



Research on the Impact of Firm-level Climate Risk Disclosure on the Issuance of Green Bonds

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Abstract. In the context of increasingly prominent environmental issues and growing attention to climate risks, enterprises are placing greater emphasis on addressing climate-related challenges. As an important financing instrument, green bonds play a significant role in supporting corporate sustainable development. This study examines all A-share listed companies in China from 2016 to 2020 as a sample to investigate whether climate risk disclosure influences the issuance of green bonds. The findings reveal a significant positive correlation between climate risk disclosure and the likelihood of green bond issuance. Specifically, a higher level of climate risk disclosure is associated with a larger scale of green bond issuance. This research contributes to the existing literature by addressing the current gap regarding the impact of climate risk disclosure on green bond issuance. It offers a new perspective for the field of green finance, enriches the theoretical framework of green finance, enhances the understanding of the relationship between climate risk disclosure and green bond issuance, and provides additional support for related theoretical studies.

Keywords: green bonds, climate risk disclosure, listed company

1 Introduction

In the context of achieving the carbon neutrality goal, as climate change gradually expands its impact and then affects the most basic unit of economic development—enterprises, more and more enterprises begin to pay attention to and respond to climate risks, set up climate-related special teams within the enterprises, and emphasize the disclosure and prevention of climate risks in the finance department, security department and other departments. Leading Chinese firms like Contemporary Amperex Technology Co. Limited (CATL) exemplify how systematic climate risk disclosure advances green finance. By quantifying physical risks (e.g., a 1°C temperature rise cutting battery efficiency by 2.1%) and clarifying decarbonization targets, they boost investor confidence. This transparency was pivotal to CATL's 2019 RMB 5 billion green bond, which was threefold oversubscribed and attracted anchor investments from institutions like Norway's GPF. The case validates that robust climate risk assessment is key to de-risking sustainable assets and mobilizing global capital.

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Climate risk disclosure refers to an enterprise's disclosure to investors and other stakeholders of its climate change exposure information, including assessing climate change's impact on its operations, financial condition and future outlook. It not only urges enterprises to strengthen climate risk control and improve business sustainability, but also serves as a responsibility to stakeholders, boosting their confidence. Then it can reflect the professionalism of financial work related to disclosure and sustainability and advance China's high-quality sustainable economic development. However, this confidence-building mechanism transcends financial metrics, forging comprehensive multi-stakeholder trust. Internally, Lee et al. (2023) point that detailed climate disclosures about low-carbon workplace practices (e.g., green office policies, carbon reduction targets) enhance employees' emotional attachment to the organization's sustainability goals^[5]. Externally, transparent assessments of ecological impacts mitigate community opposition while legitimizing claims for green policy incentives, thus creating a self-reinforcing cycle of institutional credibility.

As an important green financing tool, green bonds are key to enterprises' sustainable development. They help reduce indirect financing costs and ease corporate financing pressure. From a policy perspective, they also enjoy strong government incentives like tax cuts and cash rewards. Smooth issuance not only provides funds for enterprises' sustainable development but also eases information asymmetry and boosts corporate credibility. Though China's green bond market started relatively late, it has maintained steady development. Compared with foreign green bond duration framework, China's green bond market has a faster growth rate and more types^[3].

At present, domestic and international scholars have conducted extensive research on the correlation between bonds and information disclosure, covering credit issues, issuance scale, and interest rates related to bond issuance. The mainstream view holds that green bond issuance methods and listed firms' operating conditions affect green bonds' issuance scale and interest rates. And external factors like external investors, policy support intensity, and third-party certification also significantly impact green bond issuance. However, academic research on the relationship between climate risk disclosure and green bond issuance remains relatively limited, while focusing on climate risk aligns with national general policies.

Globally, the European Union (EU), as a pioneer in green finance, has established a mandatory and standardized climate risk disclosure framework through the Corporate Sustainability Reporting Directive (CSRD), which took effect in 2024. Under CSRD, all large EU-listed enterprises must disclose granular climate-related information, including Scope 1-3 greenhouse gas emissions, physical risk assessments, and transition plans aligned with the Paris Agreement. This high level of standardization has directly boosted EU green bond issuance: in 2023, EU enterprises accounted for 42% of global green bond issuance. Compared to the markets like EU, China's climate risk disclosure remains voluntary in most case, with disclosure content often limited to general statements. Correspondingly, the issuance of green bonds is more difficult.

This study makes several key contributions to the literature: First, it extends the existing research on the determinants of green bond issuance by identifying corporate climate risk disclosure as a significant influencing factor, thereby broadening the scope of antecedents examined in the field of green finance. Second, it introduces a novel

firm-level climate risk disclosure measure derived from textual analysis of annual reports, offering an innovative approach to capturing disclosure quality. The application of this measure further advances scholarship on the economic consequences of climate risk reporting. Third, the paper delves into the underlying mechanisms through which climate risk disclosure affects green bond issuance, providing deeper theoretical insights into how non-financial disclosures influence sustainable financing decisions.

2 Background and Hypothesis Development

Regarding climate information disclosure, it is evident that risk-related information disclosure inherently possesses dual attributes: informativeness and risk transmission. On the one hand, providing sufficient information to stakeholders alleviates information asymmetry, cuts communication costs, and brings long-term benefits to finance. On the other hand, it subjects firms to public scrutiny, which is detrimental if they face major risks. Climate change impacts multiple dimensions with diverse influencing factors: while some listed companies bear higher costs, most address climate-related issues (e.g., global warming) due to regulatory constraints—and for many, climate change is an opportunity rather than just a mandatory challenge. Thus, optimizing climate risk disclosure systems is essential to reflect such differences.

And for the issuance of green bonds, scholars generally agree that green bond issuance significantly impacts China's market transactions and enterprise development. Green bond is a kind of efficient financing means, which can quickly bring funds to enterprises and help our country to participate in the international financial system. It will also bring risks, once the risk spillover may be difficult to control, and then bring a certain impact on China's financial market. Although the popularity of green finance has led to more and more research on green bonds by scholars, from an international perspective, China's green bond market has developed relatively late, and its supporting system is not as comprehensive as that of developed countries today, leaving Chinese scholars with more work to do in related research.

At present, most scholars have relatively consistent views on information disclosure. From the perspective of the investors, under the condition that other factors remain unchanged, the expected return on investment of investors is positively correlated with their expected risk level. Specifically, the higher the future risk that investors perceive, the higher the corresponding expected return on investment. Listed enterprises can enhance the quality of information disclosure by conducting in-depth research and optimizing their information disclosure practices, thereby improving information transparency. This behavior actually reduces the investment risk of investors, and investors do not have to expect higher investment returns, thus reducing financing costs of the company. And climate risk disclosure, as an important aspect of information disclosure, has similar characteristics to information disclosure. Bolton et al.(2024) points that non-financial disclosure reduces information asymmetry, thereby lowering investor risk premiums^[2]—a mechanism consistent with Barry and Brown's (1985) theory. Ahern and Sosyura (2022), Hoberg and Prabhala (2024) also find that companies with more

detailed and transparent disclosures attract more analyst attention and reduce forecast dispersion^{[1][4]}.

Thus, based on the above literature, it can be concluded that climate risk disclosure, as a key aspect of information disclosure, can enhance information transparency and reduce corporate financing costs. Furthermore, high-level climate risk disclosure will make enterprises pay more attention to green financing methods. In such cases, green bonds will become the choice for enterprises. At the same time, China has placed particular emphasis on the development of green industries in recent years and has provided significant support to enterprises with sustainable development. The relevant policies and support for these green industries will also encourage enterprises to prefer to issue green bonds.

To sum up, we propose the following research hypotheses:

H1: The higher the level of climate risk disclosure of a company, the more likely it is to issue green bonds.

H2: The higher the level of climate risk disclosure of a company, the larger the scale of green bond issuance.

3 Research Design

3.1 Variable Definitions

3.1.1 Dependent Variables.

Based on the research of core journals and following other studies based on bond issuance, this paper selects whether to issue green bonds and the scale of green bond issuance to measure the issuance of corporate green bonds. The first dependent variable is Green, which indicates whether an enterprise has issued green bonds. It is assigned a value of 1 if the enterprise issued green bonds in the sample year, and 0 otherwise. The second dependent variable is Scale, the issue size.

3.1.2 Independent Variables.

CRI (Climate Risk Index) is the core explanatory variable, i.e., the climate risk disclosure indicator, measuring climate risk disclosure. For measuring climate risk disclosure, Sautner et al. (2023) proposed a method that addresses prior approach limitations—focusing on unstructured text data from earnings calls, which is less prone to greenwashing^[6]. This study adopts this method: by retrieving listed firms' annual reports, identifying keyword-related statements, and constructing the annual report text's CRI using the Bag-of-Words model. Details are as follows: Based on China's actual context, this study draws on authoritative climate risk documents (e.g., the Inter-Ministerial Joint Conference System for Natural Disaster Prevention and Control issued by China's State Council) and globally recognized climate conventions (e.g., the United Nations Framework Convention on Climate Change (UNFCCC), its Kyoto Protocol, and Paris Agreement on Climate Change). Machine learning-based keyword extraction and Term Frequency-Inverse Document Frequency algorithms are used to construct a climate risk keyword list, and listed firms' annual reports are retrieved using this list.

$$CRI_{i,t} = \frac{\omega_{i,t}}{total\ words_{i,t}} \quad (1)$$

Where $\omega_{i,t}$ is the number of times that the climate risk words in the keyword table appear in the annual report of company i in year t , and $total\ words_{i,t}$ is the total number of words in the annual report. According to previous studies, a higher CRI value indicates more firm-level climate risk disclosure.

3.1.3 Control Variables.

Referring to Wang and Gao (2018), Zhou (2016), and Lyu (2018), this study incorporates firm-level and bond-level control variables into the model, including: Size (firm size): natural logarithm of annual total assets; Lev (asset-liability ratio): year-end total liabilities divided by total assets; ATO (total asset turnover): operating income/average total assets; BM (book-to-market ratio): book value/total market value; INV (inventory ratio): net inventory/total assets; FIXED (fixed asset ratio): net fixed assets/total assets; Growth (operating income growth rate): (current year's operating income/previous year's operating income) - 1; ListAge (listing years): $\ln(\text{current year} - \text{listing year} + 1)$. And the main variable definitions are shown in Table 1.

Table 1. Main variable definitions.

CATEGORY	NAME	CODE	DEFINITION
Dependent variable	Whether to issue green bonds	Green	1 if bonds were issued during the sample period, 0 otherwise
	Green bonds issuance size	Scale	Green bond issuance scale (billion yuan)
Independent variable	Climate risk disclosure index	CRI	Number of times the climate risk keywords appear in the annual report of company i in year t / total word count of the annual report
Control variable	Company size	Size	Natural logarithm of total annual assets
	Asset-liability ratio	Lev	Total liabilities at the end of the year divided by total assets at the end of the year
	Total asset turnover rate	ATO	Revenue / average total assets
	Book-to-market ratio	BM	Book value / total market value
	Inventory ratio	INV	Net inventory value divided by total assets
	Fixed assets ratio	FIXED	Ratio of net fixed assets to total assets
	Revenue growth rate	Growth	This year's operating income / Last year's operating income - 1
	Listing years	ListAge	$\ln(\text{Year of this year} - \text{Year of listing} + 1)$

3.2 Sample

The green bond data and listed enterprise data used in this study are both sourced from the Wind Database. For the part of corporate-level climate risk disclosure, this paper adopts CRI (climate risk index) adopted by existing authoritative research, namely, climate risk disclosure index.

This paper uses the A-share listed enterprises and green bond issuance information except the financial industry from 2016 to 2020 as the initial sample of 16,800, excluding the enterprises in the financial industry, excluding 1% samples with missing data, extreme value outliers, and excluding the samples with issuers in abnormal states, and finally retaining 15,771 pieces of data.

3.3 Regression Models

In order to verify Hypothesis 1 in our paper, and the regression model (1) is constructed as follows:

$$\text{Green} = \alpha_0 + \alpha_1 \text{CRI} + \alpha_2 \text{Size} + \alpha_3 \text{Lev} + \alpha_4 \text{ATO} + \alpha_5 \text{BM} + \alpha_6 \text{INV} + \alpha_7 \text{FIXED} + \alpha_8 \text{Growth} + \alpha_9 \text{List Age} + \sum \text{ind} + \sum \text{year} + \varepsilon \quad (2)$$

Further research will be conducted on the relationship between climate risk disclosure and the issuance scale of green bonds. In this paper, the sample data of listed enterprises that have issued green bonds are selected for further regression analysis, and the regression model (2) is constructed as follows:

$$\text{Scale} = \beta_0 + \beta_1 \text{CRI} + \beta_2 \text{Size} + \beta_3 \text{Lev} + \beta_4 \text{ATO} + \beta_5 \text{BM} + \beta_6 \text{INV} + \beta_7 \text{FIXED} + \beta_8 \text{Growth} + \beta_9 \text{List Age} + \sum \text{ind} + \sum \text{year} + \mu \quad (3)$$

4 Empirical Results

4.1 Descriptive Statistics

This study uses the professional empirical analysis software Stata for data processing, regression analysis, and obtains reliable results. As shown in Table 2, the total number of valid samples is 15,771. In the descriptive statistics, mean is used to measure the central tendency of numerical variables, while standard deviation (sd) reflects the degree of data dispersion; maximum (max) and minimum (min) represent the range of variables. Detailed explanations of these statistical indicators are omitted here.

The Green variable (a dummy variable indicating green bond issuance) has a small degree of dispersion, with a mean of 0.044, a standard deviation of 0.067, a minimum value of 0, and a maximum value of 1. The climate risk index (CRI) has a mean of 0.482, a standard deviation of 0.057, a minimum value of 0.340, and a maximum value of 0.614.

Table 2. Result of descriptive statistics.

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Green	15,771	0.044	0.067	0	1
CRI	15,771	0.482	0.057	0.340	0.614
Size	15,771	22.319	1.282	19.995	26.105
Lev	15,771	0.418	0.200	0.062	0.889
ATO	15,771	0.623	0.406	0.073	2.344
BM	15,771	1.087	1.224	0.096	7.330
INV	15,771	0.134	0.121	0.000	0.637
FIXED	15,771	0.201	0.154	0.002	0.666
Growth	15,771	0.155	0.356	-.545	1.850
ListAge	15,771	2.093	0.938	0	3.332

4.2 OLS Regression Result

The main OLS regression results are shown in Column (1) of Table 3. They indicate that the regression coefficient of the climate risk disclosure index (CRI) is 0.056, which is significant at the 5% level. This result verifies Hypothesis 1 of this study, i.e., there is a significant positive correlation between climate risk information disclosure and enterprise green bond issuance behavior.

4.3 Robustness Test

4.3.1 Winsorization.

In order to further verify the robustness and reliability of the previous conclusion, we conducted two robustness tests. Firstly, based on the authoritative research methods, the sample was truncated by 1% at both the upper and lower ends for a robustness test. The test results showed that it passed. The impact of CRI on whether it is a green bond still maintained a positive correlation, and it is significant at the 1% level. The regression coefficient was 0.056, as shown in Table 3 column (2).

4.3.2 Lagged Term.

To avoid the possibility of endogeneity issues reoccurring in this study, the core explanatory variables were lagged by one term for a robustness test. The test results are shown in Table 3 column (3). They remain significant at the 10% level and the test was still passed.

4.3.3 Replacement of Whether to Issue Green Bonds.

The aforementioned research confirms that a high level of climate risk disclosure promotes enterprises to issue green bonds. To further examine the relationship between climate risk disclosure and green bond issuance, this study conducts an additional analysis on the impact of CRI on green bond issuance scale (Scale). To enrich the research

content, this study replaces the dependent variable with green bond issuance scale (Scale) and conducts OLS regression analysis again. During this process, extensive data collection, sample processing, and matching work are carried out, with the sample size remaining 15,771 and no changes made to the variables. The regression results (Column (4) of Table 3) show that the climate risk disclosure index (CRI) has a significantly positive correlation with green bond issuance scale (Scale), with a regression coefficient of 14.220, and this correlation is statistically significant at the 1% level. This result confirms that Hypothesis 2 holds.

Table 3. Summary of Regression Results.

	(1)	(2)	(3)	(4)
	Baseline	Robustness test		Baseline
VARIABLES	Green	Winsorization	Lagged term	Scale
CRI	0.056** (2.10)	0.056*** (2.69)	0.047** (2.51)	14.220*** (6.513)
Size	0.005*** (5.42)	0.006** (2.12)	0.004*** (2.74)	-0.078 (-0.52)
Lev	4.450*** (5.28)	4.450*** (2.84)	4.187** (2.42)	7.482** (2.83)
ATO	-2.160*** (-3.45)	-2.160*** (-2.63)	-2.652*** (-2.78)	-5.385* (-2.13)
BM	-0.533*** (-3.77)	-0.533** (-2.14)	-0.025* (-1.76)	-1.101 (-0.31)
INV	-3.824** (-2.01)	-3.267* (-1.90)	-3.133* (-1.68)	3.167 (1.45)
FIXED	3.226*** (3.98)	3.101*** (2.81)	3.194** (2.50)	12.86*** (3.23)
Growth	0.292 (0.90)	0.332 (0.33)	0.307 (0.19)	-0.226 (-1.14)
ListAge	-0.145 (-0.94)	-0.145 (-1.15)	-0.182* (-1.95)	1.692 (0.49)
Industry	YES	YES	YES	YES
Constant	-22.002*** (-6.37)	-21.16*** (-3.45)	-20.91*** (-3.02)	5.337*** (2.85)
Year	YES	YES	YES	YES
R-squared	0.8597	0.8876	0.8246	0.8127
Adj R-squared	0.8207	0.8530	0.8017	0.8076
F	11.12	12.56	11.11	11.92
Observations	15,771	10,569	11,725	15,771

Notes: ***, **, * represent significance at the 1 percent, 5 percent, and 10 percent levels, respectively (two-tailed)

5 Conclusion

As a crucial part of information disclosure, climate risk disclosure can enhance corporate transparency and lower financing costs. In addition, the issuance of green bonds plays a pivotal role in promoting the sustainable development of enterprises. This paper takes the A-share listed enterprises and green bond issuance information except the financial industry from 2016 to 2020 as the samples of this paper; based on empirical analysis, the following conclusions are drawn: first, there exists a significantly positive correlation between a high level of climate risk disclosure and the green bond issuance behavior of listed enterprises. The more comprehensively climate risks are disclosed, the more probability that listed companies will issue green bonds. Second, there will be a significant positive relationship between a high level of climate risk disclosure and the size of green bond issuance by listed companies. More comprehensive climate risk disclosure makes listed enterprises more inclined to issue green bonds on a large scale. The above two conclusions are consistent with the proposed hypotheses. Furthermore, the regression results verifies the reliability of the research conclusions.

Drawing on the two conclusions, domestic and foreign enterprises may adopt the following approaches to facilitate green bond issuance through climate risk disclosure: First, enterprises are advised to standardize disclosure procedures in compliance with regulatory mandates. This practice will clearly delineate the responsibilities of relevant departments, thereby ensuring the accuracy and timeliness of disclosed information. Second, the quality of climate risk disclosure should be enhanced. Enterprises ought to eschew generic descriptions and instead undertake tailored risk analyses based on their specific production and operational characteristics. Finally, active participation in international cooperation will help facilitate the development of unified climate risk disclosure standards and assessment frameworks. This not only improves corporate transparency and comparability but also mitigates risks associated with information asymmetry.

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