Carbon emission trading scheme and corporate financialization: Evidence from China

Hongwei Li*

Department of Economics, Tufts University, 02155 Medford, MA, USA

Abstract. To achieve the carbon goals, the Chinese government initially implemented the carbon ETS in 2013 in 7 pilot provinces and cities. Using the firm-level financial and management data of the A-share listed companies in the 30 provinces of mainland China from 2008 to 2020, this paper examines the ETS impact on corporate financialization by constructing a DID model. The result supports the "crowd-out" effect that the implementation of ETS decreases corporate financialization and this negative impact is weaker on the state-owned firms, located in the eastern region of China, and are not in the manufacturing industry. These findings imply that other than the original target to reduce carbon emissions, the ETS, by its market-based nature, is effective in reducing the risk of over-financialization.

1 Introduction

Nowadays, the human world is facing a series of challenges that threaten sustainable development. Among them, it is a worldwide consensus since the Kyoto Protocol was signed that climate change has become one of the most urgent global crises. In 2015, to conquer these challenges with the strength of all human beings, the UN Member States set up 17 Sustainable Development Goals to be achieved in 2030, and the 13th goal focuses on climate action with an emphasis on reducing greenhouse gas (GHG) emissions. Conforming with the UN agreements, the Chinese government announced its own carbon goals in September 2020 — to peak carbon emissions before 2030 and achieve carbon neutrality before 2060. In fact, China has taken action to control carbon emissions long before the two goals were released. Despite traditional environmental regulations, China planned to set up a carbon emission trading scheme (ETS) in 2010 and began trading in Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, and Shenzhen in 2013. Fujian followed up in December 2016. On July 16, 2021, national carbon trading started. Current literature has confirmed the energy conservation and emission reduction effects led by the implementation of ETS in the pilot areas [1].

In the context of reducing carbon emissions, firms face greater pressure to improve technical efficiency [1]. In terms of firms' financial performance and management, the implementation of the carbon emission trading scheme will internalize the cost of emission reduction and, as a potential result, reallocate the proportion of investment in assets. Thus, the governors of firms should evaluate their unique situations to make choices on investment and financing strategies and balance emission reduction and profit maximization.

At the same time, firms are utilizing more financial instruments in operations in recent decades. Corporate financialization not only means that firms allocate their resources to capital operations but also implies that a larger proportion of profits are expected to be from financial investment. Holding more financial investment is considered to be harmful to firms' long-term development as less capital is saved to use in the main business operations, which is the backbone of corporate development. The corporate governors, especially of those high-carbon emission productions, will put their enterprises at risk of being eliminated under stricter environmental regulations if they do not pay attention to entity investment and put an emphasis on investing in technology innovations. However, the precautionary reserves theory says that firms intend to increase cash holdings and financial assets when there exists policy uncertainty that might cause liquidity problems [2-5]. Therefore, ETS is such a policy uncertainty in this context.

Most previous literature focuses on the impacts of ETS on firms' green technological innovations, and corporate investment decisions and efficiency [6, 7]. In terms of the corporate financialization level, Qi and Duan [8] study the impact of ETS on the financialization of enterprises in a relatively short term, from 2010 to 2018, and find the conclusion supports the "reservoir" theory.

Using the firm-level financial and management data of the A-share listed companies in the 30 provinces of mainland China from 2008 to 2020, this paper examines the ETS impact on corporate financialization by constructing a DID model. The result supports the "crowd-out" effect that the implementation of ETS decreases corporate financialization and this negative impact is weaker on the firms that are state-owned, located in the eastern region of China, and are not in the manufacturing industry. Therefore, this paper contributes

* Corresponding author: li_hw_2277@163.com

to the current literature by unveiling the impact of ETS on corporate financialization and its heterogeneous effects. Also, the discovery of the policy heterogeneous effects is of meaningful supplementary. Last but not least, this study expands relevant research on the factors affecting corporate financialization.

2 Literature Review

Prior literature works on the effects of the carbon emission trading scheme on corporate investment behaviors. For example, Zhang and Wang [6] study the overall impact of ETS on corporate investment and found its negative impact has significant regional and industrial heterogeneity. Nevertheless, ETS can promote firms' investment efficiency and inhibit over-investment [7].

On the other hand, some previous literature studies the environmental regulations' impact on corporate financialization. For instance, Liu and Liu [9] investigate the financialization level of high-polluting firms under stringent environmental regulations and find that the increase in the amount of environmental investment causes a decrease in the amount of financial investment. To specify the typical possible firm financial investment reactions to the environmental policy, two main theories explain the underlying principles. The "reservoir" theory says that the financial assets could be a "reservoir" for the capital [10]. Therefore, when companies face severe financial constraints, like the increasing cost caused by the implementation of ETS in this case, they tend to invest more to save for the potential future cash flow problems. On the contrary, the "crowd-out" effect implies that the more firms invest in financial assets the less they save for other managerial and production purposes [11]. In other words, if the corporates budget more on carbon cost and related technology research and investment, the investment for financial assets will be crowded out, which is a decrease in financialization level.

Considering the impact of this market-based policy, Qi and Duan [8] study the impact of ETS on the financialization of enterprises in a relatively short term. They use the data of A-share listed companies in China from 2010 to 2018 and analyze the impact using the difference-in-difference model. Their results show that ETS positively affects the firm's financialization level as the enterprises tend to increase the liquidity reserves against the higher risk of cash flow fluctuation in the future, which justifies the "reservoir" theory. However, this paper will use different measurements of financial assets and study a slightly longer period in which the impact remains undetermined.

3 Research Design

3.1 Sample and data

All the original firm-level data is sourced from the China Stock Market & Accounting Research Database (CSMAR), a comprehensive database focusing on China's finance and economy for academic purposes. Since carbon ETS earliest started in 2013, the sample consists of A-share listed companies' financial and management information in 30 provinces of mainland China from 2008 to 2020.

To ensure the relativeness and accuracy of the regression, firms with ST or ST* signs were excluded since they might have abnormal operating issues. Also, firms in the financial industries were excluded because of their nature. Then, companies with no net assets or are insolvent, in other words, a debt-to-asset ratio less than 0% or greater than 100%, are also excluded. At last, all variables are winsorized at 1% and 99% levels to eliminate the impact of extreme values. After the above processing, the remaining panel data used in regression has 32382 observations.

3.2 Model

Based on the natural experiment of ETS, the difference-in-difference model of corporate financialization, fin_{it}, for each province i in yearly period t is specified as

$$fin_{it} = \beta_0 + \beta_1\, pilot_i * time_t + \beta X_{it} + \varepsilon_{it} + v_t + u_i \qquad (1)$$

where the dependent variable fin_{it} is the ratio of corporate financial assets to total assets. $pilot_i$ is the treatment of ETS, which equals 1 if the firm is in the pilot areas and equals 0 otherwise. $time_t$ is a dummy variable denoting the policy implementation, which equals 1 after 2013 and equals 0 otherwise. X_{it} is a vector of control variables for the company i and in period t. u_i and v_t are firm and year fixed effects and ε_{it} is a stochastic error term.

The coefficient of the interaction term, β_1, indicates the difference in the financialization level in the pilot areas compared to the financialization level in the non-pilot areas after the trading began, on average, and holding other variables constant. If the sign of β_1 is positive, ETS will be said to promote corporate financialization, which reflects the reservoir effect. But if the sign of β_1 is negative, the crowding out effect will be justified.

3.3 Variable Definition

3.3.1 Corporate Financialization

Corporate financialization is measured by the sum of the financial assets to the total assets ratio. According to some previous literature [12], they separate the total corporate assets into two categories, operating assets and financial assets. Financial assets are assets used in investment to earn profits other than used in production. The corporate financial assets in this study consist of cash, derivatives, available-for-sale financial assets, trading financial assets, held-to-maturity investments, long-term equity investments, short-term investments, financial assets purchased under resale agreements, long-term receivables, loans and advances, long-term debts, interest receivables, investment real estate, and other current assets [8, 12].

3.3.2 Carbon Emission Trading Scheme (ETS)

Carbon ETS started trading in 2013 in 6 pilot provinces and cities: Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, and Shenzhen. Among them, Shenzhen is included in Guangzhou province geographically, therefore, firms located in Shenzhen are treated to be the same as in Guangzhou in the sample. Firms in the rest 25 provinces are included in the control group. Specifically, because Fujian began trading in 2016, the corporates there are held in the control group.

3.3.3 Control Variables

Referring to Gong, Gong [13], the firm-level control variables are selected in two types: firm characteristics and corporate governance. Among firm characteristics, financial-related characteristics are returned on assets (*roa*), leverage ratio (*lev*), assets growth rate (*gro*), and firm size (*size*); non-financial-related characteristic is firm age (*age*). Control variables of corporate governance are equity concentration (*own1*); CEO duality (*dual*); executive shareholding ratio (*m_share*); and independent director proportion (*direct*).

3.3.4 Descriptive Statistics

Table 1 in the Appendix shows the summary statistics of pilot areas and non-pilot areas separately. The mean value of financialization in the pilot areas is 0.3297, which is higher than it is in the non-pilot areas (0.2800). This means firms in the pilot areas have higher levels of financialization than those in the non-pilot areas on average through the whole time range from 2008 to 2020. This fact might be an effect of the implementation of ETS but cannot be determined without time restriction. Considering the control variables, only the mean of *roa* and *lev* is higher in the control group. Except for the *m_share*, of which the mean value is significantly greater in the treatment group, control variables do not vary much between groups.

4 Empirical Analysis

4.1 Test of parallel trend

It is essential for the financialization level in the pilot areas and the other areas to conform with the parallel trend assumption so that the difference-in-difference model is valid to be adopted to estimate the treatment effect of ETS. Thus, need to make sure that the average annual financialization level in the pilot areas has a similar trend as that of the non-pilot areas before the policy was implemented. Fig. 1 shows the year-to-year annual average corporate financialization level in the pilot areas, which is relatively higher than the annual average corporate financial level in the non-pilot areas, and the trend before 2013 is paralleled. This result provides evidence that supports the parallel trend assumption that the corporate financialization level trend in both areas should have continued to be paralleled without the implementation of ETS in the following periods. After 2013, the gap between the two groups decreased, implying that the ETS probably negatively impacted the corporate financialization level.

Another approach to test the parallel trend is to construct a time trend variable and regress the interaction term of the time trend and treatment on the dependent variable before the policy is implemented [14]. The value of the trend equals 1 in 2008 and adds 1 for each following year until 2013. The regression is as follows:

$$fin_{it} = \beta_0 + \beta_1\, pilot_i * trend_t + \beta_2\, pilot_i + \beta_3\, trend_t + \beta X_{it} + \varepsilon_{it} + v_t + u_i \quad (2)$$

where the coefficient of the interaction term $pilot_i * trend_t$, β_1, should not be significant if the corporate financialization level of the pilot areas and the non-pilot areas have the parallel trend before the ETS begins. The result that is shown in Table 2 assures this assumption and can, thus, predict that both the control and treatment groups would perform parallelly in the post-treated period without the treatment group being treated. Hence, the difference-in-difference model is appropriate to be used in this case.

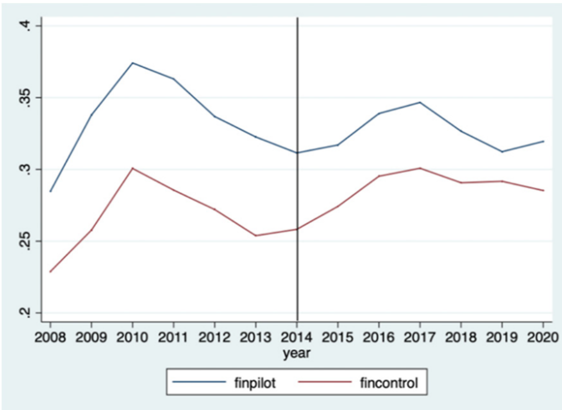

Fig. 1. Annual average of *fin*

4.2 Baseline Regression

Table 3 in the Apppendix shows the results of the baseline regressions. All the coefficients of the interaction term are significantly negative at the 1% level. Therefore, the implementation of ETS decreases corporate financialization regardless of the choice of the control variables. Both models with and without fixed effects are better fit with control variables. In column (4), with firm fixed effect and year fixed effect, the corporate financialization level in the pilot areas is 0.0188 less than that in the non-pilot areas, on average, and holding other variables constant. Compared to the result in column (2), the policy impact is smaller under the fixed effects but in the same direction. Contradicting the finding from Qi and Duan [8], in a longer period with different components of financial assets, this policy impact supports the "crowd-out" effect rather than the "reservoir" effect. When firms are facing cost increases caused by the carbon price, in the long run, the assets for financial investment will be crowded out. It is reasonable that the cost of carbon has a persistent effect on the corporate budget strategy and financial management decisions. Additionally, from the perspective of sustainable development, to survive in the market with foreseeably more stringent environmental regulations, upgrading the green production technology is essential. Some firms invest more in green technology innovation or other types of green investment. However, such a research and development process is money-consuming and time-consuming. As a result, the money saved by decreasing the financial investment could be a supplement source during this period.

5 Robustness Checks

5.1 Alternative measurement of corporate financialization

One of the essential characteristics of financial assets is their relatively high liquidity than other types of assets. Among all the components of the financial assets used in this study, investment real estate is less liquid because of its inflexibility to transform into cash. Henceforth, an alternative measurement of financialization is to exclude the investment real estate from the original financial assets. The result in Table 4 shows that the conclusion is generally not different from the baseline regression. Comparing column (3) and column (4) between Table 4 and Table 3, with firm fixed effect and year fixed effect, the negative impact of ETS is slightly greater than when including the investment real estate in the financial assets. This result indicates that the more liquid financial assets are more sensitive to ETS because they are more flexible to be transformed.

5.2 Exclusion of Fujian province

In the baseline regression, Fujian province is included in the non-pilot areas. However, Fujian became a pilot province and started trading in 2016. So, it would enhance the robustness by removing observations of Fujian from the control group. The result in Table 5 shows that after eliminating the interference of Fujian province, the magnitude of the negative impact increases which conforms to the assumption that the late implementation in Fujian causes the treatment effect to be weaker in the baseline result.

5.3 PSM-DID

The propensity score matching method is adopted to eliminate the bias caused by the significant differences in corporate characteristics between those in the non-pilot areas and the pilot areas [15]. The covariates used in predicting the propensity scores are all control variables that reflect the firm characteristics. According to Fig. 2, the propensity score matching provides a better-matched control group which could provide better counterfactual outcomes for the treatment group. By regressing with the matched sample, the result shown in Table 6 is consistent with the baseline result.

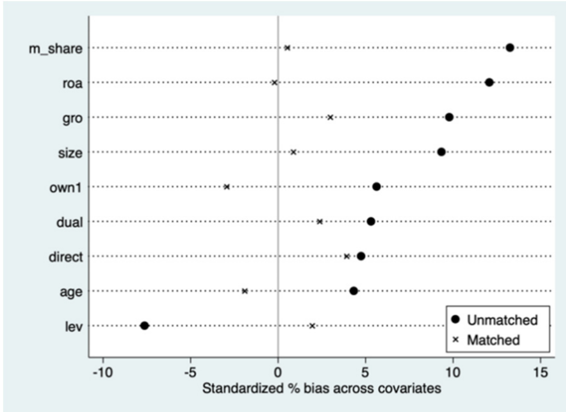

Fig. 2. Propensity score matching result

5.4 Exclusion of exogenous shocks

Previous policy literature excludes the observations in 2008 and 2009 because of the worldwide financial crisis [16]. The result shown in Table 7 column (1) indicates that the ETS impact remains significantly negative. Also, the breakdown of COVID-19 by the end of 2019 is a typical exogenous shock that data in 2020 should be excluded to eliminate possible bias. This result is shown in Table 7 column (2) that the negative impact decreases slightly but is still statistically significant. By excluding both shocks, the Table 7 column (3) result supports the baseline result as well.

6 Heterogeneous Analysis

6.1 The perspective of ownership of enterprise

The ownership of an enterprise can influence its financial constraints. According to Allen, Qian [17], SOEs have lower financing constraints because of implicit government guarantees. Therefore, these companies are less likely to adjust their financial investment strategies with relatively more stable cash flows than the non-SOEs. By separately regressing with the sample of SOEs and non-SOEs, Table 8 column (1) and column (2) show the result of SOE, and column (3) and column (4) show the result of non-SOEs. Both of the policy impacts are significantly negative, while the impact on the SOEs is weaker than that of non-SOEs. This means that the non-SOEs are relying more on the reallocation of assets from financial investments when confronting the increasing carbon costs.

6.2 The perspective of the region

By separately regressing with the sample of SOEs and Previous literature studies the regional heterogeneous effects on corporate financialization due to the gaps in the economic development between the eastern, central, and western regions of China [18]. Among the regions, the eastern part of China is the most developed area with better marketization, abundant capital and technical resources, and well-regulated and more active markets.

Such difference could also be reflected by the number of pilot provinces and cities in each of the regions. This study identifies the eastern, central, and western regions of China following the criteria of the National Bureau of Statistics. Then, there are 5 pilot cities and provinces – Beijing, Tianjin, Shanghai, Guangdong, and Fujian in the eastern region, 1 province – Hubei in the central region, and 1 city – Chongqing in the western region. The result in Table 9 from column (1) to column (3) shows the policy impact on eastern, central, and western regions respectively. ETS has a negative impact on all regions, but the estimates of the coefficient are only significant in the eastern region and central region. The financialization level of firms in the eastern regions is less affected by the ETS than those in other regions. This implies that the corporates in the eastern regions, on average, have better technology and more sufficient liquid assets to cope with the financial and technological upgrading problems that are brought by the implementation of ETS, than corporates in the rest of China.

6.3 The perspective of the industry

As the manufacturing industry is the core source of industrial economic development in China, the nature of the intensive energy consumption and consequent high carbon emission volume of this industry also causes a major environmental problem [19]. Thus, ETS is expected to have a greater impact on the firms in such industries. This paper identifies the firms in the manufacturing industries by their CSRC (China Securities Regulatory Commission) industry codes with class "C". Comparing the result in Table 10 columns (1) and (2) with columns (3) and (4), the corporate financialization level in the manufacturing industries is lower on average than in the rest of the industries, and the negative policy impact is greater. This is because manufacturing firms with lower financialization level has more financing constraints and face larger environmental cost caused by the policy. Therefore, the reallocation of the liquid assets could help them get through the hard times.

7 Conclusion

In order to achieve the carbon goals, the Chinese government initially implemented the carbon ETS in 2013 in 7 pilot provinces and cities. By using the firm-level financial and management data of the A-share listed companies in the 30 provinces of mainland China from 2008 to 2020, this paper examines the ETS impact on corporate financialization. The result of the baseline regression of a DID model shows that the implementation of ETS decreases corporate financialization. This finding supports the "crowd-out" theory, indicating that when firms are facing cost increases caused by the carbon price, in the long run, the assets for financial investment will be crowded out. This result remains robust under several tests.

The further analysis from the perspective of the ownership of the enterprise, the region, and the industry gives evidence of the policy heterogeneous effects. The carbon ETS has a weaker negative impact on the financialization levels of firms that are state-owned, located in the eastern region of China, and are not in the manufacturing industry.

These conclusions imply that other than the original target to reduce carbon emissions, the ETS, by its market-based nature, is effective in reducing the risk of over-financialization. Thus, policymakers should pay attention to such effects and design more targeted policies when extending the trading countrywide with the consideration of heterogeneous effects.

Appendix

Table 1. Summary Statistics

Pilot	Variable	Mean	Min	Max	SD
N	*fin*	0.280	0.039	0.836	0.166
	roa	5.804	-19.161	25.793	6.286
	lev	43.193	4.926	89.843	20.911
	gro	0.222	-0.330	3.331	0.483
	own1	0.345	0.088	0.749	0.146
	size	22.012	19.555	26.075	1.221
	age	17.213	4.000	31.000	5.664
	dual	0.238	0.000	1.000	0.426
	m_share	5.940	0.000	61.560	12.832
	direct	0.610	0.250	1.500	0.187
	Number of observations	20100			
Y	*fin*	0.330	0.039	0.836	0.187
	roa	5.767	-19.161	25.793	6.025
	lev	42.340	4.926	89.843	21.172
	gro	0.243	-0.330	3.331	0.508
	own1	0.354	0.088	0.749	0.156
	size	22.168	19.555	26.075	1.438
	age	17.481	4.000	31.000	6.130
	dual	0.279	0.000	1.000	0.448
	m_share	7.891	0.000	61.560	14.954
	direct	0.628	0.250	1.500	0.204
	Number of observations	12282			

Note: This table shows the summary statistics of financialization and the control variables in the pilot area (treatment group) and non-pilot area (control group) separately.

Table 2. Parallel trend test

	(1) OLS	(2) FE
*pilot*trend*	-0.0002	-0.0000
	(0.0019)	(0.0016)
pilot	0.0596***	
	(0.0080)	
trend	-0.0024**	
	(0.0011)	
Controls	Y	Y
Firm effect	N	Y
Year effect	N	Y
_cons	0.4855***	0.3113
	(0.0296)	(0.1912)
r2_a	0.3184	0.2676
F	439.7531	87.5318
N	11294	11294

Note: This table reports the result of the parallel trend test. Column (1) and (2) report the OLS estimation and fixed effects results with the control variables. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

Table 3. Baseline regression

	(1) OLS	(2) OLS	(3) FE	(4) FE
*pilot*time*	-0.0320***	-0.0221***	-0.0301***	-0.0188***
	(0.0044)	(0.0039)	(0.0061)	(0.0052)
pilot	0.0706***	0.0597***		
	(0.0037)	(0.0032)		
time	0.0183***	-0.0026		
	(0.0025)	(0.0024)		
Controls	N	Y	N	Y
Firm effect	N	N	Y	Y
Year effect	N	N	Y	Y
_cons	0.2681***	0.3988***	0.2756***	0.7063***
	(0.0020)	(0.0181)	(0.0034)	(0.0998)
r2_a	0.0207	0.2086	0.0294	0.1923
F	211.6989	650.7326	53.7914	95.4110
N	32382	32382	32382	32382

Note: This table reports the result of baseline regression. Column (1) and (2) reports the OLS estimation results without and with the control variables. Column (3) and (4) reports the estimation results without and with the control variables where the year fixed effect and firm fixed effect are controlled. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

Table 4. Regression on *fin* with alternative measurement

	(1) OLS	(2) OLS	(3) FE	(4) FE
*pilot*time*	-0.0282***	-0.0183***	-0.0314***	-0.0203***
	(0.0044)	(0.0038)	(0.0061)	(0.0052)
pilot	0.0592***	0.0477***		
	(0.0037)	(0.0031)		
time	0.0180***	0.0008		
	(0.0025)	(0.0024)		
Controls	N	Y	N	Y
Firm effect	N	N	Y	Y
Year effect	N	N	Y	Y
_cons	0.2578***	0.3603***	0.2624***	0.6093***
	(0.0020)	(0.0174)	(0.0033)	(0.0956)
r2_a	0.0149	0.2286	0.0333	0.1971
F	151.6332	690.4805	57.3660	97.4483
N	32382	32382	32382	32382

Note: This table reports the result of regression on fin with alternative measurement. Column (1) and (2) reports the OLS estimation results without and with the control variables. Column (3) and (4) reports the estimation results without and with the control variables where the year fixed effect and firm fixed effect are controlled. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

Table 5. Regression without Fujian province

	(1) OLS	(2) OLS	(3) FE	(4) FE
*pilot*time*	-0.0330***	-0.0223***	-0.0318***	-0.0196***
	(0.0045)	(0.0039)	(0.0061)	(0.0053)
pilot	0.0726***	0.0609***		
	(0.0037)	(0.0032)		
time	0.0192***	-0.0021		
	(0.0026)	(0.0025)		
Controls	N	Y	N	Y
Firm effect	N	N	Y	Y
Year effect	N	N	Y	Y
_cons	0.2661***	0.3933***	0.2748***	0.7143***
	(0.0021)	(0.0182)	(0.0035)	(0.1011)
r2_a	0.0222	0.2092	0.0288	0.1905
F	219.5805	632.9304	50.6589	91.4531
N	31190	31190	31190	31190

Note: This table reports the result of regression without Fujian province. Column (1) and (2) reports the OLS estimation results without and with the control variables. Column (3) and (4) reports the estimation results without and with the control variables where the year fixed effect and firm fixed effect are controlled. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

Table 6. PSM-DID

	(1) OLS	(2) OLS	(3) FE	(4) FE
*pilot*time*	-0.0325***	-0.0227***	-0.0307***	-0.0196***
	(0.0044)	(0.0039)	(0.0061)	(0.0052)
pilot	0.0710***	0.0604***		
	(0.0037)	(0.0032)		
time	0.0181***	-0.0023		
	(0.0025)	(0.0024)		
Controls	N	Y	N	Y
Firm effect	N	N	Y	Y
Year effect	N	N	Y	Y
_cons	0.2678***	0.3945***	0.2751***	0.6979***
	(0.0020)	(0.0181)	(0.0034)	(0.1012)
r2_a	0.0209	0.2072	0.0299	0.1921
F	211.7313	641.8445	53.6934	94.7627
N	32167	32167	32167	32167

Note: This table reports the result of PSM-DID regression. Column (1) and (2) reports the OLS estimation results without and with the control variables. Column (3) and (4) reports the estimation results without and with the control variables where the year fixed effect and firm fixed effect are controlled. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

Table 7. Regression without environmental shocks

	(1) Excluding 2008 & 2009	(2) Excluding 2020	(3) Excluding 2008, 2009 & 2020
*pilot*time*	-0.0205***	-0.0167***	-0.0184***
	(0.0052)	(0.0052)	(0.0052)
Controls	Y	Y	Y
Firm effect	Y	Y	Y
Year effect	Y	Y	Y
_cons	0.7772***	0.6683***	0.7638***
	(0.1119)	(0.1199)	(0.1371)
r2_a	0.1862	0.1932	0.1873
F	94.0584	87.8209	86.1165
N	29495	28903	26016

Note: This table reports the result of regression without environmental shocks. Column (1), (2), and (3) reports the fixed effects estimation results with the control variables and exclude observations in 2008 and 2009, observations in 2020, and observations in 2008, 2009, and 2020, respectively. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

Table 8. Heterogeneous effect by SOE and non-SOE

	(1) SOE	(2) SOE	(3) Non-SOE	(4) Non-SOE
*pilot*time*	-0.0210***	-0.0132*	-0.0416***	-0.0262***
	(0.0079)	(0.0070)	(0.0090)	(0.0077)
Controls	N	Y	N	Y
Firm effect	Y	Y	Y	Y
Year effect	Y	Y	Y	Y
_cons	0.2539***	0.7323***	0.2948***	0.6290***
	(0.0040)	(0.1434)	(0.0058)	(0.1419)
r2_a	0.0229	0.1475	0.0633	0.2275
F	19.9074	28.5877	44.9104	75.6112
N	13606	13606	18776	18776

Note: This table reports the result of the heterogeneous effect of SOE and non-SOE. Column (1) and (2) reports the fixed effects estimation results without and with the control variables of SOEs. Column (3) and (4) reports the fixed effects estimation results without and with the control variables of non-SOEs. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

Table 9. Heterogeneous effect by region

	(1) Eastern	(2) Middle	(3) Western
*pilot*time*	-0.0151**	-0.0285**	-0.0295
	(0.0061)	(0.0143)	(0.0220)
Controls	Y	Y	Y
Firm effect	Y	Y	Y
Year effect	Y	Y	Y
_cons	0.7613***	0.9617***	0.1541
	(0.1150)	(0.2248)	(0.2706)
r2_a	0.2109	0.1598	0.1718
F	78.2592	15.5025	11.4323
N	22396	5373	4613

Note: This table reports the result of the heterogeneous effect by region. The eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan provinces. The middle region includes Shanxi, Jilin, Heilongjiang, Anhui, Henan, Hubei, and Hunan provinces. The southern region includes Chongqing, Qinghai, Xinjiang, Inner Mongolia, Sichuan, Guizhou, Guangxi, Xizang, Shaanxi, and Gansu provinces, Column (1), (2), and (3) reports the fixed effects estimation results with the control variables of the eastern, middle, and western region, respectively. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

Table 10. Heterogeneous effect by industry

	(1) Manufacturing	(2) Manufacturing	(3) Other	(4) Other
*pilot*time*	-0.0362***	-0.0245***	-0.0281***	-0.0181**
	(0.0079)	(0.0067)	(0.0099)	(0.0085)
Controls	N	Y	N	Y
Firm effect	Y	Y	Y	Y
Year effect	Y	Y	Y	Y
_cons	0.2672***	0.5308***	0.2922***	0.9380***
	(0.0041)	(0.1245)	(0.0057)	(0.1553)
r2_a	0.0392	0.2216	0.0217	0.1696
F	41.2032	71.2401	18.5163	33.7202
N	20236	20236	12146	12146

Note: This table reports the result of the heterogeneous effect by indutry. Column (1) and (2) reports the fixed effects estimation results without and with the control variables of the manufacturing industry. Column (3) and (4) reports the fixed effects estimation results without and with the control variables of other industries. Robust standard errors are reported in parentheses. ***, **, and * respectively denote the statistical significance of a two-tailed test at the 1%, 5%, and 10% level.

References

1. Y. Hu, S. Ren, Y. Wang, X. Chen, Energy Econ., **85**: p. 104590 (2020)
2. S. Ding, A. Guariglia, J. Knight, J. Bank. Financ., **37**(5): p. 1490-1507 (2013)
3. H. Gulen, M. Ion, Rev. Financ. Stud., **29**(3): p. 523-564 (2016)
4. Y. Liu, J. Li, G. Liu, C.-C. Lee, J. Asian Econ., **74**: p. 101318 (2021)
5. X. Liu, L. Lv,. Fin. Res. Lett., **54**: p. 103787 (2023)
6. Y.-J. Zhang, W. Wang, Energy Econ., **98**: p. 105224 (2021)
7. W. Chen, L. Zhang, L. Shi, Y. Shao, K. Zhou, J. Clean. Prod., **358**: p. 131782 (2022)
8. S. Qi, B. Duan, J. Xian Jiaotong Univ. (Social Science), **42**(5) (2022) (In Chinese)
9. X. Liu, F. Liu, Fin. Res. Lett., **47**: p. 102974 (2022)
10. L. Tao, L. Chen, K. Li, Sustainability, **13** (2021)
11. J. He, X. Wan, *The Impact of Corporate Financial Asset Allocation on Development of Core Business* (2019)
12. B. Huang, Y. Cui, K.C. Chan, Int. Rev. Econ. Finance, **80**: p. 1153-1162 (2022)
13. C.M. Gong, P. Gong, M. Jiang, Pacific Basin Finance J., **79**: p. 102045 (2023)
14. X. Wang, F. Cao, K. Ye, J. Bus. Ethics, **152**(1): p. 253-274 (2018)
15. J.J. Heckman, H. Ichimura, P. Todd, Rev. Econ. Stud., **65**(2): p. 261-294 (1998)
16. D. Xiao, F. Yu, C. Guo, Energy Econ., **124**: p. 106770 (2023)
17. F. Allen, Y. Qian, G. Tu, F. Yu, J. Financ. Econ., **133**(1): p. 18-41(2019)
18. Y. Liu, P. Failler, Y. Ding, PLoS One, **17**(12): p. e0275461 (2022)
19. A. Zhou, J. Li, Sustain. Prod. Consum., **27**: p. 1944-1960 (2021)