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2 February 2023

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Abstract

We conducted a survey on institutional investors in Beijing and Shenzhen to analyze the factors affecting green bond (GB) investing in China, such as credit rating, GB issuer, fund use, liquidity, redemption term, certification label, and type of currency. We then compared the results for Beijing and Shenzhen, including factors that affected greenium and the two cities' willingness to pay (WTP). Using a double-bounded dichotomous choice contingent valuation method, we find that higher credit ratings tend to increase Beijing investors' WTP and that the use of GB proceeds affects Shenzhen investors' WTP. We also find that investors place importance on the type of currency, length of redemption term, and liquidity when investing in GB, while the certification label does not have an impact on WTP. The WTP for GB was higher among Shenzhen investors than among Beijing investors. The government, financial regulators, and issuers looking to enhance the design of GBs and grow their market share in China would all benefit from the study's findings.

Keywords

green bonds, greenium, willingness to pay, credit rating, China, Renminbi

JEL classification

G11: Portfolio Choice • Investment Decisions

G12: Asset Pricing • Trading Volume • Bond Interest Rates

Q51: Valuation of Environmental Effects

1. Introduction

1.1. Importance of the financing for the environmental protection

Natural disasters caused by extreme weather are damaging economies worldwide. Global warming is one of the causes of extreme weather (Calel et al., 2020). For the world to maintain sustainable economic growth and improve the environment, reducing global warming is an important issue, and countries worldwide are expected to cooperate in adopting specific measures to address this issue.

Following the Paris Agreement in December 2015, the 26th session of the Conference of the Parties (COP 26) of the United Nations Framework Convention on Climate Change (UNFCCC) in November 2021 agreed to a 1.5°C target as the "Glasgow Climate Pact." At the UNFCCC-COP 27 in November 2022, an agreement was reached to establish a fund to support developing countries. Countries around the world, including China, are beginning to recognize that to fulfill their long-term vision of global growth, they must return to achieving sustainable economic growth that protects the environment (Liu et al., 2022; Agliardi and Agliardi, 2021).

Due to its efforts to save the environment, China, the world's greatest CO_2 emitter (IEA, 2022), has caught the interest of other nations. Environmental protection is one of the most pressing concerns in the nation, and President Xi Jinping and the administration have committed to putting it into action quickly for China and other nations. One of the key challenges in achieving global CO_2 emissions peak reduction and carbon neutrality is raising the necessary funds for environmental protection. Public funds alone are insufficient to finance environmental conservation and must be raised from capital markets. Sustainable finance is a powerful tool for this financing, and one that has attracted attention is financing through green bonds (GBs), which originated with the climate awareness bond issued by the European Investment Bank (EIB) in 2007 (Ehlers and Packer, 2017; EIB, 2021). Since then, GB has been one of the most effective tools for environmental protection (Flammer, 2021).

According to International Capital Market Association (ICMA), GBs are defined as bonds issued to raise funds to invest in green projects aimed at environmental conservation (ICMA, 2018). Therefore, GBs can be described as securities committed to environmental protection between issuers responsible for raising funds for environmental projects and institutional investors who invest funds in environmental projects.

Recently, GB investments have been increasing significantly in Europe which is one of the first regions to establish guidelines or schemes for GBs (Ehlers and Packer, 2017). At the EU Summit in December 2020, the Next Generation EU Recovery Fund announced a total of 1.8 trillion euros in recovery funds and medium-term budgets (EC, 2021). According to the Climate Bond Initiative (CBI), the GB issuance in Germany and France in 2021 was $189.8 billion and $189.7 billion, respectively (CBI, 2021a). As a result, the global issuance of GBs has increased from $37.0 billion in 2015 to $578.5 billion in 2021.

1.2. Recent Developments in China's GB Market

China's GB market is characterized as a "top-down" model led by the government and related authorities, with the People's Bank of China (PBOC) and other Chinese financial authorities actively promoting the establishment of a GB market in China since 2013. GB issuance has been active since October 2015 when the Agricultural Bank of China issued its first GB in the London market.

At the United Nations General Assembly in September 2020, President Xi announced China's commitment to environmental protection by peaking its CO_2 emissions by 2030 and achieving carbon neutrality by 2060 (Zhao et al., 2022). In April 2021, the PBOC, National Development and Reform Commission (NDRC), and China Securities Regulatory Commission (CSRC) published the “China Green Bond Endorsed Project Catalogue (2021 Edition)” (PBOC,2021). The Catalogue eliminates the gray parts in China's definition of GB, which has been pointed out in the past and makes it almost the same as the European definition (Chen and Zhao, 2021). In addition, the 14th Five-Year Plan in March 2021 established "quality-enhanced development" aimed at the green and low-carbon growth.

One of the critical issues in China's GB market is the mismatch between supply and demand. (Amstad and He, 2020; Wu, 2022; Su et al., 2022). Deschryver and De Mariz (2020) noted that when bidding for GBs, there is an oversubscription and an excess of purchases, while Agliardi and Agliardi (2021) suggest for the global GB market, GB yields may be lower than conventional bonds.

1.3. The research objective

In previous studies, such as Zerbib (2019), Hachenberg and Schiereck (2018), and Wang et al. (2020), explanatory variables were selected to find the greenium in the GB market. However, these previous studies analyzed the greenium from past transaction results and did not confirm the significance of the explanatory variables from the institutional investors’ perspective.

Zenno and Aruga (2022) analyzed institutional investors in Shanghai and found that the issuer’s credit rate and the currency of the bond tend to increase the greenium, however, the study did not analyze whether the institutional investors consider Chinese Renminbi (RMB) or other currencies as a criterion for GB investment decisions in terms of currency. Furthermore, this study did not analyze which specific credit rating would make the institutional investors to decide their investment for GB. There has been some research on the impact of China's credit rates on greenium, such as Chang et al. (2021); however, there hasn't been much investigation on the connection between certain credit rates and greenium from the viewpoint of institutional investors. According to Zenno and Aruga (2022), certified labeling has no appreciable influence on greenium, whereas Gianfrate and Peri (2019) and Nanayakkara and Colombage (2019) show that certified labeling affects GB investment. In this study, we re-examine whether the labeling influences the greenium. Thus, we analyze particularly the effect of credit rating, currency, and labeling on the WTP in this study.

Studying the factors that affect green bonds from the institutional investors' standpoint to determine what institutional investors put importance on when investing in green bonds and sharing such information with the government, financial authorities, issuers, and other bond market participants could contribute to further development of China's green bond market. Therefore, this study analyzes the effect of the explanatory variables taken up in previous studies on greenium by conducting a direct survey of Chinese institutional investors.

We chose Beijing and Shenzhen as our research sites and asked questions directly to institutional investors who are investing in China's financial markets to analyze the variables that influence greenium. Therefore, in addition to analyzing the factors influencing greenium in these two cities as the research objective, this study analyzes the differences between Beijing's and Shenzhen's results in explanatory variables and WTP. The study will be valuable for governments and regulators needing to improve the regulatory framework, and for issuers instructing how to make GBs more attractive to institutional investors.

The remainder of this paper is organized as follows. In the next section, we will introduce relevant previous studies. Section 3 explains the methods of this study, and Section 4 presents the results of this study. In Section 5, we discuss the implications that could be drawn from the results. Finally, Section 6 presents the conclusions of this study.

2. Review of literature

Bhutta et al. (2021) conduct a systematic review of previous studies on GBs worldwide and noticed that there are studies in various areas of GBs, including greenium. Zerbib (2019) finds that there is a 0.02% greenhouse effect in global GBs. Baker et al. (2018) analyze the primary and secondary markets for U.S. bonds and find a greenium of 0.05-0.07% while Gianfrate and Peri (2019) show that greenium is significantly present. Larcker and Watts (2020) use a matching method to analyze 640 pairs of U.S. municipal bonds and find that greenium is zero. Tang and Zhang (2020) analyze a sample of over 1500 bonds and found no greenium.

Furthermore, some studies identify that the yield of GBs is higher than that of conventional bonds. Karpf and Mandel (2017) analyze U.S. bonds and found that the yield is lower for conventional bonds. Bachelet et al. (2019) show that yields on GBs are higher than those on conventional bonds. Kapraun et al. (2021) analyze 1500 pairs of global GBs and reveal that greenium is present in the primary market, but not in the secondary market. Agliardi and Agliardi (2021) disclose that greenium can be positive or negative and indicates the importance of corporate credit ratings. Aruga (2022) surveys Japanese retail investors to determine the level of acceptance of investing in GBs. As mentioned above, it can be recognized that the results of studies on greenium in global GBs have not reached concrete results.

Kocaarslan (2021) analyses GBs issued in US Dollars, but do not cover different currencies. Hachenberg and Schiereck (2018) illustrate the link between greenium and GB issuance costs for individual ratings, while connected to the currency. Previous studies on certified labels include Ehlers and Packer (2017) and Sartzetakis (2020), which show the development of certified labels in GBs along with the background of the global GB market. Kapraun et al. (2021) show the importance of obtaining a label from a credit enhancement perspective when companies issue GBs.

Examining China's academic papers on GB-specific subjects, some papers have been published since 2018. In a recent study, Chen et al. (2022) analyze the Chinese government's actions, regulations, and issuer trends and provide an outlook for the Chinese GB market in the future. Cao et al. (2020) analyze issuers' motivation to issue GBs by focusing on Chinese commercial banks. They show interesting results that Chinese commercial banks let GBs be issued not because of the cost of procurement, but to avoid regulations. Research papers analyzing the impact of the One Belt One Road policy and GBs include Jian et al. (2021) and Harlan (2021). Yi et al. (2021) and Hau et al. (2022) show capital flights from green equity to GBs in a COVID-19 environment. A previous study on the impact of geopolitical risk on GBs was conducted by Lee et al. (2022). They analyze the impact of oil shocks and geopolitical uncertainty on GB yields and find that an improvement in geopolitical uncertainty leads to lower oil prices and an increase in GB returns. Several studies focusing on the institutional and regulatory environments for GBs in China have recently been published. Liu et al.

(2022) show in their analysis that governance and the institutional environment, coupled with the domestic economy, affect the growth of the GB market, with state and local administration's governance. Zhang (2020) provides an analysis of the guidelines for GB frameworks, including institutional and regulatory frameworks, in the context of policy. The need for transparency and disclosure is demonstrated through comparisons with the environments of other countries. Bush (2020) conducts a representative study of issuer credit quality and ratings in the Chinese bond market. Macaire and Naef (2021) also analyze the medium-term lending facilities of GBs introduced by the PBOC from a credit perspective.

One of the few studies on China's greenium is that of Wang et al. (2020), which calculates greenium using the matching method used by Zerbib (2019). Wang et al. (2020) indicate a greenium of 0.33-0.34% for China, confirming that lower interest rates can be achieved in Chinese GBs than in conventional bonds. This result is larger than that of global greenium presented by Zerbib (2019). Hu et al. (2022) analyze greenium in primary and secondary markets, focusing on corporate bonds in China. Hyun and Li (2021) focus on the Chinese GB primary market and find a greenium of 0.40%, which is higher than that reported in previous studies. Zenno and Aruga (2022) conduct a survey of institutional investors in Shanghai, China, based on the methodology used in Aruga (2022), and analyze the greenium from the standpoint of institutional investors, finding that greenium was 0.47%.

In previous studies on other factors, for credit ratings in China, Li et al. (2020) related GBs to credit ratings and studied the impact of GB issuance on the issuer's stock price; however, we could not find previous studies that analyze how the type of currency affects the greenium for Chinese GB. We recognize that this study is the first to examine whether the type of currency affects the investing attitude regarding GBs. For certified labels, Wang et al. (2020) analyze whether the presence or absence of a label affects greenium in Chinese GBs and find that issuers reduce their debt costs by issuing GBs with a label.

3. Methods

3.1. Study area

We choose the Beijing and Shenzhen markets as the research scope. There are two reasons for choosing these two cities for this study. First, the Chinese government and financial authorities have implemented national policy measures to develop these two cities into leading financial centers in the world (Chen and Chen, 2015; Wang, 2019). Second, Beijing and Shenzhen have become leading financial centers worldwide because of China's national policy of growth. The Z/Yen group, a London-based think tank, and the China Development Institute, a think tank in Shenzhen, have published a global financial market ranking called "the Global Financial Centres Index (GFCI)". According to the index, the Beijing market is ranked the 8th in the world, second only to Shanghai in mainland China,

while the Shenzhen market is ranked the 9th in the world and the 3rd in mainland China (Z/Yen group, 2022).

Moreover, because the Beijing and Shenzhen markets are relatively unaffected by COVID-19, these cities were selected as the target markets for our survey.

3.2. Survey Methodology

This survey targeted institutional investors that invest in Chinese bonds to determine how the credit rating of the issuer and the type of currency of the issued bond affect greenium and to analyze the underlying greenium. We chose the Contingent Valuation Method (CVM) to measure greenium and its change..

There is a Great Firewall in China, making it difficult for oversea survey companies to handle the survey, and thus, we chose the Chinese survey company, Wenjuan, in this study. This company was also used in Mei and Brown (2017). We were able to select respondents who met our criteria at random from the list of respondents held by Wenjuan.

To measure changes in greenium, we employed the double-bounded dichotomous choice (DBDC) in the CVM-based questionnaire survey. We separated respondents into five groups of equal numbers at random and posed the question from five different yield levels. Then we asked the respondents whether they would invest in GBs or conventional bonds issued by taking into account the yield range between GBs and conventional bonds. We asked the respondents to participate in two rounds of such a question asking whether they would invest in GBs at five different yield levels or corporate bonds.

The survey was conducted over 13 days from August 19 to September 1, 2022.

3.3. Questionnaire design

The CVM is often used for determining the value of goods or services without markets (Carson and Hanemann, 2005). In environmental economics, CVM has been used in a wide range of fields, including community forestry programs (Gelo and Koch, 2015) and water quality (Jiang et al., 2019).

The questionnaire for institutional investors was structured into five parts. The first part included an explanation of the environmental issues, followed by questions regarding their level of interest in environmental issues. Responses were recorded on a five-point Likert scale. In the second part, we asked basic questions about bond investments, explained the GB product, and then asked questions to confirm respondents' understanding of GBs. In the third part, we first asked whether the respondents had any experience of investing in GBs. The respondents were divided into two groups. Those who answered "Yes" or "will start investing soon," and those who answered "No." Those who answered "Yes" or "will start investing soon" were asked about their reasons for investing, the

investment ratio, the country of the issuer of the bonds, whether the issuer of the GB had purchased conventional bonds, and issues related to GBs in China. For the group that answered "No," questions were asked about the reasons for not investing and the challenges faced by GBs in China. In the fourth part, all respondents were asked about their selection criteria for investing in GBs, followed by DBDC questions about whether they would invest in GBs or not, and, if so, what level of difference between the yield of GBs and that of corporate bonds they would invest in. The fifth and final part of the survey asked about the respondents' demographics.

Before conducting the final survey, a pre-test was conducted with the help of Wenjuan, and the results of the pre-test confirmed that there were no problems before administering the main questionnaire.

3.4. Variables for analyzing the effectiveness of the greenium

In addition to the specific credit rating of the issuer and RMB as the currency of the bond, we selected eight explanatory variables; the issuer's credit rates, the type of business of the GB issuer, use of the GB fund, GB amount, liquidity, GB redemption term, proof of the label, pre-explanation or post-report, and the currency of the GB. The variables are selected based on previous literature analyzing greenium or GB pricing.

Table 1 presents the variables tested for their effects on the WTP toward GBs. To analyze the impact of greenium on specific currencies, we added the explanatory variable *rmb,* which is a criterion for preferring GBs. Furthermore, to analyze the impact of the GB issuer's specific rating level on the greenium, *crrating* was added as an explanatory variable.

Table 1. Explanatory variables and variable names

Explanatory variables	Variable names	Previous literature using the variables
GB issuer's credit rating/credibility	*credit*	Bachelet et al. (2019), Fatica et al. (2021), Larcker and Watts (2019), Li et al. (2020), Sangiorgi and Schopohl (2021), Wang et al. (2020), Zerbib (2019)
GB whose issuer's credit rating	*crating*	
The type of business of the GB issuer (e.g., government, municipality, or industry in the case of a company)	*issuer*	Bachelet et al. (2019), Dou and Qi (2019), Larcker and Watts (2019), Sangiorgi and Schopohl (2021)
Use of the fund of the GB	*usage*	Dou and Qi (2019), Fatica et al. (2021)
Amount of GB issued and liquidity of the bond	*liquidity*	Bachelet et al. (2019), Fatica et al. (2021), Larcker and Watts (2019), Sangiorgi and Schopohl (2021), Wang et al. (2020)
Redemption term of the GB	*term*	Bachelet et al. (2019),

		Dou and Qi (2019), Fatica et al. (2021), Larcker and Watts (2019), Li et al. (2020), Wang et al. (2020), Zerbib (2019)
Proof of the label	*label*	Bachelet et al. (2019), Larcker and Watts (2019), Sangiorgi and Schopohl (2021)
Pre-explanation or post-report	*maintenance*	Sangiorgi and Schopohl (2021)
Currency of the GB	*currency*	Bachelet et al. (2019), Sangiorgi and Schopohl (2021)
GB in RMB	*rmb*	
The yield offered in the first question	*bid1*	
The yield offered in the second question	*bid2*	
A dummy variable representing the answer to the first question (yes = 1, no = 0)	A_1	
A dummy variable representing the answer to the second question (yes = 1, no = 0)	A_2	

3.5. WTP for the greenium and designing of bids

To study how the credit rating of the issuer and the type of currency affect the greenium, we define greenium as the WTP that institutional investors are willing to accept when purchasing GBs. To conduct our analysis in line with previous studies such as Zerbib (2019), we define the WTP to be positive if the yield from investing in a GB is lower than the conventional bond yield, and negative if the yield is higher than the yield on the conventional bond.

In this study, we explained to the respondents that the annual yield on conventional bonds was assumed to be 3.00% before asking the questions since the average annual interest rate of the 10-year conventional bonds issued by the China Development Bank was 3.00%. The yield range set in the survey questions was a 0.25% incremental yield, which is familiar to market participants dealing with the money market. (Amihud and Mendelson, 1991; Herbsta and Pergb, 2001; Labuszewski et al. 2013)

The survey was divided into five groups as shown in Table 2. In the DBDC survey, each respondent met two bids: the first and the second. If respondents agreed to invest in the GBs presented in the first bid, a higher bid was presented in the second bid. If the respondents declined their first bid in the first stage of the survey, a lower bid was placed. Let B^F denote the bid level presented in the first stage and B^u and B^l be the upper and lower bids, respectively, presented in the second stage. For example, the first question in the first group asked respondents a 0.5% higher than the conventional bond yield. For clarity, the question was appended with 3.5% as a reference for respondents. If respondents indicated yes, the bid in the second question was 0.25% lower than 3.5% and 0.25% higher than the conventional bond's yield. If the respondent answered no, the second question was set at 1.0% higher than the conventional bond (4.0%).

This resulted in a range of yields for the question to determine the WTP, with the lower limit being 0.75% lower than the conventional bond yield (2.25%), and the upper limit was set 0.75% higher than the conventional bond (3.75%).

Table 2. Distributions of the bid responses in Beijing and Shenzhen

Beijing (n=600)

1st bid	2nd bid (B^l/B^u)	y/y	y/n	n/y	n/n	Total respondents
0.50%	+0.25%/+0.75%	57 47.50%	39 32.50%	19 15.83%	5 4.17%	120 100%
0.25%	±0.00%/+0.50%	79 65.83%	23 19.17%	14 11.67%	4 3.33%	120 100%
±0.00%	-0.25%/+0.25%	91 75.83%	15 12.50%	14 11.67%	0 0.00%	120 100%
-0.25%	-0.50%/±0.00%	39 32.50%	34 28.33%	33 27.50%	14 11.67%	120 100%
-0.50%	-0.75%/ -0.25%	31 25.83%	33 27.50%	31 25.83%	25 20.83%	120 100%
Total respondents		297 49.50%	144 24.00%	111 18.50%	48 8.00%	600 100%

Shenzhen (n=600)

1st bid	2nd bid (B^l/B^u)	y/y	y/n	n/y	n/n	Total respondents
0.50%	+0.25%/+0.75%	63 52.50%	30 25.00%	16 13.33%	11 9.17%	120 100%
0.25%	±0.00%/+0.50%	79 65.83%	20 16.67%	18 15.00%	3 2.50%	120 100%
±0.00%	-0.25%/+0.25%	92 76.67%	11 9.17%	16 13.33%	1 0.83%	120 100%
-0.25%	-0.50%/±0.00%	52 43.33%	26 21.67%	33 27.50%	9 7.50%	120 100%
-0.50%	-0.75%/ -0.25%	30 25.00%	34 28.33%	35 29.17%	21 17.50%	120 100%
Total respondents		316 52.67%	121 20.17%	118 19.67%	45 7.50%	600 100%

3.6. Analysis of WTP and factors affecting the WTP

The individual WTP follows a linear function.

$$WTP_i(z_i, \varepsilon_i) = z_i\beta + \varepsilon_i \quad (1)$$

where z_i is the vector of explanatory variables, β is the vector of parameters, and ε_i represents the error term.

Since there were two rounds in our DBDC survey, we define the bids presented to the respondents in the first and second rounds as q^1 and q^2, respectively. Since we display a higher acceptance value in the second round if the respondent accepts the first bid $q^2 > q^1$, and if the

respondents also accept the second bid $q^2 \leq WTP < \infty$. Second, if the respondents accept the first bid and deny the bid in the second round $q^1 \leq WTP < q^2$. Third, if the respondents reject the first bid and accept the second bid, $q^2 < q^1$ and $q^2 \leq WTP < q^1$. Finally, if the respondents reject the bid in both the first and second rounds then $0 \leq WTP < q^2$.

Next, denoting the *i*th respondent answering *yes* or *no* to the bids as $y_i^1 = 1$ and $y_i^2 = 0$ the respondent's probability of answering *yes* or *no* can be defined as $\Pr\left(y_i^1 = 1,\ y_i^2 = 0 \middle| z_i\right) = p_i^{yn}$, where z_i is a vector of explanatory variables.

Under the assumption that $WTP_i(z_i, u_i) = z_i'\beta + u_i \; and \; u_i \sim N(0, \sigma^2)$ and from $P_r(a \leq X < b) = F(b) - F(a)$, the response probabilities can be categorized into the following four patterns:

$$\begin{aligned} P_i^{yn} &= P_r(t^1 \leq WTP < t^2) \\ &= \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) - \Phi\left(\frac{t^1 - z_i'\beta}{\sigma}\right) \\ &= \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)_r \end{aligned} \tag{2}$$

$$\begin{aligned} P_i^{yy} &= P_r\,(u_i \geq t^2 - z_i'\beta) \\ &= 1 - \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \end{aligned} \tag{3}$$

$$\begin{aligned} P_i^{ny} &= P_r(t^2 \leq WTP < t^1) \\ &= \Phi\left(\frac{t^1 - z_i'\beta}{\sigma}\right) - \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) \end{aligned} \tag{4}$$

$$\begin{aligned} P_i^{nn} &= P_r(WTP < t^1,\ \ WTP < t^2) \\ &= \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) = 1 - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \end{aligned} \tag{5}$$

Summing up (2) to (5) above, we obtain

$$\begin{aligned} &\sum_{i=1}^{N}\left[d_i^{yn}\ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right) + d_i^{yyy}\ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right) + \right. \\ &\left. d_i^{ny}\ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right)\right) + d_i^{nn}\ln\left(1 - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right)\right] \end{aligned} \tag{6}$$

Let d_i^{yn}, d_i^{yy}, d_i^{ny}, d_i^{nn} be two-limb choice indicator variables that take values of 1 or 0 depending on the relevant case. That is, each contributes to the logarithm of the likelihood function in only one of four parts.

Finally, denoting $\hat{\alpha}$ as the vector of coefficients associated with each of the explanatory variables, where $\hat{\alpha} = \frac{\hat{\beta}}{\hat{\sigma}}$, and stating $\hat{\delta}$ as the coefficient for the variable capturing the amount of the bid such that $\hat{\delta} = -\frac{1}{\hat{\sigma}}$, the mean WTP can be expressed by the following equation:

$$\overline{WTP} = \tilde{v}' \left[-\frac{\hat{\alpha}}{\hat{\delta}} \right] \quad (7)$$

where $\tilde{v}'$ is the vector of the averages of the explanatory variables.

This study analyzes the effectiveness of the issuer's credit rating and the bond's currency, using credit and credit ratings as explanatory variables. In addition, we used currency and *rmb* to analyze the effect of *rmb* on greenium to determine whether issuing in the local currency RMB is a criterion for preferring GBs. The second model (Model 2) includes all explanatory variables examined in this study, which can be stated as follows:

$$\ln(A_i) = \beta_0 + \beta_1 credit * crrating + \beta_2 issuer + \beta_3 usage + \beta_4 liquidity + \beta_5 term + \beta_6 label + \beta_7 maintenance + \beta_8 currency * rmb + \mu_A \quad (i=1,2) \quad (8)$$

where A_i is a dummy variable representing the answer to the first and second questions, and β_1 to β_8 are the coefficients of the core explanatory variables defined in Table 1.

4. Results

Table 4 summarizes the variables used in this study. Other than *term* and *currency*, more than 70% of the respondents answered *yes* to the remaining variables. 87.33% of the respondents in Beijing and 89.17% of the respondents in Shenzhen answered *yes* to the question regarding the issuer's credit rating as a criterion for investment. On the other hand, most respondents in both Beijing and Shenzhen answered *yes* to the question about the type of GB currency although the yes percentage was lower than that for the other variables.

In this study, the institutional investors who cared about the credit rating when investing in GBs were asked which level of rating they preferred among the five ratings: AAA, AA+, AA, AA-, or A. Table 4 shows the results: 51.83% of the 600 respondents answered AA+, and 82.00% preferred AAA- or higher. Those who responded that they would use currency as a factor in their investment decisions were asked whether they would use RMB or other currencies, and 56.00% of the total respondents answered that RMB was their preferred currency.

Out of 600 respondents, 535 institutional investors in Shenzhen responded that the issuer's credit rating was the criterion for their GB preference; 311 respondents answered AA+ or higher, and more than 181 respondents answered AAA or higher. Additionally, 357 respondents indicated currency as a criterion for their GB preferences. In addition, 321 respondents (53.50% of the total respondents) answered that RMB was the preferred currency for GB investment.

Table 4. Summary of the variables of the sample respondents in Beijing (n=600) and Shenzhen (n=600)

Variable name	Description	Variable	Beijing		Shenzhen	
			Frequency	%	Frequency	%
credit	Whether the respondents consider the credit rating of the issuer of GBs: yes = 1 and no = 1.	YES=1	524	87.33	535	89.17
		NO=0	76	12.67	65	10.83
crrating	Rating of the issuer of GB: 1 = below AA-, 2 = AA-, 3 = AA, 4 = AA+, and 5 = AAA.	AAA=5	181	30.17	181	30.17
		AA+=4	314	52.33	311	51.83
		AA=3	29	4.83	43	7.17
		AA-=2	0	0	0	0
		Below AA-=1	0	0	0	0
issuer	Whether the respondents think the type of issuer is important	YES=1	493	82.17	483	80.50
		NO=0	107	17.83	117	19.50
usage	Whether the respondents put importance on the use of proceeds.	YES=1	443	73.83	427	71.17
		NO=0	157	26.17	173	28.83
liquidity	Whether the respondents think the liquidity of GBs is important.	YES=1	458	76.33	464	74.33
		NO=0	142	23.67	154	25.67
term	Whether the respondents think the redemption term of GBs is important.	YES=1	411	68.50	403	67.17
		NO=0	189	31.50	197	32.83
label	Whether the respondents think the certification label is important for GBs:	YES=1	451	75.17	456	76.00
		NO=0	149	24.83	144	24.00
maintenance	Whether the respondents think pre-explanation or post-report is important when issuing GBs.	YES=1	443	73.83	428	71.33
		NO=0	157	26.17	172	28.67
currency	Whether the respondents think the type of currency is important	YES=1	367	61.17	357	59.50
		NO=0	233	38.83	243	40.50
rmb	The currency is RMB = 1, and otherwise = 0.	rmb=1	336	56.00	321	53.50
		rmb=0	31	5.17	36	6.00

In this study, we determine the average WTP for Beijing and Shenzhen and look at how explanatory factors affected the price of greenium. We specifically examine the effects of credit rating and the type of currency used for issuing GBs. As seen in Table 5, *credit*crrating* is positively significant in Beijing, which means that the higher the credit rating, the higher the WTP. In Shenzhen, *currency*rmb* was positively significant as well as *usage, liquidity, term,* and *maintenance*. Meanwhile, *credit*crrating* was not significant suggesting that the credit rating of the issuers did not affect the WTP. Finally, the mean WTP for Beijing is 0.326% and that for Shenzhen is 0.369%.

Table 5. Maximum likelihood estimation and mean WTP for Beijing and Shenzhen

	Beijing		Shenzhen	
Variable	Coef.	SE	Coef.	SE
Constant	0.419***	0.019	0.447***	0.021
*credit*crrating*	0.027**	0.013	0.009	0.016
issuer	0.101*	0.056	0.061	0.060
usage	-0.012	0.050	0.155***	0.052
liquidity	0.188***	0.050	0.205***	0.053
term	0.166***	0.046	0.152***	0.048
label	0.052	0.047	0.082	0.054
maintenance	0.058	0.049	0.028	0.053
*currency*rmb*	0.180***	0.042	0.218***	0.047
Mean WTP	0.326***	0.022	0.369***	0.024

***, **, and * indicate significance at the 1%, 5%, and 10% levels. SE denotes standard errors.

Next, Table 6 shows the results of the impact of the factors investigated on the bids offered in the first and second rounds. *credit*crrating* became significant in Stage 1 in Beijing, but not in Stage 2. Thus, the results indicate that an issuer's credit rating has a positive effect on the greenium. In Shenzhen, *credit*crrating* is not significant in either stages 1 or 2, which means that the issuer's specific credit level will not affect the greenium of institutional investors in Shenzhen. Chang et al. (2022) studied GBs in China, indicating that issuers' credit rates have an impact on the yield of GBs. However, our study, from the institutional investor's perspective shows that the specific credit rates of issuers have an impact on GB investment decisions in Beijing, while they had no impact in Shenzhen.

In addition, the type of issuer's industry did not become significant in both Beijing and Shenzhen. The results indicate that investors are indifferent about the type of the issuers' industry. *Usage* and use of funds were not significant in Beijing but they were positively significant in Shenzhen in Stage 1. The results indicate that institutional investors in Shenzhen consider the use of funds for green projects when investing in GBs. Regarding *liquidity*, both Beijing and Shenzhen are positively significant at stage 1, indicating that institutional investors use issue size and market liquidity as criteria for investment decisions. *Term* is positively significant at stages 1 and 2 in both Beijing and Shenzhen, indicating that institutional investors in the two cities base their investment decisions on the redemption period of the GBs.

For the analysis of *label*, the results show that the certified label has no significant effect on greenium in both region. In previous studies, it is recommended to obtain a certified label to raise funds (Kapraun et al. 2021). Wang et al. (2020) suggest that issuers reduce their debt costs by issuing GBs with labels in China and insist on the importance of the label. However, the results from our study suggest that the presence or absence of a label does not affect greenium in China and may not affect institutional investors' investments in GBs. It may be assumed that Chinese guidelines that do not require certified labels at the time of issuance in China may have influenced the results. *Maintenance* not being significant in both regions indicates that institutional investors do not judge GB investments in terms of maintenance, such as prior explanations at the time of issuance and post-issuance reporting.

Finally, for institutional investors in Beijing and Shenzhen, *currency*rmb* has a positive effect on greenium in both Stages 1 and 2. Regarding currency, our results suggest that the currency of the bonds issued in RMB could be a factor in selecting GBs and that institutional investors prefer GBs issued in RMB over others.

Table 6. Logit model estimation for Beijing and Shenzhen.

	Beijing				Shenzhen			
	Stage 1		Stage 2		Stage 1		Stage 2	
Variable	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Constant	-1.474**	0.519	-0.721	0.483	-1.000**	0.468	-0.491	0.456
bid1	-2.269***	0.315	n.a.		-1.983***	0.299	n.a.	
bid2	n.a.		-2.135***	0.289	n.a.		-1.973***	0.290
*credit*crrating*	0.134**	0.066	0.060	0.064	-0.010	0.073	0.068	0.069
issuer	0.189	0.288	0.434*	0.254	0.140	0.274	0.267	0.262
usage	0.229	0.244	-0.055	0.231	0.629***	0.231	0.301	0.231
liquidity	0.803***	0.241	0.267	0.234	0.870***	0.233	0.364	0.239
term	0.852***	0.223	0.431**	0.210	0.442**	0.217	0.572***	0.211
label	0.245	0.231	0.245	0.215	0.256	0.239	0.231	0.237
maintenance	0.234	0.237	0.295	0.225	0.262	0.235	-0.165	0.241
*currency*rmb*	0.595***	0.206	0.698***	0.191	0.611**	0.213	0.775***	0.210

***, **, and * indicate significance at the 1%, 5%, and 10% levels. SE denotes standard errors.

5. Discussion

5.1. Factors affecting the greenium

Our results for credit show that institutional investors in Beijing consider the rating of the bond, while those in Shenzhen did not care about the rating when investing in GBs. These results suggest that institutional investors are different between the two regions. As most of the credit ratings in China are AAA, AA+, or AA, it can be inferred that institutional investors in Shenzhen did not care about the bonds' ratings since the ratings have been relatively high. GBs issued in China will be traded in all regional markets, not just in regional markets. The positive and significant rating in the Beijing result suggests that institutional investors in Beijing are more rigorous in their investments in terms of credit ratings.

Our results indicate that bonds' liquidity and redemption periods had a positive impact on the greenium. Since liquidy and redemption periods did not show an influence on the greenium in the study conducted for the case of Shanghai (Zenno and Aruga, 2022), it could be that the effects of these factors on the institutional investors' decision to invest in GBs are different among different regions.

For the analysis of certified labels, our results suggest that labeling has no impact on the investors' WTP for GBs. The condition that there are no rules or regulations in China to order the issuers of GBs to purchase certified labels at issuance may be the reason for this result. Therefore, in the future, if the certified label is required to issue GBs in China as strictly as in Europe and other countries and become a global market practice, institutional investors in China may take GBs with a certified label for their investment.

For the maintenance of the issuance of the GB, issuers are recommended to prioritize explanations before issuance and reporting in the market. However, our results, from the standpoint of institutional investors, show no significant impact on greenium.

Our analysis of the effect of the type of issuance currency indicates that the investors prefer the GB to be issued in RMB in both Beijing and Shenzhen. This result could be explained by several reasons. First, could be that institutional investors, not limited to those in China, either do not want to take foreign exchange risk and prefer to hedge the risk by issuing the bond in domestic currency; therefore, they are more likely to invest in their domestic currencies. Second, it could be that the current level of interest rates of the RMB is relatively higher than that of other currencies and that investors cannot find the benefit of taking foreign exchange risk to invest in bonds denominated in a foreign currency. The third reason could be the strict regulations on capital transactions in China, which make it difficult for investors to invest freely in overseas assets. Bond issuers may think about issuing GBs in other currencies if interest rates in the Chinese currency fall below those in other currencies or if restrictions on capital movements are lifted. We could not find any research on GBs in China that studies the specific currency of the bonds to be issued. Therefore, this study is probably the first Chinese GB study to analyze the impact of currency on greenium from an investor's perspective, and we recognize that the results of this study are valuable.

5.2. Analysis of differences in results between Beijing and Shenzhen

This study highlights the differences between the results obtained from institutional investors in Beijing and Shenzhen. For institutional investors in Beijing, the credit rating of the issuers evaluated by credit rating agencies, the size and liquidity of the bonds issued, the maturity of the bonds, and the bonds issued in RMB are positively significant to the greenium. On the other hand, for institutional investors in Shenzhen, the use of proceeds, the size of the bonds issued, the liquidity of the bonds, the maturity of the bonds, and the bonds issued in RMB are positively significant to greenium.

These results indicate that the size of the bonds issued, the maturity of the bond, and the type of the issuance currency are factors that affect the greenium. Second, the credit rating can also affect the greenium although this impact is only sustained among the Beijing investors. Third, the use of proceeds did not influence the greenium for Beijing but affected the greenium in the case of Shenzhen. The reason for this difference might be because issuers of GBs in Beijing are expected to improve their financial performance and raise funds at a lower yield, which could be advantageous for GB issuance while issuers in Shenzhen are required to ensure that the funds raised through GB are applied transparently.

Focusing on the WTP of institutional investors in Beijing and Shenzhen, the results show 0.326% in Beijing and 0.369% in Shenzhen, which are close to the greenium of 0.33%-0.34% estimated in Wang et al. (2020). The study result implies that the Chinese institutional investors are generally willing to invest in GBs at a lower yield compared to conventional bonds.

In addition, when comparing the greenium in Beijing and Shenzhen, Shenzhen's greenium is larger than Beijing's greenium, and institutional investors in Shenzhen are more tolerant of lower yields on GBs than on conventional bonds. Although the survey was conducted at different times, the reasons why different greeniums were indicated in China are not suggested in this study, and we recognize the limitations of this study.

6. Conclusion

This study analyzes the factors that affect greenium by directly surveying institutional investors in Beijing and Shenzhen. Consequently, in Beijing, credit rating, liquidity, bond redemption period, and issuing in the bond in RMB are important factors for issuing GBs. On the other hand, in Shenzhen, the use of funds, liquidity, bond maturity, and issuing in RMB affected the greenium.

The following suggestions can be presented to bond issuers, Chinese GB market participants, and Chinese monetary authorities for the further development of China's GB market. Our first recommendation is that the GBs should be issued in RMB in China. The second recommendation is related to credit ratings. It is advised that issuers should strengthen their financial standing and improve their credit ratings since some of the outcomes have a favorable effect on greenium. The liquidity and the bond redemption duration in our study had beneficial effects on greenium when looking for additional explanatory factors. We recommend that investors pay more attention to the issue size and maturity when targeting investors in Beijing and Shenzhen. For the fourth suggestion, a certified label might be not required at the moment for issuing GBs. Finally, there exists a greenium in Beijing and Shenzhen GB markets, and hence, the study imply the potenticality of the issuance of GB to futher increase in the future in China.

China, the world's top CO_2 emitter, has been working to achieve "net zero greenhouse gas emissions by 2060." As set forth by President Xi, the country will take action to increase its GDP growth rate to that of developed countries by 2035, along with its green and low-carbon policies. To meet these goals the expansion of green finance, including GBs, is urgently needed.

As a first step toward increasing issuance in China's GB market, resolving the supply-demand balance and providing a boost for the expansion of the global GB market, we hope to share the results of investor awareness found in this study with issuers and market participants. This will help realize global environmental conservation.

Funding: This research was supported by JSPS Kakenhi Grant Number JP22H03808, and the Special Fund from the Research Center for Sustainable Development in East Asia, The Strategic Research Area for Sustainable Development in East Asia, Saitama University, Japan.

Data Availability Statement: The data source is available upon request.

Conflicts of Interest: The authors declare no conflict of interest

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