

Carbon Information Disclosure and Corporate Financing Constraints

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Abstract. Global warming keeps worsening, pushing greenhouse gas emission control into a worldwide mainstream. As China's carbon emissions trading market has grown to cover the entire nation, statistical accounting and trading management of carbon emissions of enterprises are also increasing. Against this backdrop, carbon information disclosure and relief of financing constraints have become core issues for listed enterprises to address. Taking A-share listed companies in China as an example, this paper examines how corporate carbon information disclosure influences enterprise financing constraints by applying a Difference-in-Differences model under relevant policies. This paper further explores the moderating effect of corporate ownership nature. The results indicate improving the level of carbon information disclosure can reduce financing constraints for enterprises. Consistent conclusions can be obtained through a series of robustness checks. This paper provides more research perspectives for carbon information disclosure management and empirical evidence for enterprises to actively plan and implement carbon information disclosure to improve their competitiveness and reduce financing costs.

Keywords: carbon information disclosure, corporate financing constraints, nature of property rights

1. Introduction

Global warming keeps worsening, pushing greenhouse gas emission control into a worldwide mainstream. In 2023, to fulfill the long-term dual carbon goals, China's National Development and Reform Commission rolled out a complete "1+N" policy framework. The Interim Measures for Carbon Emission Trading and revised carbon accounting standards have raised mandatory carbon disclosure requirements for firms. From the perspective of policy implementation, the release of the Basic Guidelines for Corporate Sustainable Disclosure Standards in 2024 has provided a unified system of sustainable disclosure standards for enterprises. Against such a policy backdrop, the transmission mechanism linking tightened carbon disclosure supervision to corporate financing constraints, together with the channels through which firms ease financing pressure via carbon disclosure, constitute valuable research topics.

Carbon information disclosure can release decarbonization and environmental operational data, which strengthens corporate sustainable development capacity and aligns business expansion with national green policies to improve social value, economic performance, and market competitiveness

[1]. For investors, it serves as positive operational signals to mitigate information asymmetry between firms and capital providers, enabling investors to access complete CSR data and lower risk evaluation costs [2]. Financing constraints refer to higher corporate financing costs arising from information uncertainty, under which perceived operational risks harm corporate reputation and suppress investor investment willingness [3]. Proactive carbon disclosure and long-term low-carbon strategic planning help enterprises enhance corporate value and improve public recognition [4]. This enhances public recognition of corporate environmental and social responsibility, attracts investors to provide low-cost financing, and thereby alleviates corporate financing constraints [5].

Current literature has explored the impact such as total factor productivity, operating risk, and cash holdings. Some studies also consider the regulatory role of external factors like government supervision. Nevertheless, existing studies have insufficiently examined the systematic correlation. This paper uses the 2024 sustainable disclosure guidelines as a policy shock, analyzing five years of A-share listed firms with a DID model to study the financing effect of carbon disclosure and the heterogeneity of property rights. Theoretically, it broadens existing research frameworks and offers new analytical insights. Practically, it suggests feasible ways for firms to reduce financing friction through high-quality carbon disclosure and provides robust empirical evidence for regulators.

2. Literature review and theoretical analysis

Information asymmetry is a core factor which leads to corporate financing constraints. Oversimplified operational indicators hinder stakeholders from acquiring complete carbon emission data and making rational investment judgments [6]. In many cases, selective voluntary disclosure adopted by firms to sustain investor confidence aggravates such information asymmetry [7]. Carbon information disclosure can better show the level of carbon performance and environmental risks of enterprises than traditional enterprise operating data, which can release optimistic signals of sustainable development ability and business situation of enterprises so that stakeholders can analyze the risks of enterprises more comprehensively. Therefore, it is easier for enterprises to gain long-term cooperation opportunities and reduce financing constraints.

Carbon information disclosure can also reflect the achievements and objectives of the current enterprise green development strategy, including the use of low-carbon technology and the progress of emission reduction targets. Improving carbon disclosure quality can reveal better corporate environmental performance and mitigate legitimacy pressure brought by government regulatory requirements [8]. Enterprises can also optimize the industrial chain and reduce the overall use of resources through green development strategies to improve the carbon and financial performance. In addition, the combination of carbon management and green development decision-making of enterprises can guide the allocation of resources to low-carbon areas. This signals the implementation of green transformation strategies and can reduce stakeholders' concerns over operational risks so that corporate financing constraints can be alleviated [9].

H1: Carbon information disclosure can alleviate corporate financing constraints

Corporate ownership nature has a pivotal mitigating effect on the correlation between carbon information disclosure and financing constraints. Research indicates that non-state-owned listed companies experience a more substantial impact on the cost of equity capital, which is negatively correlated with carbon information disclosure [10]. State-owned enterprises usually obtain implicit government guarantees and policy-backed credit resources, which reduces the risk-mitigation effect brought by carbon disclosure. In contrast, non-public enterprises which proactively disclose carbon information to demonstrate sustainable development capabilities can attract resources. Thus, carbon

disclosure can build investors' trust and enhance competitiveness, playing a vital role in reducing financing constraints for non-public enterprises.

H2: The nature of property rights can regulate the influence of carbon information disclosure on corporate financing constraints.

3. Study design

This paper uses the release of the "Sustainable Disclosure Standards for Enterprises Basic Standards" in 2024 as a policy node to analyze the influence of carbon information disclosure. The study chooses data from 2019 to 2024, excludes financial and insurance companies, which do not follow the carbon emission patterns relevant to this study, as well as ST and *ST companies and incomplete data.

The explained variable, financing constraints, is measured using the KZ index, which is calculated by weighting multiple financial indicators such as cash flow and debt value. A larger KZ index indicates stronger financing constraints. Also, the study chooses carbon information disclosure from the CSMAR database as the measurement of core explanatory variable. This index comprehensively evaluates the completeness and detail of carbon emission disclosures in reports of listed companies. The data undergo industry-annual Z-score standardization to obtain the final CID values. Table 1 shows the selection of adjustment and control variables.

Table 1. Variable definitions

Variable	Symbol	Definitions and Measures
Explained variable	FC	The degree of financing constraints. Calculated by the KZ index
Explanatory variable	CID	Carbon disclosure intensity. The "carbon information disclosure index" in the CSMAR database, the industry annual average is standardized.
Policy variables	POST	Take 1 for 2024 and beyond, otherwise take 0.
Adjustment variables	SOE	The nature of property rights. 1 for public-owned enterprises and 0 for non-public enterprises
	Size	Natural logarithms of total assets
	Lev	Total liabilities/Total assets
	ROA	Net profit/Total assets
Control variables	Growth	Operating income growth rate
	Cash	Monetary capital/Total assets
	Age	Natural logarithm of listing years

To test Hypothesis 1 and Hypothesis 2, this study develops the baseline regression Model (1) and Model (2) as shown below.

$$FC_{i,t} = \alpha_0 + \alpha_1 \times CID_{i,t} + \alpha_2 \times (CID_{i,t} \times Post_t) + \sum \beta_j \times Controls_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (1)$$

$$FC_{i,t} = \omega_0 + \omega_1 \times CID_{i,t} + \omega_2 \times (CID_{i,t} \times Post_t) + \omega_3 \times SOE_{i,t} + \quad (2)$$

$$\omega_4 \times (CID_{i,t} \times Post_t \times SOE_{i,t}) + \sum \psi_j \times Controls_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

4. Empirical analysis

4.1. Descriptive statistics

As seen in Table 2, the financing constraint index shows a mean value of 0.6169, a median of 0.7845, and a standard deviation of 1.2022. The range is from -15.9353 to 13.4862. This indicates significant variation in financing constraints among listed enterprises. The carbon information disclosure intensity has a mean of 0, a standard deviation of 0.9899, and a median of -0.1334, suggesting that most enterprises disclose carbon information slightly below the industry average.

Table 2. Descriptive statistics

Variable	Obs	Average	Median	Std	Min	Max
FC	24861	0.6169	0.7845	1.2022	-15.9353	13.4862
CID	24577	-0.0000	-0.1334	0.9899	-3.4546	5.5712
POST	25775	0.1923	0.0000	0.3941	0.0000	1.0000
SOE	24402	0.2996	0.0000	0.4581	0.0000	1.0000
Size	25775	22.2643	22.0426	1.3728	17.9544	28.7908
Lev	25775	0.4015	0.3897	0.2058	0.0131	3.5130
ROA	25775	0.0308	0.0362	0.0858	-2.1203	0.7859
Growth	20655	0.2380	0.0625	8.2226	-0.9991	944.0996
Cash	25775	0.1941	0.1576	0.1379	0.0006	0.9546
Age	25472	1.8638	2.1246	1.2584	-5.9006	3.5274
CID_POST	24577	0.0000	0.0000	0.4420	-3.4546	3.2401
CID_POST_SOE	23581	0.0252	0.0000	0.2477	-2.2139	2.5812

The correlation coefficient matrix shows that most absolute correlation values range between 0 and 0.58, indicating no high linear correlation and thus no multicollinearity issues in the model. The policy dummy variable post has a correlation coefficient of $r = -0.055$ with the financing constraint index, revealing a significant negative correlation. This preliminary result indicates that the policy contributes to the alleviation of corporate financing constraints. However, the simple bivariate correlation between carbon disclosure level and financing constraints lacks statistical significance, which implies other confounding variables interfere with this correlation.

4.2. Regression analysis and regulatory effect test

As seen in Table 3, column (1) is the result of the interactive effect of carbon disclosure and the exogenous policy shock on financing constraints without containing control variables. It shows that carbon information disclosure negatively impacts financing constraints at the 10% significance level, and the policy interaction term is significantly negative. Column (2) is the result which includes control variables, showing that the negative impact of carbon information disclosure on financing constraints is also significant at the 5% level. These findings support Hypothesis 1, confirming that under the policy.

Table 3. Benchmark regression analysis

	(1) FC	(2) FC	(3) FC
CID	-0.022*	-0.0117	-0.013
	(-1.78)	(-1.12)	(-1.24)
CID_POST	-0.070***	-0.027**	-0.054***
	(-4.90)	(-2.06)	(-3.27)
SOE			0.375***
			(4.43)
CID_POST_SOE			0.080***
			(3.04)
Controls	No	Yes	Yes
Firm/Year	Yes	Yes	Yes
N	18676	18676	18676
R ²	0.004	0.207	0.210

Note: *, **, and *** mean significant at 10%, 5%, and 1% levels, respectively. The same as below.

In Column (3), the coefficient is 0.080, which indicates that property rights significantly moderate the influence of carbon information disclosure on corporate financing constraints. Specifically, the positive effect of carbon disclosure in easing financing constraints is stronger in non-public enterprises and significantly weaker in state-owned enterprises. This confirms Hypothesis 2.

4.3. Robustness test

As seen in Table 4, to ensure reliability, this paper tests robustness in three perspectives. First, the study supersedes the core explained variable, the carbon disclosure index, with the original KZ index as the SA index, and carries out regression again according to the benchmark regression model. The SA index refers to the natural logarithm of the total asset size of the enterprise and the operating life of the enterprise, which is usually negative. Secondly, the explanatory variable CID, the policy interaction term CID_POST, and the control variables are all taken as the lag period and tested with reference to the benchmark regression model to reduce the possible lag. Thirdly, the robustness test is carried out by the PSM method, and the core conclusion is still valid.

Table 4. Robustness test

	(1) FC (lag phase I)	(2) FC	(3) FC
CID	0.0169	-0.0008	-0.0087
	(1.32)	(-1.11)	(-0.77)
CID_POST	-0.0275**	0.0046***	-0.0397***
	(-2.03)	(4.24)	(-2.63)
Controls	Yes	Yes	Yes
Firm/Year	Yes	Yes	Yes

Table 4. (continued)

N	18676	18676	14184
R ²	0.9802	0.142	0.212

5. Conclusion

The results indicate that higher-quality carbon disclosure can alleviate financing pressure. The nature of property rights has a moderating effect. The effect on financial constraints of carbon disclosure is much weaker for state-owned enterprises due to their inherent reliance on government resources. This paper also recommends promoting the development of more unified carbon information disclosure standards that better align with the characteristics of carbon emissions. The government should verify the collected information and optimize the disclosure standards to reduce the gap between non-public enterprises and public-owned enterprises.

This paper contributes to analyzing the internal mechanism to alleviate corporate financing constraints and the regulatory role of nature of property rights. It also provides empirical evidence for regulators to optimize carbon disclosure regimes and offers practical references for firms to optimize carbon disclosure frameworks and strengthen market competitiveness. This research still has limitations. This paper only adopts one year of sample data after the 2024 policy shock. Follow-up research can extend the sample span to identify long-term policy effects and analyze some other factors such as synergies with the national carbon emission trading market. Moreover, this paper only covers China's A-share market, and follow-up cross-market comparative research can offer more evidence for carbon disclosure governance and corporate low-carbon development.

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