SOE Premium in China's Green Bond Market*

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Abstract

We examine corporate green bonds' pricing premiums in China, focusing on pricing differences between state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs). We find that SOE-issued green bonds enjoy, on average, a 70.8 basis point lower credit spread compared to those issued by non-SOEs, with central SOE green bonds commanding lower required returns than local SOE bonds. While green bonds do not exhibit a greenium effect, SOEs' pricing advantage is amplified in the green bond market. We find that the SOE premium in China's green bond market is significantly moderated by factors that enhance environmental credibility, information disclosure, market discipline, and institutional quality. Specifically, non-SOEs that obtain third-party verification, disclose alignment with international standards, allocate proceeds to new green projects, disclose more environmental information, and operate in fiscally strong or green policy-friendly provinces experience reduced credit spreads. These findings suggest that while structural advantages persist for SOEs, non-SOEs can strategically leverage transparency, quality certification, and institutional environments to access green capital more competitively in China.

JEL Classification: G12, G32, Q56, M14

Keywords: Pricing premium, Green Bond, Ownership structure, Environmental impact, Information disclosure

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1. Introduction

State-owned enterprises (SOEs) in China are known to enjoy preferential access to credit and more favorable financing terms than non-SOEs (Ding et al.; 2022, Geng and Pan, 2024). These privileges enjoyed by SOEs can be traced back to the shareholding reform of SOEs in the mid-1990s. The government-SOE relationship was later cemented with the creation of State-owned Assets Supervision and Administration Commissions (SASACs), which in 2003 became the "sole representative of state ownership" in China (Wang, 2015; Beck and Larsen, 2025).[1] Amstad et al. (2020) highlight that it is particularly useful to recognize that the Chinese government has consciously used the financial system as a toolbox to implement government policies and to resolve financing issues it has encountered during the country's economic reforms. A recent example is the Chinese government's four trillion-yuan stimulus plan of 2009 to save the economy that was hit hard by the 2008 financial crisis. An increase in infrastructure investment was a major part of the fiscal expansion, and the government offered guarantees on loans to SOEs in the infrastructure sector.

Nowadays, low-carbon development and green transition have become top priorities for China in formulating domestic social and economic policies. In November 2021, the SASACs put forward the *Guidance on Promoting High-quality Development of central SOEs in Achieving Carbon Peaking and Carbon Neutrality*[2], deciding on the SOEs' demonstrative and leading roles in achieving the central government's carbon neutrality goals.[3] According to the SASACs' *Guidance*, executives in SOEs are assessed by their performance in promoting carbon reduction, and those who do not meet the carbon reduction targets will be criticized and held accountable. Meanwhile, a series of financial policies and financial tools have been introduced to support China's green transition. In addition to bank loans, China has been increasingly resorting to capital market financing products such as direct equity financing (see, for example, Beck and Larsen, 2025) and green bonds in transitioning the economy to sustainable growth model. China's policies supporting the development of the green bond market include policies that support the issuance of green bonds and policies that encourage the purchase and holding of green bonds. For

[1] SASACs (State-owned Assets Supervision and Administration Commissions) is the central-level body under the State Council that owns, supervises and reforms China's centrally administered SOEs. Parallel to it, every province, autonomous region, major city and some counties have their own local SASACs, special agencies set up by the local government and directly reporting to it. Each SASAC is authorized to act as the "contributor of capital" for the SOEs registered in its jurisdiction, taking charge of: appointing boards and senior managers; preserving and increasing the value of state assets; guiding restructuring, mixed-ownership reform and risk control. Where a separate SASAC has not been created, the local government may assign the same duties to its finance bureau or another designated department.

[2] http://www.sasac.gov.cn/n2588035/c22499825/content.html.

[3] There are 98 central SOEs directly overseen by the SASAC and over 460,000 branches and sub-enterprises across the country (http://www.sasac.gov.cn/n2588045/n27271785/n27271792/c14159097/content.html).

example, as the regulator of China's interbank market, which accounts for about 90% of debt securities in China in recent years, People's Bank of China (PBoC) announced '…… supporting the green financial sector reform and innovation pilot zone on issuing green bond financing instruments' on 13 May 2019 [4] and issued 'green finance evaluation scheme for banking financial institutions' on 27 May 2021 (hereafter the PBoC demand-side policy of 2021). The PBoC demand-side policy of 2021 evaluates banks' green asset holdings and incorporates the results into regulatory incentives[5].

The green bonds' pricing premium has received considerable attention from researchers over the past decade. The literature has mainly focused on whether green bonds can be issued at a premium to similar conventional bonds, i.e., whether there is a greenium (e.g., Larcker and Watts, 2020; Want et al., 2020; Baker et al., 2022; Wang and Wu, 2022). In the context of China's credit market, whether a green bond issuer is an SOE or a non-SOE may significantly affect the green bond pricing (or yield) at issuance. This conjecture builds upon the research of Geng and Pan (2024), who document significant SOE premium in China's conventional bond market, that is, SOEs can issue bonds at significantly lower yields than non-SOEs. This raises a battery of critical questions that, is there SOE premium in the green bond market as well? Are there regional differences in the SOE premium? What can the government and non-SOEs do to alleviate the cost disadvantages faced by non-SOEs and thereby reduce the overall borrowing costs in the green bond market? More specifically, what role does green bond play in supporting the green transition of both SOEs and non-SOEs in high-pollution and high-energy-consuming industries? These timely and urgent questions have not been adequately explored in the existing literature and constitute the major focus of this paper.

We include in the empirical study all Chinese Yuan denominated green bonds and conventional bonds issued during 2016-2024 by both the public and private non-financial corporations. Our main findings can be summarized as follows. First, we document significant SOE premium in China's green bond market, with central SOEs enjoy higher premium than local SOEs. However, we find that the use of green bond proceeds plays a crucial role in determining both the presence of the greenium and the magnitude of the SOE premium. Generally, companies do not enjoy lower costs by issuing green bonds than issuing conventional bonds (i.e., greenium) while SOE-issued green bonds do have lower credit spread than

[4] The Chinese State Council's executive meeting in June 2017 decided to include five provinces (regions), namely Zhejiang, Jiangxi, Guangdong, Guizhou, and Xinjiang, as the first batch of pilot projects to build pilot zones for green financial reform and innovation with their own characteristics, marking the landing and implementation of green finance. Lanzhou of Gansu province was added to the pilot zones for green financial reform and innovation in 2019. In 2019, PBoC issued a series of policies to further support the green financial reform and innovation in the pilot zones. The policies include the improvement of standards for green project identification, green bond issuance, and environmental information disclosure in pilot zones to ensure the transparency and operability of green financial products.

[5] https://www.gov.cn/zhengce/zhengceku/2021-06/11/content_5616962.htm. Data shows that commercial banks, especially large state-owned banks, are core investors in China's green bond market (CCDC, 2024).

conventional ones. Besides, non-SOEs can borrow at lower cost by issuing green bonds than issuing conventional bonds when the proceeds from green bonds are mostly used for financing green projects. However, if it is suspicious of greenwashing, for example, the proceeds are (mainly) used for refinancing existing projects or old debt, there will be no greenium. Also, when the SOEs use the proceeds from green bonds mainly for financing (new) green projects, the SOE premium is actually narrowed. The results show that the market views SOE investments in new green projects less favorably than those by non-SOEs, potentially reflecting concerns about the documented investment inefficiency of SOEs.

Second, we find that both non-SOEs and the government can implement measures to mitigate the elevated borrowing costs faced by non-SOEs in the green bond market. At the firm level, non-SOEs can reduce their borrowing costs if they can acquire third-party green verification from third-party agencies (especially from leading agencies in China such as Lianhe Equator and CCXGF) and increase information disclosure quality by following the Green Bond Principles (GBP) of the International Capital Market Association (ICMA) or being aligned with the Common Ground Taxonomy (CGT) between the EU and China. At the same time, both the central and local governments can play an important role. Among a series of policies issued by the central government, the PBoC demand-side policy of 2021, for example, has successfully lowered the borrowing costs for all bond issuers and has also narrowed the SOE premium in the green bond market. It suggests that the demand-side policies are of good effect. At local governmental level, it is found that the borrowing costs tend to be lower and the SOE premium tends to be narrower in provinces which have a high level of green financial policy development and high impact of green financial policy.

Third, our findings reveal certain trade-offs adopted by underwriters. As the issuance of green bonds by SOEs is more concentrated in the hands of a few underwriters, underwriters are more likely to push up the SOE premium, which reflects their intention to compete for the future underwriting business of SOEs (SOEs usually have high leverage and need to continuously rollover debts). However, as the market share of underwriters in the entire green bond issuance increases, they tend to lower the borrowing costs of all bond issuers while reducing the cost advantage of SOEs over non-SOEs. This might reflect that the intention of these underwriters is to maintain relationships with all clients rather than merely pleasing SOE clients (or under less pressure).

Fourth, what we are particularly interested in is how helpful green bonds have been in financing the green transition of both SOEs and non-SOEs. Both types of enterprises need a large amount of funds to support their transformation activities, such as pollution control, energy efficiency improvement, and the production and use of clean energy. Our findings indicate that the type of transition activities will affect the degree of the SOE premium in the green bond market. Specifically, the funds used by SOEs for pollution control will increase the SOE premium, while the funds used by SOEs for improving energy efficiency or producing and using clean energy will reduce the SOE premium. The discovery might be explained by the fact that non-SOEs are generally superior to SOEs in conducting business more economically and more efficiently.

The paper has several contributions to the literature. It is the first research exploring the capital allocation between SOEs and non-SOEs based on data from China's green bond market. Our research indicates that although ownership (state-owned or non-state-owned) still plays a dominant role in determining the cost of funds, the Chinese government has played an active role in formulating green finance policies and alleviating the unfavorable position of non-SOEs in the green bond market. This is ideal for promoting the entire economy to move more effectively towards green and sustainable development. It is delighted to find that non-SOEs can also reduce borrowing costs relative to SOEs by adhering to recognized domestic or international standards. Second, our research provides insights into the business strategies of underwriters in dealing with issuers. Our findings suggest that all enterprises, especially non-SOEs, may be able to issue green bonds at a lower borrowing cost with the assistance of large underwriters who hold a significant market share. Third, we conduct an in-depth study on the role of green bonds in the financing of green transformation for both SOEs and non-SOEs. The results reveal the advantages and disadvantages of SOEs in different types of transition activities through their different impacts on the scale of the SOE premium. These findings point out different directions for the future development of SOEs and non-SOEs. Fourth, the dataset we use in our research is unique. Our research is based on bonds issued by public and private non-financial companies. Most bond data and other financial data are manually collected from various sources.

The remainder of the paper consists of six sections. Section 2 provides a review of the prior literature most pertinent to our study and develops the main hypotheses. Section 3 outlines our methodological approach and describes the data sources, and measures used in the empirical analyses. We discuss our main empirical results of the paper in Section 4. Section 5 explores a number of potential factors affecting the SOE premium we documented. Finally, Section 6 provides a summary of the results and concludes the paper.

2. Literature review and hypotheses

2.1 Do SOEs enjoy lower borrowing costs than non-SOEs in the green bond market?

SOEs possess explicit or implicit government guarantees on their financial capital raising and hence are favored by commercial banks and capital markets in credit allocations (Song and Xiong, 2018). Third-party or government credit guarantees lowers the cost of debt by reducing the default risk and providing higher recovery value in the event of default (Borisova et al., 2015; Beyhaghi, 2022).

Ding et al. (2022) document issuance overpricing of corporate debt securities in China that is more severe for central SOEs than for other firms. Their research results reflect the different institutional environments in China. As the maturities of debts in China are generally short, most Chinese firms need to repeatedly issue debt securities to roll over maturing debts. Higher issuance pricing not only reduces the issuers' financing cost but provides a publicly observed benchmark for the issuer's other debt financing. The benchmark role of the issuance price thus induces an issuer to reward its future issuance to its current underwriter based on issuance pricing. Since central SOEs are usually giant firms that are more valuable issuers than other firms and thus attract more intense competition for their issuances. As a result, underwriters have stronger incentives to win central SOEs' business, leading them to generate a higher issuance overpricing (and lower issuing yield) for central SOEs than for other bond issuers.

Geng and Pan (2024) quantify the extent of SOEs' advantage in credit allocation as the SOE premium, measured as the difference in credit spreads between non-SOE and SOE bonds after controlling for credit ratings and other bond and issuer characteristics. Their investigations reveal a time-varying SOE premium that is amplified amidst liquidity deterioration caused by the 2018 government-led credit tightening policy on the banking and asset management industry. They examine the mechanism of SOE premium by developing a structural default model that integrates credit risk, liquidity, and government support (bailout). Their empirical tests demonstrate that the explosive SOE premium primarily results from the increased importance of government support during the period of heightened liquidity deterioration, which leads to significantly higher credit quality of SOEs than that of non-SOEs.

Regarding financial mechanism, green bonds and conventional bonds are identical. Both types of bonds are tradable fixed-income securities where issuers promise to pay the holders interest (coupon) and redeem the principal at maturity date, conditional on issuance terms. Therefore, whether issuing green bonds or conventional bonds, SOEs should enjoy the same cost advantages over non-SOEs because investors believe that SOEs are more likely to receive government support during financial or liquidity crises and hence would demand lower risk premium. Based on the above discussions, we propose the following hypothesis.

H1: SOE premium is present in China's green bond market.

2.2 Is SOE premium in the green bond market higher than that in the conventional bond market?

Policymakers may strategically use public statements and communication channels to promote a policy or signal government support for specific sectors. Such signaling effect can significantly influence investor perceptions of and preferences for certain assets (Ricco et al., 2016; Mertzanis, 2024). The SASACs' *Guidance* of 2021 sent a strong signal to the market that the government is promoting and supporting the green transformation of SOEs. This might make the green bonds issued by SOEs more attractive and expand the market demand for their green bonds. Chen et al. (2023) find that the infrastructure investment spree (by SOEs) following the 2009 monetary stimulus plan had adverse effects on investment of non-SOEs in the entire economy by crowding out bank loans that would otherwise have been accessible to non-SOEs. Similarly, the increased demand for green bonds issued by SOEs may crowd out the green funds that could otherwise enter non-SOEs, which will also push up the yield of green bonds of non-SOEs.

Furthermore, Beck and Larsen (2025) demonstrate that Chinese (central) government has been actively using state-backed funds, with a focus on direct equity financing and joint financing from other local green equity (sub-) funds, to alleviate the market deficiencies in green transition financing. Their case studies show that the surge in "government guidance funds" for green projects has, in most cases, favor SOEs over non-SOEs. Overall, literature indicates that SOEs have received more government support during their transition to green development and have more channels to obtain debt and equity capital. This has further improved the liquidity situation and credit quality of SOEs as green bond issuers. Therefore, the SOE premium in the green bond market should be more pronounced than that in the conventional bond market.

It is also well acknowledged that issuing green bonds involves more complex procedures and higher administrative and compliance costs than issuing conventional bonds (Flammer, 2021). Based on survey evidence of global issuers of green bonds, Sangiorgi and Schopohl (2023) report that a lack of awareness, external support and suitable green projects represent the biggest barriers for firms' entry to the green bond market. Internationally, governments have always played a leading role in protecting the environment and combating climate change (Mertzanis, 2024). In China, the government's toolkit for addressing environmental issues typically includes environmental regulations, financial policies, and the state's control over enterprises through SOEs. Compared with non-SOEs, SOEs usually receive more external support from banks (the main underwriters in China's bond market), have more opportunities to participate in government-supported sustainability projects, such as infrastructure construction, and receive more government subsidies when the government strives to improve the environment (Amstad et al., 2020; Chemmanur et al., 2024). All these factors may lead to higher SOE premium in the green bond market than that in the conventional bond market. Therefore, we propose the following second hypothesis.

H2: The SOE premium in the green bond market is higher than that in the conventional bond market.

3. Samples and data

3.1 Corporate green bond in China

We extract green bond data from the *China Stock Market & Accounting Research Database* (CSMAR) to compile a comprehensive corporate green bond database for China. This database includes green bonds issued domestically. Specifically, the CSMAR green bond database contains samples that meet the criteria of the PBoC's *Green Bond Endorsed Projects Catalogue* or the *National Development and Reform Commission's* (NDRC) *Guidelines for Green Bond Issuance*.[6] We exclude corporate green bonds issued by financial institutions, and those classified as convertible bonds or revenue-linked bonds. Applying these criteria yields a final sample of 1,449 corporate green bonds issued between 2016 and 2024.[7] The sample consists of four categories of corporate green bonds, including company-issued green bonds, enterprise-issued green bonds, mid-term notes (MTNs) and short-term commercial papers (CPs).[8] Of the 1.449 corporate green bonds, 110 are CPs and 234 are MTNs.

Figure 1 presents the spatial distribution of corporate green bonds across provinces over the observation period. The total number of green bonds per province is represented by color intensity, with darker shades indicating higher issuance volumes. As shown in the figure, Beijing leads with over 200 green bonds, followed by the provinces of Guangdong and Jiangsu. It is noteworthy that certain administrative division have not issued corporate green bonds, such as Inner Mongolia Autonomous Region.

[6] Both the *Catalogue* and the *Guideline* have undergone periodic updates since their initial release in 2015. The latest version of the *Green Bond Endorsed Projects Catalogue* was published in 2023, while the most recent update to the *Guidelines for Green Bond Issuance* was issued in 2021. These revisions have progressively aligned the compliance standards with international norms and expanded the scope of eligible industry sectors. For more details, check http://www.pbc.gov.cn/ and https://en.ndrc.gov.cn/.
[7] This period likewise represents the temporal coverage of the CSMAR green bond database.
[8] Green bonds issued by companies are regulated by the China Securities Regulatory Commission (CSRC), whereas those issued by non-financial enterprises fall under the jurisdiction of the National Development and Reform Commission (NDRC). In China, "enterprises" primarily refer to large-scale state-owned commercial entities. Medium-term notes (MTNs) and short-term commercial papers (CPs) represent shorter-maturity debt instruments within this framework. We just call all green bonds in our sample as corporate green bonds to distinct from green bonds issued by government.

[Insert Figure 1 here]

We document the evolving landscape of corporate green bonds in China, analyzing temporal trends (Table 1 and Figure 2) and cross-sectoral patterns. Utilizing the CSMAR and Wind databases, we classify issuers by ownership type (SOEs vs. non-SOEs). As illustrated in Table 1, SOEs exhibited a marked predominance in green bond issuance over the nine-year study period, with 1,357 of the 1,449 total bonds issued by SOEs. While SOE issuances demonstrate rapid growth, non-SOE quantity remains stable with only marginal increases in recent years. Figure 2 further delineates the issuance scales between these two ownership types, providing granular insights into market dynamics. Figure 2 presents the distribution of green bond issuances in China by ownership, measured in both quantity and average issuance amount. The data reveals distinct trends across SOE and non-SOE green bonds. Notably, SOEs dominate in terms of both quantity and volume of issuance, reflecting the pivotal role of large SOEs in China's green finance market. Conversely, non-SOEs exhibit comparatively stable yet diminished issuance numbers, consistent with their more circumscribed business scope. This segmentation underscores the structural differences between issuer types.

[Insert Table 1 here]

[Insert Figure 2 here]

Figure 3 presents the industry distribution of corporate green bonds. We adopt Wind's sector classification to ensure methodological consistency. The data reveal a pronounced concentration in Industrials and Utilities sectors, mirroring Flammer's (2021) U.S. findings, suggesting cross-market similarity in green bond adoption patterns in the U.S. and China. Notably, energy-sector issuances predominate in average size, exhibiting substantially higher transaction volumes compared to other sectors.

3.2 Other bond-level data

The other bond-level data are obtained from multiple sources. The majority of the information is derived from Wind and CSMAR, which complement each other, while greenness information is manually collected from green bond prospectuses. We focus on the yield at issuance because the primary market determines the actual interest rate paid by issuers to borrow funds. Details are described below.

Conventional bond information is derived from the aforementioned databases, with the Chinese Development Bank (CDB) bond yield from the same data service serving as the reference curve. The credit spread between each green bond's coupon and the yield of a CDB bond of the same maturity is the primary dependent variable of interest.[9] Other conventional bond characteristics such as issue size, maturity, credit rating, puttable/callable features, and sinking clause are also obtained from these databases. We also carefully dig into the green information of all the green bonds included in our study. This data is not available through other means, therefore, all bond prospectuses in the sample are manually downloaded and reviewed to extract the relevant details.

We collect green bond prospectus from multiples ways. Typically, the issuance and trading of corporate green bonds occurs within one of three designated bond markets: (1) the China Foreign Exchange Trade System (National Interbank Funding Center), (2) Shanghai Stock Exchange (SSE), and (3) Shenzhen Stock exchange (SZSE).[10] [11] - The interbank market is the main trading venue for domestically issued corporate green bonds in China. After identifying green bonds from the CSMAR database, we locate the issuance prospectuses by searching the "Disclosure" sections of the respective exchange websites using the issuer names and timing details. We verify each bond's primary issuance market to ensure accurate sourcing.[12] [13] With these prospectuses, we could locate the greenness information for each green bond.

We first search for the independent third-party verification (Flammer, 2021; Yu et al., 2024) in the prospectuses. As discussed by Yu et al. (2024), third-party certified green bonds provide more detailed project disclosures than uncertified bonds; certification involves pre-issuance evaluations of project compliance, fund management, and environmental impact, followed by ongoing monitoring of fund utilization and disclosure practices. We manually review each prospectus to identify third-party verification.

In addition, we have identified two metrics of greenness that have received insufficient attention in the extant literature: the refinancing ratio and the project investment ratio. The refinancing ratio, analogous to the term "rollover" in prior studies (e.g., Dangl and Zechner, 2021; Rajan et al., 2015), measures the percentage of total proceeds allocated to debt repayment. Heavy reliance on short-term rollover, or rollover failure, has the potential to substantially amplify a firm's financial risk. The project investment ratio, conversely, quantifies the percentage of proceeds allocated specifically to green projects as opposed to operational expenses or refinancing purposes, thereby reflecting the bond's environmental impact. Both

[9] Green bonds in China mainland are all issued at par, which indicates that the yield is equal to the coupon rate.
[10] For more details, check the instructions or manuals in any of the three institutions' official website.
[11] Green bonds could be listed in multiple markets. For instance, a green bond could be traded in the interbank and listed in SSE/SZSE later to be traded across different venues. Therefore, some green bonds may have several symbols indicating the multi-market lists.
[12] CSMAR provides the information of primary listed market for each green bond.
[13] All three official websites provide complete issuance documentation packages for green bonds primarily listed in their respective markets. These compulsory files include the issuance prospectus, credit rating report, underwriting agreement, and third-party verification report (where applicable) for green bonds, among other required documents.

ratios function as critical indicators of a green bond's financial and environmental integrity. We manually extract these data from the "Use of Proceeds" sections of bond prospectuses.

We collect additional environmental information disclosure data from China Central Depository & Clearing CO., Ltd (CCDC) website. CCDC has developed a proprietary database that offers multi-dimension statistics, including the specific label or area, the environmental impact, environmental benefit disclosure, etc. Such information metrics pertaining to green bonds are distinct from those of other financial variables, yet there is a paucity of studies that have thoroughly examined the greenness information disclosure in accordance with the CCDC guidance.

3.3 Firm-level data

Our corporate green bond sample includes issuers from both listed and private companies. While private firms' accounting data are not readily available through standard data services, issuers are required to disclose audited balance sheets and income statements for the most recent three years plus one interim period in their bond prospectuses. We manually collect these issuer-level financial statements from all available prospectuses to construct the following key variables. Assets is the natural logarithm of the firm's total assets. The current ratio is the ratio of the issuer's current asset over current liability. Leverage is measured by total liability scaled by total assets. Return on Assets (ROA) is the ratio of net profits to total assets. Sales growth is constructed as the year-on-year sales growth rate. All variables are winsorised at the 1^{st} and 99^{th} percentiles of the empirical distribution to mitigate the influence of outliers.

3.4 Summary statistics

The bond and firm level data are summarized in Table 2. The total of 1449 corporate green bonds correspond to 858 issuer-year observations, as certain companies may issue multiple green bonds within the same year. We follow Geng and Pan (2024) to convert letter grades of bond credit ratings into numerical numbers that AAA takes the value of 3, AA+ takes the value of 2, and AA takes the value of 1. Similar to conventional corporate bonds, there are no significant differences in the credit ratings of green bonds, with very few ratings equal to or lower than AA+. The average credit rating for all corporate green bonds in the observation group is 2.7. The bond-level amount varies from 100 million RMB to 50,000 million RMB with an average maturity of 3.8 years.

[Insert Table 2 here]

A modest proportion of corporate green bonds, constituting approximately 17.8% of the sample, incorporate optionality features. Puttable bonds, which grant investors the right to sell the bond back to the issuer at certain conditions, account for the largest share. This optionality enhances investor flexibility, resulting in lower yields.[14] Callable bonds, representing 10.7% of the observations, confer early redemption rights to the issuers. Notably, 8.3% of the green bonds include sinking fund clause, which issuers can retire portions of the debt at a predetermined date. In terms of financial conditions, the green bonds in our sample are issued by companies with an average size of about 2,500,000 million RMB, a leverage ratio of 63%, a current ratio of 1.51, a ROA of 2.12%, and annual sales growth of 23.40%.

A preliminary comparison of credit spreads between green bonds issued by SOEs and non-SOEs reveals several notable trends, as shown in Figure 4. Throughout the sample period from 2016 to 2024, non-SOE green bonds demonstrated a persistent tendency to exhibit elevated credit spreads in comparison to their SOE counterparts. This observation is indicative of the prevailing market perception of heightened default risk associated with non-SOEs issuers. The non-SOE spreads exhibited high volatility in the early years, reaching a maximum of 247.9 basis points in 2019. Conversely, SOE bonds demonstrated remarkable stability during the early years, fluctuating within a relatively narrow 110-130 basis points range from 2017 to 2020. However, a striking structural shift occurred post-2020, as SOE spreads experienced a substantial compression, declining to a mere 42.2 basis points by 2023. The persistent higher spread for non-SOE bonds underscores the enduring market differentiation between state-backed and private sector issuers in China's bond market.

[Insert Figure 4 here]

4. The pricing of SOE and non-SOE green bonds

We introduce the methodology first in this section and present the baseline analysis results.

4.1. Empirical methodology for baseline analysis

To examine the price differences between green bonds issued by SOEs and non-SOEs, we first estimate the following equation:

$$Credit\ Spread_{i,j,t} = \alpha + \beta_1 SOE_{i,j,t} + \beta_2 Bond\ Controls_{i,j,t} + \beta_3 Issuer\ Controls_{i,j,t-1} + \beta_4 Greenness\ Controls_{i,j,t} + FEs + \varepsilon_{i,j,t} \tag{1}$$

[14] Unlike U.S. green bonds, which may be issued at premium or discount prices, Chinese corporate green bonds are uniformly issued at par value. While embedded optionality features (e.g., put/call provisions) affect yield pricing, they do not create price premiums in the primary market due to China's regulated pricing framework. This reflects distinct market conventions where:

where *i*, *j*, and *t* represent green bonds, issuers, and years, respectively. The dependent variable *Credit Spread* is the difference between the green bond coupon and the Chinese Development Bank (CDB) bond yield of the same maturity at issuance (in basis points). The main independent variable SOE takes 1 if the green bond issuer is a state-owned enterprise and 0 otherwise. Green bond controls in Equation (1) include a battery of bond characteristics introduced in Section 3, including credit rating, maturity, guarantee, puttable/callable and sinking clause that allow issuer to make the payment in advance. We incorporate green bond issuing company's assets, listed or not, leverage, ROA, current ratio, and sales growth as the firm level control metrics. We also control for the unique attributes of green bonds, such as the third-party verification for the bond's greenness. Definitions of all variables are presented in Table A1.

[Insert Table A.1. here]

The baseline model includes bond types, year and industry fixed effects to control for time-invariant omitted bond characteristics. The standard errors are heteroskedasticity-consistent and clustered at the issuer level.

4.2. Baseline result

We apply the OLS regression with fixed effects in Equation (1) to examine the price differences between green bonds issued by SOEs and non-SOEs. The coefficient β_1 denotes the price difference for SOE-issued green bonds relative to the non-SOE-issued samples.

[Insert Table 3 here]

Table 3 presents the baseline regression estimates. Column (1) excludes control variables but includes bond type, year, and industry fixed effects. The estimate of *SOE* indicates that SOE green bond issue at 58.5 basis points lower credit spread than non-SOE issues (significant at 1%). Given that lower credit spreads reflect reduced borrowing costs in the bond market, this finding suggests that SOEs command a significant pricing premium in the China's green bond market relative to their private sector counterparts. Column (2) incorporates all control variables described in Section 4.1, including issuer fundamentals, bond characteristics, and market conditions. The significant and negative estimate of *SOE* in Column (2) confirms the existence of a substantial pricing premium for SOE issuers after accounting for other credit spread determinants (70.8 basis points, significant at 1%). This is consistent with our first hypothesis.

Control variable estimates align with theoretical expectations and illuminate green bond pricing dynamics. Green bonds with higher credit ratings command significantly lower yields, reflecting reduced default risk. Similarly, larger issuers benefit from economically meaningful yield reductions consistent with scale advantages. Conversely, green bonds with guarantee or sinking clause command higher credit spreads, likely due to the additional complexity and potential covenant restrictions these features impose. Importantly, third-party verified bonds demonstrate persistently lower borrowing costs, suggesting that external validation of greenness reduces information asymmetries and lowers risk premia.[15]

To alleviate potential selection bias arising from systematic differences between SOE and non-SOE issuers, we implement two matching methodologies. Following Larcker and Watts (2020), we employ the nearest neighbors matching algorithm (using the Mahalanobis distance) to pair each SOE-issued green bond with its nearest non-SOE-issued counterpart. We utilize issuer control variables and bond-level characteristics as matching covariates while imposing exact matching constraints on issuer industry, issuance year, and less prevalent contractual provisions (i.e., callable). Similar to Crabbe and Turner (1995), we allow any non-SOE green bond to be matched to multiple SOE green bonds so long as they meet the requisite restrictions. Column (3) reports the result. Moreover, to preserve equilibrium between SOE and non-SOE green bonds without sacrificing observations, we re-estimate the baseline specification employing entropy balancing (Hainmueller, 2012) and present the result in Column (4). The SOE premium persists robustly across both specifications.

4.3. Different types of SOEs

We further distinguish central SOEs (controlled by the national SASAC) from local SOEs (controlled by provincial/municipal SASAC) to test hierarchical pricing effects. Central SOEs benefit from superior resource allocation, including natural resources, raw materials, technology transfers, infrastructure advantages, and direct subsidies for national strategic mandates. On the other hand, local SOEs operate under constrained fiscal capacity and competitive market pressures (Luo et al., 2024). This governance divergence implies stronger implicit guarantees for central SOEs, thereby reducing their financing costs.

[Insert Table 4 here]

As shown in Column (2) of Table 4, green bonds issued by local SOEs exhibit credit spreads of 65 basis points lower than that of non-SOE issues, while green bonds issued by central SOEs enjoy a further 15.5 basis points reduction in credit spread relative to local SOEs. This central SOE premium persists

[15] The engagement of independent third-party verification agencies to assess and certify green bonds represents a promising mechanism for addressing credibility concerns in the green bond market. Such verification processes enable investors to distinguish between issuers genuinely committed to environmental improvement and those employing green bonds merely as instruments of greenwashing. This third-party oversight potentially enhances market transparency and investor confidence by providing standardized evaluation criteria and independent validation of environmental claims. Notably, the third-party verification is not mandatory for green bonds issued in China mainland while the majority green bonds issuance package includes the independent reports.

robustly in matched sample (Column 3) and entropy-balanced sample (Column 4), suggesting that markets explicitly price government support differentials across ownership tiers. Central SOEs enjoy measurable financing advantages in green bond issuance, directly attributable to their position in the state hierarchy.

4.4. Additional Robustness – Oaxaca-Blinder Decomposition

To determine whether the SOE premium (Section 4.2) reflects a genuine ownership premium or stems from observable fundamentals, we employ an Oaxaca-Blinder decomposition (Karpf and Mandel, 2018) for SOE versus non-SOE green bonds. This method quantifies the contribution of observable characteristics (bond, issuer, and market) versus the *ceteris paribus* effect of SOE ownership.

[Insert Table 5 here]

Table 5 presents decomposition results using non-SOE green bonds as the reference group. The mean credit spread differential (SOE minus non-SOE) is -58.7 basis points, confirming SOEs' systematic funding advantage. The twofold Oaxaca–Blinder decomposition method allows us to separate this credit spread gap into an "explained" part, which is due to differences regarding bond-level and firm-level characteristics (fundamentals) between the two groups, and an "unexplained" part, which is not due to fundamentals and would signal the existence of a "SOE" premium (pricing advantage). In other words, the "unexplained" component measures how the average credit spread of non-SOE green bonds would change if they were evaluated by the market the same way as SOE green bonds. The parameters estimated for the "explained" and "unexplained" parts are 13.1 basis points and -71.8 basis points, respectively. All parameter estimates are statistically significant. This implies that 71.8 basis points (122%) of the raw differential stems from market perceptions of SOE status, overwhelming their marginally riskier fundamentals (which would otherwise imply higher spreads). In other words, if non-SOE green bonds had been evaluated as SOE green bonds, they would have a lower credit spread conditional on fundamentals. The result is consistent with the evidence that the bonds issued by SOEs in the Chinese market have implicit government guarantees (Geng and Pan, 2024), highlighting a structural distortion disadvantaging non-SOEs: non-SOE issuers face systematically higher credit spreads despite comparable fundamentals, solely due to ownership status.

4.5 Additional Robustness – Heckman Two-step Method

Due to the distinctive greenness prerequisite for green bonds, certain corporations may deliberately opt for green bond issuance in lieu of conventional bond financing. Consequently, a salient empirical concern emerges that, green bond issuance exhibits endogenous firms' financial characteristics. Specifically, unobservable heterogeneity may simultaneously influence SOE and non-SOE propensities to issue green bonds while spuriously correlating SOE or non-SOE status with green bond credit spreads. While the matched sample analysis can partially mitigate unobservable disparities between SOEs and non-SOEs, we implement the Heckman two-step procedure to more rigorously address the endogenous selection inherent in green bond issuance versus conventional bond financing.

[Insert Table A2 here]

Table A2 reports the Heckman Two-step method results. We firstly investigate whether companies issue green bond instead of conventional bonds for some particular reasons. The output in Column (1) takes one if the green bond could find a matched conventional bond following the standards below. We match conventional bonds following Flammer's (2021) two step standards. First, the conventional and green bond issued by the same company must have the same credit rating. Then we use the Mahalanobis distance to find the nearest neighbor for each green bond based on the characteristics in the Flammer's (2021) matching process. We employ the regression method in the second step where the inverse Mills ratio is involved and report the result in Column (2). The SOE's green bond premium is robust in this sample selection bias check.

4.6 Green versus conventional bonds among SOE and non-SOE issuers

Prior studies predominantly focus on hybrid or developed markets (e.g., Flammer,2021), offering limited insights into emerging market dynamics. China's institutional context, characterized by substantial government support for green finance through preferential policies, creates fundamentally distinct pricing mechanisms relative to market-driven economies. SOEs' privileged position, coupled with their implicit government guarantees and the consistency of their development strategies with the national environmental agendas, exhibits a unique green bond pricing pattern compared with private enterprises. This institutional divergence warrants targeted investigation of China's distinctly policy-driven market to determine whether mixed greenium effects observed in developed markets persist under state-directed finance.

To validate H2, we investigate the pricing differential between green and conventional bonds among SOE and non-SOE issuers in the Chinese bond market. We explore this question by estimating the following equation:

$$
\begin{aligned}
Credit\ Spread_{i,j,t} = {} & \alpha + \beta_1 SOE_{i,j,t} + \beta_2 Green_{i,j,t} + \beta_3 SOE_{i,j,t} \times Green_{i,j,t} \\
& + \beta_4 Bond\ Controls_{i,j,t} + \beta_5 Issuer\ Controls_{i,j,t-1} \\
& + \beta_5 Issuer\ Controls_{i,j,t-1} + \beta_6 Greenness\ Controls_{i,j,t} + FEs + \varepsilon_{i,j,t} \qquad (2)
\end{aligned}
$$

where the variable *Green* is a dummy taking the value of 1 if the bond was labeled as green. Our empirical analysis begins with the identification of green bond issuers from the Wind database, covering the period from 2016 to 2024. For each green bond issuer, we collect comprehensive information on their conventional bond issuances within the same timeframe to ensure comparability. This screening procedure yields a sample of 14,720 green and conventional bonds. To mitigate potential selection bias, we implement exact matching methodology, refining the sample to 1,189 matched bond observations. While this reduces our sample size, it enhances causal identification by balancing issuer and bond characteristics.

[Insert Table 6 here]

The results are presented in Table 6. Column (1) reports our baseline findings for the full sample including both green and conventional bonds. In contrast to the prevailing expectations of a greenium effects between green and conventional bonds, our findings reveal no statistically significant variation in this regard. However, we document a stronger SOE premium in the green bond market than the conventional bond market (*SOE* × *Green* = -22.7 basis points). This SOE premium persists robustly in matched samples (Column 2), confirming that it is not driven by observable fundamentals.

To explore the heterogeneity within the SOE sector, we conduct a more granular analysis by distinguishing between central SOEs and local SOEs. The results, reported in Columns (3) and (4), reveal important heterogeneity in the green bond pricing dynamics across these SOE categories. Local SOEs have driven the overall SOE premium in the green bond market, maintaining the same spread advantage as the conventional bond market. The bonds of central SOEs show divergent pricing. While retaining the advantages in conventional bonds, their pricing advantage in green bonds has vanished.

5. Potential factors affecting SOE premium

5.1. Third-party verification and environmental credibility signals

The expansion of China's green bond market has intensified concerns about the environmental authenticity of labeled green bonds. This apprehension stems from the lack of universally binding standards to define the "green" status. Under current Chinese regulatory frameworks, bonds qualify as green if the use of proceeds aligns with the *Green Bond Endorsed Projects Catalogue* or the *Guidelines for Green Bond Issuance*, though these designations rely to a large extent on the issuers' self-reporting. The problem is compounded by inconsistent transparency in fund allocation, project advancement, and realized environmental benefits (Ehlers and Packer, 2017). Despite the recent strengthening of regulatory requirements for information disclosure, compliance remains largely voluntary, which has led to the persistence of information asymmetry, hindered accurate environmental assessment, and eroded investors' confidence.

Under such conditions, third-party verification has emerged as a crucial credibility-enhancing mechanism. By independently confirming a bond's alignment with environmental standards, such verification mitigates informational frictions and enhances market discipline (Baker et al., 2022). Additionally, some issuers voluntarily disclose adherence to international standards, such as the GBP of the ICMA or the EU-China CGT, signaling alignment with more stringent environmental protocols. We hypothesize that the above-mentioned measures to enhance environmental integrity disproportionately benefit non-SOEs because they face higher environmental uncertainty and stronger information asymmetries compared to SOEs, which already benefit from government backing and regulatory oversights. Therefore, these credit signals increase non-SOEs price discount while can weaken the SOE premium existing in the green bond market.

We test this hypothesis through four regressions examining whether third-party verification and international standard alignment moderate the SOE premium. Table 7 reports these results[16], where the dependent variable is the green bond's *Credit Spread*, and the key explanatory variables are interaction terms between SOE status and indicators of environmental credibility (*Verification*, *Leading Agencies/Other Agencies*, *GBP*, *CGT*).

[Insert Table 7 here]

Column (1) of Table 7 shows that third-party verification significantly reduces the SOE premium. For green bonds without verification, the estimated SOE premium is 128.9 basis points. The interaction term, *SOE × Verification*, is estimated at 97.9 basis points (significant at the 1% level), indicating that verification reduces the SOE premium by approximately 76%. Column (2) further disaggregates this effect by differentiating leading verification providers (e.g., Lianhe Equator, CCXGF) from other agencies. Verification by leading agencies yields a more pronounced reduction of the SOE premium (101.4 basis points) compared to other agencies (71.5 basis points), underscoring the credibility-enhancing role of market-dominant certifiers. Columns (3) and (4) examine the effects of aligning with international standards. Bonds disclosing adherence to *GBP* and *CGT* show a 51% and 90% reduction (both significant at 1%) in the SOE premium, respectively, relative to their non-disclosing counterparts. The negative estimates for

[16] Due to the limited number of green bonds issued by non-SOEs and the substantial systematic differences between SOEs and non-SOEs within China's distinctive market environment, we conducted entropy reweighting on the sample and ran regressions in Tables 7 to 11 to control for confounding variables related to green bonds and issuer characteristics. We reproduce these results in the Appendix by applying the nearest neighbor matching algorithm to confirm their robustness.

third-party verification are economically meaningful and consistent with the literature showing that credible environmental commitment signals lower perceived risk and improves pricing for green bonds (Zerbib, 2019; Gianfrate and Peri, 2019). Importantly, this mechanism is more pronounced for non-SOE green bonds than for SOE bonds, indicating that credibility signals disproportionately benefits issuers facing higher information asymmetries and less government back-ups.

Overall, these findings indicate that the SOE premium in China's green bond market is not immutable but responds to credible signals of environmental quality. Non-SOEs that obtain third-party verification, especially from leading agencies, or voluntarily disclose alignment with rigorous international standards can significantly reduce their borrowing costs, thereby partially offsetting the pricing advantage traditionally enjoyed by SOEs.

5.2. Use of proceeds and environmental disclosure quality

Investor skepticism toward the environmental authenticity of green bonds has increasingly focused on the use of proceeds, particularly the distinction between financing new green projects versus refinancing existing obligations. This distinction is critical, as the latter often lacks additionality, thereby raising concerns about greenwashing (Larcker and Watts, 2020). In the Chinese context, these concerns are exacerbated by historically opaque disclosure practices. As of 2020, only 28% of Chinese green bond proceeds were allocated to new environmental projects, while 10% were designated for refinancing, and a majority (51%) disclosed no specific use of funds (CPI, 2020). [17] Although the 2022 *China Green Bond Principles* mandate a 100% green allocation, there is still ambiguity in the classification and acceptability of refinancing, which leaves room for strategic mislabeling and undermines investors' confidence.

To assess whether the use of proceeds influences the SOE premium[18], we construct two continuous variables based on information from the 1,449 green bond prospectuses: (1) the share of proceeds allocated to new green projects (*Green Projects*), and (2) the share used for refinancing (*Refinancing*). We further construct two binary indicators, $\textit{Green Projects}^{High}$ and $\textit{Refinancing}^{High}$, which equal to one if the allocation equals or exceeds certain thresholds (70% for new green projects and 50% for refinancing, respectively).[19]

[17] CPI (2020). The State and Effectiveness of the Green Bond Market in China: https://www.climatepolicyinitiative.org/china-green-bonds-the-state-and-effectiveness-of-the-market/.

[18] The costs of refinancing existing projects are more affected by the fundamental risks of the issuer, for which SOEs are perceived to be superior because they benefit from the implicit government guarantee and their strong market position. In contrast, the costs of financing new projects are more influenced by the technological capabilities of the project or the issuer's operational and management mechanisms, for which non-SOEs are usually perceived to be superior.

[19] 70% is the 75th percentile of *Green Projects*, and all percentiles below are 0. Additionally, 50% is the median of *Refinancing*, and all percentiles below are 0.

These variables interact with the key independent variable *SOE* in our regressions to test their moderating effect on the SOE premium.

[Insert Table 8 here]

Table 8, Panel A presents the regression results. Columns (1) and (3) show that continuous allocation measures are not significantly correlated with variation in the credit spread or the SOE premium. In contrast, Column (2) reveals that bonds dedicating at least 70% of proceeds to new green projects experience significantly lower credit spreads across all issuers, indicating investors' willingness to reward additionality and credible commitment to environmental objectives (Flammer, 2021). This result indicates that when the proceeds are mainly used for new green projects, the market's traditional preference for SOE issuers substantially diminishes. On the contrary, when the proceeds are mainly used for refinancing existing projects or extending old debts, it will not affect the relative advantages of SOEs to non-SOEs in the credit market.

To gain more insight, we decompose proceeds using the 2021 *Green Bond Endorsed Projects Catalogue* issued by the PBoC, classifying the use of proceeds into three categories (in percentages): *Pollution Control* (e.g., waste treatment), *Energy Efficiency* (e.g., industrial efficiency upgrades), and *Clean Energy* (e.g., solar/wind projects). Table 8, Panel B reports these results. We observe heterogeneity in the SOE premium across green project areas. In Column (1), the interaction term *SOE* × *Pollution Control* is significantly negative (-0.698 basis points), suggesting that SOEs have particularly strong advantages in regulatory-intensive sectors, such as environmental remediation. This finding likely reflects perceived policy alignment and SOEs' systemic importance in pollution abatement areas. In contrast, positively significant interactions in Columns (2) and (3) for *Energy Efficiency* (0.254 basis points) and *Clean Energy* (0.217 basis points) indicate that non-SOEs have smaller cost disadvantages when funding green projects in these areas. These results are consistent with the common view that non-SOEs often possess comparative advantages in technological innovation industries, such as renewables, and that the capital markets recognize these specialized advantages (China Energy Transition, 2024).[20] They also align with the documented evidence that specialized capabilities mitigate ownership discounts (Fatica and Panzica, 2021).

[Insert Table 9 here]

[20] https://www.gov.cn/zhengce/202408/content_6971115.htm. The white paper argues that non-SOEs are gradually taking a dominant position in the new energy industry, represented by photovoltaics and wind power.

As reported in Table 9, we assess the role of environmental disclosure quality, using indicators from the CCDC's *Environmental Benefit Disclosure Indicator System.*[21] Drawing data from the CCDC Green and Low-Carbon Transition Bond Information Hub, we construct three indicators measuring disclosure comprehensiveness.[22] Column (1) shows that mere alignment with the CCDC's disclosure system (*CCDC* = 1) will not narrow the SOE premium, suggesting that participation in disclosure system only provides insufficient credibility enhancement . Columns (2) and (3) focus on a subsample of bonds that disclose some environmental information under CCDC's system. Column (2) reveals that full compliance with mandatory disclosure requirements reduces the credit spreads by 23.8 basis points (significant at the 5% level), although the *SOE* × *Mandatory Disclosure* interaction is insignificant, implying that the reduction is uniform across SOE and non-SOE issuers. The most compelling evidence arises in Column (3): the three-way interaction between *SOE*, the degree of complete disclosure quality (*Full Disclosure*), and proceeds used exclusively for new green projects (*Proceeds* = 1) is positive and significant (1.117 basis points). This suggests that the pricing disadvantage faced by non-SOEs is substantially reduced when bonds combine high-quality environmental disclosures with proceeds committed solely to new environmental assets. This finding reinforces the argument that the effectiveness of disclosure is conditional upon the underlying use of funds—comprehensive reporting is most valuable when paired with credible environmental commitments (Gianfrate and Peri, 2019). Conversely, the insignificance of the *SOE* × *Full Disclosure* interaction in Column (3) suggests that when the proceeds are directed toward refinancing, disclosure quality has limited signaling power, and the market continues to rely on the fundamentals of issuers, particularly their ownership status, to claim the risk premium.

In sum, these results demonstrate that while SOEs enjoy systemic advantages regardless of how proceeds are used or disclosed, non-SOEs can reduce their financing disadvantage through a strategic combination of high environmental commitment and credible, transparent reporting. This interaction offers a promising pathway for regulatory framework improvement, such as the CCDC's system, to mitigate ownership-based pricing discrimination in China's green bond market.

[21] CCDC stands for China Central Depository & Clearing Co., Ltd. It is the largest and most important bond registration, custody and settlement institution in the Chinese bond market. The CCDC's *Environmental Benefit Information Disclosure Indicator System* aims to establish a systematic and standardized information disclosure system and to encourage the disclosure for environmental information in green bond issuance. This disclosure system consists of mandatory disclosure indicators and voluntary disclosure indicators, with different disclosure requirements for different green projects. The classification of green projects is also based on PBoC's catalogue (2021).

[22] https://www.chinabond.com.cn/greenbond/#/home. It is important to note that not all green bonds in the sample disclose environmental information at their issuance. A total of 1,002 of the 1,449 green bonds disclosed environmental information to varying degrees, no relevant information has been disclosed about the others.

5.3. Supply-demand dynamics and underwriter intermediation

A fundamental requirement for a pricing premium to persist is that investor demand must be sufficiently strong to absorb supply at a higher price (lower spread). That is, the marginal investor must be willing to pay a premium for the asset. Therefore, this subsection investigates whether changes in investor demand conditions, market policies, and underwriter characteristics influence the SOE premium and whether these mechanisms can help create a fair competitive environment for non-SOE issuers in the green bond market.

[Insert Table 10 here]

Table 10 first examines two supply-demand variables. In Column (1), *Issue Size* is negatively associated with credit spreads (-16.9 basis points, significant at the 5% level), consistent with economies of scale in bond issuance. However, the insignificant interaction between *SOE* and *Issue Size* suggests that non-SOEs do not disproportionately benefit from larger issuance volumes, and thus, scale economies alone do not reduce the SOE premium. Column (2) explores the effects of the PBoC demand-side policy of 2021. The introduction of this scheme significantly lowered credit spreads across the board (-68.4 basis points, significant at the 1% level). Importantly, the positive and significant interaction term (*SOE × Post 2021 =* 46.8 basis points) indicates that the reduction of credit spread was more pronounced for non-SOE bonds than for SOE bonds. These results suggest that the policy enhanced institutional demand for green bonds and reduced the reliance on ownership-based risk heuristics, leading to a stronger demand for green bonds issued by non-SOEs.

The next set of results, presented in Column (3) and (4) in Table 10, explain how underwriter market structure influences ownership-based pricing differentials. Column (3) shows that higher concentration in underwriting teams, as measured by the Herfindahl-Hirschman Index (HHI)[23], significantly increases credit spreads (52.5 basis points, significant at 1%), indicating that the concentrated market power of underwriters raises the issuance costs of borrowers. Notably, the *SOE × Underwriter HHI* interaction is negative and significant (-46.5 basis points), indicating that SOEs are less affected by underwriter concentration than non-SOEs, possibly due to stronger bargaining power and underwriters' intention to compete for SOEs' future underwriting business (Ding et al., 2022). Column (4) highlights the beneficial role of engaging prominent underwriters. A higher weighted-average market share of the lead underwriter[24] reduces issuance

[23] The Herfindahl-Hirschman Index (HHI) of the underwriting syndicate, calculated as the sum of squared underwriting shares of all lead underwriters for the green bond.

[24] *Underwriter Share* refers to the average market share of green bonds underwritten by each lead underwriter in the underwriting syndicate during the year of issuance. It is calculated as a weighted average based on each lead underwriter's share of the green bonds they underwrote.

costs (-5.5 basis points) for all bond issuers. The *SOE* × *Underwriter Share* interaction is positive and significant (6.7 basis points), implying that non-SOEs benefit more than SOEs from using large underwriters to lower the borrowing cost of green bonds. This result supports the view that prestigious intermediaries serve a certification role, reducing informational frictions and enhancing bond credibility (Liu and Ritter, 2011).

Together, these results underscore the importance of both institutional policies and market intermediation in mitigating ownership-based pricing disparities. Regulatory reforms that stimulate investor demand, especially from banks, and underwriter certification seem to be effective tools to reduce the cost disadvantage faced by non-SOE issuers.

5.4. Provincial-level green finance preferences and local fiscal conditionals

China's administrative structure creates provincial-level variation in institutional strength and fiscal capacity that may materially influence bond pricing dynamics. Local governments often treat green finance as an instrument for political advancement, and environmentally proactive regions typically provide greater financial and policy support for green bond issuance. Furthermore, issuer-level behavior and investor perceptions may be shaped by local institutional settings, including regulatory commitment to green finance goals and the fiscal strength needed to sustain implicit guarantees.

To explore the heterogeneity in local green finance preference, we incorporate two provincial-level green finance policy indices developed by the International Institute of Green Finance (IIGF) at Central University of Finance and Economics: The *Green Financial Policy Development Index* (GFP) and the *Financial Sector Greenness Index* (GFS).[25]

[Insert Table 11 here]

Table 11 presents these results. In Column (1), *GFP* is negatively associated with credit spreads (-37.7 basis points, significant at the 1%), indicating that stronger provincial green financial policy frameworks reduce local enterprises' borrowing costs. Crucially, the positive and significant *SOE* × *GFP* interaction (34.9 basis points) suggests that the SOE premium diminishes in regions with more mature green financial policies. A similar pattern is observed with *GFS* in Column (2). These results imply that in jurisdictions

[25] In recent years, a significant number of policies promoting the development of green finance have been introduced by both central and local governments in China. The overlap between these policies complicates the assessment of the impact of the institutional environment based on a single policy. In this study, we employ a policy index that has been utilized in the extant literature to comprehensively measure the impact of different policies (e.g., Huo et al., 2022; Lee et al., 2023). Comparing with *GFP*, *GFS* focuses and captures the direct policy impact on financial institutions' green business.

with robust green finance infrastructure, investors are less reliant on ownership as a proxy for environmental or credit quality, reducing the systemic advantage enjoyed by SOEs (La Porta et al., 1998).

We next examine how local fiscal health shapes the credibility of implicit guarantees. Following Kornai's (1986) theory of soft budget constraints, we expect that fiscally strained provinces may prioritize government support to SOEs and struggle to credibly support non-SOEs in distress, thereby reinforcing the SOE premium. Consistent with this view, Column (3) shows that in regions with high local government financing vehicle (LGFV) spreads[26], the SOE premium is amplified, as evidenced by the significant and negative *SOE × LGFV spread* interaction (-0.381 basis points). Conversely, in provinces with stronger fiscal balances, the SOE advantage narrows. Column (4) reports a positive and significant *SOE × Fiscal Balance* interaction (0.895 basis points), suggesting that a strong fiscal position enhances the perceived credibility of implicit government support for all local green bond issuers, not just SOEs (Khwaja and Mian, 2005). When a local government is financially robust, its ability to honor contingent liabilities is higher, making its support for the broader local economy more believable to investors and reducing the market's reliance on the simple ownership structure in determining the risks of borrowers.

Overall, these findings highlight that the SOE premium is contingent upon the regional institutional context. Provinces with advanced green financial policy frameworks and robust fiscal capacity tend to attenuate the systemic cost advantage of SOEs, thereby fostering a more level playing field for non-SOEs in the green bond market.

6. Conclusion

Existing research reports inconsistent greenium effects across markets, underscoring the need to examine China's unique ownership heterogeneity. Given that SOE premium in the conventional bond market has been empirically validated, this paper investigates whether similar advantages manifest in China's green bond market. Using comprehensive green bond prospectus and CCDC environmental disclosure data, we analyze whether SOEs enjoy pricing premiums in the green bond market and identify the factors that affect such premiums, if they exist.

By employing the sample of corporate green bonds issued between 2016 and 2024 in China, we find that on average a 70.8 basis points credit spread advantage for SOE green bonds issues versus non-SOE

[26] The calculation and subsequent publication of *LGFV spread* (in basis points) is conducted by WIND. This is defined as the mean difference between the bond yield of AAA-rated provincial government financing vehicles and the yield of treasury bonds of the same maturity in the year preceding the issuance of green bonds. This spread essentially reflects the combined effects of provincial default risk premium, liquidity premium, and policy expectation premium.

green bonds issues, with central SOEs enjoying lower borrowing cost than local SOEs. This finding is validated by a battery of robustness checks. Crucially, while aggregate green bonds show no pricing advantage over conventional bonds, SOE premium is stronger in green bond issues compared with conventional bonds issues.

Our further analysis reveals that the SOE premium in China's green bond market is not uniform but varies meaningfully with issuer practices, market conditions, and regional institutional environments. Specifically, non-SOEs can partially mitigate their financing disadvantages by enhancing transparency through third-party verification, aligning with international standards, committing proceeds to new green projects, improving the degree of environmental information disclosure. Furthermore, stronger provincial green finance preferences and fiscal capacity reduce reliance on state ownership as a risk signal. These findings suggest that while structural advantages persist for SOEs, non-SOEs can strategically leverage transparency, quality certification, and institutional environments to access green capital more competitively in China.

Our study provides important policy implications for green financing of non-SOEs. While non-SOE green bond issuance has demonstrated significant growth in recent years, government-backed SOEs continue to dominate the market and consistently enjoy lower financing costs. To enhance non-SOEs' financing access in the green financing market, particularly in the green bond segment examined in our study, policymakers should standardize environmental disclosure frameworks and incentivize verification mechanisms, while strengthening policy promotion for non-SOEs. These measures would enable non-SOEs to leverage transparency and quality signals, reducing reliance on ownership-based pricing in the Chinese market.

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Figure 1. Spatial Heterogeneity in Green Bond Issuance across Chinese Provinces (2016–2024)

This figure illustrates the province-level distribution of green bonds from 2016 to 2024. The color indicates the total number of green bonds issued in each province. The termination year for the figure is 2024.

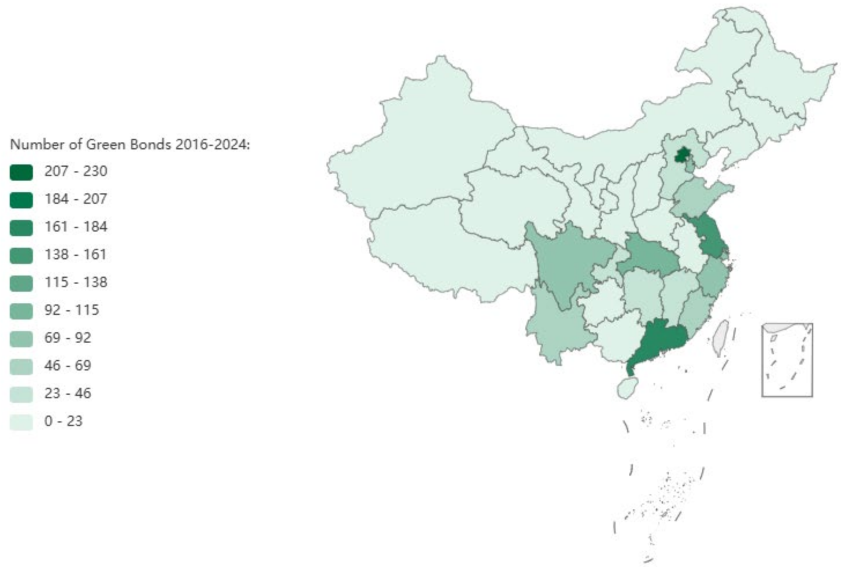

Figure 2. Green Bond Issuance and Average Amount by Year and Enterprise Type (2016-2024)

This dual-axis bar-line chart illustrates annual green bond issuance patterns from 2016 to 2024. Blue and amber bars (left y-axis) represent issuance counts by enterprise type—state-owned enterprises (SOEs) and non-SOEs, respectively. Corresponding lines (right y-axis) track average issue size per bond, with consistent color coding for enterprise types. The termination year for the figure is 2024.

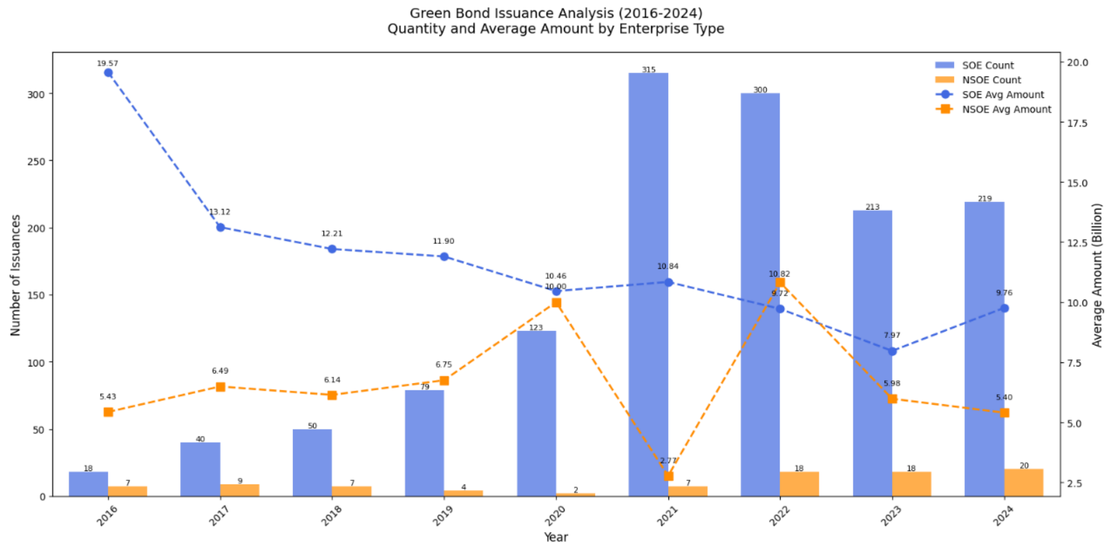

Figure 3. Green Bond Issuance and Average Amount by Industry and Enterprise Type (2016-2024)

This dual-axis bar-line chart illustrates annual green bond issuance patterns by industries. Blue and amber bars (left y-axis) represent issuance counts by enterprise type—state-owned enterprises (SOEs) and non-SOEs, respectively. Corresponding lines (right y-axis) track average issue size per bond, with consistent color coding for enterprise types. The termination year for the figure is 2024.

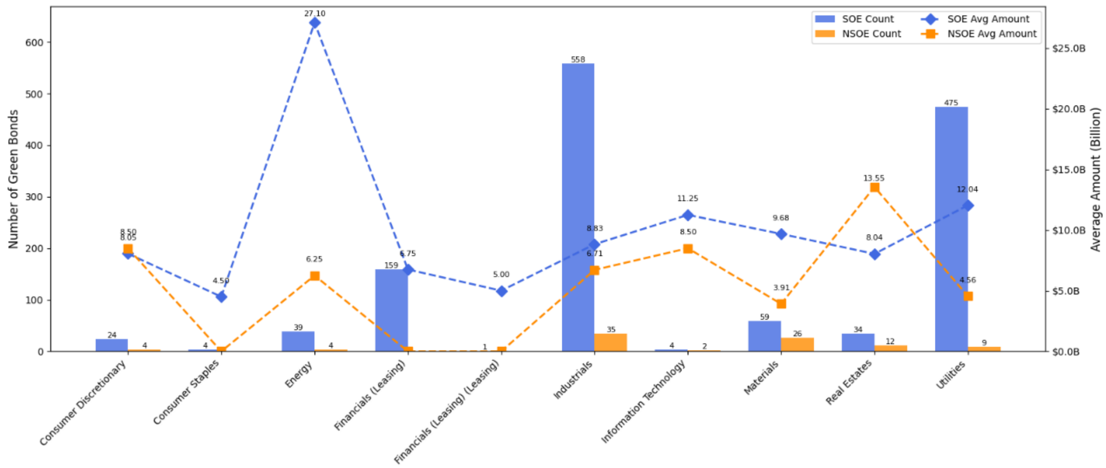

Figure 4. Green Bond Annually Average Spread by Enterprise Type (2016-2024)

This line chart illustrates annual average green bond credit spread by enterprise type. Credit Spread is defined as the difference between the green bond coupon and the Chinese Development Bank (CDB) bond yield of the same maturity at issuance (in bps). Blue and amber lines represent issuance by enterprise type, SOEs and non-SOEs, respectively. The termination year for the figure is 2024.

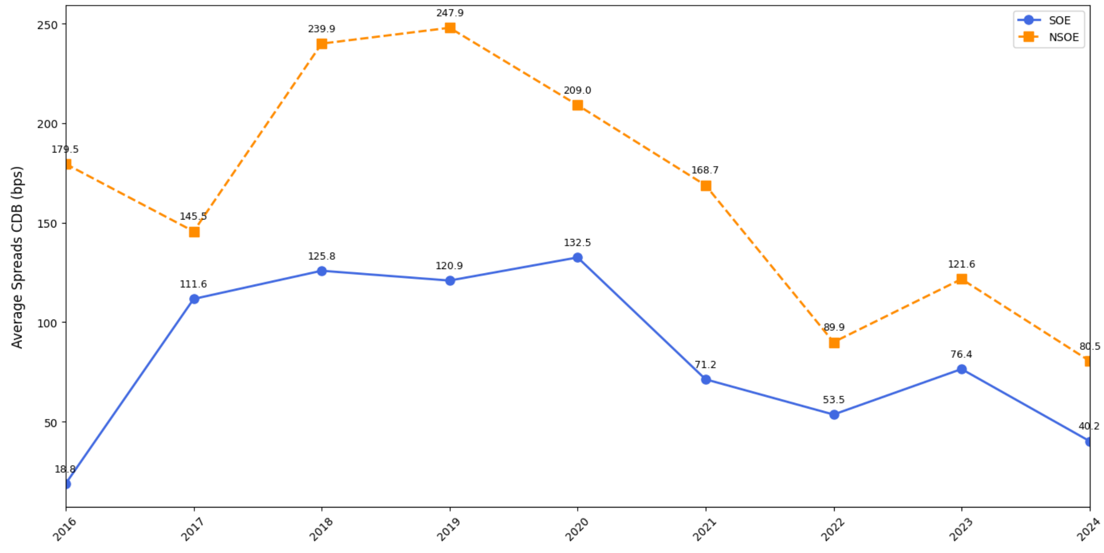

Table 1. Statistics of Green Bond Issuance

This table provides statistics of the number of green bonds issued in each year from 2016 to 2024.

Year	SOE	non-SOE
2016	18	7
2017	40	9
2018	50	7
2019	79	4
2020	123	2
2021	315	7
2022	300	18
2023	213	18
2024	219	20
Total	1,357	92

Table 2. Summary Statistics for Main Variables

This table reports the summary statistics of the core variables characterizing green bonds and green bond issuers covering observations from 2016 to 2024. Table A1 reports the definition of each variable. Green bond issuers' financial characteristics, namely, Assets, Leverage, Current Ratio, ROA, and Sales Growth have been winsorized at 1th and 99th percentiles. In the ensuing regression analyses we use the logarithm of continuous variables, and here we report the summary statistics for the raw data.

Variable	N	Mean	SD	P1	P50	P99
Credit Spread	1,449	77.812	79.311	-12.55	51.52	384.67
SOE	1,449	0.937	0.244	0	1	1
Issue Size	1,449	10.004	8.697	1	8	50
Maturity	1,449	3.849	2.867	0.2	3	15
Credit Rating	1,449	2.702	0.576	1	3	3
Guarantee	1,449	0.097	0.296	0	0	1
Puttable	1,449	0.178	0.383	0	0	1
Callable	1,449	0.107	0.309	0	0	1
Verification	1,445	0.653	0.476	0	1	1
Sinking	1,449	0.083	0.276	0	0	1
List	1,449	0.288	0.453	0	0	1
Assets	1,445	2,490.147	9,204.157	62.052	831.684	17,880.79
Leverage	1,445	62.68	15.624	24.295	63.325	87.559
Current Ratio	1,445	1.507	1.919	0.149	0.984	8.698
ROA	1,445	2.118	2.789	-4.396	1.472	13.166
Sales Growth	1,437	23.397	134.738	-37.228	10.188	228.864

Table 3. SOE Premium in China's Green Bond Market

This table reports the SOE premium in the green bond market in China with fixed-effect regressions. The dependent variable is *Credit Spread*, which is defined as the difference between the green bond coupon and the Chinese Development Bank (CDB) bond yield of the same maturity at issuance (in bps). The core independent variable is *SOE*, which assumes a value of 1 if the bond issuer is a state-owned enterprise and 0 if the issuer is a non-state-owned enterprise. Columns (1) and (2) report regression results without and with control variables, respectively Column (3) reports the regression results for a nearest neighbors matched sample between SOEs and non-SOEs, as outlined by Larcker and Watts (2020). In Column (4), entropy reweighting is employed to mitigate imbalances in bond characteristics and financial conditions between SOE and non-SOE (Hainmueller, 2012). The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Full Sample	Full Sample	Matched Sample	Entropy Balancing
Credit Spread	(1)	(2)	(3)	(4)
SOE	-58.452***	-70.842***	-77.638***	-35.782***
	(-3.935)	(-7.490)	(-7.601)	(-5.536)
Issue Size		-11.077***	-15.325***	-11.193***
		(-3.684)	(-3.509)	(-3.308)
Maturity		10.537**	1.588	9.805**
		(2.354)	(0.221)	(2.419)
Credit Rating		-49.073***	-48.544***	-54.046***
		(-7.886)	(-7.101)	(-9.039)
Guarantee		31.524***	104.215***	19.237**
		(2.996)	(5.342)	(2.081)
Puttable		-7.624	5.146	-8.463
		(-1.246)	(0.586)	(-1.357)
Callable		36.882***		41.979***
		(8.168)		(8.715)
Verification		-15.257***	-31.807***	-18.861***
		(-2.952)	(-3.515)	(-3.474)
Sinking		77.220***	29.410	105.262***
		(5.833)	(1.571)	(8.276)
List		3.066	-14.335**	2.580
		(0.658)	(-2.096)	(0.527)
Assets		0.521	-2.694	-0.955
		(0.276)	(-0.893)	(-0.492)
Leverage		0.420**	0.605**	0.350
		(2.056)	(2.035)	(1.611)
Current Ratio		5.019**	3.097	1.075
		(2.430)	(1.128)	(0.725)
ROA		-3.769***	-6.045***	-1.192*
		(-4.571)	(-3.566)	(-1.700)
Sales Growth		-0.033	0.041	-0.139***
		(-0.681)	(0.516)	(-3.088)
Constant	132.552***	249.632***	332.057***	256.030***
	(9.058)	(7.690)	(6.633)	(8.117)
Bond Type FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,449	1,437	957	1,437
Adjusted R^2	0.291	0.592	0.741	0.830

Table 4. SOE Premium in China's Green Bond Market: Different Types of SOEs

This table reports the SOE premium in the green bond market in China across different type of SOEs with fixed-effect regressions. The dependent variable is *Credit Spread*, which is defined as the difference between the green bond coupon and the Chinese Development Bank (CDB) bond yield of the same maturity at issuance (in bps). The core independent variable is *SOE Types*, which is a numerical number. The value of this number is as follows: The value of the indicator is designated as 1 if the issuer of a green bond is a central state-owned enterprise, 2 if the issuer is a local state-owned enterprise, and 0 if the issuer is a non-state-owned enterprise. Columns (1) and (2) report regression results without and with control variables, respectively. Column (3) reports the regression results for a nearest neighbors matched sample between SOEs and non-SOEs, as outlined by Larcker and Watts (2020). In Column (4), entropy reweighting is employed to mitigate imbalances in bond characteristics and financial conditions between SOE and non-SOE (Hainmueller, 2012). The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Full Sample	Full Sample	Matched Sample	Entropy Balancing
Credit Spread	(1)	(2)	(3)	(4)
Central SOE	-80.297***	-80.480***	-84.589***	-44.686***
	(-5.314)	(-8.024)	(-8.109)	(-6.757)
Local SOE	-48.199***	-65.006***	-72.197***	-28.484***
	(-3.328)	(-6.767)	(-6.467)	(-4.010)
Controls	No	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,449	1,437	957	1,437
Adjusted R^2	0.314	0.597	0.742	0.832

Table 5. Oaxaca–Blinder decomposition of the difference between the credit spreads of SOE and non-SOE green bonds

The Oaxaca-Blinder decomposition is a statistical method that is used to determine which part of the difference in credit spreads between SOE and non-SOE green bonds can be explained by the regressors (bond and issuers' characteristics, the explained part) and which part characterizes the SOE premium (the unexplained part). The set of control variables is consistent with the previous regressions. The definition of the variables can be found in Table A1. The results are based on a sample of 1,357 SOE green bonds and 92 non-SOE green bonds, as well as 200 bootstrap iterations. Full results are available upon request.

Dependent variable: *Credit Spread*	Estimated Coefficient	SD	*z*-statistic	*p*-value
Overall				
SOE	74.476	1.989	36.44	0.000
non-SOE	133.178	10.442	12.75	0.000
Difference	-58.701	10.695	-5.49	0.000
Explained	13.114	7.072	1.85	0.064
Unexplained	-71.815	7.878	-9.12	0.000

Table 6. SOE Premiums in China's Conventional and Green Bond Markets

This table reports the SOE premiums in China's conventional and green bond market with fixed-effect regressions. The sample contains 13,601 conventional bonds and 1,297 green bonds issued by the same set of issuers between the years 2016 and 2024. The dependent variable is *Credit Spread*, which is defined as the difference between the green bond coupon and the Chinese Development Bank (CDB) bond yield of the same maturity at issuance (in bps). The core independent variable in Columns (1) and (2) is *SOE*, which takes the value of 1 if the bond issuer is a state-owned enterprise and 0 if the issuer is a non-state-owned enterprise. The core independent variable in Columns (3) and (4) is *SOE Types*, which is a numerical number. The value of this number is as follows: The value of the indicator is designated as 1 if the issuer of a green bond is a central state-owned enterprise, 2 if the issuer is a local state-owned enterprise, and 0 if the issuer is a non-state-owned enterprise. Columns (1) and (3) report regression results for the full sample of 14,720 bonds issued between 2016 and 2024. Columns (2) and (4) report the regression results for an exact matched sample between green and non-green bonds, as outlined by Larcker and Watts (2020). The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Full Sample	Exact Matched	Full Sample	Exact Matched
Credit Spread	(1)	(2)	(3)	(4)
SOE	-39.761***	-47.860**		
	(-3.833)	(-2.357)		
Green	9.312	17.440	10.594	15.504
	(0.775)	(1.563)	(0.904)	(1.421)
SOE × Green	-22.735*	-21.669*		
	(-1.887)	(-1.901)		
Central SOE			-55.461***	-68.883***
			(-4.997)	(-3.262)
Central SOE × Green			-19.792*	-16.941
			(-1.673)	(-1.581)
Local SOE			-34.147***	-39.004*
			(-3.246)	(-1.954)
Local SOE × Green			-22.086*	-19.725*
			(-1.761)	(-1.703)
Controls	Yes	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	14,720	1,189	14,720	1,189
Adjusted R^2	0.349	0.449	0.359	0.469

Table 7. Environmental Impact and SOE Premium in China's Green Bond Market

This table reports the relationship between various indicators related to the environmental impact of the green bond and the green bond issuance cost differential between SOE and non-SOE. The dependent variable, *Credit Spread*, is regressed on various characteristics related to the environmental impact of the green bond issuance in China. Regressions are run using the full green bond sample with entropy reweighting. The core independent variable in Column (1) is *Verification*, which is assigned to a value of 1 if the green bond received a third-party green verification at issuance, and 0 otherwise. The core independent variable in Column (2) is the numerical variable *Leading Agencies*, which equals 2 if the green bond's third-party verification service provider was Lianhe Equator or CCXGF (the top two providers by market share), 1 if the bond was verified by average third-party agencies, and 0 if the bond did not undergo third-party green verification. The core independent variables in Columns (3) and (4) are two dummies, *GBP* and *CGT*, indicating if the green bond follows the Green Bond Principles (GBP) proposed by the International Capital Markets Association (ICMA) and if it was aligned with the Common Ground Taxonomy (CGT) between the EU and China, respectively. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Entropy Balancing			
Credit Spread	(1)	(2)	(3)	(4)
SOE	-128.881***	-121.616***	-43.143***	-38.203***
	(-6.805)	(-6.382)	(-6.765)	(-6.572)
Verification	-114.036***			
	(-6.123)			
SOE × Verification	97.944***			
	(5.208)			
Leading Agencies		-115.968***		
		(-6.233)		
SOE × Leading Agencies		101.382***		
		(5.429)		
Other Agencies		-91.561***		
		(-4.961)		
SOE × Other Agencies		71.477***		
		(3.762)		
GBP			-20.274***	
			(-2.794)	
SOE × GBP			21.824***	
			(2.643)	
CGT				-33.162***
				(-4.083)
SOE × CGT				34.446***
				(3.710)
Controls	Yes	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,437	1,437	1,437	1,437
Adjusted R^2	0.838	0.840	0.829	0.830

Table 8. Use of Green Bond Proceeds and SOE Premium in China's Green Bond Market

This table reports the relationship between various indicators related to the use of proceeds and the green bond issuance cost differential between SOE and non-SOE. The dependent variable, *Credit Spread*, is regressed on various characteristics related to the environmental impact of the green bond issuance in China. Regressions are run using the full green bond sample with entropy reweighting. In Panel A, the key independent variables in Columns (1) and (3) are two continuous indicators, namely, *Green Projects* and *Refinancing*. These variables (in percentages) are designed to assess the proportion of green bond proceeds allocated to green projects or utilized for the refinancing of existing projects and debt. The core independent variables in Columns (2) and (4) are two dummy variables that measure whether the proportion of green bond proceeds used for green projects or to refinance existing projects and debt was higher than the median. Panel B reports a further analysis on the relationship between various indicators related to the use of proceeds and the green bond issuance cost differential between SOE and non-SOE. The dependent variable, *Credit Spread*, is regressed on various characteristics related to the environmental impact of the green bond issuance in China. A further classification of the use of green bond proceeds is presented with the categories being based on the *Green Bond Endorsed Projects Catalogue* issued by PBoC in 2021. The categories are as follows: pollution control, energy efficiency, and clean energy. The variables *Pollution Control*, *Energy Efficiency*, and *Clean Energy* in Columns (1) to (3) of Panel B are three continuous variables that measure the proportion of proceeds allocated to the three endorsed project areas. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Use of proceeds				
Dependent variable:	Entropy Balancing			
Credit Spread	(1)	(2)	(3)	(4)
SOE	-39.157***	-48.282***	-38.907***	-38.540***
	(-6.048)	(-7.677)	(-5.519)	(-5.560)
Green Projects	-0.096			
	(-1.192)			
SOE × Green Projects	0.003			
	(0.038)			
$Green\ Projects^{High}$		-22.932***		
		(-3.159)		
$SOE \times Green\ Projects^{High}$		19.012**		
		(2.347)		
Refinancing			0.082	
			(1.128)	
SOE × Refinancing			0.008	
			(0.116)	
$Refinancing^{High}$				4.258
				(0.645)
$SOE \times Refinancing^{High}$				1.996
				(0.305)
Controls	Yes	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,420	1,420	1,420	1,420
Adjusted R^2	0.834	0.835	0.833	0.833

Panel B: Classification under PBoC's green bond endorsed projects			
Dependent variable:	Entropy Balancing		
Credit Spread	(1)	(2)	(3)
SOE	-31.024***	-40.986***	-46.994***

	(-5.034)	(-5.501)	(-5.960)
Pollution Control	0.614**		
	(2.283)		
SOE × Pollution Control	-0.698**		
	(-2.449)		
Energy Efficiency		-0.217	
		(-1.562)	
SOE × Energy Efficiency		0.254*	
		(1.771)	
Clean Energy			-0.203**
			(-2.254)
SOE × Clean Energy			0.217*
			(1.895)
Controls	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	1,402	1,402	1,402
Adjusted R^2	0.836	0.844	0.835

Table 9. Environmental Disclosure and SOE Premium in China's Green Bond Market

This table focuses on analyzing the impact on the SOE premium if the green bond disclosure of environmental information aligns with the *China Bond Green Bond Environmental Benefit Information Disclosure Indicator System* developed by *China Central Depository & Clearing Co., Ltd* (CCDC). The system aims to encourage the disclosure of environmental information in green bond issuance. In Column (1), the abbreviation *CCDC* is a dummy variable that serves to measure the alignment of the green bond issuer with CCDC's disclosure system. It takes a value of 1 if the green bond issuer discloses some or all of the requisite environmental information in the bond prospectus. In Column (2) and (3), we excluded green bonds from the sample that did not disclose any environmental information (CCDC = 0), then re-performed the entropy reweighting procedure. In Column (2), *Mandatory Disclosure* is a dummy variable that assumes a value of 1 if the green bond issuer fully discloses requisite environmental information in its prospectus. Otherwise, it takes a value of 0. *Full Disclosure* in Column (3) is defined as a continuous variable (in percentages) that indicates the degree to which the green bond disclosure meets the requirements stipulated by the CCDC's system for mandatory plus optional disclosure. *Proceeds* in Column (3) is a dummy variable that takes the value of 1 if the proportion of green bond proceeds allocated to green projects exceeds 0 and the proportion used for refinancing is 0, and takes the value of 0 if the proportion of green bond proceeds allocated to green projects is 0 and the proportion used for refinancing exceeds 0. Column (3) reports the key results of the three-way interaction regression, with the complete set of results that is available upon request. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Credit Spread*	Entropy Balancing		
	Full Sample	CCDC = 1	CCDC = 1
	(1)	(2)	(3)
SOE	-52.719***	-37.445***	-29.432
	(-4.399)	(-4.368)	(-1.592)
CCDC	-19.214		
	(-1.539)		
SOE × CCDC	19.853		
	(1.514)		
Mandatory Disclosure		-23.846**	
		(-2.267)	
SOE × Mandatory Disclosure		8.155	
		(0.741)	
Full Disclosure			0.037
			(0.171)
SOE × Full Disclosure			-0.263
			(-0.935)
SOE × Full Disclosure × Proceeds			1.117**
			(2.414)
Controls	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	1,437	994	828
Adjusted R^2	0.832	0.588	0.592

Table 10. Supply-demand Dynamics and Underwriter Intermediation for SOE Premium in China's Green Bond Market

This table reports the relationships between supply-demand dynamics, underwriter's characteristics, and the green bond issuance cost differential between SOE and non-SOE. The dependent variable, *Credit Spread*, is regressed on various variables related to the supply-demand dynamics and underwriter's compensation of the green bond issuance in China. Regressions are run using the full green bond sample with entropy reweighting. *Issuance Size* in Column (1) is the logarithm of the green bond issue size. *Post 2021* in Column (2) is a dummy variable that assumes a value of 1 if a green bond was issued after June 2021, and 0 otherwise. The objective is to assess the impact of the *Green Finance Evaluation Scheme for Banking Institutions* issued by the PBoC in 2021. The Herfindahl-Hirschman Index (HHI) of the underwriting syndicate, calculated as the sum of squared underwriting shares of all lead underwriters for the green bond, is indicated in Column (3) as *Underwriter HHI*. *Underwriter Share* in Column (4) refers to the average market share of green bonds underwritten by each lead underwriter in the underwriting syndicate during the year of issuance. It is calculated as a weighted average based on each lead underwriter's share of the green bonds they underwrote. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Entropy Balancing			
Credit Spread	(1)	(2)	(3)	(4)
SOE	-55.760***	-62.879***	-5.362	-62.201***
	(-2.656)	(-6.164)	(-0.340)	(-5.537)
Issue Size	-16.925**			
	(-2.185)			
SOE × Issue Size	8.989			
	(1.108)			
Post 2021		-68.385***		
		(-5.987)		
SOE × Post 2021		46.791***		
		(3.964)		
Underwriter HHI			52.536***	
			(2.597)	
SOE × Underwriter HHI			-46.470**	
			(-2.264)	
Underwriter Share				-5.549***
				(-3.314)
SOE × Underwriter Share				6.726***
				(3.308)
Controls	Yes	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	Yes
N	1,437	1,437	1,437	1,437
Adjusted R^2	0.831	0.818	0.833	0.834

Table 11. Provincial-level Characteristics and SOE Premium in China's Green Bond Market

This table reports the relationship between provincial-level green finance preferences and local fiscal conditions and the green bond issuance cost differential between SOE and non-SOE. The dependent variable, *Credit Spread*, is regressed on various characteristics related to the environmental impact of the green bond issuance in China. Regressions are run using the full sample with entropy reweighting. The *GFP* in Column (1) refers to the province-level Index of Green Financial Policy Development, which was constructed by International Institution of Green Finance (IIGF) at Central University of Finance and Economics. The index is a numerical tool used to assess the degree of to which green financial policy is implemented in 31 provinces of China. The *GFS* in Column (2) refers to the province-level Index of Financial Sector Greenness, which was also constructed by IIGF. The *GFS* places a greater emphasis on evaluating the direct impact of green financial policy, for example, its effect on the financial sector. The core independent variable in Column (3) is *LGFV Spread*, which is defined as the average difference between the yields of bonds issued by AAA-rated provincial government financing vehicles and the yield of treasury bonds of the same maturity in the year preceding the issuance of green bond. The core independent variable in Column (4) is *Fiscal Balance*, which is defined as the ratio of the provincial government's fiscal revenue to fiscal spending in the year prior to the issuance of green bond. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Entropy Balancing			
Credit Spread	(1)	(2)	(3)	(4)
SOE	-56.326***	-52.599***	-6.258	-99.877***
	(-6.972)	(-5.856)	(-0.495)	(-4.211)
GFP	-37.743***			
	(-5.062)			
SOE × GFP	34.865***			
	(5.444)			
GFS		-14.566***		
		(-3.349)		
SOE × GFS		15.401***		
		(3.687)		
LGFV Spread			0.400***	
			(3.092)	
SOE × LGFV Spread			-0.381***	
			(-3.179)	
Fiscal Balance				-2.026**
				(-2.536)
SOE × Fiscal Balance				0.895**
				(2.467)
Controls	Yes	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,165	1,165	1,351	1,423
Adjusted R^2	0.877	0.875	0.870	0.866

Appendix

Table A1 Variable Definition

Variable	Definition	Source
Main Variables		
Credit Spread	The difference between the green bond coupon and the Chinese Development Bank (CDB) bond yield of the same maturity at issuance (in basis points).	CSMAR/Wind
SOE	Equals 1 if the issuer of a green bond is a state-owned enterprise, and 0 if the issuer is a non-state-owned enterprise.	CSMAR/Wind
SOE Type	A numerical variable: equals 1 if the issuer of a green bond is a central state-owned enterprise, equals 2 if the issuer is a local state-owned enterprise, and 0 if the issuer is a non-state-owned enterprise.	CSMAR/Wind
Control Variables		
Issue Size	Logarithm of green bond issue size (100 million RMB)	CSMAR/Wind
Maturity	Logarithm of green bond maturity (years)	CSMAR/Wind
Credit Rating	Cradit rating at the time of green bond issuance. This is a numerical number: 3=AAA, 2=AA+, 1=AA, etc.	CSMAR/Wind
Guarantee	Equals 1 if a green bond is guaranteed by a third-party, and 0 otherwise.	CSMAR/Wind
Puttable	Equals 1 for green bonds issued with puttable options, and 0 otherwise.	CSMAR/Wind
Callable	Equals 1 for green bonds issued with callable options, and 0 otherwise.	CSMAR/Wind
Verification	Equals 1 if the green bond got a third-party green verification at issuance, and 0 otherwise.	Bond Prospectus
Sinking	Equals 1 for green bonds issued with prepayment clause, and 0 otherwise.	CSMAR/Wind
List	Equals 1 if the green bond issuer is a listed company, and 0 otherwise.	CSMAR/Wind
Assets	The logarithm of the issuer's total assets (100 million RMB) for the previous fiscal year at the time of the green bond issuance. The variable has been winsorized at 1th and 99th percentiles.	Bond Prospectus
Leverage	The ratio (in percentages) of the issuer's total liabilities to total assets for the previous financial year at the time of the green bond issue. The variable has been winsorized at 1th and 99th percentiles.	Bond Prospectus
Current Ratio	The ratio (in percentages) of the issuer's current assets to current liabilities for the previous financial year at the time of the green bond issue. The variable has been winsorized at 1th and 99th percentiles.	Bond Prospectus
ROA	The ratio (in percentages) of the issuer's net profit to total assets for the previous financial year at the time of the green bond issue. The variable has been winsorized at 1th and 99th percentiles.	Bond Prospectus
Sales Growth	Year-on-year sales growth rate (in percentages) for the issuer's last fiscal year at the time of the green bond issue. The variable has been winsorized at 1th and 99th percentiles.	Bond Prospectus
Other Variables		
Leading Agencies	A numerical variable: equals 2 if the bond's third-party green verification service provider is Lianhe Equator or CCXGF, 1 if the bond was vitrificated by other third-party agencies, and 0 if the bond did not get third-party green verification.	CSMAR/Wind

GBP	Equals 1 if the green bond follows the Green Bond Principles (GBP) issued by the International Capital Markets Association (ICMA), and 0 otherwise.	Bloomberg
CGT	Equals 1 if the green bond was aligned with the Common Ground Taxonomy (CGT) between the EU and China, and 0 otherwise.	China Society for Finance and Banking
Green Projects	Proportion (in percentages) of bond proceeds allocated to green projects.	Bond Prospectus
Refinancing	Proportion (in percentages) of bond proceeds used to refinance existing projects and/or existing debt.	Bond Prospectus
Pollution Control	Proportion (in percentages) of bond proceeds allocated to green projects in pollution control area.	Bond Prospectus/ CCDC
Energy Efficiency	Proportion (in percentages) of bond proceeds allocated to green projects in energy efficiency area.	Bond Prospectus/ CCDC
Clean Energy	Proportion (in percentages) of bond proceeds allocated to green projects in clean energy area.	Bond Prospectus/ CCDC
Environmental Benefit	The green bond's environmental benefits per RMB 100 million, as calculated by the CCDC's system.	Bond Prospectus/ CCDC
Mandatory Disclosure	Proportion (in percentages) of environmental information disclosed by the green bond meets the requirements stipulated by the CCDC's system for mandatory disclosure.	Bond Prospectus/ CCDC
Full Disclosure	Proportion (in percentages) of environmental information disclosed by the green bond meets the requirements stipulated by the CCDC's system for mandatory plus optional disclosure.	Bond Prospectus/ CCDC
Proceeds	A dummy variable that takes the value of 1 if the proportion of green bond proceeds allocated to green projects exceeds 0 and the proportion used for refinancing is 0 and takes the value of 0 if the proportion of green bond proceeds allocated to green projects is 0 and the proportion used for refinancing exceeds 0.	Bond Prospectus/ Manual Work
Post 2021	Equals 1 if a green bond was issued after June 2021, and 0 otherwise.	Manual Work
Underwriter HHI	The sum of squares of each lead underwriter's underwriting share for each green bond issuance.	Wind
Underwriter Share	Lead underwriter's market share of green bond underwriting in the year of issuance. A weighted average of the underwriting of each lead underwriter at the time of issuance of each green bond.	Wind
GFP	A scale ranging from 0 to 100 is employed to assess the degree of to which green financial policy is implemented in 31 provinces of China. The index has been standardized.	International Institution of Green Finance (IIGF)
GFS	A scale ranging from 0 to 100 is employed to evaluate the direct impact of green financial policy in 31 provinces of China, for example, its effect on the financial sector. The index has been standardized.	International Institution of Green Finance (IIGF)
LGFV Spread	The average difference between the bond yield of AAA-rated provincial government financing vehicles and the yield of treasury bonds of the same maturity in the year preceding the issuance of green bond (in basis points).	Wind
Fiscal Balance	The ratio of provincial government's fiscal revenue to fiscal spending in the year prior to the issuance of green bond.	Wind

Table A2. Robustness – Sample Selection Bias

This table presents the Heckman two-step selection model estimates. Column (1) reports the first-stage Probit estimates for selection into the sample. The dependent variable in Column (1) is *Matched*, a dummy variable equals to 1 if the green bond could be matched to a conventional bond issued by the same company based on the Flammer's (2021) standards. Column (2) displays the second-stage outcome equation coefficients with inverse Mills ratio (λ) adjustment. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:	Dependent variable:
	Matched	*Credit Spread*
	(1)	(2)
Issue Size	-0.107	6.731
	(-0.920)	(0.620)
Maturity	0.194	-5.824
	(1.114)	(-0.260)
Guarantee	-0.419*	141.387**
	(-1.670)	(2.007)
Credit Rating	0.175	-57.313***
	(1.445)	(-2.932)
Callable	-0.532***	87.708
	(-2.583)	(1.502)
SOE		-83.813***
		(-4.390)
IMR		-133.226
		(-0.978)
Controls	No	Yes
Bond Type FE	Yes	Yes
Industry FE	Yes	Yes
Year FE	Yes	Yes
N	1,297	359
Adjusted (Pseudo) R^2	0.199	0.445

Table A3. Environmental Impact and SOE Premium in China's Green Bond Market

This table presents a reproduction of the findings presented in Table 7, employing the nearest neighbors matching algorithm that is delineated by Larcker and Watts (2020). The matching algorithm implemented is analogous to the one delineated in Section 4.2. The other settings for the regressions are consistent with those in Table 7. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Nearest Neighbors Matching			
Credit Spread	(1)	(2)	(3)	(4)
SOE	-131.108***	-130.155***	-84.012***	-77.025***
	(-6.403)	(-6.371)	(-6.193)	(-7.522)
Verification	-86.296***			
	(-4.329)			
SOE × Verification	67.004***			
	(3.176)			
Leading Agencies		-85.460***		
		(-4.193)		
SOE × Leading Agencies		69.215***		
		(3.228)		
Other Agencies		-83.552***		
		(-4.245)		
SOE × Other Agencies		55.319**		
		(2.474)		
GBP			-15.076	
			(-1.160)	
SOE × GBP			25.135*	
			(1.747)	
CGT				-42.757***
				(-3.313)
SOE × CGT				44.449***
				(3.346)
Controls	Yes	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	957	957	957	957
Adjusted R^2	0.747	0.747	0.728	0.736

Table A4. Use of Green Bond Proceeds and SOE Premium in China's Green Bond Market

This table presents a reproduction of the findings presented in Table 8, employing the nearest neighbors matching algorithm that is delineated by Larcker and Watts (2020). The matching algorithm implemented is analogous to the one delineated in Section 4.2. The other settings for the regressions are consistent with those in Table 8. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Use of proceeds				
Dependent variable:	Nearest Neighbors Matching			
Credit Spread	(1)	(2)	(3)	(4)
SOE	-83.119***	-85.086***	-62.842***	-65.055***
	(-7.117)	(-7.499)	(-6.144)	(-6.434)
Green Projects	-0.250**			
	(-2.253)			
SOE × Green Projects	0.215			
	(1.590)			
Green Projects^{High}		-26.900**		
		(-2.558)		
SOE × Green Projects^{High}		28.791**		
		(2.245)		
Refinancing			0.399**	
			(2.031)	
SOE × Refinancing			-0.368*	
			(-1.731)	
Refinancing^{High}				24.905*
				(1.762)
SOE × Refinancing^{High}				-24.913
				(-1.581)
Controls	Yes	Yes	Yes	Yes
Bond Type FEs	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
N	949	949	949	949
Adjusted R^2	0.743	0.744	0.745	0.742

Panel B: Classification under PBoC's green bond endorsed projects			
Dependent variable:	Nearest Neighbors Matching		
Credit Spread	(1)	(2)	(3)
SOE	-60.974***	-73.891***	-86.860***
	(-6.827)	(-6.960)	(-7.526)
Pollution Control	0.640**		
	(2.357)		
SOE × Pollution Control	-0.559*		
	(-1.877)		
Energy Efficiency		-0.034	
		(-0.221)	
SOE × Energy Efficiency		0.024	
		(0.115)	
Clean Energy			-0.411***
			(-3.695)
SOE × Clean Energy			0.346***
			(2.860)
Controls	Yes	Yes	Yes

Bond Type FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	937	937	937
Adjusted R^2	0.753	0.738	0.751

Table A5. Environmental Disclosure and SOE Premium in China's Green Bond Market

This table presents a reproduction of the findings presented in Table 9, employing the nearest neighbors matching algorithm that is delineated by Larcker and Watts (2020). The matching algorithm implemented is analogous to the one delineated in Section 4.2. The other settings for the regressions are consistent with those in Table 9. Column (3) of Panel B reports the key results from the three-way interaction regression, with the complete set of results is available upon request. The definition of the controls can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Credit Spread*	Nearest Neighbors Matching		
	Full Sample	CCDC = 1	CCDC = 1
	(1)	(2)	(3)
SOE	-95.379***	-55.738***	-29.514
	(-6.601)	(-4.908)	(-0.839)
CCDC	-18.116		
	(-1.490)		
SOE × CCDC	28.852**		
	(2.003)		
Mandatory Disclosure		-19.860	
		(-1.613)	
SOE × Mandatory Disclosure		-0.654	
		(-0.047)	
Full Disclosure			0.412
			(0.986)
SOE × Full Disclosure			-0.796
			(-1.431)
SOE × Full Disclosure × Proceeds			1.141*
			(1.691)
Controls	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	957	674	561
Adjusted R^2	0.738	0.746	0.773

Table A6. Supply-demand Dynamics and Underwriter Intermediation for SOE Premium in China's Green Bond Market

This table presents a reproduction of the findings presented in Table 10, employing the nearest neighbors matching algorithm that is delineated by Larcker and Watts (2020). The matching algorithm implemented is analogous to the one delineated in Section 4.2. The other settings for the regressions are consistent with those in Table 10. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Nearest Neighbors Matching			
Credit Spread	(1)	(2)	(3)	(4)
SOE	-131.696***	-112.561***	-55.869***	-120.394***
	(-6.323)	(-6.432)	(-3.031)	(-7.788)
Issue Size	-38.261***			
	(-5.041)			
SOE × Issue Size	32.395***			
	(3.827)			
Post 2021		-78.061***		
		(-4.840)		
SOE × Post 2021		56.032***		
		(3.289)		
Underwriter HHI			25.747	
			(1.101)	
SOE × Underwriter HHI			-25.854	
			(-1.092)	
Underwriter Share				-8.030***
				(-3.683)
SOE × Underwriter Share				12.328***
				(4.405)
Controls	Yes	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	Yes
N	957	957	957	957
Adjusted R^2	0.743	0.727	0.738	0.758

Table A7. Provincial-level Characteristics and SOE Premium in China's Green Bond Market

This table presents a reproduction of the findings presented in Table 11, employing the nearest neighbors matching algorithm that is delineated by Larcker and Watts (2020). The matching algorithm implemented is analogous to the one delineated in Section 4.2. The other settings for the regressions are consistent with those in Table 11. The definition of the variables can be found in Table A1. The t-statistics reported in parentheses utilize heteroskedasticity-consistent standard deviations, which are clustered by green bond issuer. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Nearest Neighbors Matching			
Credit Spread	(1)	(2)	(3)	(4)
SOE	-85.005***	-89.489***	-23.967	-128.133***
	(-9.285)	(-11.080)	(-1.359)	(-4.312)
GFP	-9.585			
	(-0.908)			
SOE × GFP	-2.896			
	(-0.424)			
GFS		-17.803***		
		(-3.557)		
SOE × GFS		19.324***		
		(3.997)		
LGFV Spread			0.545***	
			(2.682)	
SOE × LGFV Spread			-0.541***	
			(-3.672)	
Fiscal Balance				-0.209
				(-0.192)
SOE × Fiscal Balance				0.679
				(1.641)
Controls	Yes	Yes	Yes	Yes
Bond Type FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
N	779	779	892	949
Adjusted R^2	0.807	0.814	0.810	0.792