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Green bond credit spreads and bank loans in China

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ABSTRACT

Green finance is increasingly important in both academia and industry, yet the relationship between green bonds and bank loans remains largely understudied. In this study, we conduct an empirical investigation into the impact of the credit spreads of green bonds on the structure of debt financing. Our findings suggest that companies with larger credit spreads on green bonds in the secondary market tend to experience a higher growth rate in new bank loans. The presence of such credit spreads in the secondary market exacerbates corporate financing constraints and information asymmetry. This dynamic fosters implicit collusion between enterprises and banks, enhancing the firms' ability to secure bank loans. This research sheds light on the economic implications of the credit spreads of green bonds from the banks' perspective and offers valuable insights for optimizing credit strategies and detecting greenwashing behavior among banks and investors.

1. Introduction

Green bonds, emerging as a novel financing tool, attract considerable attention, especially among international investors (Pástor, Stambaugh, & Taylor, 2021). However, they also face specific challenges compared to their conventional counterparts, including ambiguous pricing standards, irregular fund allocation, elevated repayment risks, and the most serious problem: "greenwashing". This phenomenon refers to companies issuing green bonds to portray themselves as environmentally responsible without implementing tangible actions (Flammer, 2021), which is reflected in green bond credit spreads in the market (Xu, Lu, & Tong, 2022). Nonetheless, the prevalence of nonperforming loans in green credit, coupled with insufficient incentives, has led banks to prioritize meeting regulatory targets related to green credit goals (Allen, Qian, & Gu, 2017; Macaire & Naef, 2023; Wu, Luo, & You, 2023). Firms, driven by the ethos of maximizing shareholder wealth, are highly incentivized to choose financing vehicles such as green bonds and green credit that provide policy benefits and enable access to low-cost debt financing (Lin & Su, 2022). In addition, in line with principal-agent theory, management often exhibits myopia and resorts to greenwashing strategies (Wu, Zhang, & Xie, 2020). This involves reducing environmental costs while capitalizing on environmental benefits, with the ultimate goal of improving performance (Zhang, 2022). In this context, the main objective of this paper is to examine the potential impact of the credit spread of green bonds in the secondary market on corporate borrowing opportunities. Specifically, can banks detect the adoption of greenwashing strategies by firms and modify their lending strategies accordingly?

China provides a unique context for exploring this relationship. Firstly, the Chinese government and regulatory authorities prioritize increasing direct financing (Jiang, Jiang, & Kim, 2020). By the end of 2022, the balance of green loans in both domestic and foreign currencies in China had reached 22.03 trillion yuan, marking a 38.5% year-on-year increase and achieving a leading position globally in terms of stock size. Moreover, China's bond market is gaining significant global prominence. In 2022, the issuance of green bonds in China saw a 35% year-on-

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year increase, reaching 1 trillion yuan (equivalent to 0.155 trillion dollars), while the cumulative issuance scale has now reached 3.3 trillion yuan (0.489 trillion dollars) (Fig. 1). Against this backdrop, supported by green-oriented policies, do banks in China, as major holders of green bonds, have an incentive to covertly collude with corporations to implement greenwashing strategies at the bank level when they perceive an increase in corporate environmental risk?

Bond credit spreads influence the cost of bond issuance and the financing constraints encountered by bond-issuing companies. Companies employ greenwashing strategies to alleviate their financing challenges and secure low-cost financing. The bond credit spread acts as a barometer of investors' default risk exposure and reflects the market's perception of corporate greenwashing activities. In the current evolution of green credit, scrutinizing non-standard information of enterprises is imperative for banks. This helps mitigate information asymmetry, enables more precise assessments of enterprise default risk, and reduces the probability of bad loans (Ge & Liu, 2015).

The impact of green bonds' credit spread in the secondary market on enterprises' ability to secure bank loans is theoretically ambiguous. On one hand, based on the theory of commercial loans and banks' practical reliance on standardized data, such as enterprise annual reports for evaluating enterprise risks, the employment of greenwashing strategies can result in adverse selection and moral hazard in loan transactions (Cao, Faff, He, & Li, 2022). Additionally, a higher green interest margin in the secondary market encourages enterprises to adopt greenwashing practices and bolster their green image with policy support, escalating information asymmetry with regulatory authorities. This leads enterprises to present nominally compliant green assets recognized by regulatory bodies through implicit collusion, enabling them to secure more loans and creating a positive feedback loop (Jiang & Kim, 2020). On the other hand, under the efficient market hypothesis, the credit spread of green bonds can accurately indicate whether enterprises have genuinely invested in green projects (Li, Zhang, & Wang, 2022). Banks can access this information through the open market and probe other private information. Based on the theory of behavioral consistency, a company's behavior in one domain can predict its actions in others, leading banks to conduct a comprehensive risk evaluation at the enterprise level to decide on loan approvals (Funder & Colvin, 1991). An increase in the credit spread of green bonds signals greenwashing behavior (Xu et al., 2022), prompting banks to consider the heightened risk and possibly reject loan applications.

While a substantial body of literature explores the effects of green bonds' credit spread on financing constraints and information asymmetry, as well as the asymmetry between enterprises and regulators and its impact on debt financing structure (Bhutta, Tariq, Farrukh, Raza, & Iqbal, 2022; Cao, Jin, & Ma, 2021; Fatica, Panzica, & Rancan, 2021; Tang & Zhang, 2020; Zhang, Li, & Liu, 2021), there is no consensus on the relationship between financing constraints or information asymmetry and the debt financing structure, and the information asymmetry between enterprises and regulators remains underexplored. Some studies suggest that increased financing constraints and information asymmetry hinder enterprises' access to bank loans (Chava, 2014; Ghouma, Ben-Nasr, & Yan, 2018; Ioannidou, Pavanini, & Peng, 2022), while others argue that companies facing severe financing constraints and information asymmetry are more likely to obtain bank loans (Bailey, Huang, & Yang, 2011; Hu & Varas, 2021). Nonetheless, few studies have scrutinized the impact of varying green bonds' credit spread on enterprises' access to loans, particularly utilizing Chinese data.

Thus, this study empirically examines the impact of green bonds' credit spread on the debt financing structure. It analyzes a sample of 2045 green bonds issued by Chinese companies, encompassing a total of 44,990 observations from Q4 2017 to Q1 2023. Using the time-varying green bonds credit spread estimated by the Nelson-Siegel method and firm-level new loans data, we perform panel regression models that control for firm-level factors, as well as firm- and time-fixed effects.

Our empirical results reveal that companies with a larger green bonds' credit spread in the secondary market tend to experience a higher growth rate in obtaining new bank loans. Robustness tests conducted affirm the findings of this paper. The mechanism test unveils that the credit spread of green bonds in the secondary market intensifies corporate financing constraints and amplifies information asymmetry, thereby facilitating the procurement of bank loans. The heterogeneous analysis underscores that the influence of green bonds' credit spread on the debt financing structure is contingent on factors such as corporate ownership, industry, and the complete control exerted by the largest shareholder. Compared to non-state-owned enterprises, state-owned enterprises exhibit a stronger positive correlation between the credit spread of green bonds and the acquisition of bank loans. Moreover,

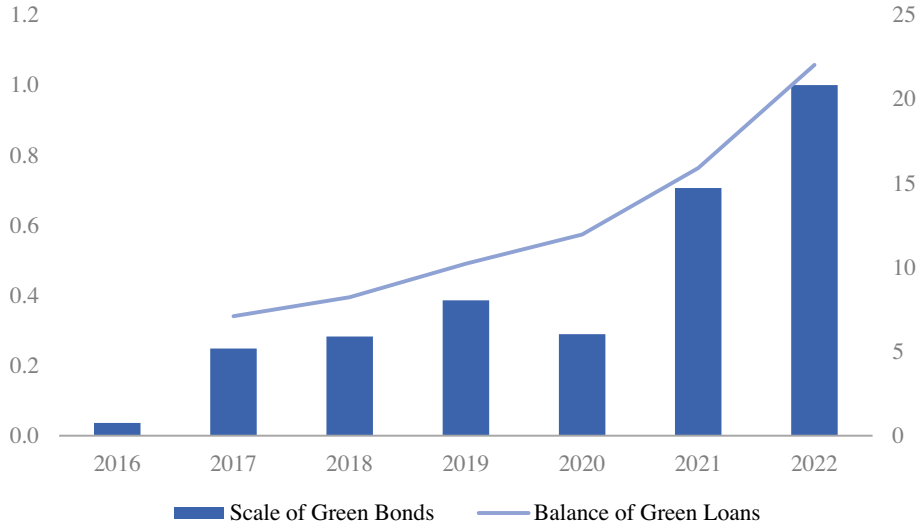

Fig. 1. The scale of green bonds and the balance of green loans in China.
This figure illustrates the scale of green bonds issued by Chinese issuers in both domestic and foreign markets from 2016 to 2022, along with the balance of Chinese green loans in domestic and foreign currency from 2017 to 2022. The scale of green bonds and the balance of green loans are represented by bar charts and line charts, respectively. The numerical unit is trillions of yuan, with the scale of green bonds corresponding to the left coordinate axis and the balance of green loans corresponding to the right coordinate axis. The data on green bonds and green loans are sourced from the Climate Bonds Initiative and the People's Bank of China, respectively. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

companies not classified as "heavy energy consumption, heavy pollution, and resource-related", and those under the complete control of the largest shareholder, display a more pronounced positive effect in securing bank loans.

This paper contributes to the discourse in several ways. Firstly, it scrutinizes the economic ramifications of green bonds' credit spread in the secondary market from a banking perspective. Diverging from existing literature, which mainly examines the effects of green bonds' credit spread from the viewpoints of shareholders (Lin & Su, 2022; Tang & Zhang, 2020; Zhang et al., 2021), institutional bond investors (Hachenberg & Schiereck, 2018; Larcker & Watts, 2020; Piñeiro-Chousa, López-Cabarcos, Caby, & Šević, 2021; Zerbib, 2019), and regulators (Cao et al., 2021; Chang, Taghizadeh-Hesary, Chen, & Mohsin, 2022), this study offers the most recent insights from the Chinese market on how green bonds' credit spread aids companies in accessing new bank loans in the secondary market. It extends the discourse on the economic implications of green bonds' credit spread in the secondary market (Bhutta et al., 2022; Fatica et al., 2021; Febi, Schäfer, Stephan, & Sun, 2018; Hammoudeh, Ajmi, & Mokni, 2020; Koziol, Proelss, Roßmann, & Schweizer, 2022; Macaire & Naef, 2023; Mensi, Shafiullah, Vo, & Kang, 2022; Pham, 2021; Reboredo, 2018; Su & Lin, 2022; Zerbib, 2019).

Secondly, this study enriches the understanding of the factors influencing corporate loan structure (Chava, 2014; Goss & Roberts, 2011; Hasan, Hoi, Wu, & Zhang, 2017) by proposing a novel non-standard indicator: the green bonds' credit spread in the secondary market. In a context where banks predominantly rely on standard financial data for decision-making (Graham, Li, & Qiu, 2008; Ioannidou et al., 2022; Jiménez & Saurina, 2004), this study expands the application of non-standard information for banks to mitigate risks and comply with regulatory mandates (Ding, Ren, Tan, & Wu, 2023; Simeth, 2022).

Thirdly, this research assesses the overall performance of China's green bond market. Past studies indicate that the primary motivation for financial institutions in China to issue green bonds is regulatory arbitrage (Cao et al., 2021). From the perspective of enterprises issuing green bonds, this study corroborates that banks are incentivized to meet the minimum loan origination requirements set by green credit policies, especially when coordinated with enterprises employing greenwashing strategies. The heterogeneity analysis further reveals that higher green bonds' credit spreads among state-owned enterprises in China significantly enhance the scale of bank loans, a trend not observed in non-state-owned enterprises. This adds to the literature on the distinct characteristics of Chinese state-owned enterprises (Gan, Guo, & Xu, 2018; Jiang et al., 2020).

2. Hypotheses development

2.1. Green bonds' credit spread enhances bank loan access

Based on the assumptions proposed below (H2a and H2b), we elucidate from both the supply and demand sides of the loan relationship how the credit spread of green bonds in the secondary market can enhance enterprises' ability to secure bank loans. We propose our main hypothesis:

H1a. Companies with a larger green bonds' credit spread in the secondary market tend to experience a higher growth rate of new bank loans.

The first rationale for proposing that a larger credit spread of green bonds in the secondary market enhances the ability to obtain bank loans stems from the idea that a high credit spread is not conducive to subsequent green bond issuances by enterprises, thereby necessitating bank loans. Initially, according to the Efficient Market Hypothesis, investors will assess the current real value of green bonds when trading. If the environmental risk associated with enterprises increases, the market price of the green bond will inevitably decline. This will, in turn, lead to increased financing costs for enterprises issuing green bonds. In extreme cases, this effect might even impact the issuance of conventional bonds by enterprises during the same period (Broadstock & Cheng, 2019; Reboredo, 2018; Uddin, Jayasekera, Park, Luo, & Tian, 2022).

Second, according to the Pecking Order Theory, companies with insufficient internal cash flow to meet the total investment demand for net operating long-term assets are more inclined towards debt financing rather than equity financing. Furthermore, within debt financing, companies generally prefer bonds over loans (Hasan et al., 2017). Thus, when the cost of bond financing increases, companies may abandon bond financing and consider bank loans to bridge the financing gap, instead of opting for equity financing (Crawford, Pavanini, & Schivardi, 2018; Jiang et al., 2020; Zhang, 2022). Especially when enterprises face risks in repaying bonds, and considering that the primary issuers of China's green bonds are state-owned enterprises, banks are likely to increase lending lines to aid enterprises in overcoming financing constraints (Cull, Li, Sun, & Xu, 2015; Gan et al., 2018). This leads us to our next hypothesis:

H2a. Companies with a larger green bonds' credit spread in the secondary market tend to experience a higher growth rate of new bank loans by exacerbating corporate financing constraints.

The second rationale is derived from the Management Self-Interest Hypothesis based on the Principal-Agent Theory, which posits that executives may engage in social responsibility activities to fulfill their personal interests (Jia, Shi, Wang, & Wang, 2020). Hence, companies with higher green bonds' credit spread may implement greenwashing strategies to disguise inconsistencies in their claims and actions (Flammer, 2021; Xu et al., 2022). These enterprises may enhance their green image and reduce information transparency through earnings management (Ertugrul, Lei, Qiu, & Wan, 2017). Some banks, due to non-participation in the secondary market trading of green bonds, may rely solely on standard data such as annual reports for decision-making. However, greenwashing behaviors are diverse, covert, and frequent, leading to information asymmetry between enterprises and banks. The higher the degree of information asymmetry, the more likely banks are to misjudge and increase their loan limits to such enterprises (Iannamorelli, Nobili, Scalia, & Zaccaria, 2023).

According to the Credit Rationing Theory, information asymmetry between banks and enterprises results in adverse selection (Stiglitz & Weiss, 1981), significantly increasing the probability of greenwashing enterprises securing loans. However, in an efficient market, most banks, being significant participants in the green bond secondary market, have access to complete information about enterprises and can identify greenwashing behavior (Dimic, Orlov, & Piljak, 2022). Nonetheless, the credit department continues to issue loans to enterprises. Consequently, it is suggested that the prevailing information asymmetry in the green finance market is primarily between regulators and market participants. On one hand, enterprises seek policy support by projecting a positive green image. Due to increasing trends in green credit issuance and policy mandates, banks tend to enhance their support for enterprises in this sector. Additionally, a commendable green performance attracts more attention from analysts and media, aiding enterprises in managing their green image and securing bank loans (Goss & Roberts, 2011; Griffin, Neururer, & Sun, 2020).

On the other hand, green bonds in China are extensively held and traded by financial institutions (Su & Lin, 2022), and banks have regulatory requirements for holding green assets of a specified scale. However, the compliance of these assets requires regulatory review, and the scale of green assets is relatively small at present (Jiang et al., 2020), making it challenging to achieve optimal investment. This situation aligns to some extent with the greenwashing behaviors of enterprises, leading to implicit collusion between enterprises and banks (Bailey et al., 2011; Cao et al., 2022; Hu & Varas, 2021). In summary, the inception of the impact path is marked by enterprises' earnings

management, which can easily mislead banks and regulators. This increases information asymmetry between banks and enterprises or between enterprises-banks and regulators post-collusion, thereby heightening the likelihood of securing bank loans. This leads to our hypothesis:

H2b. Companies with a larger green bonds' credit spread in the secondary market tend to experience a higher growth rate of new bank loans by exacerbating information asymmetry.

Debt financing of enterprises includes both short-term and long-term debt financing. Short-term debt financing is often utilized for highly liquid assets, with the asset structure and value of enterprises not prone to significant short-term changes. In contrast to long-term debt financing, short-term debt financing allows creditors to grasp information on enterprise production and operation, which is beneficial for creditor supervision and control (Diamond, 1993). The preceding discussion indicates that environmental issues possess strong professionalism and concealment. There is a serious information asymmetry between companies and regulators regarding the environmental performance of the enterprise due to greenwashing behavior. Moreover, the occurrence of an environmental accident could result not only in severe economic penalties but also in enterprise shutdowns. Therefore, long-term debt financing can better illustrate whether the green image constructed by the enterprise through greenwashing is successfully recognized by the bank when the green bonds' credit spread in the secondary market is higher than the normal value (Huang & Song, 2006). This leads to our hypothesis:

H3. Companies with a larger green bonds' credit spread in the secondary market tend to experience a higher growth rate of new long-term bank loans than short-term bank loans.

2.2. Green bonds' credit spread weakens bank loan access

However, the credit spread of green bonds in the secondary market might also impair enterprises' ability to secure bank loans. This concept aligns with the commercial loan theory articulated by Adam Smith in "The Wealth of Nations". The uncertainty associated with long-term green debt financing is substantial, compelling lenders to address information asymmetry and surmount cost barriers vigorously. Consequently, lenders typically rely on costly, privately obtained information through due diligence, in addition to considering publicly available environmental performance data such as borrower ESG scores.

Contemporaneous research indicates that the theoretical green premium of green bond prices can be estimated utilizing open market data, assuming the issuer comprehensively fulfills its eco-investing obligations (Lau, Sze, Wan, & Wong, 2022). If banks discern inadequate investment in corporate environmental performance and perceive a greenwashing risk, this realization will fully manifest in the spread when trading green bonds in the secondary market, making them reluctant to extend loans, particularly in the form of long-term debt financing. Under these circumstances, banks presume that regulatory authorities can also detect companies' greenwashing strategies, rendering any implicit collusion with companies to meet regulatory targets futile.

When enterprises confront financing constraints, resorting to greenwashing strategies such as concealing organizational issues and diminishing information quality becomes ineffectual. This eventually necessitates enterprises to enhance risk mitigation, while creditors demand higher risk premium compensation (Roberts & Sufi, 2009).

The People's Bank of China is progressively instituting a mandatory disclosure system, standardizing disclosure norms, fostering information sharing between financial institutions and enterprises, and augmenting international coordination in information disclosure. Enterprises are thereby encountering an increasingly regulated green finance ecosystem, which complicates sustaining greenwashing activities over the long term and escalates the associated costs, potentially diminishing the incentive for green image management.

Based on the aforementioned analysis, we propose the following research hypothesis:

H1b. Companies with a larger green bonds' credit spread in the secondary market tend to experience a lower growth rate of new bank loans.

3. Research design

3.1. Data sources and sample selection

The bond, company financial, and corporate governance data utilized in this study are sourced from the Wind database. We select green bonds publicly issued in China, based on the industry's definition of green bonds and bond issuance announcements on the China Currency Network, which is sponsored by the China Foreign Exchange Trade System and the National Interbank Funding Center. These are combined with samples from the Wind and Choice databases. Consequently, bonds issued by financial institutions are excluded, and samples with missing or abnormal key variables are omitted. The data span from October 1, 2017, to March 31, 2023, covering the trading period of green bonds in the secondary market. Ultimately, we acquire 2045 green bonds, comprising 44,990 observations.

3.2. Model settings and variable definitions

To analyze the impact of green bond credit spreads on debt financing structure, we establish the following regression models:

$$\Delta Loan_{i,t} = \beta_0 + \beta_1 Spread_{i,t} + \sum \beta_k FirmControl_{i,k,t} + Firm_i + Quarter_t + \varepsilon_{i,t} \quad (1)$$

$$\Delta Long\_Loan_{i,t} = \beta_0 + \beta_1 Spread_{i,t} + \sum \beta_k FirmControl_{i,k,t} + Firm_i + Quarter_t + \varepsilon_{i,t} \quad (2)$$

Herein, i and t represent the company and quarter indices, respectively, while $\varepsilon_{i,t}$ denotes the disturbance term. In accordance with prior studies, we measure the change in corporate debt financing ability using new loans, that is, new loans ($\Delta Loan_{i,t}$) and new long-term loans ($\Delta Long\_Loan_{i,t}$).[1]

The green bonds credit spread ($Spread_{i,t}$) is the difference between the yield to maturity of a green bond in the secondary market on the last trading day of each quarter and the yield to maturity of treasury bonds with the same remaining maturity, estimated by the Nelson-Siegel method (Cao et al., 2021; Nelson & Siegel, 1987).

$$y_{treasury}(m) = \delta_0 + \delta_1 \frac{1 - exp\left(-\frac{m}{\tau}\right)}{\frac{m}{\tau}} + \delta_2 \left(\frac{1 - exp\left(-\frac{m}{\tau}\right)}{\frac{m}{\tau}} - exp\left(-\frac{m}{\tau}\right) \right) \quad (3)$$

Eq. (3) exemplifies the Nelson-Siegel estimation method for bonds with analogous attributes; m denotes the bond maturity time. In this equation, δ_0 is a long-term bond factor, δ_1 a short-term factor, δ_2 the bond curvature factor, and τ a time constant ensuring the model accurately reflects reality. Subsequently, we calculate the risk premiums of all green bonds to negate any potential impact of the macroeconomy on

[1] $\Delta Loan_{i,t}$ is as follows: $\Delta Loan_{i,t} = \frac{Loan_{i,t} - Loan_{i,t-1}}{Loan_{i,t-1}}$. Among them, $Loan_{i,t}$ represents total loans at the end of the year, $Loan_{i,t-1}$ represents total loans at the beginning of the year. $\Delta Long\_Loan_{i,t}$ is as follows: $\Delta Long\_Loan_{i,t} = \frac{Long\_Loan_{i,t} - Long\_Loan_{i,t-1}}{Long\_Loan_{i,t-1}}$. Among them, $Long\_Loan_{i,t}$ represents long-term loans at the end of the year, $Long\_Loan_{i,t-1}$ represents long-term loans at the beginning of the year.

our empirical results:

$$Spread_j(m) = y_j(m) - y_{treasury}(m) \quad (4)$$

In Eq. (4), $y_j(m)$ signifies the yield-to-maturity of green bond j with m years to bond maturity, and $y_{treasury}(m)$ represents the fitted yield-to-maturity of treasury bonds. Hence, $Spread_j(m)$ symbolizes the risk premium of bond j, defined as the green bonds credit spread in this study to differentiate it from the risk premium of conventional bonds. If a company issues multiple green bonds, their average value is taken.

Following Carvalho, Gao, and Ma (2023), Ge and Liu (2015), Wang, Chen, Li, Yu, and Zhong (2020), and Zhang et al. (2021), Models (1) and (2) also account for various factors that might influence a corporation's debt financing ability. These primarily include: ROA – the ratio of current net profit to total assets at the end of the period; Size – the natural logarithm of total assets; Fix_Asset – the ratio of current fixed assets to total assets at the end of the period; Growth – the growth rate of the company's sales revenue; Cash – the ratio of the sum of monetary funds and trading financial assets to total assets; Turnover – the ratio of operating revenue to total assets; Leverage (Lev) – the ratio of interest-bearing debt to total assets at the end of the period; and GDP_Growth – the quarterly GDP growth rate of the province where the company is located.

In addition, firm characteristics, the macroeconomic environment, and other unconsidered time-varying factors may also affect the debt financing ability of corporations. We add firm-fixed effects and time-fixed effects to the model for control. To control for potential heteroskedasticity and serial correlation issues, we adjust the standard errors for clustering at the firm level during regression.

3.3. Summary statistics

Table 1 presents the descriptive statistics for the variables used in the empirical analyses. The mean and standard deviation of the green bond credit spread are −0.022 and 0.237, respectively. These values suggest that certain green bonds in the secondary market are priced above their par value, resulting in significant variations in green bond credit spreads (Cao et al., 2021; Febi et al., 2018). For ΔLoan, the mean is 0.047 with a standard deviation of 0.141, indicating a general uptrend in new loans for the bond issuers each reporting period. Regarding ΔLong_Loan, the mean and standard deviation are 0.059 and 0.201, respectively, implying a notable increase in long-term loans for green bond issuers, surpassing the overall loan growth trend. The mean values of ROA, Size, Fix_Asset, Growth, Cash, Turnover, Lev, and GDP_Growth are 0.011, 25.092, 0.595, 0.132, 0.077, 0.137, 0.715, and 0.282, respectively.

Table 1
Summary statistics.

	Obs	Mean	S.D.	Min	Max
ΔLoan	26,422	0.047	0.141	−0.313	0.648
ΔLong_Loan	28,551	0.059	0.201	−0.430	1.139
Spread	13,458	−0.022	0.237	−1.687	0.105
Roa	32,551	0.011	0.016	−0.025	0.078
Size	32,636	25.092	1.516	20.969	28.233
Fix_Asset	32,565	0.595	0.263	0.018	0.969
Growth	32,134	0.132	0.184	0.002	0.981
Cash	32,517	0.077	0.052	0.008	0.264
Turnover	32,506	0.137	0.193	0.002	1.042
Lev	32,717	0.715	0.178	0.177	0.979
GDP_Growth	44,506	0.282	0.694	−0.791	1.220

This table presents summary statistics for the credit spread between green bonds and treasury bonds with the same remaining maturity, calculated using the NS model, alongside the structure of corporate debt and the corporate financial data for the sample period (2017q4–2023q1).

4. Regression results analysis

4.1. Benchmark regression results

Table 2 presents the estimation results for Eqs. (1) and (2). In columns (1) and (2), firm and time fixed effects are controlled for. Columns (3) and (4) incorporate bond characteristics and corporate financial variables. Our focus is on the estimated coefficients of Spread in each regression column. The Spread coefficients in ΔLoan are significantly positive at the 10% or 5% significance levels, while those in ΔLong_Loan are significantly positive at the 1% level. We refer to columns (3) and (4), which include all control variables, to illustrate the economic significance of the estimated results. With every one-unit increase in the standard deviation of the green bonds' credit spread in the secondary market, the average growth rate of total loans/long-term loans increases by 0.58% (0.0246 × 0.237) / 1.13% (0.0475 × 0.237). This represents 12.40% (0.0246 × 0.237 / 0.047) / 19.08% (0.0475 × 0.237 / 0.059) of the sample mean. It is evident that the green bonds' credit spread, demanded by investors in the secondary market, can enhance the financing capacity of issuing companies, with a more substantial increase in long-term financing capacity. This supports hypotheses H1a and H3, respectively.

In the control variables, the coefficients for ROA and GDP_Growth are negative / positive at the 5% / 10% significance levels, respectively, in the long-term loan, while the Fix_Asset coefficient is negative at the 1% significance level in the overall loan. The Cash and Turnover coefficients are significantly positive, aligning with prior literature (Ding et al., 2023). The size and cash flow of the enterprise, as indicators for repaying loans, have garnered attention from banks; an increase in these indicators can reduce the banks' credit risk after issuing loans (Chava, 2014; Graham et al., 2008; Javadi & Masum, 2021; Khan, Ali, Hossain, & Bairagi, 2023).

Table 2
Benchmark regressions.

	(1)	(2)	(3)	(4)
	ΔLoan	ΔLong_Loan	ΔLoan	ΔLong_Loan
Spread	0.0226*	0.0476***	0.0246**	0.0475***
	(0.0117)	(0.0160)	(0.0118)	(0.0139)
Roa			−0.1923	−0.7892**
			(0.2413)	(0.3537)
Size			0.1439***	0.1600***
			(0.0245)	(0.0453)
Fix_Asset			−0.1705***	−0.0272
			(0.0566)	(0.0912)
Growth			−1.3694***	−2.0404***
			(0.2938)	(0.3948)
Cash			0.2585**	0.4567***
			(0.1019)	(0.1476)
Turnover			1.2794***	1.9246***
			(0.2818)	(0.3819)
Lev			0.3156***	0.2697***
			(0.0458)	(0.0776)
GDP_Growth			0.1052	0.1927*
			(0.0669)	(0.1077)
_cons	0.0480***	0.0617***	−3.7696***	−4.2566***
	(0.0000)	(0.0000)	(0.6313)	(1.1636)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
N	8171	8920	8101	8796
R^2	0.2588	0.2092	0.2946	0.2341
adj. R^2	0.1395	0.0889	0.1801	0.1159
F	3.7478*	8.8716***	15.8400***	10.3591***

This table reports the results of the benchmark regression model analyzing the relationship between the green bonds credit spread of the sample enterprises' green bonds in the secondary market and their debt structure. The study period spans from 2017q4 to 2023q1. Standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, according to p-values.

4.2. Tests for endogeneity

First, following Wang et al. (2020), we employ the two-stage Heckman regression to mitigate potential sample selection bias. In the first stage, we use a dummy variable (whether the Spread is greater than zero) for the probit regression. We compute the inverse Mills ratio (IMR) for each observation in the sample. We then include the IMR as a control variable in models (1) and (2). As reported in Table 3, Panel A, we continue to document the positive and significant Spread coefficients, further supporting the observed positive correlation between green bond credit spread and corporate financing capacity.

Second, we use propensity score matching (PSM) to address potential issues. The observed increase in new loan size due to a higher credit spread of green bonds in the secondary market cannot only be attributed to variations in the credit spread, but is also influenced by variations in other firm characteristics. We consider observations with Spread$\geq$0 as the treatment group and search for matching samples with similar characteristics (control group) for the treated firms. To address the time mismatch problem, we use a 1:1 matching approach on a quarterly basis. The results of the balance test indicate a significant reduction in the standardized deviations of most covariates after matching, suggesting that the differences in characteristics between firms with high and low green bond credit spreads in the matched sample are reduced. The regression results presented in Table 3, Panel B, columns (1) and (2) confirm that the spread coefficients retain their significance.

Thirdly, we employ the instrumental variable method, using the green bonds' credit spread from the previous period (L.Spread) as the instrumental variable for each green bond. This spread should not directly impact the bank loan structure of company i. To assess the validity of the instrumental variables, we conduct the under-identification test and weak instruments test, using the Kleibergen-Paap rk LM statistic and the Kleibergen-Paap rk Wald F statistic, respectively. The results, presented in Table 3, Panel C, confirm the validity of the instrumental variables. The regression results of the first and second stages of the two-stage least squares (2SLS) method, reported in Panel C columns (1) (3) and (2) (4), indicate that the estimated coefficients of Spread remain significantly positive, supporting the paper's conclusion even after considering endogeneity.

In addition, we recognize that regional differences, such as the level of regional economic development, may affect both the green bond secondary market interest rate and the level of corporate debt, leading to endogeneity issues. Therefore, we include province fixed effects and quarter*province fixed effects in the model to control for missing variables. Panel D of Table 3 reports the regression results after this control, and shows that the estimated coefficients of Spread remain significantly positive at the 5% and 1% levels.

4.3. Other robustness tests

Firstly, to align with recent developments, we narrow down the sample period. On July 29, 2022, the China Green Bond Standard Committee released the Green Bond Principles (GBP), clearly outlining that 100% of the funds raised from green bonds must be allocated to environmentally friendly projects within green industries and must meet specific criteria for sustainable economic activities. Consequently, we restrict our analysis to the period from 2017Q4 to 2022Q3 and re-estimate regression models (1) and (2). The regression results, presented in Table 4, columns (1) and (2), demonstrate that the Spread coefficients remain significantly positive at the 10% and 1% levels.

Secondly, although we address the influence of industrial policies by incorporating firm fixed effects, the majority of green bond issuers belong to the construction and engineering, power, and other industries. To mitigate potential biases resulting from industrial agglomeration, we exclude bond issuers from the construction and engineering, power, and comprehensive categories, retaining only industries where green bond issuance accounts for <10% of the sector. We then conduct a regression analysis, as shown in Table 4, columns (3) and (4). The results indicate significantly positive Spread coefficients at the 5% and 1% significance levels, suggesting that even after accounting for industrial policies and agglomeration effects, the impact of green bonds credit spread on the scale of new loans remains.

Furthermore, urban investment enterprises predominantly operate in the construction, comprehensive, and transportation industries, overlapping with the main industries of green bond issuers. Additionally, urban investment bonds often benefit from implicit government guarantees and enjoy lower financing costs. To account for these factors, we exclude urban investment bonds from the sample and re-estimate Models (1) and (2). The results, displayed in Table 4, columns (5) and (6), reaffirm the significance of positive Spread coefficients at the 10% and 1% significance levels, thereby demonstrating the robustness of our findings.

5. Economic mechanism

5.1. Does a high green bonds credit spread exacerbate corporate financing constraints?

We use the SA index to measure corporate financing constraints, following Hadlock and Pierce (2010). In the regression process, absolute values are taken for the SA index, meaning that a larger SA index indicates higher financing constraints. Table 5, Panel A, reports the regression results for Eqs. (5) to (7), using the SA index as a mediator. Columns (1) to (3) show that the increase in the green bonds' credit spread in the secondary market has significantly raised the SA index, indicating that a high green bonds' credit spread can aggravate the financing constraints of companies. When companies with high green bonds' credit spreads in the secondary market issue green bonds the next time, investors will increase the requirement of the risk premium, leading to an increase in the cost of financing through green bonds (Ge & Liu, 2015). In severe cases, this effect can even spill over to the issuance of conventional bonds by enterprises in the same period (Broadstock & Cheng, 2019; Reboredo, 2018; Uddin et al., 2022). When a company faces high financing constraints, its capital structure adjustment becomes procyclical, and it tends to borrow heavily from banks (Bailey et al., 2011; Chong, Lu, & Ongena, 2013; Jiang et al., 2020), thus verifying hypothesis H2a. Considering that in the Chinese green bond market, non-financial institutions, mainly state-owned enterprises, issue green bonds (Wang et al., 2020). The existing literature has found that poor financial performance and high management fees increase the likelihood of obtaining bank loans in China, while bank loan approval indicates poor performance for subsequent borrowers (Bailey et al., 2011), which also partially confirms our hypothesis.

Additionally, drawing on Cleary (1999) and Fee, Hadlock, and Pierce (2009), we employ a logit model that incorporates financial indicators such as firm asset size, financial leverage, cash dividends, market-to-book ratio, net working capital, and EBIT. The resulting FC index is then utilized to gauge corporate financing constraints. The findings presented in Table 5, Panel B, corroborate the earlier results obtained using the SA index, thus reinforcing the robustness of our findings.

$$Mediator_{i,t} = \alpha_0 + \alpha_1 Spread_{i,t} + \sum \alpha_k FirmControl_{i,k,t} + Firm_i + Quarter_t + \varepsilon_{i,t} \quad (5)$$

$$\Delta Loan_{i,t} = \gamma_0 + \gamma_1 Mediator_{i,t} + \gamma_2 Spread_{i,t} + \sum \gamma_k FirmControl_{i,k,t} + Firm_i + Quarter_t + \varepsilon_{i,t} \quad (6)$$

$$\Delta Long\_Loan_{i,t} = \gamma_0 + \gamma_1 Mediator_{i,t} + \gamma_2 Spread_{i,t} + \sum \gamma_k FirmControl_{i,k,t} + Firm_i + Quarter_t + \varepsilon_{i,t} \quad (7)$$

Table 3
Endogeneity tests.

Panel A: Heckman two-step estimation

	(1)	(2)	(3)
	Heckman First Stage	Heckman Second Stage	
	Spread_dum	ΔLoan	ΔLong_Loan
Spread		0.0244**	0.0469***
		(0.0118)	(0.0141)
Roa	−0.3413	−0.2005	−0.8365**
	(2.1711)	(0.2426)	(0.3520)
Size	0.0740***	0.1462***	0.1764***
	(0.0284)	(0.0248)	(0.0469)
Fix_Asset	−0.2225	−0.1772***	−0.0756
	(0.1664)	(0.0600)	(0.0972)
Growth	2.2849	−1.2968***	−1.5450***
	(2.3982)	(0.3192)	(0.4482)
Cash	−0.0406	0.2555**	0.4347***
	(0.8229)	(0.1024)	(0.1475)
Turnover	−1.9407	1.2172***	1.4992***
	(2.2628)	(0.3006)	(0.4235)
Lev	0.6145**	0.3352***	0.4023***
	(0.2582)	(0.0615)	(0.0980)
GDP_Growth	0.6372	0.1235*	0.3077***
	(0.9594)	(0.0736)	(0.1170)
Imr		0.1586	1.0538**
		(0.3325)	(0.4871)
_cons	−1.4003	−3.8610***	−4.8906***
	(0.9106)	(0.6495)	(1.2287)
Firm FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes
N	9867	8101	8796
R^2		0.2947	0.2350
Pseudo R^2 / adj. R^2	0.0276	0.1800	0.1168
χ^2 / F	104.84***	14.2437***	9.6682***

Panel B: Propensity score matching

	(1)	(2)
	ΔLoan	ΔLong_Loan
Spread	0.0235*	0.0447***
	(0.0128)	(0.0145)
Roa	−0.1241	−0.4545
	(0.2653)	(0.3285)
Size	0.1321***	0.1682***
	(0.0254)	(0.0497)
Fix_Asset	−0.1610**	−0.0598
	(0.0631)	(0.0991)
Growth	−1.3473***	−1.8068***
	(0.3319)	(0.4197)
Cash	0.2825**	0.5037***
	(0.1150)	(0.1543)
Turnover	1.2512***	1.6883***
	(0.3165)	(0.4046)
Lev	0.3165***	0.3269***
	(0.0492)	(0.0798)
GDP_Growth	0.0980	0.2365**
	(0.0675)	(0.1127)
_cons	−3.4703***	−4.4982***
	(0.6542)	(1.2746)
Firm FE	Yes	Yes
Quarter FE	Yes	Yes
N	7291	7863
R^2	0.3013	0.2493
adj. R^2	0.1761	0.1207
F	12.7501***	9.3599***

Panel C: Instrumental variables estimation

	(1)	(2)	(3)	(4)
	2SLS First Stage	2SLS Second Stage	2SLS First Stage	2SLS Second Stage
	Spread	ΔLoan	Spread	ΔLong_Loan

(*continued on next page*)

Table 3 (*continued*)

Panel C: Instrumental variables estimation				
	(1)	(2)	(3)	(4)
	2SLS First Stage	2SLS Second Stage	2SLS First Stage	2SLS Second Stage
	Spread	ΔLoan	Spread	ΔLong_Loan
L.Spread	0.9872***		0.9991***	
	(0.0491)		(0.0468)	
Spread		0.0290*		0.0415**
		(0.0166)		(0.0200)
ROA	−0.1798	−0.2171	−0.1346	−0.8483**
	(0.1162)	(0.2712)	(0.1071)	(0.3902)
Size	−0.0029	0.1553***	−0.0003	0.1470**
	(0.0210)	(0.0312)	(0.0190)	(0.0582)
Fix_Asset	−0.0127	−0.1259**	−0.0229	−0.0224
	(0.0330)	(0.0582)	(0.0292)	(0.1062)
Growth	−0.0927	−1.1395***	−0.0823	−1.9046***
	(0.0843)	(0.3461)	(0.0790)	(0.4452)
Cash	−0.0484	0.2958**	−0.0412	0.4806***
	(0.0641)	(0.1174)	(0.0597)	(0.1687)
Turnover	0.1061	1.0660***	0.0951	1.8154***
	(0.0793)	(0.3329)	(0.0746)	(0.4322)
Lev	−0.0151	0.2644***	−0.0060	0.1930**
	(0.0285)	(0.0522)	(0.0261)	(0.0903)
GDP_Growth	0.0139	0.1409**	0.0101	0.1522
	(0.0356)	(0.0675)	(0.0307)	(0.0982)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
N	7016	7016	7615	7615
R^2		0.0327		0.0223
adj. R^2		0.0287		0.0185
F-statistic		11.6553***		6.4485***
Kleibergen-Paap rk LM		15.22		17.02
		[0.0001]		[0.0000]
Cragg-Donald Wald F statistic		6502.99		7399.00
Kleibergen-Paap rk Wald F		404.14		456.43

Panel D: Add fixed effects				
	(1)	(2)	(3)	(4)
	Add Province Fixed Effect		Add Quarter*Province Fixed Effect	
	ΔLoan	ΔLong_Loan	ΔLoan	ΔLong_Loan
Spread	0.0246**	0.0475***	0.0204**	0.0375**
	(0.0118)	(0.0139)	(0.0098)	(0.0150)
Roa	−0.1923	−0.7892**	−0.3550	−0.8912**
	(0.2418)	(0.3542)	(0.2602)	(0.3751)
Size	0.1439***	0.1600***	0.1400***	0.1649***
	(0.0245)	(0.0454)	(0.0283)	(0.0492)
Fix_Asset	−0.1705***	−0.0272	−0.1609**	0.0168
	(0.0567)	(0.0914)	(0.0628)	(0.0968)
Growth	−1.3694***	−2.0404***	−1.3342***	−2.0600***
	(0.2943)	(0.3955)	(0.3316)	(0.4098)
Cash	0.2585**	0.4567***	0.3134***	0.5973***
	(0.1021)	(0.1478)	(0.1140)	(0.1647)
Turnover	1.2794***	1.9246***	1.2415***	1.9299***
	(0.2823)	(0.3826)	(0.3165)	(0.3934)
Lev	0.3156***	0.2697***	0.3431***	0.3201***
	(0.0458)	(0.0777)	(0.0509)	(0.0799)
GDP_Growth	0.1052	0.1927*		
	(0.0670)	(0.1079)		
_cons	−3.7696***	−4.2566***	−3.6696***	−4.3991***
	(0.6324)	(1.1655)	(0.7280)	(1.2644)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Quar*Prov FE	No	No	Yes	Yes
N	8101	8796	8011	8708
R^2	0.2946	0.2341	0.3865	0.3252
adj. R^2	0.1766	0.1126	0.2340	0.1660
F	15.7831***	10.3248***	14.2337***	11.2650***

This table presents the estimation results of the endogeneity test, which includes Heckman two-step estimation (Panel A), Propensity score matching (Panel B), Instrumental variables estimation (Panel C), and Add fixed effects (Panel D). We employ the Heckman Selection Model by conducting two-stage regressions and 1:1 nearest distance propensity score matching to address sample selection bias. The green bonds credit spread on the same green bond with a lag period of one (L.Spread) is chosen as the instrumental variable. Additionally, We add province fixed effects and quarter*province fixed effects to control for differences and quarterly

differences between provinces where firms are located. Standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, according to *p*-values.

Table 4
Robustness tests.

	(1)	(2)	(3)	(4)	(5)	(6)
	ΔLoan	ΔLong_Loan	ΔLoan	ΔLong_Loan	ΔLoan	ΔLong_Loan
Spread	0.0269*	0.0534***	0.0359**	0.0762***	0.0209*	0.0428***
	(0.0149)	(0.0191)	(0.0148)	(0.0243)	(0.0109)	(0.0152)
Roa	−0.5435*	−1.1069***	−0.3985	−0.8584	−0.4425*	−1.0834**
	(0.2919)	(0.3979)	(0.3003)	(0.5815)	(0.2411)	(0.4273)
Size	0.1235***	0.1241***	0.1531***	0.0893	0.1260***	0.1150**
	(0.0233)	(0.0397)	(0.0364)	(0.0641)	(0.0265)	(0.0525)
Fix_Asset	−0.2072***	−0.0449	0.0325	0.4803***	−0.3821***	−0.1381
	(0.0637)	(0.1064)	(0.0809)	(0.1439)	(0.0804)	(0.1503)
Growth	−1.8470***	−2.2565***	−0.5931**	−1.0086***	−0.9962***	−1.7489***
	(0.3076)	(0.4626)	(0.2629)	(0.3883)	(0.2379)	(0.3991)
Cash	0.2075*	0.4573***	0.2116	0.6530**	0.2188*	0.5917***
	(0.1082)	(0.1594)	(0.1562)	(0.2650)	(0.1237)	(0.2185)
Turnover	1.7496***	2.1071***	0.5459**	0.9454**	0.8773***	1.6051***
	(0.2948)	(0.4526)	(0.2470)	(0.3744)	(0.2265)	(0.3892)
Lev	0.3122***	0.1745**	0.3617***	0.3942***	0.4705***	0.5359***
	(0.0471)	(0.0873)	(0.0727)	(0.1276)	(0.0655)	(0.1184)
GDP_Growth	0.0532	0.1670	−0.0601	−0.1431	−0.0115	0.1501
	(0.0717)	(0.1077)	(0.1148)	(0.1993)	(0.0743)	(0.1510)
_cons	−3.2067***	−3.2600***	−4.0784***	−2.7536*	−3.2294***	−3.2030**
	(0.6027)	(1.0219)	(0.9361)	(1.6630)	(0.6896)	(1.3759)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
N	6681	7282	3456	3916	5345	5590
R^2	0.2889	0.2221	0.2992	0.2208	0.2992	0.2301
adj. R^2	0.1659	0.0942	0.1837	0.1027	0.1871	0.1097
F	14.6359***	7.8773***	7.5194***	5.0165***	16.9931***	9.5474***

The table reports the estimation results of the robustness test. Empirical analysis is conducted changing the sample interval (columns (1) and (2)), and reducing samples (mitigating industry agglomeration, columns (3) and (4); excluding urban investment bonds, columns (5) and (6)). Standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, according to *p*-values.

5.2. Does a high green bonds credit spread exacerbate information asymmetry?

Drawing on Hutton, Marcus, and Tehranian (2009) and Xu, Xuan, and Zheng (2021), we employ earnings management to measure information asymmetry. The residual, calculated by the modified Jones model proposed by Dechow, Sloan, and Sweeney (1995), represents accrued earnings management (DA). We then incorporate DA as a mediator variable into Eqs. (5)–(7). Table 6 Panel A reports the corresponding regression results, indicating that the green bonds credit spread significantly elevates the level of companies' accrued earnings management, compromising the quality of information disclosure and intensifying information asymmetry between enterprises and regulators (Xu et al., 2022). This condition facilitates collaboration with banks to invest in recognized compliant green assets or issue green credit at a specified scale (Cao et al., 2021), thereby increasing the likelihood of bank lending and confirming hypothesis H2b.

Furthermore, following Roychowdhury (2006), we employ real earnings management (TREM), wherein sales manipulation, production manipulation, and discretionary expense manipulation serve as sources, to assess earnings management. The results are summarized in Table 6 Panel B, and our findings are in line with the use of accrued earnings management (DA) as a proxy for information asymmetry.

The elevated green bonds credit spread in the secondary market intensifies enterprises' financing constraints and drives them to engage in greenwashing to secure financing, further heightening information asymmetry to gain policy support (Zhang, 2022). In China, financial institutions hold and trade green bonds extensively (Su & Lin, 2022), and banks have regulatory requirements for maintaining green assets of a specified scale, akin to green credit. However, determining whether the assets held are compliant green necessitates regulatory review. The present scale of green assets is relatively modest (Jiang et al., 2020), posing challenges to achieving optimal investment. This aligns with the enterprises' execution of greenwashing behavior to deceive and fulfill financing objectives, leading to implicit collusion between enterprises and banks (Bailey et al., 2011; Cao et al., 2022; Hu & Varas, 2021). This elucidates that, in an efficient market, banks, as key participants in the green bond secondary market, can discern enterprises' greenwashing behavior, yet credit departments persist in extending loans to such enterprises.

6. Heterogeneity analysis

6.1. SOE versus non-SOE

Firstly, ownership nature influences the motivation behind a company's issuance of green bonds. As relatively pure market participants, private enterprises primarily issue green bonds to meet their financing needs and reduce costs, thereby reaping more economic benefits. In contrast, state-owned enterprises (SOEs) are more responsive to policy influences and align their actions with national initiatives (Lin & Su, 2022). Consequently, after successfully issuing green bonds, private enterprises tend to continue this financing route rather than resorting to more challenging bank channels.

Secondly, the ownership nature affects the efficacy of green bond credit spreads in securing external support. SOEs, due to their strong political connections, can readily secure loans from the government and state-owned financial institutions and face less stringent financing oversight (Bailey et al., 2011; Jiang et al., 2020). In contrast, non-SOEs have weaker relationships with financial institutions, making financing more challenging. Hence, any greenwashing behavior is more easily detected through due diligence, complicating their ability to secure bank

Table 5
Impact mechanism test (financing constraints).

Panel A: SA index			
	(1)	(2)	(3)
	SA	ΔLoan	ΔLong_Loan
Spread	0.0069**	0.0251**	0.0519***
	(0.0031)	(0.0126)	(0.0143)
SA		0.0989***	0.1065***
		(0.0180)	(0.0318)
Roa	0.0778	−0.1982	−0.7705**
	(0.0501)	(0.2408)	(0.3535)
Fix_Asset	−0.0210	−0.1735***	−0.0459
	(0.0174)	(0.0584)	(0.0934)
Growth	0.0093	−1.3767***	−2.0597***
	(0.0535)	(0.2970)	(0.3958)
Cash	0.0448	0.2566**	0.4469***
	(0.0303)	(0.1015)	(0.1474)
Turnover	−0.0086	1.2844***	1.9451***
	(0.0505)	(0.2850)	(0.3829)
Lev	−0.0252**	0.3192***	0.2837***
	(0.0116)	(0.0462)	(0.0783)
GDP_Growth	0.0162**	0.1056	0.1942*
	(0.0067)	(0.0670)	(0.1078)
_cons	−26.8671***	−0.9344***	−1.0737***
	(0.3126)	(0.1654)	(0.2863)
Firm FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes
N	9627	8048	8743
R^2	0.9999	0.2935	0.2342
adj. R^2	0.9999	0.1783	0.1156
F	1789.5151***	15.4669***	10.6621***

Panel B: FC index			
	(1)	(2)	(3)
	FC	ΔLoan	ΔLong_Loan
Spread	0.0144**	0.0336	0.0574
	(0.0072)	(0.0255)	(0.0368)
FC		0.4386**	0.9381***
		(0.2128)	(0.2671)
Roa	0.3696**	−0.2716	−1.7714**
	(0.1661)	(0.3386)	(0.7681)
Size	−0.0476**	0.1671***	0.0316
	(0.0185)	(0.0614)	(0.0938)
Fix_Asset	0.1249*	−0.2856*	−0.3870*
	(0.0728)	(0.1566)	(0.2303)
Growth	0.0562	−0.5187	−1.8994***
	(0.0670)	(0.3538)	(0.5197)
Cash	0.0378	0.2136	0.4955
	(0.1531)	(0.2609)	(0.4240)
Turnover	−0.0482	0.4108	1.7459***
	(0.0647)	(0.3404)	(0.5143)
Lev	−0.0655*	0.4615***	0.6504***
	(0.0372)	(0.1160)	(0.1848)
GDP_Growth	0.0248	−0.1209	−0.2056
	(0.0576)	(0.1378)	(0.3521)
_cons	1.1992**	−4.2184***	−0.8601
	(0.5117)	(1.5408)	(2.3463)
Firm FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes
N	1736	1708	1729
R^2	0.9434	0.2903	0.2108
adj. R^2	0.9344	0.1764	0.0853
F	4.8564***	5.6395***	4.8552***

This table reports the results of the impact mechanism test conducted on the mediator variable of financing constraints (SA in Panel A and FC in Panel B). Standard errors are clustered at the firm level, and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, according to *p*-values.

Table 6
Impact mechanism test (earnings management).

Panel A: Accrued earnings management (DA)			
	(1)	(2)	(3)
	DA	ΔLoan	ΔLong_Loan
Spread	0.0123*	0.0374	0.0494
	(0.0067)	(0.0256)	(0.0349)
DA		0.6588***	0.5990**
		(0.1560)	(0.2541)
Roa	0.6224***	−0.4094	−3.0842***
	(0.1333)	(0.4741)	(0.9347)
Size	0.0195	0.0675*	0.0177
	(0.0120)	(0.0401)	(0.0938)
Fix_Asset	−0.1476***	0.1430	−0.5756**
	(0.0460)	(0.1271)	(0.2797)
Growth	0.0256	−0.8240**	−2.4124***
	(0.1346)	(0.3656)	(0.6167)
Cash	−0.1773***	0.3679	−0.1755
	(0.0584)	(0.2403)	(0.4728)
Turnover	−0.0473	0.7571**	2.3420***
	(0.1320)	(0.3579)	(0.5711)
Lev	0.0809***	0.1606	0.2479
	(0.0285)	(0.1137)	(0.1890)
GDP_Growth	−0.0888***	−0.1610	−0.2460
	(0.0281)	(0.1599)	(0.3200)
_cons	−0.3943	−1.8003*	−0.0198
	(0.3151)	(1.0091)	(2.3973)
Firm FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes
N	1835	1614	1832
R^2	0.5948	0.4282	0.3527
adj. R^2	0.4177	0.1675	0.0682
F	5.3068***	4.4798***	3.6556***

Panel B: Real earnings management (TREM)			
	(1)	(2)	(3)
	TREM	ΔLoan	ΔLong_Loan
Spread	0.0379*	0.0187	0.0445
	(0.0229)	(0.0274)	(0.0349)
TREM		0.2227***	0.2130*
		(0.0644)	(0.1084)
Roa	−1.3538***	0.2835	−2.1908***
	(0.2920)	(0.4166)	(0.8229)
Size	0.0405	0.0993**	0.0036
	(0.0247)	(0.0454)	(0.0979)
Fix_Asset	−0.3292***	−0.0442	−0.9090***
	(0.0882)	(0.1419)	(0.3028)
Growth	−0.6277***	−0.5603	−2.1497***
	(0.2067)	(0.4239)	(0.6803)
Cash	−0.5007***	0.6227***	0.1192
	(0.1129)	(0.2367)	(0.4883)
Turnover	0.6447***	0.4280	2.0175***
	(0.1977)	(0.4212)	(0.6387)
Lev	0.0320	0.3173***	0.5307***
	(0.0722)	(0.1083)	(0.1758)
GDP_Growth	−0.0896*	−0.1711	−0.2444
	(0.0492)	(0.1494)	(0.3291)
_cons	−0.7401	−2.6110**	0.3436
	(0.6327)	(1.1593)	(2.5656)
Firm FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes
N	1620	1405	1620
R^2	0.6331	0.4233	0.3462
adj. R^2	0.4790	0.1712	0.0706
F	5.7268***	4.9712***	4.1916***

This table reports impact mechanism test results conducted on the mediator variable of accrued earnings management (DA) in Panel A and real earnings management (TREM) in Panel B. Standard errors are clustered at the firm level. The standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, according to *p*-values.

loans to alleviate financing constraints.

Lastly, ownership nature impacts stakeholders' sensitivity to a company's greenwashing behavior. The State-owned Assets Supervision and Administration Commission of the State Council emphasizes fortifying the green and low-carbon framework of state-owned capital, serving the national green and low-carbon development strategy, and incorporating the green and low-carbon development concept throughout the reform and development process of SOEs. From the stakeholders' perspective, SOEs issuing green bonds have government endorsement and align with policy direction, making them less sensitive to SOEs' greenwashing behavior. This results in a subdued market reaction to the high green bonds credit spread of SOEs, facilitating their loan acquisition.

In conclusion, we hypothesize that higher green bond credit spreads among SOEs will significantly enhance the scale of bank loans. Group regression tests this hypothesis, and as shown in columns (1) and (2) of Table 7, the Spread coefficient for SOEs is significantly positive, aligning with our expectations and corroborating the findings of Lau et al. (2022) and Li and Wu (2020).

6.2. The role of "Heavy Energy Consumption, Heavy Pollution and Resource-Related" policy

The People's Bank of China has established policies to support green credit and incentivize green businesses, while constraining loans to high-pollution, high-energy-consumption, and overcapacity industries (HHR). Eco-conscious enterprises uphold the "Clear waters and green mountains" principle, operating within the bounds of natural resources and ecological environment to foster resource conservation, environmental protection, and green development. Thus, regardless of the greenwashing strategies employed by HHR industry enterprises, banks will deny them loans, even if the loan yields are high. We posit that the impact of green bonds credit spreads on the debt financing structure is non-existent for such enterprises.

Table 8 showcases whether being an HHR company affects the impact of green bonds credit spread in the secondary market on enterprise loan structure. In columns (1) and (2), neither of the Spread coefficients is significant at the 10% level, suggesting that greenwashing by such enterprises doesn't lead to new bank loans. The influence of green bonds credit spread on the debt financing structure is driven by enterprises outside the HHR category, affirming that this impact is absent in HHR industry enterprises.

6.3. The role of absolute holding

Legally, holding >67% of a company's shares constitutes absolute control. However, in practice, absolute control refers to shareholders contributing >50% of the total capital of a limited liability company or holding >50% of the total shares. To enhance the robustness of our research, we use 50% as the threshold and investigate whether companies under absolute control are more conducive to leveraging the impact of green bonds credit spread to obtain bank loans—essentially, whether greenwashing behavior in such companies yields better results.

Firstly, shareholders of an absolute holding company possess economic incentives to engage in greenwashing activities to secure higher loan limits, especially when there is an increase in green bonds credit spread. Secondly, they have the absolute executive power to swiftly and comprehensively control the quality of information disclosure, fostering the sustainable development of the company's financing and investment

Table 7
Heterogeneity analysis (SOE or non-SOE).

	(1)	(2)	(3)	(4)
	SOE		Non-SOE	
	ΔLoan	ΔLong_Loan	ΔLoan	ΔLong_Loan
Spread	0.0419***	0.0407***	−0.0022	0.0377
	(0.0127)	(0.0146)	(0.0383)	(0.0627)
Roa	−0.0585	−0.6177	−1.1282**	−1.9483**
	(0.4445)	(0.6136)	(0.5348)	(0.8391)
Size	0.1715***	0.2488***	0.1454***	0.0017
	(0.0421)	(0.0617)	(0.0541)	(0.0830)
Fix_Asset	−0.2122**	−0.2163*	0.1291	0.4687***
	(0.0876)	(0.1211)	(0.0892)	(0.1637)
Growth	−1.8298***	−1.6247**	−1.3669***	−2.4541***
	(0.4041)	(0.7924)	(0.4970)	(0.5861)
Cash	0.3746***	0.5412***	0.0315	0.7586**
	(0.1310)	(0.1609)	(0.2129)	(0.3441)
Turnover	1.7354***	1.5705**	1.3080***	2.3709***
	(0.3925)	(0.7680)	(0.4802)	(0.5585)
Lev	0.2699***	0.2147**	0.2472***	0.3626**
	(0.0633)	(0.0933)	(0.0870)	(0.1498)
GDP_Growth	0.0415	0.1178	−0.2063	−0.1139
	(0.1101)	(0.1341)	(0.1606)	(0.2644)
_cons	−4.3686***	−6.3056***	−3.7039***	−0.4573
	(1.0828)	(1.5765)	(1.3291)	(2.0532)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
N	4239	4801	1619	1728
R^2	0.3120	0.2627	0.3346	0.2938
adj. R^2	0.1972	0.1488	0.2210	0.1792
F	10.7400***	6.6565***	5.0552***	5.7655***

This table presents the heterogeneity analysis based on the benchmark regression, categorizing the samples into state-owned enterprises (SOEs) and non-state-owned enterprises (Non-SOEs). Columns (1) and (2) display the regression results for state-owned enterprises, while columns (3) and (4) illustrate the regression results for non-state-owned enterprises. Standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, according to *p*-values.

Table 8
Heterogeneity analysis (HHR policy).

	(1)	(2)	(3)	(4)
	HHR		Non HHR	
	ΔLoan	ΔLong_Loan	ΔLoan	ΔLong_Loan
Spread	0.0077	0.0136	0.0316**	0.0591***
	(0.0218)	(0.0170)	(0.0123)	(0.0203)
Roa	−0.2688	−0.2615	−0.8572**	−1.4697***
	(0.3833)	(0.7842)	(0.3707)	(0.4412)
Size	0.1557***	0.3112***	0.1354***	0.1258**
	(0.0403)	(0.0817)	(0.0279)	(0.0489)
Fix_Asset	−0.8605***	−0.5099**	−0.1021*	0.0160
	(0.1760)	(0.1989)	(0.0608)	(0.1038)
Growth	−1.3298***	−2.0271***	−1.3942***	−2.0830***
	(0.3861)	(0.7511)	(0.3595)	(0.4584)
Cash	−0.1604	−0.4040	0.3062**	0.5696***
	(0.2000)	(0.3239)	(0.1221)	(0.1696)
Turnover	1.1668***	1.8047***	1.3327***	2.0130***
	(0.3700)	(0.6890)	(0.3479)	(0.4499)
Lev	0.5346***	0.2593	0.2784***	0.2722***
	(0.1242)	(0.1673)	(0.0491)	(0.0852)
GDP_Growth	0.1529**	0.4835***	0.0405	0.0268
	(0.0695)	(0.1072)	(0.1060)	(0.1474)
_cons	−3.7104***	−7.8798***	−3.5278***	−3.3539***
	(1.0764)	(2.1353)	(0.7096)	(1.2455)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
N	2541	2570	5560	6226
R^2	0.3166	0.3234	0.3095	0.2328
adj. R^2	0.1971	0.2055	0.1963	0.1158
F	10.7539***	7.8982***	10.6002***	7.9207***

This table presents the heterogeneity analysis based on the benchmark regression, distinguishing between enterprises that fall under the "two high and one limited" category (HHR) and those that do not. Columns (1) and (2) display the regression results for HHR enterprises, while columns (3) and (4) exhibit the regression results for enterprises not belonging to the HHR category. Standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, according to *p*-values.

fields (Wang et al., 2020). Thirdly, in a bid to safeguard the position of the controlling shareholder, there is also a motivation to cultivate a green image of the enterprise and build a reputation for environmental friendliness (Jia et al., 2020).

Table 9 presents the corresponding regression results. The estimated Spread coefficients of absolute holding companies remain significantly positive at the 10% and 1% levels, showing an increase compared to the benchmark regression. However, the estimated Spread coefficient for new loans of non absolute holding companies is not significant, while the Spread coefficient in new long-term loans continues to be significantly positive at the 1% level. In summary, the green bonds credit spread can positively influence loan growth for absolute holding companies, whether considering all loans or just long-term loans. Conversely, non-absolute holding companies only exhibit this phenomenon in the growth rate of long-term loans.

Table 9
Heterogeneity analysis (absolute holding).

	(1)	(2)	(3)	(4)
	Absolute Holding		Non Absolute Holding	
	ΔLoan	ΔLong_Loan	ΔLoan	ΔLong_Loan
Spread	0.0255**	0.0375***	0.0159	0.1599***
	(0.0129)	(0.0133)	(0.0217)	(0.0425)
Roa	−0.2617	−0.7915**	−0.0603	−0.7160
	(0.2987)	(0.3430)	(0.4461)	(0.9037)
Size	0.1813***	0.2950***	0.0884**	−0.0846
	(0.0325)	(0.0512)	(0.0438)	(0.0677)
Fix_Asset	−0.1618**	−0.0957	−0.0394	0.1835
	(0.0641)	(0.0931)	(0.1555)	(0.2651)
Growth	−2.4615***	−2.5361***	−0.5835	−2.1241***
	(0.3672)	(0.5459)	(0.3651)	(0.5399)
Cash	0.2330**	0.4001***	0.5183**	0.7453*
	(0.1099)	(0.1281)	(0.2577)	(0.4467)
Turnover	2.3065***	2.4110***	0.4851	1.8046***
	(0.3465)	(0.5143)	(0.3534)	(0.5369)
Lev	0.2618***	0.1851**	0.4550***	0.5042**
	(0.0534)	(0.0792)	(0.1107)	(0.1939)
GDP_Growth	0.1702**	0.3623***	−0.1315	−0.5132*
	(0.0709)	(0.1046)	(0.1425)	(0.3013)
_cons	−4.7263***	−7.6714***	−2.4099**	1.8746
	(0.8436)	(1.3238)	(1.1093)	(1.7051)
Firm FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
N	6553	7226	1548	1570
R^2	0.3196	0.2883	0.2672	0.1855
adj. R^2	0.2045	0.1753	0.1503	0.0562
F	15.1493***	11.0153***	6.2499***	7.0099***

This table presents the heterogeneity analysis based on the benchmark regression, examining whether the shareholding ratio of the largest shareholder exceeds half. Columns (1) and (2) display the regression results for companies where the largest shareholder has absolute control, while columns (3) and (4) show the regression results for companies without absolute control by the largest shareholder. Standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, according to *p*-values.

7. Conclusion

In recent years, the development of green bonds and green credit within the green financial system has attracted increased investor attention towards the management of enterprise green image (greenwashing behavior). Furthermore, the frequent occurrence of major defaults in China's bond market and the reliance of most enterprises on bank financing emphasize the limitations of banks relying solely on traditional financial accounting information for lending decisions. The research sample for this study comprises 2045 Chinese green bonds issued between Q4 2017 and Q1 2023. The empirical analysis in this study establishes a positive correlation between the green bonds credit spread in the secondary market and the growth of enterprise loans, with a more significant impact on long-term loans. Mechanism analysis indicates that investors' perception of green bonds impacts bank lending by exacerbating corporate financing constraints and promoting greenwashing behavior, which contributes to increased information asymmetry with regard to green bonds credit spread. In contrast to the existing literature (Bhutta et al., 2022; Cao et al., 2021; Fatica et al., 2021; Zerbib, 2019), this research assesses the overall performance of China's green bond market, scrutinizes the economic ramifications of the credit spread of green bonds in the secondary market from a banking perspective, and enriches the understanding of the factors influencing corporate loan structures. Based on the survey findings, the following policy implications can be identified:

Firstly, it is crucial to incorporate information from the secondary market into the bank lending evaluation and regulatory system. The findings of this study underscore that, under the current policy background, even if banks have information on the secondary market of green bonds, they are still prone to implicit collusion with enterprises. Therefore, it is recommended that banks (and regulators) integrate the green bonds credit spread in the secondary market into their investment decision-making (and regulatory) framework (Bertini, Buehler, Halbheer, & Lehmann, 2022). When assessing the financial viability of enterprises that have issued green bonds, banks should carefully consider the corresponding changes in market prices of these bonds and their repayment performance. Moreover, from a regulatory perspective, policies need to be introduced to address the issue of implicit collusion between banks and enterprises to achieve green targets.

Secondly, enterprises must enhance their green practices and refrain from employing greenwashing strategies. This study reveals that the secondary market has the ability to detect enterprises' greenwashing behavior through changes in green bond prices, which can have negative consequences for their subsequent bond issuances. Consequently, enterprises may be limited to selective information disclosure and become reliant on extensive borrowing from banks, resulting in a detrimental cycle. Therefore, enterprises should integrate the green concept into their daily operations, establish relevant assessment indicators, and put mechanisms for rewards and penalties in place. They should also enhance the transparency of accounting information disclosure and willingly embrace public oversight.

Finally, it is imperative for the government to enhance the regulation of greenwashing practices among state-owned enterprises. This study demonstrates the profound influence of the green bond spread in the secondary market on the loan accessibility of state-owned enterprises. Given the extensive presence of state-owned enterprises in China and the challenges faced by small and micro enterprises in securing financing, the perpetuation of greenwashing behavior by state-owned enterprises will intensify the crowding-out effect and hinder efficient capital allocation. Therefore, the government must prioritize the oversight of enterprises' green reputation and leverage the influential position of state-owned enterprises to foster compliance with green standards.

Data availability

No

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