Study on the Relationship between Carbon Trading and Future Development of Enterprises--Based on Double Difference Model

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Abstract: As an initiative to promote carbon emission reduction, it is worth studying whether carbon trading can promote the future development of enterprises in the context of the "double carbon" target. The article investigates the impact of carbon trading on the future development of enterprises based on the business data of emission-controlled enterprises from 2002 to 2020 using a double difference model. The results of the empirical study find that carbon trading can promote the future development of enterprises, and this result still holds after robustness testing by various methods; the heterogeneity analysis finds that private, large-scale, and long-lived enterprises are more inclined to diversify. This paper provides some theoretical and empirical evidence to further promote the development of China's carbon market from the perspective of micro enterprises.

1. Introduction

On May 25, 2021, the World Bank released "Carbon Pricing Mechanisms Development Status and Future Trends 2021", stating that there are currently 64 carbon pricing mechanisms operating around the world, covering 21.5% of global greenhouse gas emissions, an increase of 6.4 percentage points over the previous year. 6.4 percentage points higher than the previous year; carbon pricing is a tool to reduce greenhouse gas emissions, which can record the external cost of greenhouse gas emissions, provide price signals to emitters, and help reduce the burden of carbon emissions; with the convening of the United Nations Conference on Development and Environment and the signing of the Kyoto Protocol, carbon peaking has become a global hot topic triggering discussions, along with the establishment of the EU ETS, EU- ETS has provided an effective paradigm for countries around the world to operate emissions trading, and has accumulated a large amount of data and experience, and more and more countries are shifting the control of carbon emissions from administrative regulation to the market area.

With the rapid economic development, China's greenhouse gas emissions have increased dramatically. In order to speed up the pace of transition to a green and low-carbon economy, China's carbon trading market has been gradually established following the EU-ETS approach. By creating two types of basic assets, namely carbon emission quota and project emission reduction, China has formed a market similar to the stock market that can be used for trading and circulation. Since 2011, China has conducted carbon emission trading pilot projects in seven provinces and cities, including Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong and Shenzhen, and has correspondingly established seven carbon trading institutions. All of them have started online trading in 2014. China has been working hard to fulfill peak carbon dioxide emissions's goal of carbon neutrality. The 2022 Beijing Winter Olympics will adopt hydrogen, the ideal clean energy in the 21st century, to neutralize all the carbon emissions generated and become the "greenest" Olympics.

In this study, the carbon emission trading pilots in Beijing, Shanghai, Tianjin, Guangdong, Hubei, Chongqing, Shenzhen and Fujian are taken as quasi-natural experiments, and the control group and the experimental group are set up for the companies that are included in carbon trading and those that are not. The data of listed companies from 2002 to 2020 are used to explore the relationship between carbon trading and the future development of enterprises.

2. Literature Review and Research Assumptions

2.1 Research on the Influencing Factors of Enterprise's Future Development

In recent years, domestic and foreign scholars have focused on the consideration of geographic expansion and business diversification for the future development and operation of enterprises[1].

With regard to the research on the geographical expansion of enterprises, Li Shanmin and Zhu Tao (2006) found that the uneven development of the marketization process led to the disparity of enterprises' choice of geographical expansion[2]; Song Tiebo (2010) found that different institutional environments have a great influence on the expansion of enterprises' geographical expansion[3]; Damianos and Skuras (1996) concluded that factors such as environment, soil characteristics, climate, and topography influence the development direction by studying the development tendency of agricultural enterprises' geographical expansion[4]; Khanna and Palepu (2000), Fauver et al. that factors such as environment, soil characteristics, climate, and topography influence the direction of development[5]; Fauver,L and Houston,J et al.,(2003) showed that institutional environmental factors in a country can have an impact on the future development of business operations, while institutional environmental factors have uncertain results due to other aspects of business considerations[6].

For the study of business expansion, Lian, Xi-Ping (2003) argued that the degree of perfection of the market economy system and the influence of government policies can, to a certain extent, play a misleading role in business expansion, which in turn is detrimental to the future development and growth of enterprises[7]; Stein (1997) compared the development of enterprises with business expansion and a single business sector to conclude that environmental factors have a more significant impact compared to market policy factors[8].

2.2 The Impact of Carbon Trading on Microenterprises

For the analysis of carbon trading on enterprise business performance, most scholars corroborate the positive impact of carbon trading on enterprise performance from the perspectives of production cost and total factor productivity. Zhang Tao (2022) conducted a study through multi-period DID and found that carbon trading can effectively improve the investment efficiency of enterprises[9]; Fan Dan and Fu Jiawei (2022) used a double difference model to obtain that carbon trading significantly improves the total factor productivity of enterprises, which in turn improves the business performance of enterprises[10]; Zhou Chang, Cai Haijing and Liu Meijuan (2020) studied the impact of carbon trading on the production cost of enterprises, and then concluded that carbon trading can reduce the production cost of enterprises and effectively improve their financial performance[11].

For the impact of carbon trading on enterprise green innovation,, Song Deyong (2021) studied the impact of different carbon trading on green innovation, and compared with the historical method, the benchmark method allocation has a stronger promotion effect on enterprise green innovation[12]; from the perspective of carbon price signal, Wei Lili (2021) concluded that the higher the carbon price, the stronger the impact of carbon trading on enterprise green technology innovation[13]. Xuan Wan and Jun Wang (2022) The impact of carbon trading on enterprises' green product innovation The direct effect of carbon emissions trading policy and the moderating effect of product conversion rate can both promote green product innovation of export enterprises within the pilot provinces and cities[14].

In summary, the existing research has the following shortcomings: the research on the value of carbon trading for the future development of enterprises in the context of “double carbon” is still in a blank stage, and the literature on the future development direction of enterprises is yet to be explored. Based on this, this paper studies the impact of carbon trading on the development of enterprises with pilot policies.

3. Research Design

3.1 Sample Selection and Data Sources

In this paper, the establishment of carbon trading market is considered as a proposed natural experiment, and the differential method is used to explore the impact of the implementation of carbon trading on the future development development of enterprises. The data in this paper are obtained from Wind database, and the data of enterprises listed in Shanghai and Shenzhen A-shares are selected as the original data, and some treatments are done according to the research convention: (1) eliminating the abnormal sample data of ST and PT; (2) eliminating the data of duplicate years; (3) eliminating the data that cannot effectively distinguish the industries and regions to which they belong, and processing by the tailing and interpolation method, and finally obtaining 2167 enterprises' annual data.

3.2 Model and Variable Definition

Since the implementation time of carbon emission policies varies from province to province, this paper adopts an asymptotic double difference approach, specifically setting up the following econometric research model:

$$HI_{it} = \beta_0 + \beta_1 AP_{it} + \lambda M_{it} + v_i + \mu_t + \varepsilon_{it} \quad (1)$$

1). Explained variable

This paper uses HI to measure future development (HI_{it}), Indicates the development level of province “i” in the “t” year..It is the proportion of key business profits to total business profits.

2). Core explanatory variable

The core explanatory variable of the model is the establishment of the carbon trading pilot market, including two dummy variables PT and AP_{it}. ①It is the time virtual variable of policy implementation, which is 0 before implementation and 1 after implementation. In addition, in addition to the above six provinces and cities, Fujian Province participated in carbon trading and established a carbon emission reduction market in 2016.② AP_{it} represents the interaction between grouping and policy time, and its coefficient β_1 represents the effect of policy implementation.

3). Control variable

M_{it} is a control variable composed of other factors that affect the future development of an enterprise. The selection of control variables refers to the practice of authoritative literature (Chen Xinyuan, 2007), including enterprise scale, property right attribute and innovation input[15].

4. Empirical Results and Analysis

4.1 Statistical Results

Table 1 Variable Description Statistics

Variable	Mean	SD	Min	Max
HI	0.249	0.273	0.000408	2.500
AP	0.0380	0.191	0	1
treat	0.0426	0.202	0	1
PT	0.375	0.484	0	1
id	257,667	263,840	2	900,957
year	2,017	2.684	2,006	2,020
state	0.299	0.458	0	1
age	2.872	0.333	0	3.970
dual	0.303	0.458	0	1
size	22.20	1.294	19.71	25.68

Table 1 is a descriptive statistical result of the variables studied. The average HI index of enterprises is 0.249, and the standard error is 0.273. It can be seen that there is little difference

between the enterprises included in the carbon emission trading pilot and those not included. The average value of the AP indicator is 0.038, indicating that 197 enterprises were included in the carbon emissions trading pilot in the sample annual interval. It can be seen that enterprises of different sizes differ greatly.

4.2 Correlation Analysis

Table 2 shows that the correlation coefficient between the variables is kept at a low level, indicating that the multicollinearity of the model is weak, in which the future development degree of the enterprise has a positive correlation with the core explanatory variable carbon trading, which basically conforms to the above hypothetical analysis.

Table 2 Variable Correlation Coefficient Table

	HHI	TP	ind to~q	mb	state	dual	sharer~1
HHI	1						
TP	0.0116	1					
ind to~q	-0.0370*	0.0148	1				
mb	-0.0180	0.0310*	-0.5039*	1			
state	0.1199*	0.0383*	-0.1621*	0.2348*	1		
dual	-0.0779*	-0.0193	0.1178*	-0.1276*	-0.2586*	1	
sharerate1	0.0232	0.0614*	-0.1392*	0.1282*	0.2091*	-0.0604*	1

	roe	debtrate	tran	intan	ocf	size	age
roe	1						
debtrate	-0.1361*	1					
tran	-0.0452*	0.0593*	1				
intan	-0.0365*	-0.00980	0.1709*	1			
ocf	0.2936*	-0.1927*	0.2436*	0.0675*	1		
size	0.1048*	0.4429*	0.0809*	-0.0285*	0.0530*	1	
age	-0.0499*	0.1260*	0.00830	-0.0196	-0.0217	0.1564*	1

4.3 Regression Analysis of Double Difference Model

1). Net Benefit Analysis of Carbon Trading

The sample time spans the years before and after the implementation of the policy, and the observed values are all at the enterprise level, so the panel data analysis method should be adopted. Table 3 The results show that the regression coefficient between the core explanatory variable AP and the future development of the enterprise is higher, and the more obvious the effect, the higher the future development of the enterprise.

Table 3: Regression Analysis Table

HI	CC	SD	t	p	CI	
AP	0.3416	0.0823	4.150	0.000	0.180	0.503
dual	0.00537	0.0182	0.300	0.768	-0.0303	0.0411
size	-0.0123	0.0175	-0.700	0.484	-0.0467	0.0221
age	-0.0238	0.134	-0.180	0.859	-0.287	0.239

2). Influence analysis of control variables

Through the analysis of the control variables and the future development of the enterprise, it is concluded that the proportion of the largest shareholder has a negative correlation with the future development of the enterprise; There is a significant positive correlation between innovation investment and the future development of the enterprise, which can promote the future development of the enterprise.

4.4 Robustness Test

4.4.1 Parallel Trend Test

An important prerequisite for using the asymptotic double difference approach is that there is no significant difference in the level of development or a common growth trend between firms participating in carbon trading and those not participating before and after the implementation of the

policy, and this paper tests the trends presented. The results in Figure 1 show that there is a significant difference between before and after the implementation of the mechanism, and the parallel trend test is passed.

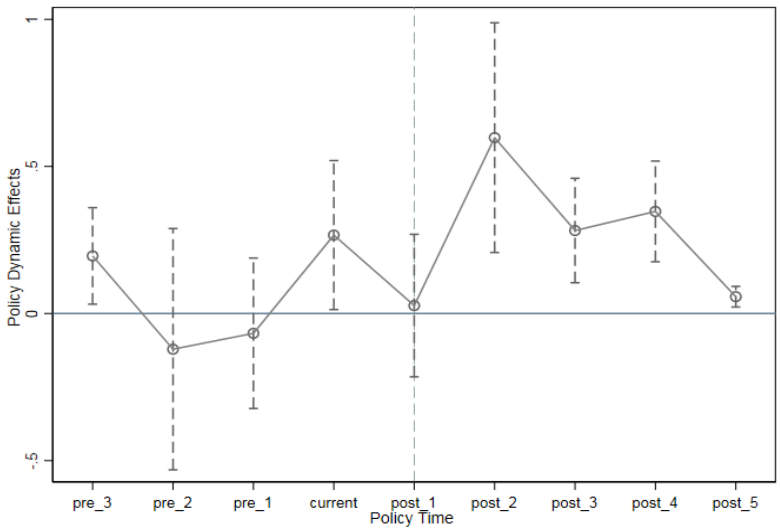

Figure 1 Parallel Trend Test

4.4.2 Placebo Test

In this paper, a placebo test was conducted by randomizing the treatment groups and time variables. The new dummy treatment groups are randomly selected according to the proportion of treatment groups to the total number of samples; the new dummy time variables are randomly selected according to the number and the interaction term is constructed to re-estimate model (1), and the above process is repeated 500 times. the proportion of 500 coefficients inside less than the true coefficient reaches 87.4%, the mean value is around 0, and the probability of less than the true value is 87.4%, indicating that the true coefficients are reliable, indicating that carbon trading has the most significant driving effect on the degree of development of enterprises' future development.

5. Further Analysis

Although this paper has argued for the driving effect of the carbon emission mechanism on the future development development of enterprises, are there differences in the responses of different enterprises in the pilot regions to policy shocks? Therefore, this paper discusses the heterogeneity of enterprises' internal characteristics from the perspective of enterprises.

5.1 Enterprise Size.

This paper investigates whether the diversification of larger firms under carbon trading is somewhat different from that of smaller firms. The results in Table 4 conclude that larger firms are more inclined to diversify.

Table 4 Analysis on Heterogeneity of Enterprise Scale

	size1_0	size1_1
AP	-0.0278**	0.0301**
	(-0.68)	(1.23)
_cons	0.622***	0.384***
	(-11.23)	(-3.6)
Control variable	Yes	Yes
Time fixed effect	Yes	Yes
Indi fixed effect	Yes	Yes
Regi fixed effect	No	No
r2	0.0542	0.0323

The above analysis may be attributed to the fact that companies face competition and often

choose to dominate the market as quickly as possible. And for smaller enterprises there are more restrictions, costs staff quality and other pressures.

5.2 Ownership.

Does participation in carbon trading have different effects depending on the ownership of the enterprise? The analysis in Table 5 concludes that private enterprises have a better effect on future development. The results of the heterogeneity analysis may be attributed to the following reasons: state-owned enterprises are mostly government-invested enterprises, which are in a dominant position in resource allocation and have financial support, and state-owned enterprises are not willing to take risks.

Table 5 Analysis on Heterogeneity of Enterprise Ownership

	state1_0	state1_1
AP	0.0427**	0.0368**
	(1.04)	(0.76)
_cons	0.896***	1.024***
	(10.42)	(10.38)
Control variable	Yes	Yes
Time fixed effect	Yes	Yes
Indi fixed effect	Yes	Yes
Regi fixed effect	No	No
r2	0.0342	0.0690

5.3 Business Age

Through the regression data in Table 6, it can be found that the longer the duration of the enterprise, the more willing it is to make development plans for the future. Generally speaking, the long-lived enterprises have a strong ability to withstand the impact of internal and external pressures, and are more likely to develop in the future due to their resource advantages and cost advantages.

Table 6 Analysis on Heterogeneity of Enterprise Age

	age1_0	age1_1
AP	0.249*	0.324***
	(1.43)	(3.21)
_cons	1.465***	1.082***
	(7.43)	(7.86)
Control variable	Yes	Yes
Time fixed effect	Yes	Yes
Indi fixed effect	Yes	Yes
Regi fixed effect	No	No
r2	0.0724	0.0499

6. Conclusions and Recommendations

6.1 Conclusions

This paper investigates the relationship between carbon trading and the future development and growth of enterprises using fundamental data of listed companies and a differential model, and further analyzes the heterogeneity of enterprise ownership, enterprise size, and enterprise age.

The results of this paper show that: (1) the establishment of carbon market can significantly promote the future development of enterprises, and this result still holds after the robustness test of multiple methods; (2) when considering the situation of enterprise ownership, private enterprises are more willing to carry out future development planning; (3) when considering the size of enterprises, larger enterprises are more willing to carry out future development planning; (4) when considering the age of enterprises, enterprises with longer existence time are more willing to carry out future development planning.

6.2 Recommendations

The policy recommendations are mainly the following two points:

1). To continue to promote China to carry out the establishment of a national carbon trading market and the development of carbon trading. According to the research results, the carbon market has a catalytic effect on the future development of enterprises, and the future development of enterprises is more conducive to exploring the market and improving their competitiveness.

2). We should actively explore the policy measures to establish a carbon market suitable for enterprises of different scales and nature. According to the results of the study, enterprises of different sizes, different ownership attributes and different duration of existence are different in terms of their future development after participating in the carbon market. When formulating measures, specific analysis should be made on a case-by-case basis to avoid the situation that "speed is not enough".

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