion and Inspirations

Promoting the improvement of the total factor productivity of enterprises is an important way to achieve high-quality economic development in China. From the perspective of total factor productivity, this paper uses the quasi-natural experiment of the opening of the carbon trading market to evaluate the impact of carbon emissions trading on enterprises by using the double-difference method. The impact of total factor productivity and the impact path, and also passed the robustness test. This paper further explores the difference in the impact of carbon emissions trading on the total factor productivity of enterprises under different circumstances, and conducts a heterogeneity analysis. Finally, the following conclusions are drawn: First, carbon emission trading has promoted the total factor productivity of enterprises in the pilot provinces. The empirical results have passed robustness tests such as parallel trend test and placebo test. Second, carbon emission trading can improve the total factor productivity of enterprises by promoting technological progress and capacity utilization. Third, there is heterogeneity in the impact of carbon emission trading on the total factor productivity of enterprises under different circumstances. Compared with enterprises in state-owned, low-enforcement areas, and inland provinces, carbon emissions trading has a greater effect on the total factor productivity of enterprises in non-state-owned, high-enforcement areas, and inland provinces.

The research conclusions of this paper can provide experience and evidence for enterprises to improve production efficiency and for the government to improve and continue to carry out national carbon emissions trading, and also provide inspiration for promoting high-quality economic development in China. For enterprises: First, under the carbon trading policy, enterprises should actively change their production methods, rationally allocate production factors, and improve their own total factor productivity by eliminating outdated production capacity and improving capacity utilization, so as to achieve sustainable profitability and ecological the environment is improved. Second, we must pay attention to the importance of technological innovation, increase investment in innovation, improve production technology or introduce new process technology, and promote the simultaneous improvement of production efficiency and quality. For the government: First, it should adhere to and improve the carbon emission trading system, and further expand the scope of industries involved in the national carbon trading market. Second, adhere to the combination of market-oriented environmental regulation and the promotion of high-quality economic development, insist on eliminating outdated production capacity, advocate technological innovation, accelerate the transformation of enterprise production methods, reduce environmental pollution and improve production efficiency and quality, that is, promote total factor productivity, in order to achieve A win-win situation between ecological environment improvement and high-quality economic development. Third, the key to the effective use of carbon emissions trading is a sound market mechanism. The government should continue to improve the market system and allow the market to play a decisive role in resource allocation. Fourth, the government should increase the enforcement of environmental protection, force enterprises to innovate in technology, improve the allocation of production factors, and independently eliminate backward production capacity. At the same time, it is necessary to "prescribe the right medicine" according to the differences in the attributes of different regions and enterprises.

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