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Comparative Study on the Dual Impact of environmental Tax and Emissions Trading System (ETS) on Emission Reduction Effects and Financing Costs for High-Emission Enterprises

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Abstract: This study employs a difference-in-differences model based on corporate bond data from the Shanghai and Shenzhen stock exchanges between 2007 and 2021. It examines the effects of China's carbon trading policies and environmental tax policies on corporate financing costs and carbon emissions to reveal the interactive patterns between environmental policies and capital market pricing. Empirical results indicate that environmental policies exert a positive effect on corporate emissions reduction. Short-term carbon trading policies yield superior emission reduction effects, while carbon tax policies demonstrate more significant long-term reduction impacts. Regarding corporate financing costs, carbon trading policies effectively reduce financing expenses, whereas carbon tax policies increase them. Furthermore, heterogeneity analysis reveals that carbon disclosure levels and corporate ownership structures moderate the impact of environmental policies on firms. Firms with higher carbon disclosure levels are more affected by environmental policies, while state-owned enterprises exhibit a more pronounced response to such policies. The empirical findings of this study provide micro-level evidence for understanding the impact of environmental policies on corporate financing costs under the “dual carbon” goals, offering reference for policy optimization, corporate carbon management decisions, and investor risk assessment.

1. Introduction

In global climate governance, carbon taxes and ETS are mainstream environmental tools. Their effects and applicable scenarios concern academia and policymakers (Xu et al., 2023; Pietzcker et al., 2021) [1-2]. As the world’s largest carbon emitter, China advances "dual carbon" goals via environmental taxes (carbon tax substitutes) and the national carbon market. High-emission enterprises affect policy effectiveness through emission reduction and financing costs (Zhang et al., 2022; Hua et al., 2024) [3-4].

Carbon taxes and ETS differ in economic costs and emission reduction intensity. Xu et al. (2023)[1] used an EDCGE model to compare 2020-2030 effects in China, Yangtze River Delta, and Beijing-Tianjin-Hebei: ETS has economic advantages (2030 GDP down 1.8% vs 3.4% for carbon tax; unit cost ¥9,100 vs ¥9,800/ton); carbon tax reduces emissions more (407m vs 317m tons CO_2, peaking 2029 vs 2030). The Yangtze River Delta outperforms Beijing-Tianjin-Hebei (5.35% vs 4.58% reduction under carbon tax, 2030) (Xu et al., 2023, Table 1)[1]. This aligns with Nordhaus (2014)[5]; Roy (2025)[6] found carbon taxes boost green trade; Panza and Peron (2025)[7] noted current carbon taxes fail to drive circular economy.

Energy, heavy industry, and transportation are most sensitive. Xu et al. (2023)[1] showed 2030 carbon tax cuts their emissions by 6.01%, 5.83%, 5.07% (ETS: 4.97%, 4.77%, 3.72%); agriculture/services <2%. Luo et al. (2022)[8] confirmed carbon taxes' differentiated incentives; Zhao et al. (2018)[9] noted high-emission industries' sensitivity to carbon prices.

EU ETS offers lessons. Pietzcker et al. (2021)[2] simulated tightening 2030 targets (43%→63%): more renewables, near-eliminated coal power, 54% electricity emission cut; cost up 5%. Ellerman and Buchner (2007)[10] confirmed EU ETS guides reductions.

Cross-regional production and CBAM enrich comparisons. Hua et al. (2024) [4]used a game model: no CBAM causes carbon leakage; CBT cuts offshore production, boosts tech investment. CBT expands carbon tax applicability, aligning with Bovenberg and Goulder (1996)[11].

Policy synergies and corporate decisions aid design. Zhang et al. (2022)[12] showed hybrid policies (carbon tax+ETS) better achieve peak emissions by 2030. Luo et al. (2022) [8]noted carbon taxes need consumer preferences in centralized supply chains. Wang et al. (2020) [13]highlighted policy combinations' role; Sun et al. (2025)[14] provided a high-emission sector case.

Existing research has limits: insufficient corporate financing cost analysis (only Luo et al., 2022[8] mentioned credit rating impacts without quantification) and short/long-term effect comparison. This study focuses on: (1) DID model to quantify carbon tax/ETS impacts on financing costs; (2) moderating variables (carbon disclosure, ownership); (3) short/long-term policy comparison.

2. Research Hypothesis

H1: Both carbon taxes and ETS significantly reduce carbon emission intensity in high-emission enterprises. In the short term, ETS yields stronger emission reduction effects, while in the long term, carbon taxes outperform ETS in reducing emissions.

Carbon taxes raise corporate emission costs via direct taxation to drive reductions. ETS optimizes emission strategies through quota constraints and market transactions. Short-term: ETS's quota allocation and trading quickly transmit market signals. To avoid extra costs from insufficient quotas, enterprises cut carbon intensity swiftly (via adjusting quotas or improving processes), delivering more obvious reduction effects. Long-term: Carbon tax price signals are continuous and stable, sustaining incentives for enterprises to invest in emission-reduction R&D and equipment upgrades, driving fundamental production shifts for deep cuts. While ETS tightens total allowances gradually, enterprises may form "buy-and-comply" inertia via trading; technological advances can also fluctuate allowance value, weakening incentive persistence. Thus, carbon taxes have better long-term emission reduction effects.

H2: Carbon taxes exhibit a dynamic pattern of increasing but gradually diminishing impacts on high-emission enterprises' financing costs, while ETS imposes an overall "negative impact" on corporate financing costs.

Initial carbon tax implementation: Enterprises bear extra emission costs, compressing profits and possibly lowering credit ratings, thus raising financing costs. Over time, enterprises absorb costs via production optimization and energy efficiency improvements; market recognition of their adaptability eases negative credit assessments, gradually reducing carbon tax’s upward pressure on financing costs.For ETS: Surplus allowances let enterprises sell for profit, improving financial position and capital market image to cut financing costs. Even with allowance deficits needing purchases, ETS-driven low-carbon transition strengthens enterprises’ long-term potential and market recognition. Overall, ETS negatively impacts high-emission enterprises’ financing costs, effectively reducing them.

H3a: Companies with high carbon disclosure levels experience more pronounced policy impacts

Companies with high carbon disclosure levels demonstrate greater transparency regarding their carbon emissions-related information. This enables policymakers and markets to gain clearer insights into a company's emissions status and mitigation actions. For carbon taxes, transparent carbon data helps tax authorities levy taxes more accurately while enabling companies to better understand the costs and benefits of their own emissions reductions, thereby encouraging more proactive compliance with carbon tax policies. For ETS, high carbon disclosure levels enhance market understanding of a company's allowance holdings and trading activities, boosting its credibility within the ETS market. This gives companies advantages in allowance trading, financing, and other areas, making the policy's impact more pronounced for such firms.

H3b: State-Owned Enterprises Experience More Significant Policy Impact

State-owned enterprises typically possess stronger policy implementation capabilities and resource integration strengths. When carbon tax and ETS policies are rolled out, they can more efficiently fulfill policy requirements—such as actively participating in ETS trading or investing in emissions reductions in response to carbon taxes. Furthermore, state-owned enterprises often shoulder greater social responsibilities. Against the backdrop of policies promoting low-carbon development, they tend to proactively respond to policies to establish a positive social image. Simultaneously, SOEs enjoy greater access to policy support and financial institutions' trust in areas like financing, further amplifying the impact of policies on their operations.

3. Methodology and Data

3.1 Methodology

3.1.1 Double Difference Model

To examine the effects of carbon trading and environmental tax policies on corporate bond credit spreads and carbon emissions, we construct a Double Difference (DID) model as follows, drawing on existing policy evaluation frameworks (Lv and Bai, 2021; Huang et al., 2022):

$$CS_{it}/CE_{it} = \delta_0 + \beta_1 ETS_{it} + \beta_2 ET_{it} + \beta_x control_{it} + \vartheta_t + \mu_i + \tau_j + \varepsilon_{it} \quad (1)$$

Where CS_{it} denotes the bond issuance coupon rate minus the corresponding term structure government bond yield, reflecting bond financing costs, CE_{it} is Corporate carbon emissions; $post_{it}$ is a time dummy variable equal to 1 if the year is greater than the policy implementation period and 0 otherwise; $tread_{it}$ is a dummy variable equal to 1 if the company is located in a pilot city, 0 otherwise; $control_{it}$is a control variable comprising firm-specific and bond-specific characteristics; $\vartheta_t, \mu_i, \tau_j$represent time, region, and industry fixed effects, respectively.

3.1.2 Parallel Trends Test

In studies examining the impact of carbon trading systems on credit spreads of high-polluting companies' bonds, the parallel trends assumption is a critical prerequisite for the effective application of double-difference (DID) and extended models. To test this assumption, the following parallel trends test model is constructed:

$$CS_{it}/CE_{it} = \omega_0 + \sum_{s=1}^{3} \alpha_{\text{bef\_s}} Bef_s + \alpha_{\text{cur}} Cur + \sum_{m=1}^{3} \alpha_{\text{aft\_m}} Aft_m + \rho X_{it} + \vartheta_t + \mu_i + \tau_j + \varepsilon_{it} \quad (2)$$

Where ω_0 is the intercept term reflecting the baseline impact level; Bef_s(s = 1,2,3) is the dummy variable for period s preceding policy implementation, capturing trend characteristics across different pre-policy phases; $\alpha_{\text{bef\_s}}$ is its corresponding coefficient, measuring the impact of each pre-policy period on credit spreads; Cur denotes the dummy variable for the policy implementation period, with coefficient α_{cur} reflecting the immediate effect during implementation; Aft_m(m = 1,2,3)represents the dummy variable for the mth period after policy implementation, with corresponding coefficient $\alpha_{\text{aft_m}}$examining the sustained impact across different post-implementation phases; X_{it}constitutes the set of control variables;

3.1.3 Heterogeneity Analysis

To further validate the heterogeneous effects of the carbon emissions trading pilot policy on corporate bond financing costs in high-carbon-emission regions and companies with high carbon disclosure, this study constructs a triple difference model based on Equation 1:

$$CS_{it}/CE_{it} = \delta_0 + \beta_1(post_{it} \times tread_{it} \times group) + \beta_2(post_{it} \times tread_{it}) + \beta_3(post_{it} \times group) + \beta_4(tread_{it} \times group) + \beta_x control_{it} + \vartheta_t + \mu_i + \tau_j + \varepsilon_{it} \quad (3)$$

Where $group$ is the control variable for heterogeneity analysis, and other variables are defined as in Equation (1). When the company is located in a region with high carbon disclosure, $group$= 1; otherwise, $group$ = 0. When the company is state-owned, $group$ = 1; otherwise, $group$ = 0.

3.2 Data

This study collected data on both matured and outstanding corporate bonds traded on the Shanghai and Shenzhen stock exchanges between 2007 and 2021. By combining the yield-to-maturity data of bonds on their last trading day each year with government bond yield-to-maturity data, we employed linear interpolation to fit government bond yields. This enabled the calculation of government bond yields with identical remaining maturities. The credit spread for each bond was then derived by subtracting the corresponding government bond yield from the bond's yield-to-maturity.

This study utilizes monthly corporate bond data and annual corporate financial data from January 2007 to December 2021 as its research sample, sourced from the Guotai An (CSMAR) database. The year 2013 is designated as the policy implementation starting point for the carbon trading system, with 2014 and subsequent years constituting the policy implementation period. As a carbon tax has not yet been implemented in China, we substitute it with an environmental tax, which serves a similar function, treating 2018 as the policy implementation point for the environmental tax. Additionally, we screened the initial sample data: - Excluded samples with severe variable data missingness - Excluded floating-rate bonds - Excluded bonds issued by financial institutions, international organizations, and government departments - Excluded bonds maturing within one year - Excluded bonds lacking credit ratings All variables in this paper underwent tail trimming at the 1%–99% level.

Building on prior research, our study incorporates several control factors. First, at the firm level, we control for profitability (ROE), leverage, and firm size. Firms with higher profitability typically exhibit lower default risk, while highly leveraged firms may carry greater risk and command higher bond yield spreads. Larger firms generally face lower default risk. We also controlled for economic disparities across provinces by accounting for per capita GDP. Given varying levels of development across industries, we further controlled for industry concentration (HHI).

Table 1: Variable Explanations

Variable	Definition
CS	The spread between corporate bond issuance yields and risk-free interest rates
CE ETS ET Leverage	Annual corporate carbon emissions Interaction term between carbon trading policy time dummy variable and dummy variableInteraction term between environmental tax policy time dummy variable and dummy variable Total liabilities divided by total assets, measured in %
Size ROE HHI GDP CDI SOE	Corporate scale, represented by the natural logarithm of total assets Return on equity calculated as net profit divided by net assets Industry competitiveness, measured as the cumulative sum of the square of the ratio of a single firm's main business revenue to the total main business revenue of the industry Per capita GDP by province Corporate carbon disclosure index Corporate ownership structure

4. Empirical Analysis

4.1 Benchmark Regression

Table 2: Benchmark Empirical Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
	CE	CS	CE	CS	CE	CS
ET			-0.0799***	0.578***		
			(-10.21)	(11.21)		
ETS			-0.0891***	-0.368***		
			(-9.20)	(-6.54)		
Lev			-0.0619**	2.443***	-0.0575**	2.452***
			(-2.52)	(14.54)	(-2.40)	(14.64)
ROA			-0.0176	-0.295***	-0.0194*	-0.301***
			(-1.63)	(-2.78)	(-1.84)	(-2.83)
Size			0.0236***	-0.382***	0.0189***	-0.374***
			(3.84)	(-19.35)	(3.12)	(-19.02)
GDP			-0.000009***	-0.0000011	-0.000009***	0.000000131
			(-38.56)	(-1.49)	(-36.30)	(0.16)
HHI			0.00720	1.142***	-0.0434	1.035***
			(0.12)	(4.01)	(-0.71)	(3.64)
ETS_s					-0.0961***	-0.271***
					(-9.82)	(-4.03)
ETS_l					-0.0856***	-0.481***
					(-7.70)	(-7.69)
ET_l					-0.182***	0.364***
					(-16.40)	(5.17)
ET_s					-0.0643***	0.634***
					(-8.31)	(11.71)
PRE_3	-2.71 (-0.3325)	-1.44 (-0.3082)				
PRE_2	-0.65 (-0.0789)	0.28 (0.0553)				
PRE_1	-1.73 (-0.1389)	0.43 (0.0600)				
CURRENT	-1.51 (-0.1093)	-0.83 (-0.1056)				
POST_1	-1.56 (-0.1063)	-0.28 (-0.0337)				
POST_2	-4.06*** (-0.2559)	-3.31** (-0.3643)				
POST_3	-5.64*** (-0.1753)	-7.82 (-0.4259)				
N			4781	4781	4781	4781

t statistics in parentheses

Control: YesIndi_FE: YesYear_FE: YesRobust: Yes

$* p < 0.1$, $** p < 0.05$, $*** p < 0.01$

For emission reduction effectiveness: Both the carbon tax (ET) and carbon emissions trading policy (DID) have a significant negative impact, meaning both can significantly suppress the carbon emission intensity of high-emission enterprises and effectively promote their emission reductions. In terms of short-term and long-term effects of policies: The carbon tax shows significant negative effects in both short and long term, with a stronger long-term emission reduction effect, and these results support Hypothesis H1, as show in table 2.

For financing costs: The carbon tax has a significant positive impact, which can significantly widen the credit spreads of high-emission enterprises and thus increase their financing costs; on the contrary, the carbon emissions trading policy has a significant negative impact, which can significantly narrow the credit spreads of high-emission enterprises and thus alleviate their financing pressures. Analyzing the short-term and long-term effects of policies: The emissions trading policy has significant negative effects in both short and long term, with a more pronounced long-term effect on reducing financing costs; the carbon tax has significant positive effects in both short and long term, with a stronger short-term effect on increasing financing costs, and these results support Hypothesis H2.

4.2 Placebo Test

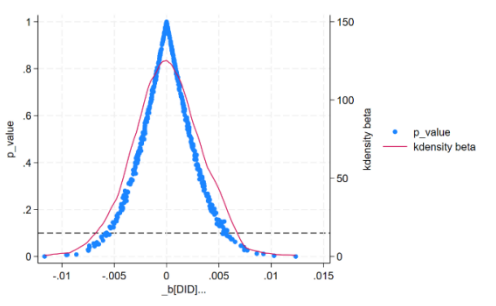

Figure 1: Carbon Trading Policies and Corporate Credit Spreads

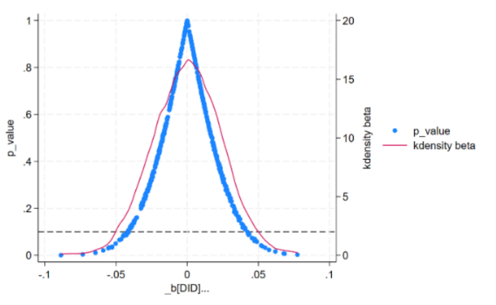

Figure 2: Carbon Trading Policies and Carbon Emissions

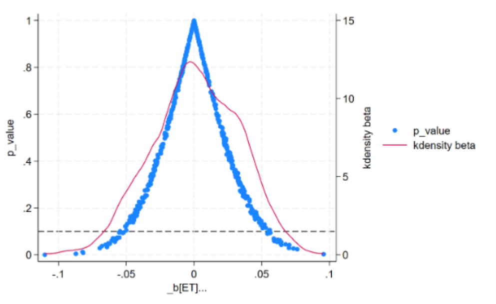

Figure 3: Carbon Tax Policy and Corporate Credit Spreads

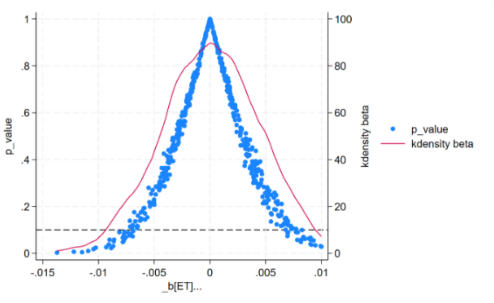

Figure 4: Carbon Tax Policy and Carbon Emissions

In figure 1, figure 2, figure 3 and figure 4, to further validate the reliability of causal inference regarding the impact of carbon trading policies and environmental tax policies on corporate bond credit spreads and carbon emissions, this study conducts a placebo test. The figure above presents the kernel density distribution and p-values for the placebo test, where the blue curve represents the kernel density of the estimated coefficient (kdensity beta), and the red scatter points denote the corresponding p-values (p_value). The distribution reveals that estimated coefficients cluster around zero, with most p-values failing to exceed conventional significance thresholds (e.g., the 0.1 threshold indicated by the dashed line). This indicates that no significant or systematic spurious policy effects were detected in the placebo scenario, where policy shocks were randomly assigned. This suggests that the associations observed in the benchmark regression between carbon trading policies, environmental tax policies, corporate bond credit spreads, and carbon emissions are not driven by unobservable confounding factors or random fluctuations, further enhancing the credibility of the DID model estimates.

4.3 Heterogeneity Analysis

Table 3: Heterogeneity Analysis

	(1)	(2)	(3)	(4)
	CS	CE	CS	CE
CDI_ETS	-0.120**	-0.0266***		
	(0.0535)	(0.00689)		
CDI_ET	-0.0409	-0.0294***		
	(0.0621)	(0.00797)		
SOE_ETS			-0.635***	-0.0710***
			(0.0609)	(0.0104)
SOE_ET			-0.515***	-0.0659***
			(0.0619)	(0.00801)
ROA	-0.239**	-0.0160	-1.936***	-0.0298
	(0.0960)	(0.0107)	(0.326)	(0.0349)
Size	-0.414***	0.0197***	-0.367***	0.0231***
	(0.0223)	(0.00636)	(0.0219)	(0.00623)
Lev	2.050***	-0.0456*	1.906***	-0.0828***
	(0.174)	(0.0252)	(0.194)	(0.0273)
GDP	-0.00000462***	-0.00000984***	-0.000000817	-0.00000903***
	(0.000000783)	(0.000000236)	(0.000000818)	(0.000000240)
HHI	0.0546	0.0146	-0.0128	0.00751
	(0.532)	(0.0623)	(0.552)	(0.0612)
_cons	10.82***	11.21***	8.245***	11.02***
	(0.880)	(0.478)	(1.010)	(0.482)
N	4432	4432	4613	4613

t statistics in parentheses

Control: YesIndi_FE: YesYear_FE: YesRobust: Yes
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In table 3, in terms of corporate carbon disclosure levels: For financing costs, the interaction between carbon disclosure index (CDI) and ETS is significantly negative, meaning companies with carbon disclosure levels above the mean see a more pronounced ETS-driven reduction in credit spread, thus better alleviating financing pressure. However, the interaction between CDI and environmental tax (ET) is not statistically significant, indicating carbon disclosure has no significant moderating effect on ET's impact on financing costs. For emission reduction effectiveness, both CDI-ETS and CDI-ET interactions are significantly negative, consistent with hypothesis h3a.

In terms of ownership structure: For financing costs, interactions between state-owned enterprise (SOE) status and both ETS and ET are significantly negative, showing SOEs experience larger financing cost reductions under either policy—likely due to greater policy support access and financial institution trust. For emission reduction effectiveness, both SOE-ETS and SOE-ET interactions are significantly negative, consistent with hypothesis H3b.

5. Conclusion

This study analyzes 2007–2021 corporate bond data from the Shanghai and Shenzhen stock exchanges to examine the impacts of carbon trading policies (ETS) and carbon tax policies (with environmental tax as a substitute) on high-emission enterprises, yielding key findings. Both policies drive corporate emissions reductions, but they differ in short- and long-term effects: ETS leverages the immediacy of its quota trading mechanism to achieve more pronounced short-term reduction effects, while carbon taxes, through stable and persistent price signals, demonstrate greater efficacy in promoting deep corporate emissions reductions over the long term. In terms of financing costs, the two policies exert opposite impacts that also show short- and long-term differences: ETS reduces corporate financing costs, with this effect more pronounced in the long term, as enterprises profit from surplus allowances and the policy conveys positive signals for low-carbon transition; carbon taxes, by contrast, increase corporate financing costs, though the upward impact is stronger in the short term and diminishes over time as enterprises gradually optimize production and absorb related costs. Regarding corporate heterogeneity, companies with high carbon disclosure levels experience more significant emissions reduction effects from both policies and larger financing cost reductions driven by ETS, thanks to enhanced transparency of carbon-related information; state-owned enterprises (soes), leveraging their stronger policy implementation capabilities, resource integration strengths, and awareness of social responsibility, achieve greater reductions in both financing costs and emissions under both policy frameworks compared to other types of enterprises. A placebo test confirms that these policy effects are not driven by chance factors and are therefore reliable.

This study fills gaps in existing research by quantifying the impacts of the two policies on corporate financing costs and comparing their short-term versus long-term effects, providing critical guidance for policymakers to optimize environmental policies (such as expanding ETS coverage in the short term and promoting coordination between ETS and carbon taxes in the long term), for enterprises to develop carbon management strategies, and for investors to conduct risk assessments. Future research directions may include industry segmentation and the incorporation of cross-border carbon mechanisms.

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