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A Study on the Impact of Pilot Carbon Emission Trading Policies on Corporate Performance

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Abstract: This paper uses the carbon emission trading policy as a quasi-natural experiment to comprehensively investigate its impact on the financial and market performance of firms. The study uses data from A-share listed companies for the period from 2009 to 2022 and adopts the difference-in-differences model for a rigorous analysis. The mediating effect of financing constraints and the moderating role of managerial capabilities are examined with respect to the influencing mechanisms; heterogeneity was also analyzed in terms of carbon allowance allocation methods, carbon prices, environmental enforcement efforts, and type of industry. The results of the study show that the carbon trading policy has a significant effect on improving the financial performance of firms, while also inhibiting their market performance. The feasibility of the findings was further validated after conducting robustness tests such as propensity score matching and placebo tests. The mechanism analysis finds that financing constraints play a masking effect on the impact of carbon trading policies on firms' financial performance; managerial competence can positively moderate firms' market performance. Heterogeneity analysis shows that the inhibitory effect of emissions trading policies on market performance is more significant for firms in regions with a smaller share of free allowances. For companies in high carbon price regions, carbon trading policies have a more significant impact on financial performance. For companies located in regions with higher levels of environmental enforcement, the positive effect of carbon trading policies on financial performance is unchanged, but the dampening effect on market performance is more significant. Carbon trading policies have a stronger positive effect on the financial performance of high-polluting firms, but a more significant dampening effect on the market performance of low-polluting firms. The findings of this study enhance China's research framework on the economic impacts of carbon trading policies on micro-enterprises, promoting sustainable business development and serving as a useful reference for policy sustainability.

Keywords: carbon emission trading policy; corporate performance; difference-in-differences model

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1. Introduction

As the process of global industrialization continues to advance, energy consumption continues to increase, accompanied by the production of large quantities of carbon emissions, leading to global warming and greater damage to the ecological environment. Jointly and actively combating climate change has become a major concern for most countries. In September 2020, chairperson Xi made an announcement at the 75th United Nations General Assembly, stating that "China will increase its national contribution, adopt stricter policies and measures, aim to peak carbon dioxide emissions by 2030, and achieve carbon neutrality by 2060". To achieve this goal, the Chinese government has strengthened top-level planning, linked up and down with provinces and municipalities, and formulated a

series of policies. How to reduce greenhouse gas emissions and ensure healthy economic development has become an important issue that needs to be addressed urgently.

The carbon emission trading policy is one of the policy tools used to achieve the goal of carbon peaking, which is conducive to the green transformation and development of enterprises; it is regarded as an important link to support economic and social green transformation and low-carbon emission reduction and plays an important role in promoting the completion of China's carbon emission reduction tasks. As a result, China has established a carbon emissions trading market to find a more cost-effective path to low-carbon development. Seven provinces and municipalities, namely Beijing, Shanghai, Shenzhen, Tianjin, Chongqing, Guangdong and Hubei, have been set up as pilot regions for early and pilot implementation and each pilot region has set different thresholds for enterprises to be included in the transaction, according to the enterprises in their jurisdiction. In 2021, the national carbon emission rights market began operating and, as of now, the emission control enterprises participating in the carbon emission rights market are electric power enterprises and will be gradually expanded to other industries in the later stage. Both the local carbon market and the national carbon market saw a rebound in trading volume in 2023, with carbon quota sales reaching 70.12 million tons and 212 million tons, respectively (data from the International Institute of Green Finance (IIGF), Central University of Finance and Economics. https://iigf.cufe.edu.cn/info/1013/8404.htm, accessed on 30 January 2024).

With the growth and expansion of the carbon market, researchers have been focused on analyzing the impact of carbon emissions trading policy. Research by Huang Xianglan et al. and Li Zhiguo et al. demonstrates the significant inhibitory effects of such policies on carbon emissions [1,2]. However, in the face of global economic uncertainty and the dilemma of the traditional economic growth model, it is obviously insufficient to focus only on the emission reduction effect of the carbon emission trading policy, and it is necessary to explore its impact on economic development in depth, so as to better assess the effectiveness of the policy on the sustainable development of the low-carbon economy. Most existing studies have focused on the abatement effects of carbon policies and economic development under the carbon policy regime; there is not a rich literature of research at the micro-firm level and there is even less research on the further decomposition of carbon emissions trading on firm performance. Liu Haiying and Wang Yu's research shows that the enterprise is the primary actor in the carbon emissions trading market and, while pursuing the goal of reducing carbon emissions, the carbon emissions trading policy is bound to affect the development of the enterprise [3]. Therefore, it is necessary to explore the impact of carbon emissions trading policies on corporate financial and market performance in depth.

The possible contributions of this paper are as follows: First, utilizing data from A-share listed companies between 2009 and 2022, our study employs a double-difference model to examine the effects of carbon emissions trading policies on both corporate financials and market performance, in order to obtain a more precise net impact; Second, by analyzing the mechanism of the carbon emissions trading policy, the masking effect of financing constraints is found, which provides ideas for improving policy formulation; Third, this study includes indicators for managerial competence to investigate its influence on the market performance of enterprises from the enterprise's perspective. This offers suggestions for enterprises to adjust their policies and create development strategies; Fourth, the conclusions are more relevant when exploring the heterogeneity of the impact of carbon emission trading policies on firm performance from the perspective of the carbon allowance allocation mode, carbon price, environmental enforcement efforts, and type of industry.

The structure of the rest of the paper is as follows: the second part is a literature review; the third part presents the research hypotheses of this paper based on the theoretical analysis; the fourth part is the research design; the fifth part is the results and analysis of the baseline regression; the sixth part is the mechanism test and heterogeneity test; and finally, there are the concluding recommendations and shortcomings.

2. Literature Review

Carbon emissions trading, which belongs to the category of emissions trading, is an important mechanism for combating global climate change. Dales further developed Coase's theory, introduced the concept of property rights into the field of pollution control, and introduced the concept of emissions trading for the first time, which, subsequently, became the theoretical basis of emissions trading [4]. Montgomery showed that emissions trading has the lowest abatement cost of the various abatement methods [5]. Under this approach, 28 carbon markets have been established and are operating in several countries around the world. Companies participating in carbon trading buy and sell allowances in the market based on their actual carbon emissions, i.e., companies with low emissions can sell allowances to make a profit and companies with high emissions need to buy allowances to meet their emission reduction targets. Carbon emission trading can encourage enterprises to take the initiative to reduce emissions in order to ensure that the marginal abatement cost is equal, and then make the whole market first realize the Pareto optimization, and then fundamentally reduce abatement costs.

Research has demonstrated that this approach can more effectively reduce carbon emissions. Huang Xianglan conducted an empirical study using data from seven carbon emissions trading pilots in China from October 2011 onwards. The study found that China's carbon trading pilot policy significantly reduced greenhouse gas emissions and effectively lowered the total energy consumption [1]. Zhang et al. discovered that implementing a carbon emissions trading policy led to a notable decrease in carbon emissions through the creation of a double-differential, two-way fixed effects model [6]. Li Zhiguo et al. conducted a quasi-natural experiment using a synthetic control approach, confirming that the carbon trading mechanism can considerably reduce carbon emissions in the pilot provinces and neighboring regions through spatial spillover effects [2]. Li Guangming et al. analyzed the industrial carbon emissions data from the carbon emissions trading pilot provinces in China using the DID and PSM-DID methods. They investigated the effects of carbon emissions trading policies on carbon emissions and carbon intensity, finding that these policies significantly inhibited both emissions and carbon intensity from large-scale industries in pilot provinces, while also significantly improving industrial energy technology efficiency and pilot city allocation [7].

The current body of research analyzing the effect of carbon trading policies on the financial and market performance of corporations at the micro level has yet to produce consistent findings. One view is that carbon trading mechanisms have a positive effect on improving corporate performance. Gans and Hintermann demonstrated that firms experienced a noteworthy boost in their market performance upon announcing their membership to the Chicago Climate Exchange [8]. Oestreich et al. state that the main reason for the improved performance of firms is the cash inflows that firms can receive through allocations as a result of the large number of uncostly, over-issued quotas in the market [9]. Zhou Chang et al. analyzed A-share listed companies between 2008 and 2017 by constructing the PSM-DID model to examine how their financial performance was impacted by participation in the carbon emissions trading market. The study results confirm that businesses' involvement in the carbon emissions trading market contributes to a better financial performance [10]. Lu Min et al. performed an analysis using the double-difference method and concluded that carbon emission trading can improve the financial performance of listed companies in Beijing, Guangdong and Shenzhen provinces and cities [11]. Lin Ping found that the implementation of carbon emissions trading policies significantly improves financial performance for corporations. This effect is even more pronounced for state-owned enterprises [12]. Another view is that the carbon trading mechanism reduces business performance, i.e., the system significantly increases the environmental costs that companies use to acquire allowances and carry out activities such as complying with emissions reductions, thereby reducing business performance. Brouwers utilized the event study method to examine 368 firms and discovered that the emission control firms that participate in carbon emissions trading display a statistically significant market response

when the price of carbon emissions rises. Additionally, Brouwers' cross-sectional analysis of anomalous reporting indicates that firms suffer a stock price decrease when their actual carbon emissions increase, in comparison to their allocated emissions. This implies that the under-allocation of carbon allowances by firms could adversely affect their market performance [13]. Shen Hongtao and Huang Nan et al. conducted an empirical study with China's listed companies and various pilot emission control enterprises as research objects and found that the carbon emission trading policy does not significantly improve the long-term financial performance of listed companies [14]. Yan Zheng found that for China's carbon emission trading mechanism, the market liquidity is low, the quotas are more generous and most of them are allocated for free, and the supply of carbon quotas exceeds the demand, causing the carbon price to be too low; therefore, China's carbon emission trading mechanism cannot effectively improve the performance of enterprises in pilot industries in the pilot provinces [15].

Overall, prior research has primarily investigated the effects of carbon emissions trading policies on a macro scale, but there has been insufficient attention paid to these policies' micro level impacts. Due to the relatively short time frame of implementing carbon emissions trading in China and a limited amount of empirical data, the current literature primarily focuses on normative analyses. Few scholars have researched the micro-transmission mechanism of the carbon emissions trading policy and its impact on corporate performance. In addition, current research findings lack consensus due to differences in factors such as the researcher's chosen subject, as well as the time frame and perspective of the research. Based on this, this study uses the difference-in-differences method to focus on the depth of the impact of carbon trading policies at the micro level of firms' financial position and market performance. This paper also examines the mechanism of financing constraints and the moderating role of managerial capabilities from the perspectives of financing constraints and managerial capabilities; In addition, regression analyses are conducted to examine the heterogeneity of the effects of the carbon quota allocation model, the carbon price, environmental enforcement efforts, and type of industry. It is hoped that the study in this paper can enrich the research related to the micro perspective of carbon emission trading on enterprises and provide constructive comments and suggestions for improving the carbon emission trading system in China.

3. Theoretical Analysis and Hypothesis

First, the Porter hypothesis suggests that the implementation of appropriate environmental regulatory policies can induce firms to actively engage in innovative activities, leading to productivity gains [16]. This will offset the costs associated with environmental regulations and ultimately lead to an improved financial performance. China's carbon trading policy gives pilot companies enough time to adjust and lessen stringent requirements, giving them an innovative and first-mover advantage, which helps improve the pilot companies' financial performance. Second, the standardization of emissions by companies can reduce unnecessary expenditures on environmental penalties, which is conducive to improving the financial performance of companies. Zhou Chang et al. studied China's A-share listed companies based on PSM-DID and found that the carbon emissions trading policy can effectively promote a reduction in carbon emissions, thus reducing the outflow of economic benefits in terms of environmental penalties and other aspects of enterprises [10]. Based on the property rights theory, carbon emissions trading can be categorized into "carbon property rights" and "carbon financial rights". Oestreich et al. found that the implementation of the market mechanism of carbon emissions trading and the acquisition of free allowances by companies can lead to cash inflows and, thus, improve the financial performance of companies [9]. In the carbon market, carbon emission rights can be traded as a product, making it a specific financial asset. Deng Maozhi et al. proposed that China's carbon emission trading system is in the stage of "pilot" to "national unification" [17] and the trading system mostly adopts the form of free allowance issuance, so that the emission control enterprises included in the pilot carbon emission trading system can use free al-

lowances to obtain additional cash inflows, which produces a policy effect similar to that of eco-transfer payments. Finally, cost pass-through by monopolies also leads to an improved corporate financial performance. Smale et al. found a high number of firms in monopolistic industries, such as electricity and cement, in the carbon market and these firms pass on the cost of carbon into the price of their products. Since most companies currently receive carbon allowances for free, the cost of carbon is zero, which, combined with price increases, allows them to make excess profits and improve their financial performance [18]. Most of the firms on the pilot list in China are in the manufacturing, steel, or energy sectors, so this paper argues that the case for carbon cost pass-through by pilot firms in China is equally likely. Based on the above analysis, the following hypotheses are proposed in this paper:

Hypothesis 1: *Carbon emissions trading policies positively impact corporate financial performance*.

According to stakeholder theory and the theory of sustainable development, companies will build a good social image by engaging in carbon investment activities and such "good" signals will inevitably be transmitted to consumers, suppliers, investors, and other stakeholders to obtain more favorable resources. However, the cycle of generating positive impacts is longer and needs to be tested over time, and a "good" image comes at a financial cost. Chapple et al. found that firms' participation in carbon emissions trading leads to a decrease in the firms' market performance, due to an increase in production costs [19]. Because of the uncertainty of past policies, environmental costs incurred by companies are driven more by compliance than by financial gain. As a result, companies are more likely to adopt low-carbon technologies or achieve CO2 reductions through short-term production reductions rather than risky and time-consuming research and development. Zhang et al. (2019) found that carbon trading did not effectively promote enterprises' independent R&D innovation by studying the enterprises included in carbon emissions trading, and they, instead, preferred to adopt low-carbon technologies [20]. Again, Zhou et al. found that in the operation of carbon markets, if the information disclosure mechanism is not perfect enough, market participants cannot obtain the necessary information in a timely manner, which triggers the problem of information asymmetry [21]. At present, China's carbon emissions trading mechanism is still in the early stages of development, and accounting standards are not yet complete. This has resulted in the accounting treatment and disclosure of statements by many emission control enterprises being too brief to accurately reflect their carbon emission status. As a result, the implementation of a carbon emissions trading policy may also, to some extent, undermine investors' confidence in regulated companies, which, in turn, may have a negative impact on the companies' market performance. At the same time, future regulations will be stricter and the required rate of return for high emitters will be higher, which will undoubtedly increase the capital burden on companies. Consequently, this research proposes the following hypothesis based on the aforementioned analysis:

Hypothesis 2: *Carbon emissions trading policies negatively affect firms' market performance*.

Adequate financial support is crucial for business development. Although the balance of green loans in China has been growing year by year, they mainly target projects in industries or sectors that are in line with the direction of green and low-carbon development, such as new energy, green transportation, and construction. At present, the development of transition financing for the low-carbon transition of two-high-percentage enterprises is still in its infancy and it is difficult for two-high-percentage enterprises to obtain support from financial institutions for their transition projects. For the too-high-enterprises, which are mainly integrated into the carbon market, internal corporate finance alone for transformation projects may generate greater cash flow pressure and operational risks. Therefore, the external financing constraints that pilot companies face in implementing environmental investments may have an impact on their financial performance. Based on the policy shock of higher sewage fees from 2007 and the pollution data of industrial enterprises from 2004 to 2013, Chen Shiyi et al. found that the increase in sewage fees

significantly led to a decrease in borrowing and an increase in the financing constraints of enterprises [22].

As the number of years that companies have been in the emissions trading market increases, policymakers have progressively increased the emissions requirements for companies that control emissions, and the cycle of green technology innovation tends to be longer, making it increasingly difficult for companies to meet stringent emissions requirements while maintaining production. In order to avoid a serious loss of market share, companies will have to maintain production by purchasing quotas and increasing investment in green technological innovation, which will undoubtedly increase their demand for capital, further exacerbating their financial constraints. Zhu Lin conducted an empirical study using data from A-share listed companies between 2007 and 2018 to examine the correlation between the government's green policy and the extent of the financing impediments faced by polluting enterprises. The study concluded that an enhancement in the green policy significantly amplifies the degree of financing constraints for such companies [23]. In addition, the participation of companies in the carbon emissions trading market implies a mandatory environmental information disclosure. Based on the difference-in-differences method, Fan Xiaoyu conducted a study of 935 high-polluting enterprises listed as Shanghai and Shenzhen A-share companies from 2007 to 2018. The findings indicate that the implementation of environmental information regulation policies significantly intensified the financing constraints faced by high-polluting enterprises [24]. Therefore, this paper proposes the following hypothesis based on the above analysis:

Hypothesis 3: *Carbon trading policies may exacerbate the degree of financing constraints for companies*.

Hambrick and Mason proposed the Upper Echelons Theory, which emphasizes the pervasive impact of cognitive skills, values, and other attributes of the top management team on organizational strategy and performance [25]. Regarding corporate investment, Yao Lijie et al. demonstrated that competent managers are better poised to seize investment opportunities, ultimately leading to an enhanced investment efficiency within the firm [26]. In addition, in terms of business management, Zhang Lu et al. found that highly capable managers are more adept at gathering, processing, and interpreting information and are better able to prepare in advance for changes in the business environment and to take effective countermeasures, which can significantly reduce the firm's cost stickiness [27]. Wang et al. found that high-capacity managers tend to disclose high-quality information, which can effectively reduce the moral hazard caused by information asymmetry, attract external investors, and bring in diversified resources, as well as improving the firm's market performance [28].

In the carbon market, where a policy-driven environment is rife with uncertainty, the abilities of managers significantly affect corporate market performance. Managers who are competent can capture and interpret policy trends, anticipate market changes promptly, adjust corporate strategies, lower operating costs, and earn the trust of investors. These competencies result in an improved corporate market performance. Therefore, based on this analysis, this paper puts forward the following hypothesis.

Hypothesis 4: *Managerial competence moderates the negative inhibitory effect of carbon trading policies on firm market performance*.

4. Data and Methods

4.1. Sample Selection and Data Sources

In this study, we selected A-share listed companies from 2009 to 2022 as the initial sample. The research subjects of the experimental group were selected from the first batch of listed companies in Beijing, Tianjin, Shanghai, Hubei, Guangdong, and Shenzhen that were included in the local carbon market to control emissions; the listed companies that were not included in the pilot carbon market were the control group. With the exception of

Hubei, the pilot markets in the other five provinces and cities launched in 2013. Therefore, to maintain sample accuracy, this study considers 2013 as the policy's starting year.

The relevant data sources used for the empirical analysis in this paper are as follows: first, the list of corporate carbon emission pilot projects mainly comes from the official website of the Development and Reform Commission of each pilot province and city, as well as the Carbon Emission Trading Center, etc.; second, the financial data of listed companies come from the database of Cathay Pacific (CSMAR); and third, the other macro data come from the China Statistical Yearbook and the China Environmental Yearbook. In order to ensure the accuracy of the sample data, the data are processed as follows: companies in the financial sector are excluded; companies marked with ST, *ST, and other symbols are excluded; and companies with severe missing data and companies listed after 2009 are excluded.

4.2. Variable Definition

4.2.1. Explained Variables

The explained variable in this paper is firm performance, divided into financial performance and market performance, following established literature practices. Financial performance is an indicator calculated from financial data that reflects the enterprise's financial status, representing its operational capacity. Return on total assets (ROA) represents the most commonly utilized ratio to evaluate a company's overall financial position. It is calculated by dividing a company's net profit by its average total assets. In this paper, the return on total assets (ROA) is chosen as a proxy variable for corporate financial performance, based on the methodology of Wang Bo et al. and He Shengbing et al. [29,30]. Market performance refers to the assessment of enterprise performance from a market perspective, which reflects the market value of the enterprise. In the previous literature, Tobin's Q is the most widely used, which is the ratio of the market value and replacement cost of an enterprise and can effectively combine the financial data of the enterprise with the market data to comprehensively reflect the long-term growth of the enterprise. Therefore, Tobin's Q is selected as a proxy variable for firms' market performance in this paper.

4.2.2. Explanatory Variables

This paper's explanatory variables are the result of multiplying the dummy variable for the year of the launch of the carbon emissions trading market and the dummy variable for pilot enterprises, represented by 'did'. A value of one is assigned to enterprise i if it participates in the carbon emissions trading market in year t; otherwise, a value of zero is assigned. The pilot carbon market policy's year is chosen as 2013; pilot companies are listed controlled emission enterprises.

4.2.3. Mediating Variable

This paper tests the impact of carbon trading policies on corporate financial performance with financing constraints as a mediating variable. Financing constraints refer to a phenomenon in which the mobilization of funds in financial markets is limited by a number of factors that prevent access to the required funds. This paper measures corporate financing constraints using the SA index constructed by Hadlock and Pierce [31], which is calculated as follows:

$$SA = -0.737Size + 0.043Size^2 - 0.04Age \quad (1)$$

where $Size$ represents the natural logarithm of the company's total asset size and Age indicates the number of years the company has been operating. A bigger SA index corresponds to a more significant financing constraint.

4.2.4. Moderating Variable

This paper aims to evaluate the impact of managerial competence on the firms' market performance by testing the moderating effect of this variable. This paper measures manage-

rial competence based on the indicators constructed by Zhu Changming [32]. Using Sales as the output variable, and Company Operating Costs (*COGS*), Selling and Administrative Expenses (*SG&A*), Net Fixed Assets (*PPE*), Net Intangible Assets (*Intangible*), Goodwill, and Net Research and Development Expenditures (*R&D*) as the input variables, the effect of industry variables is controlled for in calculating productivity. And the highest efficiency value of the firms in the industry is standardized as a benchmark to obtain the efficiency value (θ) of all firms in the industry, as in Equation (2).

$$Max_{\theta} = \frac{Sales}{V_1 COGS + V_2 SG\&A + V_3 PPE + V_4 Intangible + V_5 Goodwill + V_6 R\&D} \quad (2)$$

However, the efficiency value calculated in Equation (2) includes both the efficiency created by the management's capacity and the efficiency created by the firm's resources. Therefore, this paper conducts Tobit regressions to separate managerial competence from the efficiency of firm resource creation. Firm size (*Size*), market share (*MS*), free cash flow (*FCF*), years in the market (*Age*), and business complexity (*BHHI*) are the main factors influencing firm level efficiency (*Efficiency*). Based on this, this paper develops model (3) and the residuals of the regression are used to measure managerial competence.

$$Efficiency = \alpha_0 + \alpha_1 Size + \alpha_2 MS + \alpha_3 FCF + \alpha_4 Age + \alpha_5 BHHI + \sum Year_i + \varepsilon_i \quad (3)$$

4.2.5. Control Variables

This paper selected control variables based on the existing literature [33,34], introducing asset size, operating leverage, cash flow position, company age, corporate growth, and equity concentration into the model. Table 1 defines the main variables.

Table 1. Definition of variables.

Variable Type	Variable Symbol	Variable Definition
Explained variables	ROA	Net profit/average balance of total assets
	Q	Market value of the company/replacement cost of assets
Explanatory variable	'did'	A value of one if company i participates in the carbon emissions trading market during year t; a value of zero otherwise.
Intermediary variable	SA	Construction of SA index based on Hadlock and Pierce
Moderator variable	Mability	Indicators of managerial competence constructed according to Zhu Changming
Control variable	CR1	Shareholder ratio of the largest majority owner.
	Growth	(Total assets at the end of the current period–total assets at the end of the previous period)/total assets at the end of the previous period
	Dol	(sales revenue–variable costs)/(sales revenue–variable costs–fixed costs)
	Cash	Net cash flows from operating activities/total assets at the beginning of the period
	Size	Logarithmic total assets of the company.
	Age	Logarithmic year of listing.

4.3. Model Setup

In this paper, benchmark regression, mediation effect, moderating effect, and heterogeneity tests were conducted on the sample data using Stata, and the following are the three models used in this paper.

4.3.1. DID Model

In this paper, we conduct a quasi-natural experiment utilizing the carbon emissions trading policy as an exogenous event. We utilize the double-difference model (DID) to test the influence of this policy on the financial and market performance of enterprises. The treatment group comprises enterprises participating in the carbon emissions trading pilot,

while the control group comprises enterprises not participating in the carbon emissions trading pilot. Specific model settings are as follows:

$$Roa_{it} = \beta_0 + \beta_1 Did_{it} + \beta_2 Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

$$Q_{it} = \beta_0 + \beta_1 Did_{it} + \beta_2 Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

where "i" denotes the firm and "t" denotes the year. Roa_{it} and Q_{it} are the explained variables of this paper, denoting financial performance and market performance, respectively. Did_{it} is the explanatory variable, a value of one means that firm i was included in the carbon market in year t. $Controls_{it}$ is the control variable, μ_i denotes individual fixed effects, λ_t denotes time fixed effect, and ε_{it} is a randomized perturbation term (math.). β_1. indicates the effect of carbon trading policy implementation on corporate financial and market performance.

4.3.2. Mediation Effects Model

To test whether the carbon trading policy can affect the financial performance of enterprises by exacerbating the situation of financing constraints, the stepwise regression method is used to test the mediation effect, i.e., the following model is constructed based on del (4).

$$SA_{it} = \alpha_0 + \alpha_1 Did_{it} + \alpha_2 Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (6)$$

$$Roa_{it} = \delta_0 + \delta_1 Did_{it} + \delta_2 SA_{it} + \delta_3 Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (7)$$

where SA_{it} is the mediating variable financing constraints and the other variables are the same as in (4).

4.3.3. Moderation Effect Model

This study aims to examine whether managerial competence can influence corporate market performance under the carbon emissions trading policy. The moderation effect test is utilized, and the following model is built based on model (5).

$$Q_{it} = \beta_0 + \beta_1 (Did_{it} \times Mability_{it}) + \beta_2 Did_{it} + \beta_3 Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (8)$$

where $Did_{it} \times Mability_{it}$ is the moderated interaction term and the other variables are the same as in (5).

5. Empirical Analyses

5.1. Descriptive Statistics

Table 2 presents the descriptive statistics of the main variables. It can be observed that Roa and Q have minimum and maximum values of 0.288, −0.018 and 11.424, 0.787, respectively, which implies significant individual variations among firms. Additionally, most control variables exhibit mean values exceeding the standard deviation, indicating the sample's good stability.

Table 2. Descriptive statistics of main variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	14,430	0.051	0.046	−0.018	0.288
Q	14,430	1.917	1.249	0.787	11.424
did	14,430	0.045	0.207	0.000	1.000
Size	14,430	22.775	1.360	19.820	26.760
CR1	14,430	0.364	0.152	0.089	0.770
Cash	14,430	0.062	0.083	−0.304	0.416
Growth	14,430	0.156	0.536	−0.707	37.029
Dol	14,430	1.646	0.871	1.009	12.687
Age	14,430	14.593	6.242	2.000	32.000

5.2. Benchmark Regression Results

In this study, we apply the DID model to evaluate how carbon trading policies affect the financial and market performance of corporations. Table 3 presents the benchmark regression outcomes. The first two columns show the results of the test of the impact of carbon trading policy on firm financial performance, which are the cases when no control variables are added and when control variables are added. The coefficients of 'did' are 0.006 and 0.006, and they are significant at the 5% level when control variables are added. The last two columns show the results of the test of the impact of carbon trading policies on the firms' market performance, with and without the addition of control variables, with the coefficients of −0.139 and −0.080, respectively, for 'did' and were significant at the 5% level with the addition of control variables. It can be seen that the carbon trading policy significantly improves the financial performance of the pilot companies and significantly hinders the market performance of the pilot companies. This study provides strong evidence that the adoption of the carbon emissions trading policy significantly affects the financial and market performance of businesses, while also revealing the policy's restraining impact on market performance, which is a crucial factor in the conflict between environmental regulation and enterprise development. The findings presented in Table 3 demonstrate that the implementation of a carbon emissions trading system can have a significant positive impact on corporate financial performance, while simultaneously diminishing corporate market performance, thus providing support for Hypotheses 1 and 2.

Table 3. Benchmark regression results.

Variables	(1)	(2)	(3)	(4)
	ROA	ROA	Q	Q
'did'	0.006	0.006 **	−0.080	−0.139 **
	(1.61)	(2.18)	(−1.19)	(−2.17)
Size		−0.005 ***		−0.427 ***
		(−4.91)		(−12.28)
CR1		0.020 ***		−0.423 **
		(2.78)		(−2.41)
Cash		0.134 ***		1.423 ***
		(17.06)		(9.63)
Growth		0.005 **		−0.032
		(2.33)		(−1.50)
Dol		−0.017 ***		−0.061 ***
		(−20.27)		(−6.20)
Age		0.001***		0.004
		(3.45)		(0.90)
_cons	0.058 ***	0.179 ***	2.281 ***	11.749 ***
	(48.00)	(7.55)	(87.85)	(15.93)
Year−FE	Yes	Yes	Yes	Yes
Frim−FE	Yes	Yes	Yes	Yes
N	14,430	14,430	14,430	14,430
R^2	0.034	0.296	0.171	0.233

Notes: ** and *** denote significance at the 5% and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

5.3. Parallel Trend Test

Meeting the parallel time trend assumption is a crucial requirement for implementing the difference-in-differences model. This necessitates that the companies in the control and experimental groups had identical trends in financial and market performance alterations before the policy's execution.

This study employs 2012, the year prior to the adoption of the carbon trading policy, as the benchmark year. To pass the parallel trend test, the coefficient change must not be significant between 2009 and 2011. Figures 1 and 2 demonstrate the results of the test. From Figures 1 and 2, it can be seen that the 95% confidence interval of the coefficients from 2009 to 2011 contain 0, indicating that there is no significant difference between the financial and market performance change trends of the experimental group and the control group before the implementation of the carbon trading policy, which satisfies the parallel trend hypothesis. By analyzing the changes in the coefficients from 2013 to 2022, it can be found that significant changes have occurred in the year of policy implementation and the following three years. Among them, there is a significant positive change in financial performance and a significant negative change in market performance.

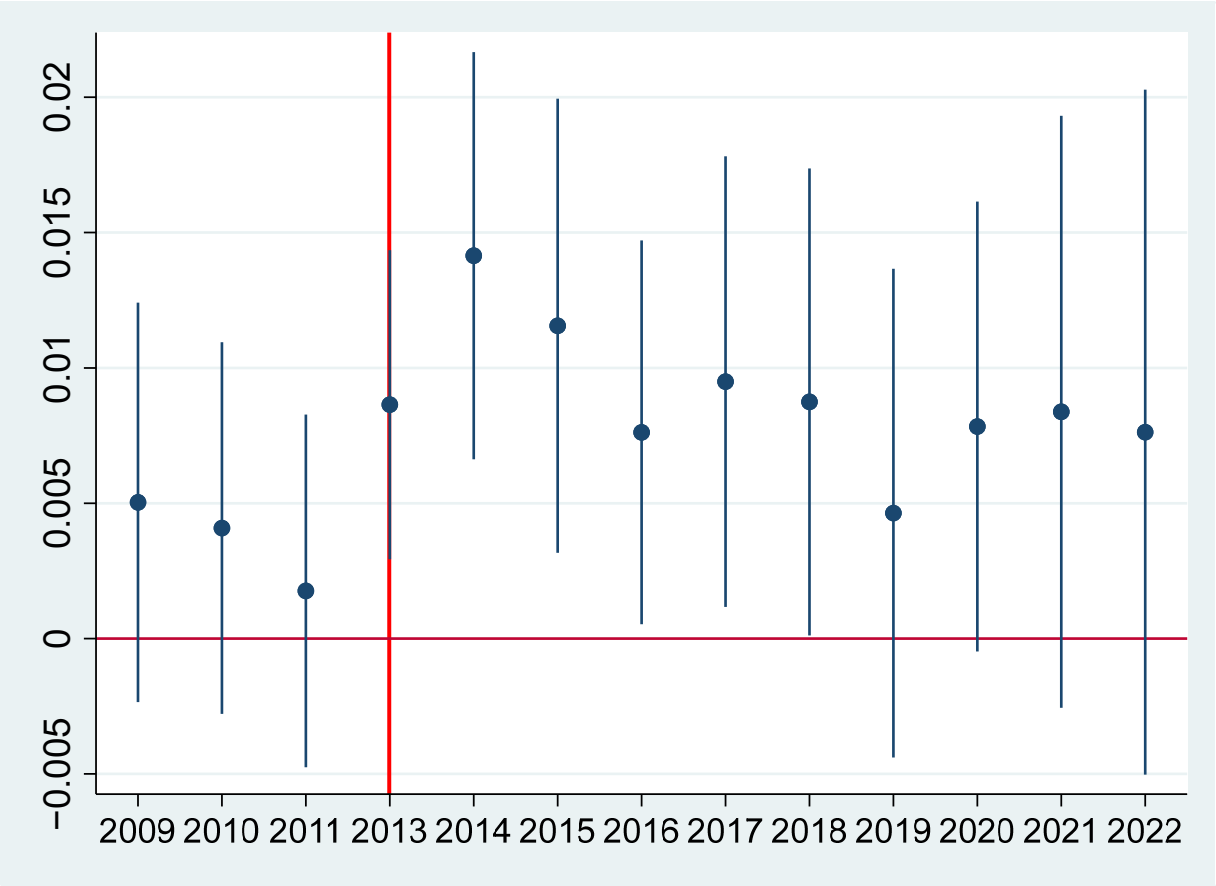

Figure 1. Parallel trend test of corporate financial performance. Notes: The red line is the year the policy starts.

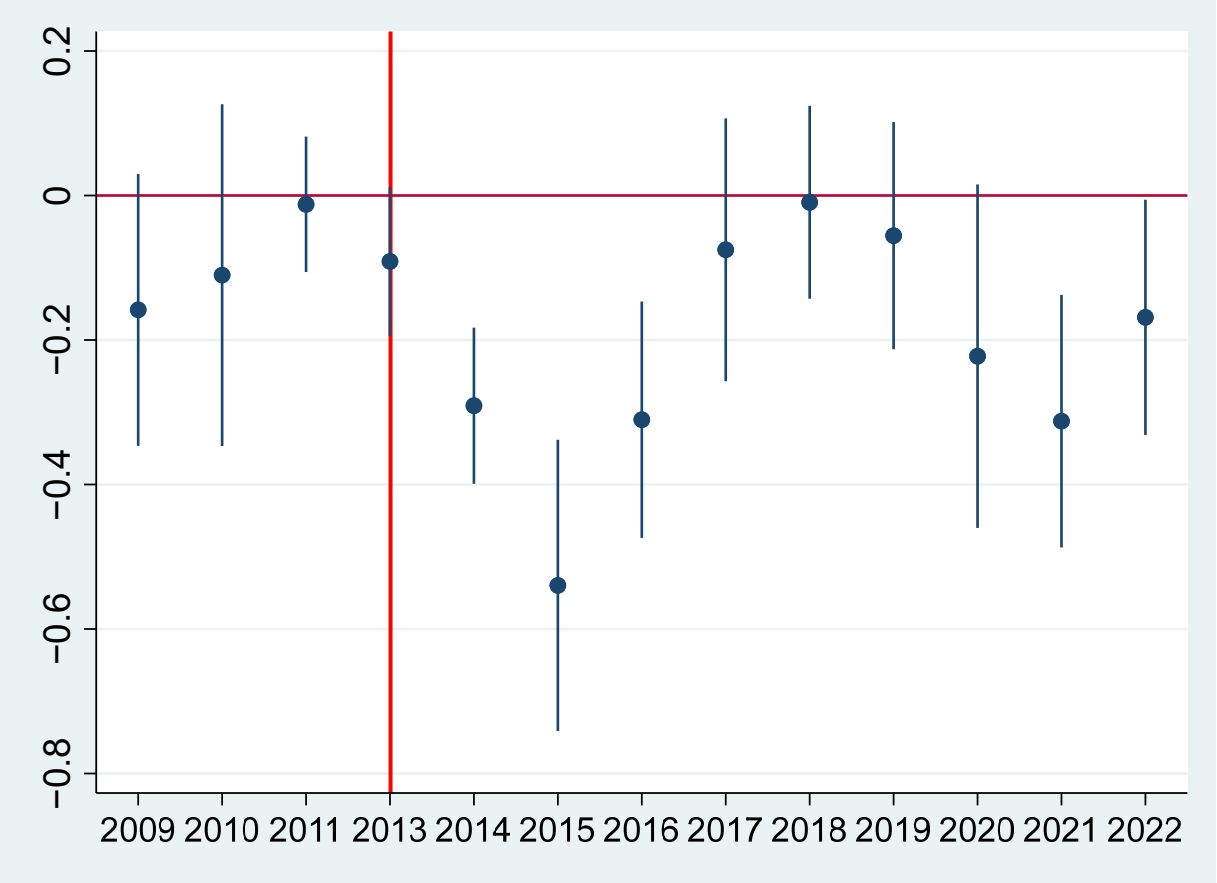

Figure 2. Parallel trend test of corporate market performance. Notes: The red line is the year the policy starts.

5.4. Robustness Check

5.4.1. Placebo Test

To confirm that the carbon emissions trading policy has a direct impact on firm performance, a placebo test was conducted in the paper to create a false policy occurrence year. In this study, the sham policy for the treatment group was implemented in 2010 and a placebo test was conducted using data from 2008 to 2012. If the estimated coefficients of the hypothetical policy variables are not significant, this indicates that there is no discernible distinction in the performance of firms between pilot and non-pilot provinces, while excluding the impact of the carbon emission trading policy. The test findings are displayed in Table 4, featuring regression outcomes for columns (1) and (3) without control variable inclusion, and columns (2) and (4) with control variable inclusion. The regression results show that the coefficients of the main explanatory variables in columns (1)–(4) are not significant, supporting the verification of Hypotheses 1 and 2 in this paper. This confirms that the implementation of the carbon emission trading policy affects the financial and market performance of the enterprises.

Table 4. Placebo test.

Variables	(1)	(2)	(3)	(4)
	ROA	**ROA**	**Q**	**Q**
'did'	−0.001	−0.001	0.011	0.019
	(−0.25)	(−0.26)	(0.11)	(0.21)
Size		−0.011 ***		−0.622 ***
		(−4.09)		(−9.99)
CR1		0.033 **		−0.579 *
		(2.48)		(−1.91)
Cash		0.064 ***		0.543 ***
		(8.52)		(3.79)
Growth		0.026 ***		−0.018
		(10.42)		(−0.34)
Dol		−0.017 ***		−0.042 ***
		(−15.29)		(−2.80)
Age		0.000		0.167 ***
		(0.25)		(13.42)
_cons	0.055 ***	0.294 ***	1.376 ***	13.846 ***
	(43.31)	(5.31)	(56.91)	(10.78)
Year-FE	Yes	Yes	Yes	Yes
Frim-FE	Yes	Yes	Yes	Yes
N	5165	5165	5165	5165
R^2	0.052	0.274	0.334	0.374

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

5.4.2. Propensity Score-Based Matching Double Difference Estimation

There are many factors affecting the inclusion of enterprises in the carbon emissions trading mechanism, including total operating revenue, the proportion of independent directors, liquidity ratio, and other indicators. This paper refers to the existing literature and combines the research content of this paper, the actual selection of the total operating revenue, capital expenditure, liquidity ratio, and the proportion of independent directors as a matching variable, using the 1:5 near-neighbor matching method. The results of the overall sample balance test in Table 5 demonstrate a significant decrease in standard deviations of all matched variables after overall sample matching. Additionally, these standard deviations are well below 10%. Thus, the paper's data matching has improved. There is no significant difference between the treatment and control groups for all variables after matching. Using the matched samples, the regression is, again, performed according to the baseline model. Columns (1) and (3) in Table 6 display the regression results obtained before introducing the control variables, while columns (2) and (4) show the regression results after including them. The coefficients obtained after introducing the control variables were not significantly different from the coefficients of the baseline model. Our findings confirm that financial performance remains significantly positive and market performance remains significantly negative. Therefore, Hypotheses 1 and 2 are further confirmed.

Table 5. PSM matching results.

Variables	U/M	Mean		%reduct		*t*-test	
		Treated	Control	%bias	|bias|	t	$p > \|t\|$
Total revenue	U	6.6×10^{10}	1.8×10^{10}	20.7	58.6	11.54	0.000
	M	4.7×10^{10}	6.7×10^{10}	−8.6		−1.72	0.086
Capital expenditures	U	5.8×10^{9}	1.2×10^{9}	31.0	83.9	13.15	0.000
	M	5.0×10^{9}	4.2×10^{9}	5.0		0.93	0.354
Liquid	U	1.587	1.869	−15.5	97.0	−4.21	0.000
	M	1.594	1.602	−0.5		−0.11	0.913
Indep	U	37.081	37.239	−2.8	75.5	−0.80	0.423
	M	37.090	37.052	0.7		0.14	0.892

Table 6. PSM regression results.

Variables	(1)	(2)	(3)	(4)
	ROA	ROA	Q	Q
'did'	0.006	0.006 *	−0.071	−0.116 *
	(1.42)	(1.88)	(−0.94)	(−1.65)
Size		−0.007 ***		−0.348 ***
		(−3.92)		(−6.15)
CR1		0.024 ***		−0.176
		(2.62)		(−0.67)
Cash		0.165 ***		1.670 ***
		(11.92)		(5.96)
Growth		0.015 ***		0.009
		(3.17)		(0.14)
Dol		−0.015 ***		−0.035 **
		(−10.45)		(−2.02)
Age		0.001 ***		0.003
		(3.04)		(0.33)
_cons	0.057 ***	0.208 ***	2.141 ***	9.814 ***
	(26.54)	(5.25)	(45.34)	(7.90)
Year-FE	Yes	Yes	Yes	Yes
Frim-FE	Yes	Yes	Yes	Yes
N	4409	4409	4409	4409
R^2	0.037	0.336	0.174	0.226

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

6. Effect Mechanisms and Heterogeneity Analysis

6.1. Impact Mechanism Testing

The above results indicate that the carbon trading policy has a significant effect on the improvement of corporate financial performance and, at the same time, it significantly inhibits corporate market performance. This section explores the role mechanism of the carbon trading policy on financial performance and the moderating effect of managerial competence on market performance.

6.1.1. The Masking Effect of Funding Constraints

In this paper, the stepwise regression method is used for validation, i.e., models (4), (6), and (7) are regressed sequentially. As shown in column two of Table 7, the coefficient of 'did' is 0.039 and is statistically significant at the 1% level, indicating that the carbon emissions trading policy worsens financing constraints for firms. The financing constraint index in column (3) displayed a significant negative trend, with an increase in the 'did' coefficient compared to column (1). These findings reveal a masking effect of financing constraints on the indirect effect, according to the approach for determining mediating and masking effects. In terms of masking effects, carbon emissions trading policies exacerbate firms' financing constraints and the positive effect of carbon emissions trading policies on firms' financial performance is higher after controlling for financing constraint variables. Wu Jingtai and Yang Lixia's research states that the financing constraint index and enterprise financial performance are negatively correlated; that is, the higher the financing constraint index, the higher the cost of enterprises to obtain funds for investment, which will inevitably lead to the difficulty of improving the financial performance of the enterprise [35].

Table 7. Concealment effect—funding constraints.

Variables	(1)	(2)	(3)
	ROA	SA	ROA
'did'	0.006 **	0.039 ***	0.007 **
	(2.18)	(3.89)	(2.45)
SA			−0.023 ***
			(−3.55)
Size	−0.005 ***	0.026 ***	−0.005 ***
	(−4.91)	(4.76)	(−4.34)
CR1	0.020 ***	0.014	0.020 ***
	(2.78)	(0.55)	(2.85)
Cash	0.134 ***	0.016	0.135 ***
	(17.06)	(1.40)	(17.14)
Growth	0.005 **	−0.012 ***	0.005 **
	(2.33)	(−4.45)	(2.26)
Dol	−0.017 ***	0.002 **	−0.017 ***
	(−20.27)	(1.96)	(−20.25)
Age	0.001 ***	−0.038 ***	−0.000
	(3.45)	(−62.40)	(−0.66)
_cons	0.179 ***	−3.834 ***	0.090 ***
	(7.55)	(−33.07)	(2.65)
Year-FE	Yes	Yes	Yes
Frim-FE	Yes	Yes	Yes
N	14,430	14,430	14,430
R^2	0.296	0.841	0.298

Notes: ** and *** denote significance at the 5% and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

6.1.2. The Moderating Role of Leadership Competencies

Summarizing the previous regression results, it can be seen that there is a significant inhibitory effect of the carbon emission trading policy on the corporate market performance, mainly because the carbon emission trading policy will affect the investors' confidence in

the controlled companies, thus negatively affecting their corporate market performance. But does the impact of carbon trading policies on firms' market performance vary across firms' managerial capabilities? Based on the benchmark model, this paper further adds the cross-multiplier term 'did'Mability between 'did' and managerial ability to explore the moderating mechanism of managerial ability on the firms' market performance. The regression results in Table 8 show that the coefficient on the cross-multiplier term for 'did'Mability, 0.693, is significantly positive at the 10% level. This suggests that the negative effect of carbon trading policy on firms' market performance is mitigated when firms' managerial competence is stronger, and managerial competence is able to regulate the negative inhibitory effect of the carbon trading policy on firms' market performance. Hypothesis 4 is tested. The stronger the managerial competence, the more it attracts external investors to enter and bring in diversified resources, which improves the firm's market performance.

Table 8. Moderating effect—managerial capacity.

Variables	(1)	(2)
	Q	Q
'did'	−0.139 **	−0.151 **
	(−2.17)	(−2.14)
'did'Mability		0.693 *
		(1.68)
Size	−0.427 ***	−0.409 ***
	(−12.28)	(−11.73)
CR1	−0.423 **	−0.404 **
	(−2.41)	(−2.23)
Cash	1.423 ***	1.412 ***
	(9.63)	(9.19)
Growth	−0.032	−0.013
	(−1.50)	(−0.48)
Dol	−0.061 ***	−0.062 ***
	(−6.20)	(−6.40)
Age	0.004	0.003
	(0.90)	(0.52)
_cons	11.749 ***	11.371 ***
	(15.93)	(15.38)
Year-FE	Yes	Yes
Frim-FE	Yes	Yes
N	14,430	13,537
R^2	0.233	0.230

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

6.2. Heterogeneity

The previous paper has verified the positive and negative effects of carbon emission trading policies on corporate finance and market performance and the mechanism of their effects, respectively, but further tests are needed to determine whether the effects of carbon emission trading policies are heterogeneous, taking into account the differences in the allocation modes of allowances in different carbon markets, the price of carbon, and the

strength of regional environmental enforcement. In this section, the paper will analyze the heterogeneity of the effects of the carbon market quota allocation mode, carbon price, regional environmental enforcement efforts, and type of industry on the impact of carbon emissions trading policies.

6.2.1. Heterogeneity of Carbon Allowance Allocation Models

On the one hand, the carbon emission allowance allocation mode is the basis of each province's carbon trading policy, which plays a decisive role in the implementation of the carbon trading policy; on the other hand, the carbon emission allowance allocation mode of each province's carbon trading policy varies widely, which mainly includes three modes and their combinations, viz. Among them, the allocation modes of Shanghai and Tianjin only adopt the free allocation mode; the allocation mode of Guangdong includes free allocation and bidding auction; the allocation modes of Beijing, Shenzhen, and Hubei also include free allocation, bidding auction and pricing and selling [36]. As a result, this study splits the policy interaction term in the baseline regression model into the policy interaction terms 'did'quota1, 'did'quota2, and 'did'quota3 in turn, according to the three quota allocation modes mentioned above, in order to examine the differential impact of the carbon trading policy on firms' market performance in these three quota allocation modes. Columns (1), (2), and (4) of Table 9 show that the estimated coefficients of the interaction term for the pilot, using only the free distribution model, are significantly negative at the 10% level and the negative effect is smaller than that in the baseline regression; the estimated coefficients of the interaction term are not significant when using the two models of free distribution and bidding auctions; the estimated coefficients of the interaction term are significantly negative at the 10% level for the three models of free distribution, bidding auctions, and pricing and selling; the estimated coefficients of the interaction term are significantly negative at the 10% level and the negative effect is larger than the negative effect of the baseline regression. The estimated coefficient of the interaction term is significantly negative at the 10% level and the negative effect is larger than the negative effect of the baseline regression. This suggests that the use of the free allocation model and the three mixed allocation models have a significant negative effect on the firms' market performance, and the free allocation model mitigates this negative effect, while the three mixed allocation models amplify this negative effect. The possible reason for this phenomenon is that investors believe that the higher the proportion of free allowances, the weaker the inhibiting effect of the carbon trading policy on the development of enterprises, the greater the confidence of investors, and the corresponding improvement in the market performance of enterprises. Under the three mixed allocation modes, the lower the proportion of free allowances, the relatively stronger the inhibiting effect of the carbon emission trading policy on the development of enterprises, and the worse the investors' expectations of the market of emission control enterprises, the negative impact of the carbon emission trading policy on the market performance of enterprises will be strengthened accordingly.

Table 9. Carbon allocation model—market performance.

Variables	(1)	(2)	(3)	(4)
	Q	Q	Q	Q
'did'	−0.139 **			
	(−2.17)			
'did'quota1		−0.118 *		
		(−1.78)		
'did'quota2			−0.054	
			(−1.04)	

Table 9. *Cont.*

Variables	(1)	(2)	(3)	(4)
	Q	Q	Q	Q
'did'quota3				−0.149 *
				(−1.84)
Size	−0.427 ***	−0.426 ***	−0.425 ***	−0.426 ***
	(−12.28)	(−12.24)	(−12.23)	(−12.25)
CR1	−0.423 **	−0.420 **	−0.418 **	−0.422 **
	(−2.41)	(−2.39)	(−2.39)	(−2.40)
Cash	1.423 ***	1.422 ***	1.423 ***	1.424 ***
	(9.63)	(9.62)	(9.63)	(9.63)
Growth	−0.032	−0.032	−0.032	−0.032
	(−1.50)	(−1.50)	(−1.51)	(−1.51)
Dol	−0.061 ***	−0.061 ***	−0.061 ***	−0.061 ***
	(−6.20)	(−6.23)	(−6.22)	(−6.19)
Age	0.004	0.004	0.004	0.004
	(0.90)	(0.76)	(0.73)	(0.85)
_cons	11.749 ***	11.739 ***	11.725 ***	11.728 ***
	(15.93)	(15.90)	(15.90)	(15.90)
Year-FE	Yes	Yes	Yes	Yes
Frim-FE	Yes	Yes	Yes	Yes
N	14,430	14,430	14,430	14,430
R^2	0.233	0.232	0.232	0.233

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

6.2.2. Carbon Price Heterogeneity

The effectiveness of the implementation of the carbon trading policy is closely related to the high and low prices of carbon emissions transactions. Cui et al. found that a higher carbon price provides greater incentives for firms to participate in carbon abatement [37]. Wei Lili et al. believe that when the carbon price is relatively high, the government's responsibility includes maintaining the carbon price and encouraging it to be effectively raised within a reasonable range, and that effective management and guidance of the carbon price is conducive to strengthening the effect of carbon trading policy implementation [38]. Considering the differences in carbon prices in different pilot cities, this study examines the heterogeneity of policy effects by classifying the six pilot provinces into high and low carbon price categories based on the average carbon price of the pilot regions in 2015–2022 in the wind database (Figure 3), and classifying the pilot regions of the carbon trading policy into high and low carbon price areas based on the average price of carbon emission rights transactions. Among them, the high carbon price regions include Beijing, Shanghai, and Guangdong, and the low carbon price regions include Hubei, Tianjin, and Shenzhen. As a result, this study splits the policy interaction term in the baseline regression model into 'did'high and 'did'low policy interaction terms based on the two carbon price types mentioned above to examine the differential impact of carbon trading policies on the financial performance of firms in high and low carbon price regions, respectively. The analysis of carbon price heterogeneity is displayed in Table 10. The estimated coefficient of 'did'high is 0.009, which is significant at the 5% level. This suggests that as the carbon price increases, the financial performance of enterprises is positively impacted by the carbon emissions trading policy. The possible reason for this is that the higher the carbon price,

the more it can force enterprises to increase R&D investment and promote technological innovation, thus reducing costs and increasing revenues; at the same time, green technological innovation reduces the carbon emissions of the enterprise, which makes the surplus of carbon allowances increase, and thus improves the financial performance of the enterprise.

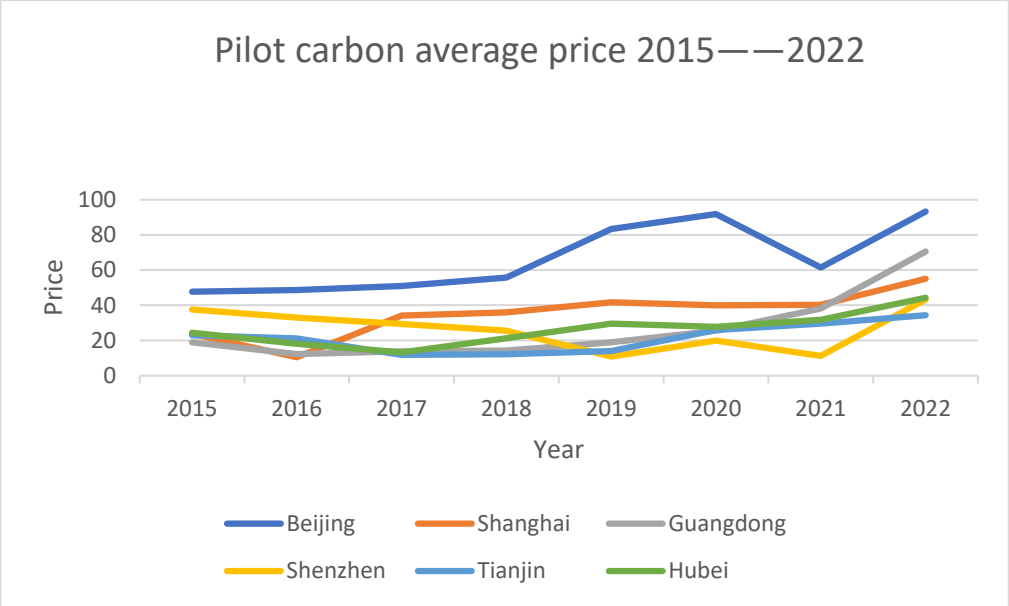

Figure 3. Pilot average carbon price, 2015–2022.

Table 10. Pilot carbon price—financial performance.

Variables	(1)	(2)	(3)
	ROA	ROA	ROA
'did'	0.006 **		
	(2.18)		
'did'low		0.001	
		(0.12)	
'did'high			0.009 **
			(2.56)
Size	−0.005 ***	−0.006 ***	−0.005 ***
	(−4.91)	(−4.94)	(−4.85)
CR1	0.020 ***	0.020 ***	0.020 ***
	(2.78)	(2.76)	(2.79)
Cash	0.134 ***	0.134 ***	0.135 ***
	(17.06)	(17.06)	(17.06)
Growth	0.005 **	0.005 **	0.005 **
	(2.33)	(2.33)	(2.33)
Dol	−0.017 ***	−0.017 ***	−0.017 ***
	(−20.27)	(−20.23)	(−20.30)
Age	0.001 ***	0.001 ***	0.001 ***
	(3.45)	(3.66)	(3.42)

Table 10. *Cont.*

Variables	(1)	(2)	(3)
	ROA	ROA	ROA
_cons	0.179 ***	0.180 ***	0.178 ***
	(7.55)	(7.57)	(7.50)
Year-FE	Yes	Yes	Yes
Frim-FE	Yes	Yes	Yes
N	14,430	14,430	14,430
R^2	0.296	0.296	0.296

Notes: ** and *** denote significance at the 5% and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

6.2.3. Regional Environmental Enforcement Efforts

To examine the impact of different environmental enforcement efforts on the effect of the carbon trading policy, this paper refers to Ren Shengang et al. and uses the number of cases of environmental administrative penalties to characterize regional environmental enforcement efforts [39]. According to the number of environmental administrative penalty cases in each region in the year of carbon trading policy implementation, regions with more than the median number of cases are classified as regions with higher enforcement efforts, and regions with less than the median number of cases are classified as regions with lower enforcement efforts. From columns (1) and (2) in Table 11, we can see that the estimated coefficient of the interaction term for regions with strong environmental enforcement is still significant at 0.006, which means that there is little change in the positive effect of environmental enforcement on the firms' financial performance; from columns (3) and (4), we can see that the estimated coefficients of the interaction term for regions with strong environmental enforcement are still significantly negative, and the coefficients are larger in absolute value, which indicates that the stronger the environmental enforcement, the stronger the negative effect on the firms' market performance. This suggests that the stronger the environmental enforcement, the stronger the negative effect on firms' market performance. One possible reason for this is that when environmental enforcement is stronger in the region where the firm is located, the firm will face higher violation costs, be more likely to strictly follow the carbon trading policy, and be more motivated to carry out technological innovations to achieve high-quality production, which results in the effect on financial performance remaining significantly positive [39]; on the other hand, stronger environmental enforcement may have dampened the investors' confidence and lowered the investors' firms' market expectations, resulting in a stronger negative effect on market performance.

Table 11. Regional environmental enforcement efforts.

Variables	(1)	(2)	(3)	(4)
	ROA	ROA	Q	Q
'did'	0.006 **		−0.139 **	
	(2.18)		(−2.17)	
'did'regulate		0.006 **		−0.143 **
		(2.01)		(−2.22)
Size	−0.005 ***	−0.005 ***	−0.427 ***	−0.427 ***
	(−4.91)	(−4.91)	(−12.28)	(−12.28)
CR1	0.020 ***	0.020 ***	−0.423 **	−0.423 **
	(2.78)	(2.77)	(−2.41)	(−2.41)

Table 11. *Cont.*

Variables	(1)	(2)	(3)	(4)
	ROA	**ROA**	**Q**	**Q**
Cash	0.134 ***	0.134 ***	1.423 ***	1.423 ***
	(17.06)	(17.06)	(9.63)	(9.63)
Growth	0.005 **	0.005 **	−0.032	−0.032
	(2.33)	(2.33)	(−1.50)	(−1.50)
Dol	−0.017 ***	−0.017 ***	−0.061 ***	−0.061 ***
	(−20.27)	(−20.27)	(−6.20)	(−6.20)
Age	0.001 ***	0.001 ***	0.004	0.004
	(3.45)	(3.47)	(0.90)	(0.91)
_cons	0.179 ***	0.179 ***	11.749 ***	11.751 ***
	(7.55)	(7.56)	(15.93)	(15.93)
Year-FE	Yes	Yes	Yes	Yes
Frim-FE	Yes	Yes	Yes	Yes
N	14,430	14,430	14,430	14,430
R^2	0.296	0.296	0.233	0.233

Notes: ** and *** denote significance at the 5% and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

6.2.4. Type of Industry

In order to examine the heterogeneity of the effects of different industry types on carbon trading policies, this paper refers to the research practice of Ailing Pan et al. and defines the industries with industry codes B06, B07, B08, B09, C17, C19, C22, C25, C26, C28, C29, C30, C31, C32, and D44 as heavily polluting industries [40]. In Table 12, (1) and (2) are the effects on financial performance of high and low polluting firms, respectively, and (3) and (4) are the effects on market performance of high and low polluting firms, respectively. From regression result (1), we find that the carbon trading policy has a stronger positive impact on the financial performance of high polluters; from regression result (4), the carbon trading policy exacerbates the negative impact on the market performance of low polluters. The likely reason for this is that in the early stages of carbon trading, high-polluting firms shared more free allowances and benefited more from carbon trading compared to the regulatory risk burden associated with inclusion, which, in turn, had a positive impact on financial performance. Low-polluting firms, on the other hand, bear more of the burden of regulatory risk and benefit less from carbon trading, which in turn adversely affects market performance.

Table 12. Type of industry.

Variables	(1)	(2)	(3)	(4)
	ROA	**ROA**	**Q**	**Q**
'did'	0.013 ***	0.002	0.034	−0.296 ***
	(2.71)	(0.50)	(0.51)	(−2.70)
Size	−0.010 ***	−0.004 ***	−0.372 ***	−0.449 ***
	(−4.30)	(−2.77)	(−6.85)	(−10.46)
CR1	0.010	0.027 ***	−0.390	−0.485 **
	(0.76)	(3.02)	(−1.61)	(−2.19)

Table 12. *Cont.*

Variables	(1)	(2)	(3)	(4)
	ROA	**ROA**	**Q**	**Q**
Cash	0.244 ***	0.102 ***	1.427 ***	1.301 ***
	(12.96)	(12.36)	(5.32)	(7.71)
Growth	0.032 ***	0.004**	0.037	−0.024
	(5.94)	(2.08)	(0.46)	(−1.25)
Dol	−0.016 ***	−0.015 ***	−0.040 ***	−0.068 ***
	(−11.65)	(−16.01)	(−3.05)	(−5.51)
Age	−0.001	−0.000	−0.210 ***	0.011 *
	(−0.23)	(−0.12)	(−4.56)	(1.76)
_cons	0.317 ***	0.142 ***	14.711 ***	12.229 ***
	(4.85)	(5.07)	(9.58)	(13.51)
Heavily polluting	Yes	No	Yes	No
Year-FE	Yes	Yes	Yes	Yes
Frim-FE	Yes	Yes	Yes	Yes
N	3042	11,388	3042	11,388
R^2	0.467	0.252	0.241	0.228

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% confidence levels, respectively; unmarked regression results are not significant, as follows.

7. Concluding Recommendations and Shortcomings

7.1. Concluding Recommendations

This paper uses the carbon emission trading policy as a natural experimental tool and employs the difference-in-differences model to examine the influence of the policy on the financial state and market performance of companies. It also conducts an in-depth analysis of the mechanism of the role of the carbon trading policy on the financial state and market performance of companies, as well as the heterogeneity of the impact effect. The study found the following: (1) Carbon trading policies significantly improve the financial performance of pilot firms and inhibit the market performance of pilot firms and pass a series of robustness tests. (2) Through the mediation effect model, it is found that financing constraints play a masking role in the carbon trading policy affecting the financial performance of enterprises; meanwhile, it is verified that managerial ability plays a moderating role in the carbon trading policy affecting the market performance of enterprises. (3) Heterogeneity analysis shows that carbon trading policies improve the financial performance more for firms with higher carbon prices, higher environmental enforcement, and heavy polluters, and hinder market performance more for firms with small shares of free allowances, higher environmental enforcement, and low polluters.

The success of carbon emissions trading policy implementation depends on the scientific planning of governments and the active participation of enterprises. To effectively promote the carbon emissions trading policy and achieve a win–win situation for both economic development and the ecological environment, this paper presents measures and suggestions from the viewpoints of government and enterprises. Therefore, the government should accelerate the enhancement of the design of the carbon emissions trading system and integrate it with China's specific national conditions to establish a carbon market that embodies Chinese characteristics.

(1) Actively promote and continuously improve the carbon emission trading policy, while utilizing the market mechanism to effectively address environmental issues. This study shows that the carbon emissions trading policy has had a positive impact on the

financial performance of enterprises, resulting in a mutually beneficial outcome for both environmental improvement and corporate development. A single emission reduction measure is difficult to promote the transformation and upgrading of enterprises, and the research and development and application of low-carbon transformation technology can achieve a real win–win situation. Therefore, the future carbon trading market should be aimed at energy saving, emission reduction and environmental protection technology research and development, and design of carbon financial products, in order to encourage enterprises to strengthen R&D and innovation and to enhance the role of carbon trading technology to improve.

(2) Reduce corporate financing constraints and broaden corporate financing channels. This paper reveals that the carbon emissions trading policy intensifies the financing constraints faced by firms, thereby adversely impacting the enhancement of their financial performance. Previous green credits have eased the financing constraints of enterprises with green behaviors, while the development of transformational finance for the financing of high-carbon enterprises is still incomplete. Therefore, the government ought to provide additional funding assistance to companies and establish more accessible financial channels. The government can increase enterprise participation in the carbon trading market by creating a dedicated fund for carbon emissions trading, boosting awareness of the market to encourage investment by institutional players, and other similar measures aimed at promoting the formation of carbon pricing and fostering growth in carbon finance products. Such moves will help support the stable development of the emissions trading market.

(3) Given the heterogeneity of the carbon allowance allocation models, carbon prices, environmental enforcement efforts, and type of industry, it is imperative that the government formulates precise and scientific standards for quota allocation. In addition, it must establish a comprehensive mechanism for preventing and controlling risks and stabilizing the market. Corresponding regulatory and legal safeguards should also be put in place to fully harness the beneficial potential of the carbon market. Government departments can adopt a phased approach in evaluating the environmental performance of enterprises, and apply rewards and penalties based on the assessment outcomes. Highly polluting projects can be shut down, while enterprises that comply with energy conservation, emission reduction, and green development obligations can take advantage of incentives such as tax breaks and financial subsidies to encourage restructuring towards a dual goal of enhanced efficiency and environmental consciousness.

(4) Companies must improve the quality of their carbon disclosure and increase the capacity of their managers. It was found that the main reason for the negative impact of carbon trading policies on the firms' market performance was the lack of investor confidence due to imperfect information disclosure. The capital market and investors are more concerned about the economic effect of carbon trading; therefore, enterprises should include in the disclosure of the implementation of emission reduction costs, profits and other trading information, so that investors can more accurately assess the company's operation and development potential. The study presented in this paper reveals that the proficiency of managers plays a pivotal role in alleviating the adverse impact of carbon policy on the firms' market performance. Accordingly, firms need to invest in enhancing managerial competence, efficiently utilizing the financial attributes of carbon allowances, and adaptively adjusting their strategies to comply with the increasingly stringent emission standards.

7.2. Shortcomings

This paper still has some limitations, as follows: The first is the limitations of theoretical analysis. China's carbon trading market, as an immature market, has not yet clarified the pathways of influence on corporate financial and market performance. This paper finds the masking effect of financing constraints through mediation studies and the positive moderating effect of managerial competence on market performance through moderation studies, but other existing mediating and moderating variables have not been studied in depth, and variables such as operating costs, government subsidies, carbon quota trading,

etc. that may have an impact are not thoroughly analyzed. The second is the limitation of data collection. Due to the carbon emissions trading network, as well as the company's official website, public data is less and may affect the analysis results to some extent. It is hoped that after the amount public data increases, it can subjected to more in-depth research, on the basis of this paper.

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