

The Relationship Between Carbon Market Participation, Green Credit Accessibility, and Loan Pricing: Evidence from Chinese Enterprises

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Abstract: Research on the combined impact of participation in the carbon emissions trading scheme (ETS) and accessibility to green credit on corporate loan prices for Chinese listed companies. A panel dataset of 1,842 firm-year observations from 2015 to 2022 was used to conduct a difference-in-differences model with fixed-effects panel regression to examine the causal effect. According to the above results, ETS participation is associated with a rise in loan spreads of about 18–22 basis points, and lenders are thus adding a risk premium for regulatory carbon exposure. At the same time, the improved accessibility of green credit has reduced the loan spread by approximately 21–24 basis points; that is to say, favorable loan policies have effectively lowered borrowing costs for eligible enterprises. ETS participation is negatively associated with green credit accessibility; that is to say, green credit financing somewhat offsets the harm to loan pricing caused by carbon market regulations. The above results have added to the growing body of research at the intersection of environmental regulation and corporate finance, offering reference for both regulators in designing carbon market policies and enterprises in adapting to the dual green-finance and emissions-regulation system.

Keywords: Carbon emissions trading; Green credit; Loan pricing; Chinese enterprises; Sustainable finance

Online publication: August 31, 2026

1. Introduction

Over the past decade, the Design and implementation of carbon pricing mechanisms have been advancing at a faster pace due to the world's climate goals and an increasing number of financial market participants who recognize that unpriced carbon risk represents a significant exposure for regulated enterprises. Given the above, a basic question has arisen as to whether the paths through which companies are affected by participation in the carbon market are changing, and whether the simultaneous development of green credit in China has created offsetting price signals. Study these changes to help companies develop financial plans and assist the government in designing policies that coordinate carbon pricing and green finance tools for a stable green transition.

Evidence from global equity markets shows that carbon transition risk has been priced into all types of assets and regions ^[1], and areas with higher carbon emissions have been associated with lower returns due to expected future regulatory costs. Many studies in the debt market have also found that banks and syndicated loan companies consider the carbon risk of borrowers when determining credit spreads, especially after the 2015 Paris Agreement ^[2]. However, research on the effect of formal emissions trading scheme (ETS) participation at the firm level on credit terms (i.e., carbon-intensity exposure broadly defined) is relatively scarce, especially in China's institutional system for green finance. Huang and others ^[3] have directly addressed this problem by examining the impact of China's ETS pilot experiments on corporate cost of debt and credit access, but their framework does not simultaneously consider the role of green credit accessibility as a possible mitigation measure.

China has established a large national carbon market and a state-guided green credit system in tandem to create a natural laboratory for research on the joint impact of these two regulatory tools on corporate loan pricing. Firms that participate in the ETS and also access green credit financing operate under a multi-layered institutional system and must consider both carbon-risk signals and incentives for green finance at the same time. Although the policy emphasis is on this setup, most of the previous research has only explored carbon markets and green credit separately, failing to determine how they work together to change the cost and supply of corporate debt.

Based on this, the three links in this study are: how does ETS participation affect loan pricing for Chinese enterprises? Does green credit accessibility reduce loan spreads, and by how much? Finally, is there a moderating effect of access to green credit finance on the loan-pricing changes resulting from ETS participation? The answers contribute to the three partially separate literatures of carbon market economics, green credit policy, and corporate debt pricing, and provide practical references for enterprise financing in China's new dual-regulation environment. Section 2 reviews related literature and builds a theoretical system; Section 3 outlines the research plan; Section 4 shows the results of the experiment; Section 5 presents a conclusion.

2. Literature review and theoretical basis

2.1. Carbon markets and corporate debt financing

Theoretical studies on the impact of carbon market participation on corporate finance generally assume risk premia and information asymmetry. When a firm joins the ETS, it will have regulatory obligations and thus face contingent liabilities linked to the price and supply of carbon allowances. Lenders believe that these obligations will reduce cash flow and increase the risk of default in a stressed allowance-price environment, so they have raised the interest margin or tightened credit policies. Bolton and Kacperczyk ^[1] have provided the first comprehensive global evidence that carbon-transition risk is already reflected in equity markets, and subsequent studies have extended this logic to debt. Park ^[4] takes the Korean ETS as a natural experiment and finds that ETS adoption increases firm betas—an indirect indicator of a higher cost of capital—without corresponding emission reductions; thus, it suggests that capital markets punish the uncertainty of regulatory compliance rather than reward achieved decarbonization. Delis *et al.* ^[5] showed that in the syndicated loan market, banks have begun to incorporate climate-policy risk into loan terms since the Paris Agreement, and the difference in pricing for fossil fuel borrowers is about 16–18 basis points; furthermore, even self-designated green lenders charge higher interest rates for such companies. Huang and his colleagues ^[3] specifically studied Chinese enterprises

and used a difference-in-differences model on eight ETS pilot regions to find that participation in ETS is associated with a higher cost of debt and reduced debt access; lenders interpreted this as a sign of increased transition risk.

2.2. Green credit policy and loan pricing

Green credit literature studies how policy-directed credit allocation and borrower-side green credentials affect the terms of debt financing. Caramichael and Rapp^[6] have found that in the primary bond market, a green-bond issuance greenium of 3–8 basis points emerged after 2019, and it was concentrated among large, investment-grade issuers in developed countries; green-labeled instruments thus attracted a premium from investors, although this premium was relatively small and unevenly distributed. Li and others^[7] have shown that the Green Credit Guidelines introduced by Chinese banks in 2012 have increased the amount of bank lending to environmentally friendly projects and achieved measurable environmental benefits, but at the cost of some economic sacrifices at the bank level. Carnevale and Drago^[8] have systematically reviewed 41 empirical studies to find that they are significantly asymmetric: lenders consistently apply a higher spread to poor ESG performance, but positive ESG performance does not reliably lead to a lower rate. Thus, it is not clear whether green credit access leads to a price advantage; therefore, more research needs to be conducted in the Chinese institutional environment to see if policy-supported green credit will establish a lower price floor for eligible borrowers.

2.3. ESG, environmental disclosures, and loan pricing

A supporting body of evidence explores whether ESG scores and environmental disclosures moderate debt pricing. Fiorillo *et al.*^[9] found that high-ESG bond issuers pay about 11 basis points less than low-ESG issuers, the environmental pillar accounts for most of this effect, and regulatory disclosure requirements have increased the premium in the post-SFDR period. Huang and others^[10] proposed the problem of ESG washing, showing that low-ESG banks extend preferential loan terms to high-ESG borrowers because this optics attract favorable market reactions; that is to say, the observed green-lending pricing advantage may be strategic signaling rather than genuine risk repricing. Ge and others^[11] have shown that firms in high-climate-risk areas have a wider loan spread, but this penalty is reduced by voluntary climate-risk disclosures in conference calls, especially when the lead lender lacks climate-lending expertise. Kempa^[12] extends the climate-risk and loan-pricing nexus to physical risk, and has shown that climate vulnerability increases borrowing costs globally and alters collateral and covenant terms beyond interest rate spreads. In short, all of these studies show that environmental and climate factors have been systematically priced into corporate debt; however, the extent and direction of this effect vary significantly depending on the type of environmental signal, institutional conditions, and how much information asymmetry has been reduced through disclosure.

2.4. Theoretical foundation

Based on the above studies, we propose a dual-channel theoretical system as shown in **Figure 1**. The first is a risk premium channel; due to information asymmetry, lenders believe that participants in ETS have substantial carbon liabilities and are thus willing to accept a higher loan spread and stricter credit conditions. The second path is the green-finance offset mechanism; that is, the availability of green credit leads to a reduction in the price of capital through either direct policy support or indirect signals of strong environmental responsibility given by borrowers. An interaction effect exists: ETS-participating firms that have obtained green credit

from lenders may be viewed as lower carbon risk by those lenders due to the green-credit signal, and thus the uncertainty over the firm's capacity to meet transition obligations is partially reduced. Based on the above framework, three hypotheses are proposed: H1, ETS participation is positively associated with loan spreads for Chinese enterprises; H2, green credit accessibility is negatively associated with loan spreads; and H3, green credit accessibility negatively moderates the relationship between ETS participation and loan spreads, that is to say, the positive effect of ETS participation on loan spreads is weaker for firms with greater green credit access.

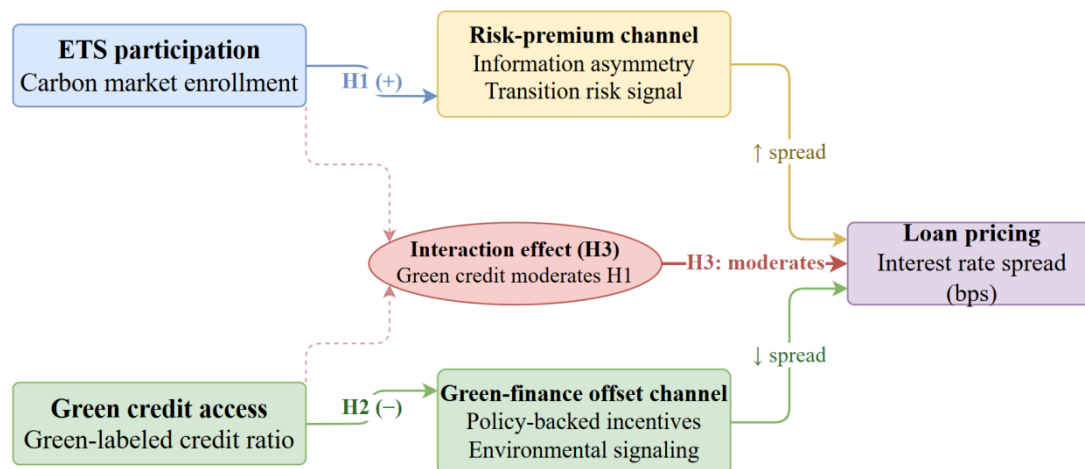


Figure 1. Dual-channel theoretical framework for the effects of carbon market participation and green credit accessibility on loan pricing

3. Research design

3.1. Samples and data

The three links are to the following data. Firm-level financial and loan data are provided by the China Stock Market and Accounting Research (CSMAR) database and the WIND financial database for A-share listed companies. ETS participation status is identified by using the official registry of firms in China's regional pilot ETS programs (2013–2021) and the national ETS scheme (2021–present), which have been compiled from Ministry of Ecology and Environment disclosure records. Green credit accessibility is proxied by the number of green bonds or green loans issued by the company and recorded in the China Central Depository and Clearing green bond database, as well as bank-level disclosures of green credit portfolios.

The first set of samples includes all non-financial, non-utility A-share listed companies in Shanghai and Shenzhen from 2015 to 2022. After excluding observations with missing financial data and winsorizing continuous variables at the 1st and 99th percentiles, the final panel has 1,842 firm-year observations from 312 unique firms. As shown in **Table 1**, the sample includes the manufacturing, materials, and energy-intensive service sectors, and due to the expansion of ETS coverage, the proportion of ETS-participating enterprises in this sample increased from 18% in 2015 to 47% by 2022. The rising proportion will provide adequate within-sample variation to detect the treatment effect of interest in both the pre- and post-national-ETS sub-periods.

3.2. Variables

Loan Spread is set as the difference between the annualized interest rate of the company's primary bank loan

and the People's Bank of China's one-year benchmark lending rate for the same period, expressed in basis points. This way can exclude a firm-specific credit premium caused by changes in monetary policy and is in line with spread measures used in the international loan-pricing literature. The two main independent variables are ETS_Participation and Green_Credit; ETS_Participation is a binary variable that equals 1 in firm-years where the enterprise has been listed on a carbon trading scheme, and Green_Credit is a continuous variable indicating the proportion of green-labeled credit facilities to total outstanding debt. In line with the previous studies on loan pricing^[5,12], we control for firm size (natural logarithm of total assets), leverage (total debt to total assets), return on assets (net income to total assets), carbon intensity (CO₂ emissions per unit of revenue), and SOE (a binary indicator of whether it is a state-owned enterprise). State-owned enterprises are included because their SOE status systematically affects access to preferential loans in China's bank-dominated financial system, and excluding them would confound the estimates of the ETS effect.

3.3. Model specification

The first design is a difference-in-differences model. The first estimating equation is: $\text{Loan_Spread}_{it} = \alpha + \beta_1 \text{ETS}_{it} + \beta_2 \text{GreenCredit}_{it} + \beta_3 (\text{ETS}_{it} \times \text{GreenCredit}_{it}) + \gamma X_{it} + \delta_t + \mu_j + \varepsilon_{it}$, where X_{it} is a vector of firm-level control variables, δ_t are year fixed effects, μ_j are industry fixed effects, and ε_{it} are idiosyncratic error terms. Standard errors are clustered at the firm level to address within-firm serial correlation. β_1 is the main effect of ETS participation on loan spread, β_2 is the direct green-credit pricing effect, and β_3 , the coefficient of primary interest, tests Hypothesis 3 by determining whether green credit access moderates the increase in spread caused by ETS.

4. Empirical results

4.1. Descriptive statistics

Table 1 shows the summary statistics of the whole sample. The mean loan spread is 195.3 basis points, and the standard deviation is 87.6 bps; highly-rated state-owned enterprises have a minimum spread of 45 bps, and smaller carbon-intensive enterprises in competitive credit markets have a maximum spread of 520 bps. Approximately 34% of the firm-year observations are ETS participants, whereas green credit access is relatively constrained, and its mean ratio is only 0.22 with a large right skew. Firm size, leverage, and ROA are consistent with the features in comparable samples of Chinese industrial enterprises. The average carbon intensity is 0.58, the samples are mainly located in energy-intensive industries, and they meet the ETS coverage requirements for the pilot stage. Bivariate analysis shows that ETS participation is positively correlated with loan spread, and the green credit ratio is negatively correlated with loan spread; thus, Hypotheses 1 and 2 are preliminarily supported.

Table 1. Descriptive statistics

Variable	Mean	SD	Min	Median	Max	N
Loan Spread (bps)	195.3	87.6	45.0	182.0	520.0	1,842
ETS Participation (0/1)	0.34	0.47	0	0	1	1,842
Green Credit Ratio	0.22	0.19	0	0.17	0.84	1,842
Carbon Intensity	0.58	0.43	0.04	0.47	2.31	1,842
Firm Size (ln assets)	22.14	1.23	19.42	22.08	25.87	1,842
Leverage	0.47	0.16	0.09	0.46	0.86	1,842

Variable	Mean	SD	Min	Median	Max	N
ROA	0.045	0.038	-0.092	0.041	0.198	1,842
SOE (0/1)	0.43	0.50	0	0	1	1,842

4.2. Baseline regression results

Model 1 shows that ETS participation is positively associated with loan spread at the 1% level ($P < 0.01$), thus supporting Hypothesis 1 and aligning with the previous findings of Huang *et al.* ^[3] that lenders increase the risk premium upon ETS enrollment. The estimated size is generally in line with the foreign research of Delis *et al.* ^[5] on fossil fuel companies after the Paris Agreement, but it is smaller in absolute terms due to lower carbon allowance prices in China's historical period compared to those in the European carbon market.

In Model 2, adding the green credit ratio shows that it is negatively correlated with 24.18 basis points ($P < 0.01$), thereby supporting Hypothesis 2. This result is consistent with the green-bond greenium shown by Carmichael and Rapp ^[6], and the preferential-pricing logic has been extended to the loan market in China. The ETS participation coefficient is still positive and statistically significant at 15.67 bps ($P < 0.01$); thus, green credit access reduces the carbon-risk premium but does not eliminate it.

Model 3 adds the interaction term and is thus the preferred specification. The interaction coefficient is negative and statistically significant at -19.83 basis points ($P < 0.05$), thus supporting Hypothesis 3. For a firm at the mean green credit ratio (0.22), the marginal effect of ETS participation on loan spread is approximately 18.0 bps ($22.35 - 19.83 \times 0.22$), and for a firm at the 75th percentile of green credit access (ratio = 0.38), this marginal effect is about 14.8 bps. The expanded adjusted R-squared values are 0.384 for Model 1 and 0.425 for Model 3; therefore, the interaction term in Model 3 explains more variation than in Model 1. Control variables behave as expected: larger and state-owned enterprises have lower spreads, and higher leverage and carbon intensity are related to wider spreads.

5. Conclusion

This paper studies how carbon market participation and green credit accessibility jointly and interactively affect loan pricing for Chinese enterprises. Based on a panel of 1,842 firm-year observations from 2015 to 2022, the following three main results were obtained. First, ETS participation raises loan spreads by about 18–22 basis points due to a risk premium, and lenders consider regulatory carbon exposure a contingent financial liability. Second, green credit accessibility reduces the loan spread by about 21–24 basis points through policy-supported preferential pricing and thus lowers the borrowing cost for eligible enterprises. Third, a substantial negative interaction effect indicates that access to green credit reduces the harmful price impact of ETS participation, and the degree of reduction is positively correlated with the ratio of green credits.

The financial manager of the company will combine green-credit qualifications with other financing options to reduce the cost of borrowing for participating in the ETS. An interaction effect may support the joint development of China's carbon market and green finance instruments by providing additional incentives for the corporate debt market for policymakers. With the development of China's national ETS and an increase in allowance prices under the dual-carbon strategy, green credit as a cost-of-capital modifier will gradually be revealed and requires continuous empirical studies and policy coordination.

Disclosure statement

The author declares no conflict of interest.

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