How do Carbon Emissions Trading Impact the Financialization of Non-Financial Companies? Evidence from a Natural Experiment in China

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Article

How Do Carbon Emissions Trading Impact the Financialization of Non-Financial Companies? Evidence from a Natural Experiment in China

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Abstract: This study examines whether and how carbon trading policy impacts the financialization of non-financial firms, using China emission trading scheme as a natural experiment. We show that the carbon trading policy has effectively long-term inhibitory effect on corporate financialization. Our findings are robust to possible result bias and more precise control group. In addition, we explore potential channels through which carbon trading policy can affect financialization, and find that it contributes to curb financialization by reducing financing constraints. Finally, we show that the relationship between carbon trading policy and financialization of non-financial companies is moderated by company's ownership, region and industry competition.

Keywords: carbon emissions trading; corporate financialization; financing constraints; difference-in-differences model

1. Introduction

Threats over global warming linked to carbon dioxide (CO_2) emissions from human activity have recently become salient [1], which are received growing attentions by academics, media, and politicians [2]. Countries are actively adopting carbon reduction action and may introduce significant limits on CO_2 emissions within the next decade to accomplish the 2°C or even 1.5°C control in the Paris climate agreement [1,3]. Previous research has documented that the carbon emissions trading has significant effects on firm-level outcomes (e.g. innovation, performance and stock returns) [4–7]. However, the literature widely neglects its influence on corporate financialization.

This study aims to explore how carbon emissions trading affects the financialization of non-financial companies (NFC). Corporate financialization can be defined as NFC increase investment in financial assets while reducing productive investment [8]. The financialization of NFC has become a common phenomenon in emerging markets. Taking China as an example, the disproportionately high growth beyond real economic needs of China's financial sector has enabled financial assets to bring substantial profits to enterprises [9], which exacerbates the profitability gap between the financial sector and the non-financial sector, leading NFC are forced to invest in more profitable financial assets due to the downturn in entities. However, existing research showed that financialization makes the surplus capital of NFC increasingly used for speculation and arbitrage instead of their main businesses [8], such as innovation or production improvement, thereby reducing the company's core business potential future profitability [10,11], which may cause a vicious circle of "low profit - financialization - lower future profitability".

At the same time, the possible impact of carbon emissions trading on corporate financialization is inconclusive. As a typical environmental regulation, carbon emissions trading can not only further damage NFC's profits through compliance costs, but also reduce the return on entities investment thereby weakening investor confidence in polluting companies, leading to underperformance of company stocks [12,13]. In this case, carbon emissions trading may exacerbate the financialization of NFC. However, the emissions trading may also reduce the financialization of NFC because, on the

one hand, companies can directly obtain economic benefits by selling carbon emission rights. On the other hand, it can stimulate firms to disclose carbon information [14], thus sending green signals to the market, which can attract more investors and ease the financial pressure of NFC. Therefore, it is necessary to assess the relationship between carbon emissions trading and the financialization of NFC.

To conduct the examinations, we use China as a laboratory since it provides an ideal research context. First, as the world's largest carbon emitters and emerging economies, China approved carbon emissions trading pilots in 7 provinces and cities since 2011 to promote the low-carbon economy transition, all of which launched trading in 2014. The implementation of carbon emissions trading pilots can be seen as a quasi-natural experiment for identifying the causal relationships between carbon emissions trading and financialization, whose strictly exogenous characteristic can prevent the possibly reverse shaping of carbon emissions trading by financialization. Second, the financialization of NFC and low-carbon development is a prominent social issue in China. China not only needs low-carbon economic transformation, but also rapid economic development. However, if carbon policies intensify the financialization of NFC, it will have a negative impact on the real economy in the future. Hence, studying the impact of carbon emissions trading on NFC financialization based on China context has practical significance.

Based on the differences between covered companies and non-covered ones before and after the carbon emissions trading pilots, we construct a difference-in-differences (DID) model and link it with the financialization index [11,15] to explore the impact of carbon emissions trading on the financialization of NFC. Using a sample of China listed NFC over the period of 2008 to 2020, we find that the financialization degree of NFC located in pilot areas significantly decreases, which still exists when we validate the robustness of the research. Hence, carbon emissions trading effectively inhibits the financialization of NFC.

Then, we explore the influence channel of carbon emissions trading. We find that carbon emissions trading can inhibit corporate financialization by reducing corporate financing constraints. The possible reason for this result is that, companies can gain direct economic benefits by selling carbon emissions rights. Li et al. [14] also pointed out that carbon trading can improve enterprises' transparency of carbon information, which can reduce information asymmetry and create an environmentally friendly corporate image, thereby alleviating financing distress.

Finally, we conduct several cross-sectional tests in terms of company ownership, company location and the degree of industry competition. We find that non-state-owned ownership, eastern location and high level of industry competition promotes the inhibitory effect of carbon emissions trading on financialization. Non-state-owned enterprises turn to holding more financial assets in order to survive in the context of the downturn in the entities economy leading they are more significantly affected by carbon trading policies. Whereas firms in eastern regions and highly competitive industries have to holding more financial assets under the combined pressure of competition and shrinking markets makes them very sensitive to the alleviation of financing constraints brought by carbon emissions trading.

Our research makes several contributions to the existing literature. First, to our best knowledge, we are the first to explore the relationship between carbon emissions trading and the financialization of non-financial companies. As one of the effective means to curb climate change, carbon emissions trading has attracted the attention of all countries. Previous research has proved carbon emissions trading has real effects on firms [4–7], but neglected its influence on corporate financialization. Our study extends the consequences of carbon emissions trading at the company level. Second, our results provide clear policy implications for low-carbon transitions in emerging markets. Nowadays, more than half of the world's top 10 carbon dioxide emitters are emerging and developing countries [16]. For them, non-financial firms not only are the main carbon emissions source, but also the key driver of economic development. Therefore, it is important to assess the impact of carbon emissions trading on the financialization of non-financial companies in emerging markets, because financialization is one of the obstacles to the corporate development. Taking the typical emerging market China as the background, we find that carbon emissions trading can reduce the financialization of non-financial

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companies, thereby promoting the low-carbon economy development, which can be referenced by other emerging markets.

The rest of this paper is organized as follows. Section 2 discusses the institutional background and hypothesis development. Section 3 introduces the sample construction and research design. Section 4 reports the empirical results, and Section 5 presents the influence channels of carbon trading policies. Then, section 6 presents the further tests conducted. Section 7 concludes.

2. Institutional Background and Hypothesis Development

2.1. Institutional Background

In order to effectively curb greenhouse gas emissions for achieving a carbon peak by 2030 and carbon neutrality by 2060, the Chinese government has taken several measures. One of the most effective policies is the carbon emissions trading pilots [17]. In 2011, China's National Development and Reform Commission (NDRC) designated Beijing, Shanghai, Tianjin, Hubei, Guangdong, Shenzhen and Chongqing as the first batch of pilot areas for the emissions trading. The pilot area spans from the eastern coastal area to the central and western regions. In 2014, all carbon trading markets in the seven pilot provinces and cities were in operation, including more than 20 industries such as steel, electricity, cement, etc. The specific pilot areas and covered industries are shown in Figure 1. From 2013 to 2019, the total amount of carbon trading in the pilot market increased from 445,500 tons to 31 million tons with the transaction volume raising from RMB 25 million to RMB 952 million, which brought significant economic impact [6].

Given that the characteristics and behaviors of firms cannot influence the formulation and promulgation of carbon emissions trading pilots, they can be regarded as a strictly exogenous quasi-natural experiment. Hence, the pilots provide an ideal context without endogeneity to examine the impact of carbon trading on the financialization of NFC due to the post-policy differences among companies caused by their external shock. Specifically, the carbon emissions trading pilots bring two significant differences, one is that the carbon emission allowances can be traded after the pilots and the other is that carbon trading can only be carried out by covered industries in pilot areas. Therefore, based on the two-dimensional changes brought by the pilots, we construct the difference-in-differences model to identify the causal influence of carbon trading on the financialization of NFC.

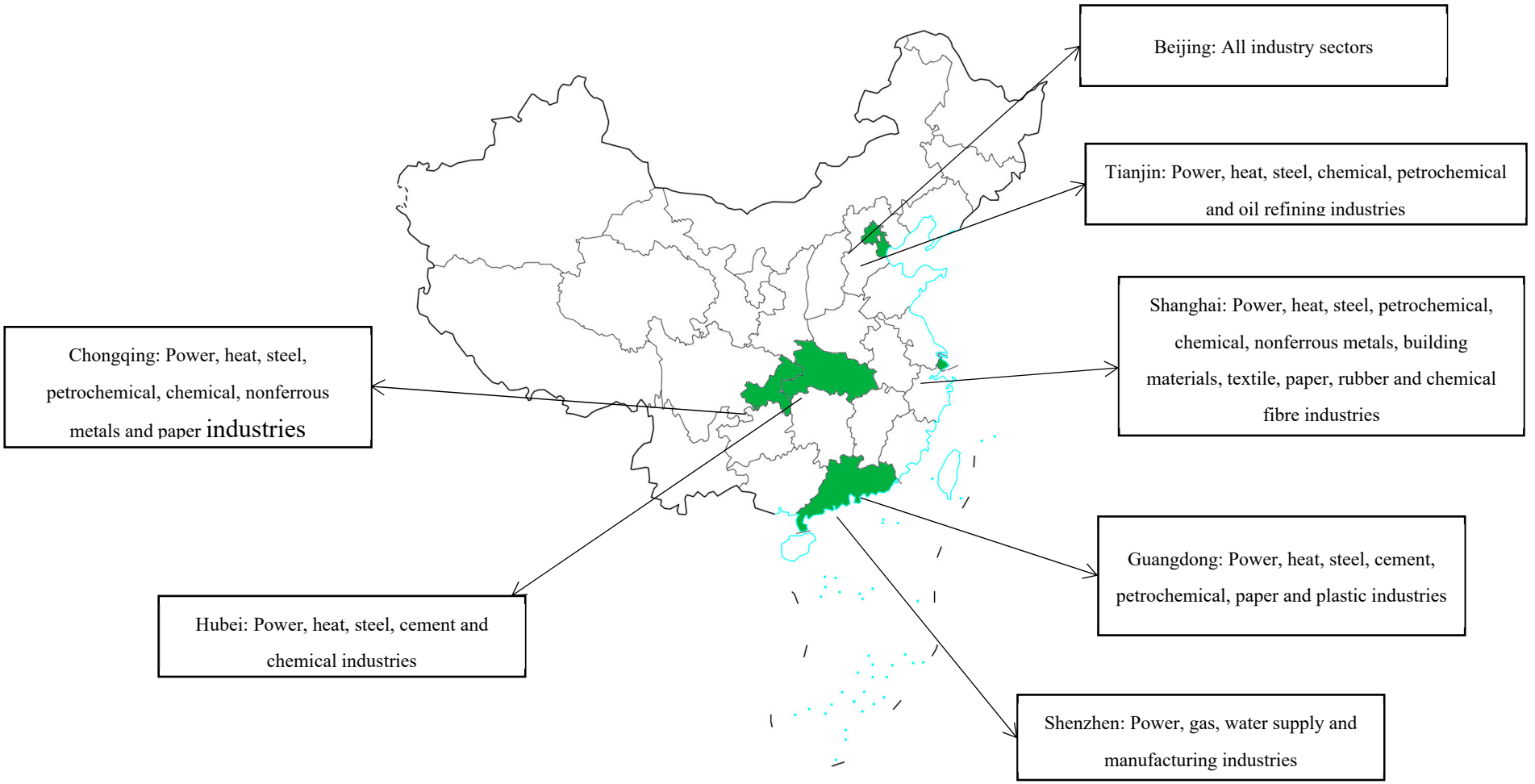

Figure 1. The pilot areas and covered industries.

Note. Figure 1 shows China emission trading scheme (ETS) pilots in 7 provinces and cities with industries covered by each pilot.

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2.2. Hypothesis Development

Given that environmental regulations are able to influence corporate behavior, carbon trading policies can affect corporate financial decisions [18]. Existing research pointed out that the main motivations for non-financial companies to hold financial assets are liquidity reserves and operating losses compensation [19,20]. Therefore, we analyze the possible impact of carbon trading policies from these two motivations.

2.2.1. Liquidity Reserves Motivation

The reservoir theory believes that companies hold financial assets to prevent future cash flow uncertainties [21,22], while environmental regulations can increase the indeterminacy of an expected cash flow of business entities.

On the one hand, the compliance costs caused by environmental regulations，such as emission fees and equipment upgrade cost, can directly damage corporate profits and thus reducing cash flow [23]. On the other hand, financial institutions may choose to reduce the scale of loans or increase borrowing costs for enterprises, especially those with heavy pollution, to avoid potential credit risks derived from environmental issues under strict environmental regulations, which makes loan financing more difficult [24]. At the same time, the policy risks of environmental regulations will weaken investors' confidence of polluting companies when transmitting to the capital market. It can increase difficulty in corporate equity financing through resulting in poor performance of company stock [13].

In addition, information asymmetry and environmental regulations' strict exogenous characteristics make firms only can predict the changing trend of future environmental regulations based on the current intensity. At this stage, increasingly stringent environmental regulations may lead to companies' expected cash flow intensified volatility, which make firms raise financial assets investment to reduce future financing constraints and survival risks. Hence, non-financial companies will increase financial assets holding to store liquidity in the face of environmental regulations.

2.2.2. Losses Compensation Motivation

Neoclassical economics believes that environmental policies can alleviate environmental pollution by internalizing negative externality costs [25]. However, the additional costs caused by environmental regulations need to be borne by companies in most cases, rather than state subsidies [26]. Therefore, companies need to invest revenue to reduce pollution emissions, which will hurt profits [12,27]. Based on the principal-agent theory, managers pay more attention to short-term interests rather than risk, especially while facing earning pressure [28]. Therefore, high-return and financial assets with high-risk may become a life-saving straw for managers to compensate the compliance costs of environmental regulation.

On the basis of the above analysis, we formulate the following hypothesis.

Hypothesis: *Carbon trading policy intensifies the degree of financialization of Chinese non-financial companies.*

3. Data and Variables

3.1. Data and Sample Selection

In order to evaluate how carbon trading policy impacts the financialization of non-financial companies, we collect firm data from China Research Data Services Platform (CNRDS) and China Security Market and Accounting Research (CSMAR).

This study takes all listed enterprises in China from 2008, which is the sixth year before ETS implementation, to 2020 as the initial sample because the available post-ETS firm-year data ends in in 2020, the sixth year after promulgation, and use the following selection criteria. First, we exclude financial, insurance and real estate listed companies. Second, we eliminate the items with missing

data. Third, we exclude the enterprises (marked as ST or *ST) that suffered serious losses in the sample period according to Tian, Xu and Zhang [29]. Moreover, we winsorize continuous variables at the 1% and 99% percentiles to control the effect of extreme value. After processing the data, the final sample contains 28,600 observations.

3.2. Measuring Corporate Financialization

Following the views of Xu and Xuan [11] and Akkemik and Özen [15], we propose of using the ratio of financial assets to total assets to measure the financialization of enterprises, can present the inclination of firms' investment choices, that is, the willingness to financialize. The specific indicators are constructed as follows: the sum of transactional financial assets, derivative financial assets, the amount of loans and advances issued, the net amount of financial assets available for sale, net investments held to maturity and net investment real estate divided by the year-end total assets. Since the rapid development of China's real estate at this stage, the real estate investment of many firms has changed from the self-use purpose to profit-seeking, which is consistent with the definition of financial assets in this paper. Hence, we include net investment real estate in financial assets. However, we exclude cash from financial assets because the purpose of holding currency funds by companies is mostly used in the daily production and operation of the company, which cannot bring capital appreciation to the company [30].

3.3. Research Design

We identify the impact of carbon trading policy on corporate financialization by difference-in-differences (DID) model. The basic logic of the DID model is to observe the treatment group and the control group before and after the policy shock. Changes in external policies only affect the treatment group, which leads to the difference between the treatment group and the control group after the policy shock is the result of external influences. Therefore, the two-dimensional changes of ETS pilot on intercompany (belonging affected industry or not) and time (before and after the implementation) can be used as a laboratory to identify the causal impact of carbon trading policy on financialization through DID model.

The DID model has several advantages. First, the DID model compares the differences between the treatment group and the control group under exogenous shocks to exclude non-policy-related influence and identify the net effect of the policy and thus reduce endogeneity [31]. Second, Tang et al. [32] stated that the results of the DID model are more reliable than traditional methods that use dummy variables to evaluate policy effects. Finally, it is widely used in causality identification of carbon trading policy and company reaction in context of China [4,6,33]. Hence, we build the following model (1):

$$Fin_{i,t} = \beta_0 + \beta_1 Treat_i \times Post_t + \beta_2 Controls_i + \mu_j + \gamma_c + \theta_t + \varepsilon_{i,t,j,c} \quad (1)$$

where the subscript i and t means company i and year t, respectively. $Fin_{i,t}$ represents degree of corporate financialization, which is measured by the ratio of financial assets to total assets, of company i in year t. Higher $Fin_{i,t}$ represent companies are more inclined to invest in financial assets. We connect the enterprises in ETS pilot area covering industries with the year of all pilot carbon markets starting transaction to construct $Treat_i \times Post_t$ as an explanatory variable according to Qi et al. [6] and Zhang and Duan [34]. For $Treat_i$, it equals 1 if the firm is in in the industries actually covered by the ETS pilots area, and 0 otherwise. $Post_t$ equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise.

We also include several widely used control variables in the model based on Duchin [35] and Feng et al. [36], which relate with financialization. These variables include Lev (a proxy for enterprise leverage), LnSize (a control for firm size), SS and Rid (a control for corporate governance), LnAge (a proxy for enterprise maturity), ROA (a control for company performance) and Growth (a control for company growth ability). The specific definitions of the variables are detailed in the Appendix 1.

In addition, according to Chen et al. [4] and Qi et al. [6], we add θ_t (year fixed effects) and μ_j (industry fixed effect) to control the potential impact of time-varying economic cycle and the

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unobserved time-invariant characteristics across industries on financialization. In addition, to further account the unobservable time-invariant differences across cities that may affect firms' financial assets holding, we refer Liu et al. [33] to add γ_c (cities fixed effects). The main coefficient of interest in model (1) is β_1. If the coefficient of β_1 is positive, then the carbon trading policy intensifies the degree of financialization of Chinese non-financial companies, vice versa.

3.4. Descriptive Statistics

Table 1 shows the descriptive statistics of the main variables. The minimum value of Fin is 0.000, and the maximum value is 0.981, which show that there are significant differences in the degree of financialization of Chinese non-financial companies. The mean and standard deviation of Fin are respectively 0.036 and 0.080, which are consistent with the existing literature [36] thereby proving that the sample selection without deviation.

For the mean of control variables, ROA is 0.036. Lev is 0.427. LnSize is 22.053. Rid is 0.388. SS is 4.462. LnAge is 2.754. Growth is 0.172. Overall, the control variables are all within the reasonable range because they are similar to the existing research [36,37].

Table 1. Descriptive statistics.

Variables	Mean	Std. Dev.	Min.	Q1	Median	Q3	Max.	N
Fin	0.036	0.080	0.000	0.000	0.006	0.034	0.981	28,600
Treat	0.120	0.325	0.000	0.000	0.000	0.000	1.000	28,600
Post	0.661	0.473	0.000	0.000	1.000	1.000	1.000	28,600
ROA	0.036	0.069	-0.316	0.013	0.037	0.067	0.206	28,600
LnSize	22.053	1.254	19.482	21.154	21.900	22.782	25.805	28,600
Lev	0.427	0.207	0.053	0.265	0.419	0.578	0.978	28,600
LnAge	2.754	0.386	1.386	2.565	2.833	3.045	3.434	28,600
SS	4.462	2.145	2.000	3.000	4.000	5.000	15.000	28,600
Rid	0.388	0.100	0.000	0.333	0.375	0.444	0.667	28,600
Growth	0.172	0.446	-0.597	-0.029	0.103	0.262	2.967	28,600

4. Carbon Trading Policy and Corporate Financialization

4.1. Baseline Regression Results

We employ the OLS estimation to model (1) for exploring the impact of carbon trading policy on the financialization of non-financial firms. Table 2 presents the regression results. Column (2) adds control variables to column (1).

From column (1), we find that the coefficient of $Treat_i \times Post_t$ is negatively significant at the level of 1%, which shows that carbon trading policy effectively prevents the intensification of corporate financialization. After adding control variables, the coefficients of $Treat_i \times Post_t$ is still negatively significant.

Surprisingly, the regression results are contrary to our hypothesis that carbon trading policy curbs the financialization of non-financial firms. Specifically, the carbon trading policy with compliance cost does not make managers invest in more financial products for liquidity reserving and losses compensation. On the contrary, companies in the pilot covered industries cut down the financial assets investment after carbon trading launching.

For the control variables, LnSize and Lev are both negatively related to $Fin_{i,t}$ showing that large company scale and adequate financing can reduce enterprises' willingness of financialization. SS also presents negatively significant. Hence, strict internal management can prevent companies from investing in high-risk financial assets. However, LnAge is positively correlated with financialization,

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thus indicating that old non-financial companies may have to hold more financial assets to obtain liquidity and prevent profits from being squeezed by the financial industry.

Table 2. Pilot carbon trading policy and corporate financialization.

Variables	(1) Fin	(2) Fin
Treat × Post	-0.006***	-0.005**
	(0.002)	(0.002)
ROA		-0.003
		(0.007)
LnSize		-0.001**
		(0.000)
Lev		-0.042***
		(0.003)
LnAge		0.024***
		(0.001)
SS		-0.001**
		(0.000)
Rid		0.003
		(0.005)
Growth		-0.001
		(0.001)
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
City fixed effect	Yes	Yes
Adj.R^2	0.138	0.154
Observations	28,600	28,600

Note. This table shows the impact of pilot carbon trading policy on corporate financialization. Column (2) adds control variables to the column (1). Fin represents degree of corporate financialization, higher of which means that companies are more inclined to invest in financial assets. Treat is a dummy variable, which equals 1 if the firm is in in the industries actually covered by the ETS pilots area, and 0 otherwise. Post is a dummy variable, which equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise. Control variable: (1) LnAge represents the natural logarithm of company age. (2) Rid represents the ratio of the number of independent directors to the board directors. (3) SS is the number of the supervisory board. (4) ROA is the return on assets, which equals to net profits divided by total assets. (5) Lev represents the total debt divided by total assets. (6) LnSize represents the natural logarithm of total assets. (7) Growth represents the growth rate of the company's main business. Cluster robust standard errors are in parentheses. *, **, *** indicates significant at 10%, 5%, 1% level, respectively.

4.2. Parallel Trend Test

The key logic of the DID model (1) is that the difference between the treatment group and the control group is caused by the ETS pilot instead of other factors. Specifically, the firms in treatment group and the control group should maintain the parallel financialization trend before the ETS pilot, but present significant differences after it. For proving the parallel trend, we reference Qi et al. [6] to examine the dynamic effects of the enactment of the ETS pilot on financialization of non-financial

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firms through construct new independent variable, which is the product of the dummy variable $Treat_i$ and the dummy variable of corresponding year (the value is 1 in the corresponding year, and 0 otherwise), and build the following model (2):

$$Fin_{i,t} = \beta_0 + \beta_1 pre3plus_{i,t} + \beta_2 pre3_{i,t} + \beta_3 pre2_{i,t} + \beta_4 pre1_{i,t} + \beta_5 im_{i,t} + \beta_6 post1_{i,t} + \beta_7 post2_{i,t} + \beta_8 post3_{i,t} + \beta_9 post3plus_{i,t} + \beta_{10} Controls_i + \mu_j + \gamma_c + \theta_t + \varepsilon_{i,t,j,c} \quad (2)$$

where the subscript i and t means company i and year t, respectively. $Fin_{i,t}$ represents degree of financialization, which is measured by the ratio of financial assets to total assets, of company i in year t. $pre3plus_{i,t}$, $pre3_{i,t}$, $pre2_{i,t}$, $pre1_{i,t}$, $im_{i,t}$, $post1_{i,t}$, $post2_{i,t}$, $post3_{i,t}$ and $post3plus_{i,t}$ are is the product of the dummy variable $Treat_i$ and the dummy variable of corresponding year. All other variables in model (2) are consistent with the model (1), whose explanation is not repeated for brief.

Table 3 shows result of parallel trend test. Column (2) adds control variables to column (1). We find that the coefficients prior to ETS pilot is insignificant thus verifying the parallel financialization trend between treatment group and control group. After pilot, the results signify that carbon trading policy curb the degree of financialization of treatment group enterprises whose inhibition effect still exists more than three years after the pilot. Hence, the carbon trading policy effectively and long-term deceases the tendency of Chinese non-financial companies to invest in financial assets.

Table 3. Pilot carbon trading policy and corporate financialization: parallel trend test.

Variables	(1) Fin	(2) Fin
Pre3+	-0.003	-0.002
	(0.004)	(0.004)
Pre3	-0.007	-0.005
	(0.006)	(0.006)
Pre2	-0.007	-0.006
	(0.005)	(0.005)
Pre1	-0.008	-0.007
	(0.005)	(0.005)
Implementation	-0.009*	-0.008
	(0.005)	(0.005)
Post1	-0.010*	-0.009*
	(0.005)	(0.005)
Post2	-0.011**	-0.010**
	(0.005)	(0.005)
Post3	-0.009*	-0.008*
	(0.005)	(0.005)
Post3+	-0.006*	-0.005*
	(0.003)	(0.003)
Controls	No	Yes
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
City fixed effect	Yes	Yes
Adj.R^2	0.138	0.154
Observations	28,600	28,600

Note. This table shows the parallel trend test on the impact of pilot carbon trading policy on corporate financialization. Column (2) adds control variables to the column (1). Fin represents degree of corporate financialization, higher of which means that companies are more inclined to invest in financial assets. Pre3+, Pre2, Pre1, Implementation, Post1, Post2, Post3+ are the multiplying item of the dummy variable Treat and the dummy variable of the corresponding year. Control variable: (1) LnAge represents the natural logarithm of company age. (2) Rid represents the ratio of the number of independent directors to the board directors. (3) SS is the number of the supervisory board. (4) ROA

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is the return on assets, which equals to net profits divided by total assets. (5) Lev represents the total debt divided by total assets. (6) LnSize represents the natural logarithm of total assets. (7) Growth represents the growth rate of the company's main business. Cluster robust standard errors are in parentheses. *, **, *** indicates significant at 10%, 5%, 1% level, respectively.

4.3. Placebo Test

To verify whether there is possible results bias, we conduct a placebo test by randomly selecting 15% of the 3,367 companies in full sample as the dummy treatment group while the remaining firms setting as the control group. Then, we do the random sampling with replacement three times to generate Dummy $treat_1$, Dummy $treat_2$ and Dummy $treat_3$ to replace the variable $Treat_i$ in model (1) and repeat the regression. If the estimated coefficient of Dummy $treat_1$, Dummy $treat_2$ and Dummy $treat_3$ are still significant, it will show that our original estimation result is likely to be biased, that is the change of financialization is affected by other policy changes or random factors, and vice versa.

Table 4 presents the results of the placebo test whose dependent variable is $Fin_{i,t}$. Column (1), (2) and (3) show the results of Dummy $treat_1$, Dummy $treat_2$ and Dummy $treat_3$, respectively. We find that the all dummy treat is not significant. As a result, the decreasing of the financialization of non-financial firms brought by the carbon trading policy.

Table 4. Pilot carbon trading policy and corporate financialization: placebo test.

Variables	(1) Fin	(2) Fin	(3) Fin
Dummy treat1 × Post	0.001		
	(0.002)		
Dummy treat2 × Post		0.002	
		(0.002)	
Dummy treat3 × Post			-0.001
			(0.002)
Controls	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes
Adj.R^2	0.154	0.154	0.154
Observations	28,600	28,600	28,600

Note. This table shows the placebo test on impact of pilot carbon trading policy on corporate financialization. Column (1), (2) and (3) show the results of Dummy $treat_1$, Dummy $treat_2$ and Dummy $treat_3$, respectively. Fin represents degree of corporate financialization, higher of which means that companies are more inclined to invest in financial assets. Dummy treat is a dummy variable, which equals 1 if companies belong to the experimental group obtained by random sampling, and 0 otherwise. Post is a dummy variable, which equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise. Control variable: (1) LnAge represents the natural logarithm of company age. (2) Rid represents the ratio of the number of independent directors to the board directors. (3) SS is the number of the supervisory board. (4) ROA is the return on assets, which equals to net profits divided by total assets. (5) Lev represents the total debt divided by total assets. (6) LnSize represents the natural logarithm of total assets. (7) Growth represents the growth rate of the company's main business. Cluster robust standard errors are in parentheses. *, **, *** indicates significant at 10%, 5%, 1% level, respectively.

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4.4. PSM-DID Estimate

We also extend the DID model to a DID model linking propensity score matching (PSM) method in order to improve the reliability of the research results. The control group still is firms, which are not covered by ETS pilot, but through propensity score matching based on companies' characteristics, we can get a more suitable control group than randomly selecting [38]. According to Qi et al. [6], we use nearest-neighbour matching to estimate PSM-DID whose results of the propensity score matching balance test are shown in Appendix 2. To ensure a sufficient number of observations, we match each processing group company with three control group companies. Table 5 shows the estimation results of PSM-DID. Column (2) adds control variables to the column (1). From the results, we find that the test results are all same as the original results, which prove that our research results are reliable.

Table 5. Pilot carbon trading policy and corporate financialization: PSM-DID.

Variables	(1) Fin	(2) Fin
Treat × Post	-0.005**	-0.006**
	(0.002)	(0.002)
Controls	No	Yes
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
City fixed effect	Yes	Yes
Adj.R^2	0.126	0.137
Observations	13,519	13,519

Note. This table shows the impact of pilot carbon trading policy on corporate financialization by PSM-DID. Column (2) adds control variables to the column (1). Fin represents degree of corporate financialization, higher of which means that companies are more inclined to invest in financial assets. Treat is a dummy variable, which equals 1 if the firm is in in the industries actually covered by the ETS pilots area, and 0 otherwise. Post is a dummy variable, which equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise. Control variable: (1) LnAge represents the natural logarithm of company age. (2) Rid represents the ratio of the number of independent directors to the board directors. (3) SS is the number of the supervisory board. (4) ROA is the return on assets, which equals to net profits divided by total assets. (5) Lev represents the total debt divided by total assets. (6) LnSize represents the natural logarithm of total assets. (7) Growth represents the growth rate of the company's main business. Cluster robust standard errors are in parentheses. *, **, *** indicates significant at 10%, 5%, 1% level, respectively.

5. Influence Channels of Carbon Trading Policy

The analysis in Section 4 presents that the carbon trading policy effectively suppress the financialization of non-financial firms in China. What is the influencing channel of this policy curbs corporate financialization? On the one hand, enterprises can obtain economic benefits by selling carbon emission rights. On the other hand, carbon trading policies can stimulate companies to disclose more carbon emission information [14]. Based on the theory of information asymmetry, carbon information disclosure improves corporate transparency and reduces information asymmetry while transmitting to outside investors a green signal that the company attaches importance to environmental protection, which can attract more investors thereby obtaining external financial support. Through the above two analysis, it can be seen that the carbon trading policy may alleviate the financing constraints, who are precisely the important reasons for companies to expand financial asset holdings. Hence, we explore whether carbon trading policies can reduce the degree of corporate financialization by decreasing corporate financing constraints through model (3) and (4):

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$$SA_{i,t} = \beta_0 + \beta_1 Treat_i \times Post_t + \beta_2 Controls_i + \mu_j + \gamma_c + \theta_t + \varepsilon_{i,t,j,c} \quad (3)$$

$$Fin_{i,t} = \alpha_0 + \alpha_1 Treat_i \times Post_t + \alpha_2 SA + \alpha_3 Controls_i + \mu_j + \gamma_c + \theta_t + \varepsilon_{i,t,j,c} \quad (4)$$

where model (3) is a benchmark DID model whose explained variable $SA_{i,t}$ is the measurement of corporate financing constraints (Hadlock and Pierce, 2010). A higher $SA_{i,t}$ indicates firms with higher financing constraints. Model (5) adds $SA_{i,t}$ based on model (1). All other variables in model (3) and (4) are consistent with the model (1), whose explanation is not repeated for brief. The basic idea of the exploration of influence channels is that if β_1 in model (3) is significant, carbon trading policies can affect corporate financing constraints, and vice versa. In the case where β_1 in model (3) is significant, if α_1 and α_2 in model (4) are significant, and α_1 is significantly closer to 0 than β_1 in model (1), then the financing constraint is the channel through which carbon trading policy affects the company financialization, and vice versa.

The regression results are shown in Table 6. All columns include control variables and fixed effects. Column (1), (2) and (3) show the results of model (1), (3) and (4), respectively. The significant negative coefficient of $Treat_i \times Post_t$ in column (2) indicates that the carbon trading policy eases the level of corporate financing constraints. The coefficient of $SA_{i,t}$ in column (3) is significantly positive while $Treat_i \times Post_t$ is significantly negative and lower than the coefficient in the column (1), showing that carbon trading policies curb financialization of non-financial firms by alleviating corporate financing constraints.

Table 6. Influence channel of pilot carbon trading policy.

Variables	(1) Fin	(2) SA	(3) Fin
SA index			0.0320***
			(0.0020)
Treat × Post	-0.0053**	-0.0114*	-0.0049**
	(0.0021)	(0.0064)	(0.0021)
Controls	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes
Adj.R^2	0.1543	0.4517	0.1622
Observations	28,600	28,600	28,600

Note. This table shows the influence channel of pilot carbon trading policy on corporate financialization. Column (1) show the influence of pilot carbon trading policy on financialization. Column (2) show the impact of pilot carbon trading policy on firm financing constraints. Column (3) show the effect of pilot carbon trading policy and firm financing constraints on corporate financialization. Fin represents degree of corporate financialization, higher of which means that companies are more inclined to invest in financial assets. SA index shows the degree of corporate financing constraints. Treat is a dummy variable, which equals 1 if the firm is in in the industries actually covered by the ETS pilots area, and 0 otherwise. Post is a dummy variable, which equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise. Control variable: (1) LnAge represents the natural logarithm of company age. (2) Rid represents the ratio of the number of independent directors to the board directors. (3) SS is the number of the supervisory board. (4) ROA is the return on assets, which equals to net profits divided by total assets. (5) Lev represents the total debt divided by total assets. (6) LnSize represents the natural logarithm of total assets. (7) Growth represents the growth rate of the company's main business. Cluster robust standard errors are in parentheses. *, **, *** indicates significant at 10%, 5%, 1% level, respectively.

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6. Heterogeneity Analysis

Given that we find that carbon trading policy reduces the financialization of non-financial companies by easing financing constraints in the previous sections, do carbon trading policies have the same impact on companies with different characteristics? To address this issue, we explore the influence of heterogeneity on the inhibitory effect of carbon trading policy on enterprises with differences between the ownership structure, geographical locations and industry characteristics.

6.1. Ownership Heterogeneity

Company ownership has an impact on the financialization degree of the companies [36]. Therefore, we explore the ownership heterogeneity impact on the inhibition effect of carbon trading policy.

We divide the full sample into state-owned enterprises (SOE) and non-state-owned enterprises (non SOE), which respectively include 11,194 observations and 17,406 observations, and reproduce the regression of model (1). Table 7 shows the results of ownership heterogeneity. The results of SOE and non SOE are presented in column (1) and (2), respectively. From the results, the carbon trading policy only decrease the financialization of non-state non-financial enterprises.

The reasons of state-owned enterprises and non-state-owned enterprises choosing different financial asset holding strategies while facing carbon trading policies may be as follows. First, the natural political connection between state-owned enterprises and the government makes the it become the guarantor of state-owned enterprises. When non-financial state-owned enterprises are in financial distress due to lower profits, the government can help them get out of it by granting subsidies. Moreover, the connection between the government and the bank reduces the difficulty of financing for state-owned enterprises. Second, preventing major financial risks is one of the main strategies of the Chinese government. As a stable of area economic development and employment, state-owned enterprises may not be allowed to hold large amounts financial assets with high risks by government. Both of the above points may cause state-owned enterprises to maintain a low level of financialization before the carbon trading policies, thereby being not sensitive to the inhibitory effects of it. However, non-state-owned enterprises turn to holding more financial assets in order to survive in the context of the downturn in the entities economy leading they are more significantly affected by carbon trading policies.

Table 7. Pilot carbon trading policy and corporate financialization: ownership heterogeneity.

Variables	**(1)** **SOE** **Fin**	**(2)** **Non-SOE** **Fin**
Treat × Post	-0.001	-0.007**
	(0.003)	(0.003)
Controls	Yes	Yes
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
City fixed effect	Yes	Yes
Adj.R^2	0.340	0.139
Observations	11,194	17,406

Note. This table shows the ownership heterogeneity of pilot carbon trading policy on corporate financialization. Column (1) and (2) show the results of state-owned enterprise and non-state-owned enterprise, respectively. Fin represents degree of corporate financialization, higher of which means that companies are more inclined to invest in financial assets. Treat is a dummy variable, which equals 1 if the firm is in in the industries actually covered by the ETS pilots area, and 0 otherwise. Post is a

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dummy variable, which equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise. Control variable: (1) LnAge represents the natural logarithm of company age. (2) Rid represents the ratio of the number of independent directors to the board directors. (3) SS is the number of the supervisory board. (4) ROA is the return on assets, which equals to net profits divided by total assets. (5) Lev represents the total debt divided by total assets. (6) LnSize represents the natural logarithm of total assets. (7) Growth represents the growth rate of the company's main business. Cluster robust standard errors are in parentheses. *, **, *** indicates significant at 10%, 5%, 1% level, respectively.

6.2. Regional Heterogeneity

China is a large country with varying development levels of regional economic. Differences in regional macroeconomic factors can affect the company's operating conditions, thereby changing their financial investment decisions [39]. Hence, we verify whether regional heterogeneity affects the effectiveness of carbon trading policies.

Based on the location of the company, we divide the total sample into two sub-samples of companies located in the east and central and western regions' companies, and perform model (1) on them. Table 8 shows the results of regional heterogeneity. Column (1) and (2) show the results of Eastern region firms and central and western regions ones, respectively. From the results, the carbon trading policy only decrease the financialization of eastern region non-financial firms.

The reasons for this situation may be that, the rapid economic development in the eastern China results in a high-density distribution of firms, which increases the pressure of competition and financing difficulties in the east region. As a result, non-financial companies in the eastern region have to hold more financial assets under the dual pressure of competition and market shrinkage before the carbon trading policy, which makes they be sensitive to reduced financing constraints and additional benefits brought about by the carbon trading policy. However, for central and western regions' companies, on the one hand, the low level of firms overlap makes the companies less competition pressure. On the other hand, the Chinese government has given more support policies to the central and western regions in order to achieve the strategic goal of common prosperity, which can reduce the difficulty of financing for enterprises in the central and western regions. Hence, low competition and relatively sufficient funds make companies in the central and western regions are not sensitive to direct or indirect benefit from carbon trading policies.

Table 8. Pilot carbon trading policy and corporate financialization: regional heterogeneity.

Variables	**(1)** **Eastern region** **Fin**	**(2)** **Central and western regions** **Fin**
Treat × Post	-0.004*	-0.007
	(0.002)	(0.006)
Controls	Yes	Yes
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
City fixed effect	Yes	Yes
Adj.R^2	0.162	0.154
Observations	19,773	8,827

Note. This table shows the regional heterogeneity of pilot carbon trading policy on corporate financialization. Column (1) and (2) show the results of eastern region and central and western regions, respectively. Fin represents degree of corporate financialization, higher of which means that companies are more inclined to invest in financial assets. Treat is a dummy variable, which equals 1 if the firm is in in the industries actually covered by the ETS pilots area, and 0 otherwise. Post is a

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dummy variable, which equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise. Control variable: (1) LnAge represents the natural logarithm of company age. (2) Rid represents the ratio of the number of independent directors to the board directors. (3) SS is the number of the supervisory board. (4) ROA is the return on assets, which equals to net profits divided by total assets. (5) Lev represents the total debt divided by total assets. (6) LnSize represents the natural logarithm of total assets. (7) Growth represents the growth rate of the company's main business. Cluster robust standard errors are in parentheses. *, **, *** indicates significant at 10%, 5%, 1% level, respectively.

6.3. Industry Competition Heterogeneity

In this section, we verify the impact of industry competition on the effect of carbon trading policies. According the view of Rhoades [40] and Tingvall and Poldahl [41], this paper use Herfindahl index to measure the level of industry competition. We compute the average Herfindahl index of each industry from the sample start to ETS pilots trading launching based on total assets, and classifies the industries whose average Herfindahl index below the median as highly competitive industries, others are set as industries with less competition. Referring to the 2012 edition of the China Securities Regulatory Commission industry classification, we the divide the total sample into two sub-samples of companies in highly competitive industries and firms in non-high competition industries. Table 9 shows the results of industry competition heterogeneity. Column (1) and (2) show the results of high competition industry firms and non-high competition industry firms, respectively.

Through the results, we find that the carbon trading policy only decrease the financialization of high competition non-financial firms. The plausible explanation is that in industries with low market competition, most companies have a certain degree of monopoly, which may make them have sufficient market control thereby reducing the pressures of financing and operating. In addition, industries with low market competition are mostly occupied by state-owned enterprises, whose close relationship with the government lead them not sensitive to the extra benefits caused by carbon trading policy. However, for companies in industries with a high degree of market competition, their investment decisions react more strongly to the extra benefits.

Table 9. Pilot carbon trading policy and corporate financialization: industry competition heterogeneity.

Variables	(1) High competition Fin	(2) Non-high competition Fin
Treat × Post	-0.004*	-0.017
	(0.002)	(0.010)
Controls	Yes	Yes
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
City fixed effect	Yes	Yes
Adj.R^2	0.139	0.255
Observations	24,911	3,617

Note. his table shows the industry heterogeneity of pilot carbon trading policy on corporate financialization. Column (1) and (2) show the results of high competition industry and non-high competition industry, respectively. Fin represents degree of corporate financialization, higher of which means that companies are more inclined to invest in financial assets. Treat is a dummy variable, which equals 1 if the firm is in in the industries actually covered by the ETS pilots area, and 0 otherwise. Post is a dummy variable, which equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise. Control variable: (1) LnAge represents the

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natural logarithm of company age. (2) Rid represents the ratio of the number of independent directors to the board directors. (3) SS is the number of the supervisory board. (4) ROA is the return on assets, which equals to net profits divided by total assets. (5) Lev represents the total debt divided by total assets. (6) LnSize represents the natural logarithm of total assets. (7) Growth represents the growth rate of the company's main business. Cluster robust standard errors are in parentheses. *, **, *** indicates significant at 10%, 5%, 1% level, respectively.

7. Conclusion

Reducing carbon emission plays an important role in alleviating global warming. At the same time, the trend of financialization of China's non-financial enterprises intensified. Nevertheless, the neglecting of the contradictions between environmental regulations and financialization in existing research leads the impact of carbon trading policy on financialization of non-financial firms unclear. Therefore, taking China emission trading scheme pilots as a quasi-natural experiment, we use the difference-in-differences model to study the impact of carbon trading policy on financialization of non-financial companies, which can effectively identify the causal relationship between carbon trading policies and corporate financialization and eliminate the influence of non-result related factors. In doing so, we expand the research of carbon trading policy influence on micro-company level and the influence factor of corporate financialization. In addition, our research results provide a policy reference for reduce the corporate financialization in emerging markets under low-carbon transition.

According to our results, carbon trading policy can effectively restrain the financialization of non-financial enterprises through reducing firms' financing constraints. In parallel trend test, we find that the inhibition effect of ETS pilot on corporate financialization consistently remains significant. Our findings show robust validity even when (1) extending the DID model to a PSM-DID model to get a more appropriate control group and (2) using the placebo test to verify possible results bias. Finally, we conduct a cross-sectional test in terms of company ownership, company location and industry competition and find that carbon trading policy have a more significant mitigation on the financialization of (1) non-state-owned enterprise (2) eastern region companies (3) highly competitive industry firms.

In summary, emerging economies can achieve a win-win situation for low-carbon transition and stable economic development through carbon trading policies.

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Appendix A

Table A1. Variable definitions.

Variable	Definitions
Fin	The degree of corporate financialization measured by the ratio of financial assets to total assets, higher of which means that companies are more inclined to invest in financial assets
Treat	Dummy variable, Treat equals 1 if the firm is in the industries actually covered by the ETS pilots area, and 0 otherwise
Post	Dummy variable, Post equals 1 if year is greater or equal to 2014, which is the starting year of trading in all ETS pilot, and 0 otherwise.
Growth	The growth rate of the company's main business
LnAge	The natural logarithm of company age
Rid	The ratio of the number of independent directors to the board directors
SS	The number of the supervisory board
ROA	Return on assets equals to net profits divided by total assets
Lev	Total debt divided by total assets
LnSize	The natural logarithm of total assets

Table A2. Test of covariate balancing in nearest-neighbour matching method.

		Mean				T-test	
Variable		Treated	Control	%bias	%reduct bias	t	$p > t$
ROA	Unmatched	0.038	0.035	3.9	68.3	2.08	0.037
	matched	0.038	0.037	1.2		0.52	0.605
LnSize	Unmatched	22.290	22.021	19.9	94.0	11.84	0.000
	matched	22.279	22.295	-1.2		-0.48	0.634
Lev	Unmatched	0.422	0.428	-3.0	-20.3	-1.62	0.106
	matched	0.422	0.429	-3.6		-1.48	0.139
LnAge	Unmatched	2.696	2.761	-16.2	97.8	-9.28	0.000
	matched	2.701	2.699	0.4		0.14	0.888
SS	Unmatched	4.383	4.473	-4.3	83.7	-2.30	0.021
	matched	4.388	4.402	-0.7		-0.30	0.766
Rid	Unmatched	0.394	0.387	6.3	92.9	3.47	0.001
	matched	0.393	0.394	-0.4		-0.19	0.851
Growth	Unmatched	0.177	0.172	1.1	-18.4	0.60	0.547
	matched	0.177	0.171	1.3		0.56	0.575

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