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The Impact of Carbon Emissions Trading on Exporters' High-Quality Development -- Evidence from Chinese Listed Companies

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Abstract: *In this paper, we test whether the carbon emissions trading system can generate the "Porter effect" and thus affect the total factor productivity of enterprises in a quasi-natural experiment based on the carbon emissions trading policy piloted in China since 2011. Using the data of listed companies with export business in Shanghai and Shenzhen stock markets from 2008 to 2019, an asymptotic double difference model is used to test the effect of the carbon emissions trading policy by comparing the total factor productivity levels of exporting enterprises before and after the implementation of the policy. It is found that the implementation of carbon emissions trading policy contributes to the high-quality development of exporting firms, and the findings still hold after a series of robustness tests such as mitigating endogeneity and overcoming the selectivity bias of the sample.*

Keywords: *environmental regulation; carbon emissions trading; high-quality development; asymptotic double difference*

1. Introduction

Over the past four decades since the reform and opening up, China's economy has developed rapidly and achieved world-renowned achievements. However, at the same time, the crude economic growth model based on resource inputs has led to increasingly serious environmental problems, increasing energy consumption and carbon dioxide emissions, and increasing pressure on China to save energy and reduce emissions in the international arena. In September 2020, General Secretary Xi Jinping proposed at the general debate of the United Nations General Assembly that China would commit to promoting a low-carbon transition, actively participate in green cooperation among countries, and strive to achieve two goals: first, to peak carbon emissions by 2030 The first is to achieve peak carbon emissions by 2030, and the second is to achieve carbon neutrality by 2060.

From a global perspective, the EU carbon trading system is currently the world's largest carbon trading market, which started in 2005 and has performed remarkably in terms of development speed, financial attributes and carbon financial derivatives, which has greatly promoted the process of carbon emission reduction. China's carbon market started late compared with it.In October 2011, the National Development and Reform Commission (NDRC) issued the Notice on the Pilot Work of Carbon Emission Trading, which clearly launched the pilot work of carbon emission trading in seven provinces and cities, including Beijing, Shanghai, Hubei, Chongqing, Guangdong, Tianjin and Shenzhen.At the end of 2017, the NDRC issued the National Carbon Emission Trading Market Construction Plan, indicating that China's carbon emission trading The era is fully opened.

Under the dual background of increasingly prominent environmental problems and China's continuous pursuit of high-quality economic development, the impact of environmental regulation on high-quality economic development has also become more and more valuable for research [1-4]. Therefore, this paper focuses on carbon emissions trading to explore whether the implementation of this policy can promote the high-quality development of export enterprises and achieve a win-win situation for both economic development and environmental protection.

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2. Literature Review and Policy Background

2.1 Literature review

There are abundant studies on the impact of environmental regulations on the high-quality development of enterprises at home and abroad, but the relationship between the two has been controversial and can be divided into three views. First, from the perspective of cost, some scholars believe that environmental regulations will increase the additional burden of enterprises, leading to an increase in the cost of production and management, thus reducing the level of high quality development [5]. Barbera and McConnell (1990) and Gray and Shadbegian (2003), based on data from the U.S. manufacturing industry, conclude that command-based environmental regulations reduce the level of quality development of firms [6-7].

Second, some scholars argue from an innovation perspective that appropriate environmental regulations can stimulate firms to continuously innovate and thus enhance their high quality development. Among them, Porter's hypothesis proposed in Porter and van der Linde (1995) is the most influential, that is, appropriate environmental regulation can lead to innovation, efficiency improvement, more rational internal distribution, and ultimately productivity enhancement [8]. The Porter hypothesis has been widely accepted by scholars. Hamamoto (2006) and Testa et al. (2011), using the Japanese manufacturing sector and the EU construction industry, respectively, find that environmental regulation brings about an increase in R&D investment, which promotes firm innovation and, in turn, brings about productivity growth [9-10].

Third, another part of scholars argues that there is a non-linear relationship between environmental regulation and high quality development. The impact of environmental regulation on quality development depends on the relative magnitude of the "cost" and "innovation" of environmental regulation.

2.2 Policy background

The concept of carbon emissions trading was first introduced by the American scientist Dales in 1986, and then it was applied to the environmental governance of many European countries. With the signing of the Kyoto Protocol in 1997, the emission reduction tasks of each country were further clarified, which made the carbon emission trading policy gain wider attention and application. China, as a responsible power, has proactively taken the global responsibility to reduce carbon emissions and made a commitment to reduce its total carbon emissions by 60%-65% by 2030 compared to 2005. The National Development and Reform Commission designated Beijing, Shanghai, Shenzhen, Tianjin, Chongqing, Guangdong Province and Hubei Province as pilot areas for carbon emissions trading policies in October 2011. By reviewing historical trading data in the China Carbon Emissions Trading Network, it was determined that carbon emissions trading officially began in Shenzhen in June 2013, in Beijing and Shanghai in November 2013, in Guangdong Province and Tianjin in December 2013, in Hubei Province and Chongqing in April and June 2014, and in Fujian Province in October 2016.

The carbon trading policy is a type of tradable emission permit system, which means that each enterprise that emits pollutants is allocated a certain amount of pollutant emission targets according to a certain method, and the enterprises use these targets according to their own pollutant emissions and buy and sell the targets in the market according to their needs [11-13].

In the 1980s, China's tradable emission rights system began with the practice of trading water pollution emission rights in Shanghai, and in 1989, China promulgated the Pilot Work Program for the Emission Permit System for Air Pollutants, which launched the pilot implementation of the air pollutant emission trading policy. Then, at the beginning of the 21st century, China conducted the pilot implementation of sulfur dioxide emission trading policy, which provided the experience for the pilot implementation of carbon emission trading policy.

3. Model Setting, Sample and Data

3.1 Setting of the asymptotic double-difference model

This paper considers the implementation of the pilot carbon emissions trading policy as a quasi-natural experiment and examines the impact of the implementation of the policy on the

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high-quality development of export enterprises. The total factor productivity of enterprises is taken as a proxy variable for high-quality development, and a progressive double difference model is used to study the change in the level of high-quality development of export enterprises before and after the implementation of the policy. Among them, export enterprises in eight pilot provinces and cities are used as the treatment group, and enterprises in other non-pilot provinces and cities are used as the control group.

$$Y_{ijtk} = \beta_0 + \beta_1 post \times treat + \lambda X + \gamma_i + \mu_j + n_t + m_k + \varepsilon_{ijtk}$$

Y_{ijtk} denotes the total factor productivity of an enterprise k located in the province i industry j in year t. $post$ is a dummy variable with values of 0 and 1, taking 0 before the pilot carbon trading and 1 after the pilot emissions trading; $treat$ denotes the value of 1 when the firm is located in the pilot region and 0 when it is located in the non-pilot region. $post \times treat$ is the treatment effect, and its coefficient β_1 is the effect of the pilot carbon trading policy on the total factor productivity of the firms of interest in this paper, and if it is significantly positive, it indicates that the pilot carbon trading policy helps improve the total factor productivity of exporting firms in the pilot region. X is a set of control variables, including firm age, number of employees, gearing ratio, return on net assets, operating cash flow, cash paid for the purchase and construction of fixed assets, etc., book-to-market ratio, administrative expense ratio, operating income growth rate, market-to-net ratio, and regional economic development level. γ_i is regional fixed effects, μ_j is industry fixed effects, n_t is year fixed effects, m_k is individual fixed effects, and ε_{ijtk} is random error terms.

3.2 Sample and data

This paper selects the data of listed companies from 2008-2019 for the study, and the basic characteristics and financial data of the companies are obtained from the CSMAR database. Macro-level data are from the China City Statistical Yearbook. The official start of trading in the pilot areas is obtained from the historical data of China Carbon Emission Trading Network. For the definition of exporting enterprises, this paper uses one item of overseas business income from Wind database for screening and removes those enterprises without overseas business income in the sample period.

To ensure the reliability of the empirical results, this paper refers to the common practice in other literatures and excludes the data of the following enterprises:

a. enterprises suffering from continuous losses, i.e., ST and *ST enterprises;

b. financial enterprises. The industry specificity of financial enterprises may cause their sensitivity to environmental policies to be much lower than that of other industries, making the empirical results biased;

c. enterprises with serious missing values.

3.3 Description of important variables

3.3.1 Carbon emission trading pilot policy

The core explanatory variable of this paper, carbon emissions trading pilot policy, is the product of the time dummy variable of policy implementation and the pilot area dummy variable. In the treatment of the start time of the pilot policy, since it takes a certain response time for the enterprises implementing the pilot policy in the current year to make adjustments and affect total factor productivity, at the same time, the actual compliance time of enterprises each year is June of the next year. Based on this, this paper treats the occurrence of policies that start trading before June of the current year as the current year, and the occurrence of policies that start trading after June as the next year.

3.3.2 Control variables

In order to select the factors that affect the high quality development of enterprises as comprehensively as possible, this paper refers to the relevant literature on the study of high quality development of enterprises and selects control variables including enterprise age (lnAge), enterprise size (lnSize), gearing ratio (lnLEV), cash flow (lnOpcf), purchased assets (lnPpe), book-to-market ratio (lnMB), net Return (lnROE), Management Expense Ratio (lnMER), Operating Income Growth Rate

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(lnGrowth), Price to Net Ratio (lnPB), and Regional Economic Development Level (lnrgdp), and each variable and its definition are shown in Table 1 below.

Table 1: Descriptive statistics of main variables

Variable Name	Variable Definition	N	mean	sd	min	max
tfp_op	OP method calculates the total factor productivity of the enterprise	14,955	6.610	0.895	1.049	10.78
did	$post \times treat$ Interaction items	14,955	0.305	0.460	0	1
lnSize	Number of employees + 1 in natural logarithm	14,717	7.709	1.286	0	12.72
lnAge	Business age + 1 take the natural logarithm	14,955	2.824	0.338	0	4.174
lnLEV	Gearing ratio + 1 takes the natural logarithm	14,715	0.338	0.169	0.00749	4.968
lnMB	Book-to-market ratio + 1 takes the natural logarithm	14,613	0.465	0.149	0.000571	2.021
lnROE	Return on net assets + 1 takes the natural logarithm	14,776	0.0565	0.196	-10.26	3.960
lnMER	Management expense ratio + 1 takes the natural logarithm	14,951	0.0990	0.107	0.00111	7.375
lnGrowth	Operating income growth rate + 1 is taken as natural logarithm	14,434	0.196	0.512	-4.433	8.412
lnPB	Net Price Ratio+1 takes the natural logarithm	14,556	1.422	0.528	0.115	7.602
lnOpcf	Net cash flow from operating activities/total assets + 1 taking the natural logarithm	14,950	0.0401	0.0719	-0.833	0.664
lnPpe	Cash paid for the acquisition of fixed assets, intangible assets and other long-term assets/total assets + 1 taking the natural logarithm	14,950	0.0503	0.0457	0	0.472
lnrgdp	Regional GDP per capita + 1 by natural logarithm	14,955	17.60	1.044	13.49	19.33

4. Empirical Results and Analysis

4.1 Impact of the pilot policy of carbon emission trading on the high-quality development of export enterprises

The regression model set above is used to study the impact of the implementation of the carbon emissions trading policy on the high-quality development of export enterprises. Table 2 shows the estimation results of model . The regression controls for year, individual, region, and industry fixed effects, and the difference between the two columns of regression results is whether control variables are added or not. This regression was conducted separately by adjusting the control variables with fixed effects, and the results are presented in Table 2. The estimation results show that in several regressions, the regression coefficients of the core explanatory variables are significantly positive at least at the 5% level. This indicates that the pilot implementation of the research carbon trading policy has a significant contribution to the high-quality development of export enterprises. In the following, this paper will conduct a series of robustness tests to make the empirical results more reliable.

Table 2: Regression results

	(1)	(2)	(3)	(4)
VARIABLES	tfp_op	tfp_op	tfp_op	tfp_op
did	0.0902**	0.0655***	0.0655***	0.0643***
	(0.0384)	(0.0138)	(0.0138)	(0.0239)
Constant	6.381***	6.590***	6.590***	-3.765
	(0.0383)	(0.00528)	(0.00528)	(3.659)
Control				YES
year FE	YES	YES	YES	YES
id FE		YES	YES	YES
diqu FE			YES	YES
hangyeFE			YES	YES
Observations	14,955	14,952	14,952	13,733
R-squared	0.029	0.830	0.830	0.895

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

ISSN 2616-5902 Vol. 4, Issue 9: 16-21, DOI: 10.25236/AJBM.2022.040903

4.2 Parallel trend test

The parallel trend hypothesis is a prerequisite for the consistency of the double-difference results, which means that the total factor productivity trends of the treatment and control groups should be the same without the existence of policy intervention. To ensure the validity of the empirical results, this paper uses dynamic analysis to conduct a parallel trend test to verify whether the changes in total factor productivity are consistent between the two groups of regions before the implementation of the pilot policy. According to the parallel trend results, the coefficients of the interaction terms are not significant in the first five years of policy implementation, but start to be significant gradually after the policy implementation, and pass the parallel trend test. According to the parallel trend test results, the reason for the insignificance in the 2nd year of policy implementation may be that there is a certain lag in the effect of the pilot policy, the policy needs to be promoted gradually, and the R&D innovation and resource allocation optimization of enterprises need time.

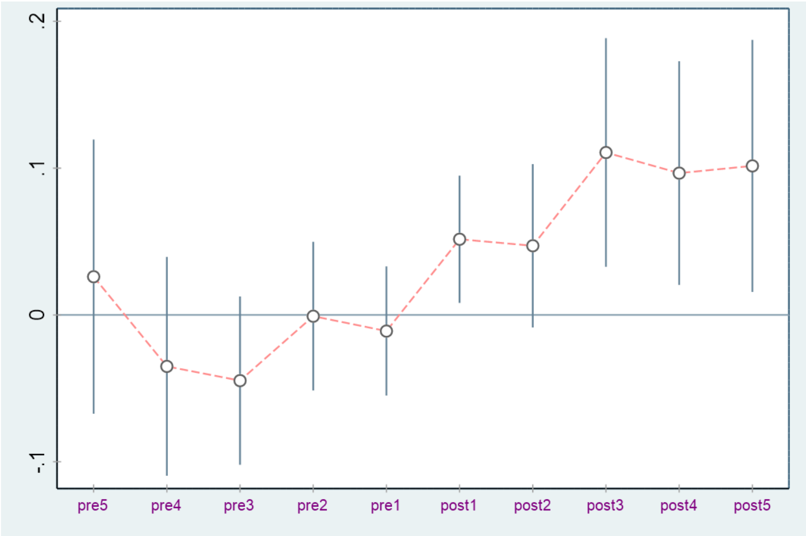

Figure 1: Parallel trend test results

5. Conclusions and Policy Implications

China's economic development is constantly pursuing high quality rather than high speed, and the improvement of enterprises' high quality development level is not only crucial in the structural change on the supply side, but also a fundamental driving force to ensure that the economy can develop with high quality and maintain medium-high growth. The carbon emission trading system is an important policy tool to fully mobilize market factors to promote the reduction of carbon emissions by enterprises, and is an important innovation to promote low-carbon development and green development in the system, which is an important part of achieving "carbon peak" by 2030 and "carbon neutral" by 2060. It is an important part of achieving "carbon peak" in 2030 and "carbon neutral" in 2060. In the context of the increasingly severe global environment and the development of China's foreign trade, with a considerable proportion of export business, can the pilot policy of carbon emissions trading enhance the high-quality development of export enterprises and thus contribute to the high-quality development of China's economy?

In order to answer this question, this paper uses the 2011 Chinese carbon emissions trading pilot policy as a quasi-natural experiment, employs micro firm-level panel data from 2008-2019, measures total factor productivity of exporting firms using the OP method, and uses an asymptotic double difference model to estimate according to the difference in the actual implementation time of the policy in each region, finally confirming that the carbon emissions trading pilot policy The impact of the implementation of the pilot policy of carbon emissions trading on the level of high-quality development of export enterprises in the pilot regions is finally confirmed. To address the endogeneity problem brought by different factors, a placebo test and a parallel trend test are conducted in this paper, and the empirical results still hold. The high level of total factor productivity of enterprises is a key factor in measuring the high quality development of the economy, and it can be expected that the carbon emissions trading policy can play a role in contributing to the high quality development of the Chinese

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economy.

Based on the above findings, this paper proposes a policy implication: make full use of market forces to develop a carbon emission trading system. In the current context of focusing on improving the level of high-quality economic development, it is important to make full use of the strong power of the market to solve environmental problems. The results of this paper confirm that the carbon trading policy can effectively promote the improvement of total factor productivity of enterprises while restraining their carbon emissions. It is foreseeable that the future promotion of carbon emissions trading policy nationwide should help the combination of high-quality economic development and ecological civilization construction, all of which cannot be achieved without the decisive role of the market in resource allocation.

The results of this paper provide some support for the positive relationship between carbon trading emission trading policy and the level of high-quality development of export enterprises, but there are limitations in the study due to certain data limitations, and the study can be further improved with further disclosure of data.

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