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Institutional Investors' Willingness to Pay for Green Bonds: A Case for Shanghai

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Abstract: The issuance of green bonds has been increasing since 2016 in China, and the number of papers covering the topic is growing. In previous studies on greenium, not much has been investigated from the institutional investors' perspective. The study estimates the institutional investors' level of greenium by surveying the institutional investors in Shanghai, China, from October 23 to 1 November 2021, using the double-bound dichotomous choice (DBDC) contingent valuation method (CVM). The study also analyzes the effects of variables that are known to be important for the green bond based on previous studies. The study identifies that there is a greenium level of 0.47%. Among the seven variables tested with logit regression models, the credit and currency of the bond had a positive effect on the greenium. The study provides helpful insights for issuers' strategic planning and could be a stepping stone to increasing issuance not only for the Chinese green bond market but also for the global green bond market.

Keywords: green bonds; China; greenium; willingness to pay (WTP); contingent valuation method (CVM)

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1. Introduction

To mitigate and navigate global warming, the issuance of thematic bonds or sustainable bonds, such as green bonds and social impact bonds, is attracting attention (Kumar 2022; Morano et al. 2020). Green bonds are bonds issued to finance projects intended to improve various environmental problems such as reducing GHG emissions, climate change adaptation, natural resource and biodiversity conservation, etc. Green bonds have attracted attention in recent years, especially after the 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change agreed on the Paris Agreement's target to maintain the temperature increase from preindustrial times, at well below 2 °C. Green bonds originate from the issuance of the first "climate awareness bonds" by the European Investment Bank in 2007 (Ehlers and Packer 2017). According to the Climate Bond Initiative (CBI), the global issuance of green bonds was less than USD 50 billion in 2015, but by 2021, it reached more than USD 500 billion (see Figure 1). One of the reasons that green bonds are attracting attention is that natural disasters, such as typhoons, torrential rains, and fires, are occurring more frequently due to rising temperatures, and the need to mitigate and navigate global warming has become an international concern (Higano and Otsuka 2022). Governments, local governments, organizations, and others have become increasingly supportive of issuing green bonds, and regulations, laws, and markets have been established to promote green bonds to raise the funds needed to prevent global warming.

Green bonds have environmental benefits for market participants (stakeholders), enabling them to directly contribute to the global environment by purchasing or issuing green bonds (Bhutta et al. 2022; Lin and Su 2022). There are economic advantages for the issuers of green bonds, as they can attract funds from environmentally minded investors

and may raise funds at lower yields than conventional bonds. In addition, raising market awareness that a green bond is being issued could increase corporate value. There are benefits for investors as well, since investing funds in green bonds can indirectly contribute to society and such earth-friendly action may be appealing to the public. Green bonds have rapidly gained attention in recent years for these reasons. The issuance of green bonds has increased, and many countries are taking action to achieve environmental protection.

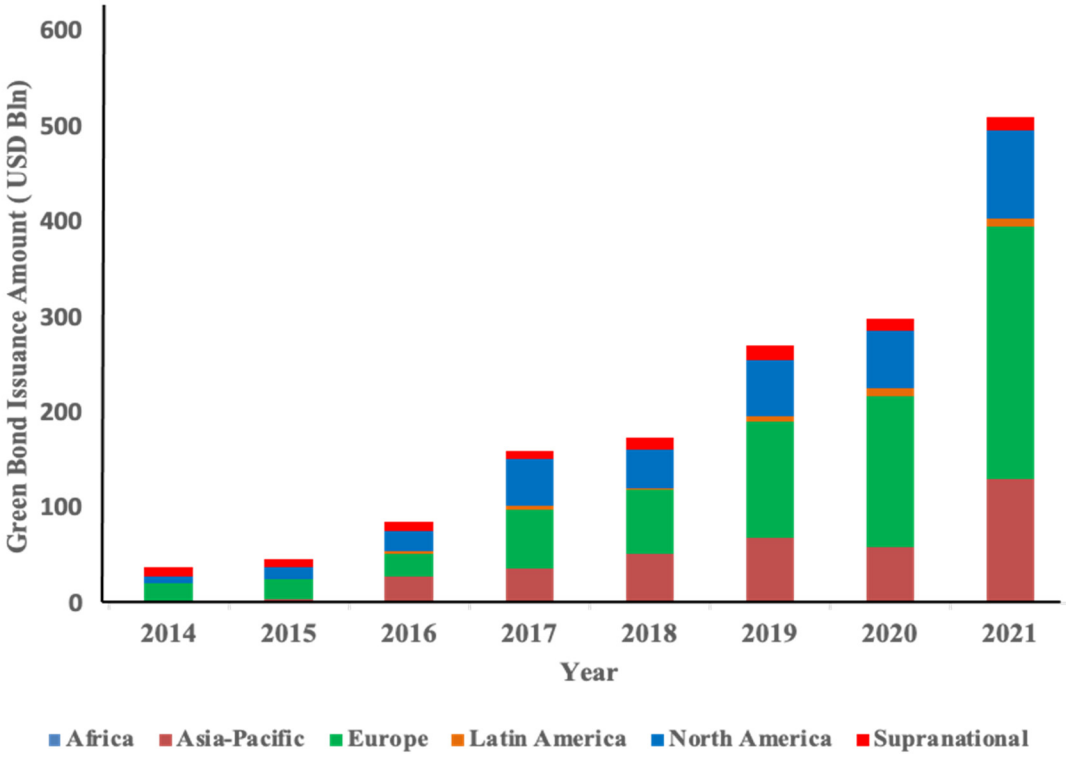

Figure 1. Global Green Bond Issuance by Regions. Prepared by the authors based on data from CBI (2021a).

In addition to the urgent need for environmental action across the globe, China faces urgency in achieving the more concrete plans established by the government. According to the International Energy Agency (IEA 2020), China's greenhouse gas emissions in 2020 reached 9.5 billion tons. Amid this urgency, in September 2020, President Xi Jinping announced at the United Nations General Assembly that China's efforts to improve the environment would pass peak CO_2 emissions by 2030 and achieve carbon neutrality by 2060. Corresponding to President Xi's announcement, the State Council of China revealed the "Carbon Peak Action Plan by 2030" in October 2020. As the world's highest CO_2 emitter, China's action plan will have a significant impact on improving the global environment. Nevertheless, it will not be easy to achieve, and efficient urgent actions must be taken. Subsequently, more than any other country, China must develop its green bonds market to raise funds to achieve the nation's action plan.

One of the important issues that this study examines is determining whether green bonds are being issued sufficiently and supplied to green projects. The IEA (2021) estimates that decarbonization of the energy sector requires an additional investment of about USD 4 trillion annually from 2026 to 2030, while the actual figure from 2016 to 2020 was about USD 1 trillion per year. The shortage of about USD 3 trillion must be raised from the financial market, primarily through green bonds, and the financial sector is expected to hold the primary role in escalating the issuance of green bonds to address global warming.

According to the Bank for International Settlement (BIS 2020), the total amount of bonds issued globally in 2020, excluding residents, was USD 6743.5 billion, of which green

bonds were issued for USD 290.1 billion, representing only 4.3% of the total amount of the bond issuance. If China and the rest of the world's bond markets are actively in favor of environmental improvement and protection, and if the green bond issuance reaches about half of all issued bonds, the USD 3 trillion shortage estimated by the IEA for annual financing could be covered.

It could be effective to investigate how much investors are looking to invest in green bonds and share the results with the related stakeholders, including bond issuers. Raising issuers' awareness of investors' attitudes could facilitate some changes in issuers' behavior, increasing the issuance of green bonds.

In this article, our first objective is to identify the greenium (green bond premium) from the perspective of institutional investors, by focusing on the attitudes of Chinese investors that were not introduced in the previous studies. This will present new and potentially actionable insights for understanding the investors' perceptions of green bonds. To achieve this objective, we apply the contingent valuation method (CVM) to determine the greenium that institutional investors are willing to pay. The CVM is used to determine the value of goods and services by conducting a survey to ask about people's willingness to pay (WTP) toward goods and services in a hypothetical market curated by the investigator. Our second objective is to analyze the factors that are likely affecting the Chinese institutional investors' purchase for green bonds, such as the issuers' credit rating, type of business, and bond currency.

Understanding the level of WTP for Chinese institutional investors will help to expand the green bond markets in China and provide crucial information to raise the liquidity of green bonds in China. Furthermore, the results of the expansion of the green bond market can lead to more funds being allocated to projects to advance environmental protection and prevent global warming.

The remainder of this paper is organized into five sections. In Section 2, we introduce previous relevant studies. Section 3 details the study methods. Section 4 presents the results of the study, followed by discussions in Section 5. Finally, Section 6 presents the conclusions of the study.

In this article, we indicate the Chinese Renminbi as RMB, because the Renminbi could include CNY and CNH. We used the exchange rate of USD/RMB = 6.39 as of 23 October 2021, when the survey was conducted.

2. Previous Studies

Considerable research on green bonds has been undertaken since 2016. Initially, studies investigated the background of green bonds to understand the initial issuance process and procedures differing from conventional bonds, such as the certification process. More recent studies have examined more specific topics, such as determining a greenium, which is often defined as the difference in the yield between green bonds and conventional bonds. In addition, with the global spread of COVID-19, some studies examined the effect of COVID-19 on the green bond markets (Yi et al. 2021). Below, we review previous studies in the following fields: (a) global green markets, (b) green bond market in China, (c) greenium in the global market, and (d) greenium in China.

For studies examining the situation of global green bond markets, Deschryver and Mariz (2020) find that the green bond market is in excess demand and is facing an imbalance in supply and demand. Ehlers and Packer (2017) explore the greenium with green bond certificates in global markets, and Bhutta et al. (2022) conduct a systematic literature review on green premiums in the global market. Lebelle et al. (2020) study the market reaction to the announcement of green bond issuances.

For the green bond market in China, Amstad and He (2019) determine that a lack of liquidity is one of the main challenges to be solved in the Chinese green bond market. Zhou (2019) reveals some general problems in China's green bond market, showing that the green bond market has grown rapidly since 2016, with strong promotion needed to expand the volume of transactions from the Chinese government and authorities. Wang

et al. (2019) examine the risk premium in China's green bond issuance, finding third-party certification to lower the financing costs of green bonds and that the issuers' credit rating and the terms of the bond affect the financing costs of green bonds. Lin and Su (2022) analyze the roles of potential factors that might cause issuers to choose between green bonds or conventional bonds in Chinese markets. Escalante et al. (2020) explain that the funds raised from the green bond market are used for clean transportation, clean energy, pollution prevention control, and other activities for environmental preservation purposes, respectively in China.

Recently, there are some studies on greenium; however, the theoretical literature is still scarce. Various results can be found in previous studies on greenium. There is a controversial debate in the literature about the existence of greenium

Regarding greenium in the global market, we reviewed Zerbib (2016) and Zerbib (2019). The former study investigates the green premium and the latter studies investigate the impact of environmental protection preferences on bond prices, with a latter study indicating a greenium of 0.02% using the matching method. Both articles contributed to the spread of greenium research worldwide, and are used to determine the explanatory variables to test their effects on the greenium in the study. Flammer (2021) summarizes previous greenium studies and examines the impact of the issuance of green bonds on other markets, and estimates no premium. Karpf and Mandel (2017) examine the US municipal bonds market and estimate a greenium of 0.02%, while Löffler et al. (2021) studied global bonds markets and indicate a greenium of 0.15–0.20%. On the other hand, Larcker and Watts (2020) analyzed U.S. municipal green bonds and found no greenium, while Agliardi and Agliardi (2021) analyze two uncertainties, the cash flows of the firm and the effectiveness of the financed green projects indicating that greenium can generate both positive and negative outcomes.

Wang et al. (2020) are one of the few studies to examine greenium in China with the matching method, finding that green bonds in China raise funds at lower interest rates than conventional bonds. However, this study does not offer insights into why the greenium is not expanding and does not propose measures for green bond expansion.

For the studies on CVM, in addition to Aruga (2022a) and Hoyos and Mariel (2010), we reviewed Gelo and Koch (2015), studying the value of community forestry programs and a study by Jiang et al. (2019), which identifies the value of water quality.

The contributions of this study can be summarized in two ways. First, although most previous studies examine greenium by applying the matching method using existing data, our study applies the CVM survey method. Second, since the study surveyed institutional investors, the study is distinctive from other studies as the greenium is investigated from the investor's standpoint. The closest study to the current one is Aruga (2022b), which examines Japanese retail investors' willingness to buy green bonds using the CVM. However, no studies have investigated the existence of greenium for Chinese institutional investors to date.

3. Materials and Methods

3.1. Study Area

We chose the Shanghai market as our research scope. The Chinese government and financial authorities have made it a national policy to develop Shanghai into one of the leading financial centers in the world (Chen and Chen 2015; Wang 2019). Since opening the port in 1843, the "qian zhuang," which means banking concerns in Chinese, foreign banks, and domestic banks have established a formidable trade and financial center in Shanghai (Zeng 1997), and Shanghai has become one of the world's leading financial centers. According to the Global Financial Centres Index (GFCI), which is a ranking of the world's financial markets produced by the Z/Yen group, the Shanghai market was ranked sixth in the world and third in Asia, after Hong Kong and Singapore, in 2021 (Z/Yen Group 2021).

3.2. Survey Methods

Our survey targeted institutional investors in Shanghai who invest in Chinese bonds, seeking to conduct a CVM-based survey posing direct questions to ascertain the investors' attitudes. The survey was conducted with the help of Wenjuan, the Chinese online survey company also used by Mei and Brown (2018). There are two reasons for choosing Wenjuan. First, there is a Great Firewall in China that overseas survey companies may not be able to manage. Second, a CVM-based survey requires a relatively large sample size. Wenjuan can facilitate an online survey with respondents selected at random from the existing survey list to accommodate more than 500 institutional investors in Shanghai.

The double-bounded dichotomous choice (DBDC) approach was adopted for our CVM-based survey to minimize biases (Lopez-Feldman 2012). The respondents were divided at random into five groups of equal numbers and asked whether they would invest in green bonds or conventional bonds issued by the same issuer, considering the range of yields between green bonds and conventional bonds.

At the time of the survey, there was widespread concern regarding the creditworthiness of the Hengda Group of China, in both Chinese and global markets (Sun and Cao 2021). It was necessary to conduct the survey at a time when financial markets were calm and not affected by great concern. Thus, we decided to conduct the survey between 23 October and 1 November 2021, after the National Day holidays in China.

3.3. About Wenjuan

Wenjuan is an online research service provider located in Shanghai, China, operated by the Zhongyan Network Technology Co. Many studies conducting survey in China have used this company (Mei and Brown 2018). As of October 2021, Wenjuan had about 8.9 million users, managing information on each user's age, education, occupation, and place of residence. When requesting Wenjuan to conduct a survey, the client offering the survey indicates the conditions, including the desired number of respondents, to confirm whether Wenjuan can conduct the survey. We requested that the company gather at least more than 500 institutional investors in Shanghai, and we were able to obtain responses from 600 Shanghai institutional investors. We also randomly divided respondents into five groups of 120 people and administered the questionnaire using two-stage, two-choice questions.

3.4. Survey Design

There are several random sampling techniques in surveys, such as simple random, stratified, systematic, and cluster sampling (Taherdoost 2016; Zhao et al. 2019). We used the stratified sampling method to select respondents from among the 8.9 million people registered with Wenjuan. The composition of the survey was based on individuals, regardless of gender, income, or whether the company they work for is listed or unlisted; however, the following three criteria were used to categorize the respondents: (a) age between 20 and 59 years old, (b) reside in Shanghai, and (c) institutional investors working for financial institutions, such as banks, securities firms, and asset management companies. As a result, 600 respondents meeting these conditions were selected, and a pretest was conducted before the implementation of the survey. The pretest was conducted, with 28 Chinese institutional investors randomly selected as respondents from the registered users of Wenjuan research company. The pretest was handled with the same questionnaire as the actual survey, confirming that the respondents understood our survey questions.

The questionnaire was presented in six parts. In the first section, environmental issues were explained; then, questions concerning the respondent's level of interest in environmental issues were asked using a five-point Likert-type scale for the answers. In the second section, basic questions regarding bond investment were first asked, followed by an explanation of green bond products and confirmation of respondents' understanding of green bonds. Based on the Green Bond Endorsed Project Catalogue (2021 Edition) (PBC 2021), respondents were informed that the definition of "green bond" is a bond issued

to protect and improve the environment and that the funds raised through "green bonds" are used to improve energy-use efficiency. The third section asked questions to ascertain whether respondents had invested in green bonds. The respondents were divided into two groups; one group included those who answered YES or "will start investing soon" and the other group with those who answered NO. The group that answered YES or "will start investing soon" were asked about their reasons for investing, the percentage of investment, the country of the issuer of the investment bond, whether the issuer of the green bond purchases conventional bonds and the challenges of green bonds in China. Those who answered NO were asked why they did not invest in green bonds and what are the issues with green bonds in China. The fourth section asked all respondents about their selection criteria for investing in green bonds. The fifth part of the survey was the primary part of the questionnaire based on a two-stage and two-choice DBDC-CVM analysis. The final section of the survey asked about respondents' attributes.

3.5. Contingent Valuation Design

We used the DBDC approach for our first objective to find the greenium of institutional investors because it has the advantage of being more statistically efficient than the single-bound dichotomous choice (SBDC) method (Watson and Ryan 2007). The DBDC in this study first presented the yield of conventional bonds, so that respondents could understand the market level, and then presented the yield of green bonds. If the respondent answered YES to the first question, the second question asked for the lower level of yield that the respondent considered unfavorable. If the respondent answered NO, in addition to the first question, a higher level of yield that is potentially favorable to the respondent was presented as the second question.

3.6. WTP for the Greenium and Designing of Bids

WTP was defined along with greenium. According to Zerbib (2019), greenium is defined as the yield difference between green bonds and conventional bonds having the same risk. If the yield of the green bond is lower than the yield of the conventional bond, the WTP will be positive. If the yield of the green bond is higher than the yield of the conventional bond, the WTP will be negative.

Regarding the design of bids in the CVM, the level of the first question affects the results of WTP (Budhathoki et al. 2019); therefore, it is necessary to set the level of the first question with care. The yield of conventional bonds was first presented to the respondents as an assumption for the question as a reference. Since the yield of 10-year Chinese government bonds in November 2021when the survey was conducted was at the level of 2.80–2.90% per annum (hereinafter all yields are annualized); the question was asked after explaining to the respondents that the yield on conventional bonds was assumed to be 2.80%.

Then, bids that ranged from −0.50% to +0.50% compared to the yield on conventional bonds were divided into five groups: (−0.50%, −0.25%, 0.00%, +0.25%, +0.50%) for the first bid. Depending on the first reply of YES or NO, follow-up bids were set to −1.00% or −0.25%, −0.50% or 0.00%, −0.25% or +0.25%, 0.00% or +0.50%, and +0.25% or +1.00%. The bids were set in increments of 0.25% or 0.5% in recognition that market participants engaged in the money market are familiar with such spreads (Herbsta and Pergb 2001; Amihud and Mendelson 1991; Labuszewski et al. 2013).

In the first question of the first group, we asked the respondents for the first bid at +0.50%, indicating a yield that is 0.50% higher than that of a conventional bond. If the respondent answered YES and chose the green bond, the second bid was set at +0.25%, which elicits a yield that is 0.25% higher than that of a conventional bond. If the respondent answered NO and did not choose the green bond, the second bid was set at +1.00%, indicating a yield that is 1.00% higher than that of a conventional bond.

3.7. Analysis of WTP

With a linear function, the individual WTP can be stated as follows:

$$WTP_i(z_i, \varepsilon_i) = z_i\beta + \varepsilon_i \tag{1}$$

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

The analysis was conducted using DBDC, so respondents provided two answers. In addition, here, we defined t as the amount an individual is willing to pay, which varies randomly among individuals. The first question is denoted by t^1, and the second question is denoted by t^2. This can be represented by the following four patterns of two answers (Lopez-Feldman 2012). First, if the first and second answers are both *yes*, then $t^2 > t^1$ and $t^2 \leq WTP < \infty$. Second, if the first answer is *yes* and the second answer is NO, then $t^1 \leq WTP < t^2$. Third, if the first and second answers are *no* and *yes*, respectively, then $t^2 < t^1$ and $t^2 \leq WTP < t^1$. Fourth, if the first answer is *no* and the second answer is also NO, then $0 \leq WTP < t^2$.

If the first answer is *yes*, the value is 1, and if the second answer is *no* the value is 0. The probability that the first answer is YES, and the second answer is *no* is shown as $Pr(y_i^1 = 1,\ y_i^2 = 0|z_i) = P_r(yes, no)$, where z_i is a vector of explanatory variables. However, the right-hand side of the equation omits the fact that the probability is conditional on the value of the explanatory variables.

Under the assumption that $WTP_i(z_i, u_i) = z_i'\beta + u_i$ *and* u_i–$N(0, \sigma^2)$, the four potential patterns of responses are as follows:

If the first answer is *yes* and the next answer is *no*, it will be indicated as $y_i^1 = 1$ and $y_i^2 = 0$.

The probability of answering *yes* to the first bid and *no* to the second bid will be indicated as $P_r(yes, no)$. $P_r(yes, no)$ can be expressed as follows:

$$\begin{aligned} P_r(yes, no) &= P_r(t^1 \leq \text{ WTP} < t^2) \\ &= P_r(t^1 \leq z_i'\beta + u_i < t^2) \\ &= P_r(\tfrac{t^1 - z_i'\beta}{\sigma} \leq \tfrac{u_i}{\sigma} < \tfrac{t^2 - z_i'\beta}{\sigma}) \\ &= \Phi\left(\tfrac{t^2 - z_i'\beta}{\sigma}\right) - \Phi\left(\tfrac{t^1 - z_i'\beta}{\sigma}\right) \end{aligned} \tag{2}$$

where the last expression follows from $P_r(a \leq X < b) = F(b) - F(a)$.

Using the symmetry of the normal distribution, $P_r(yes, no)$ can be indicated as the following equation.

$$P_r(yes, no) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \tag{3}$$

Then, the probability of the remaining three cases, answering *yes* to both the first and the second bids, *no* to the first and *yes* to the second, or *no* to both bids could be indicated as follows:

$$P_r(yes, yes) = 1 - \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \tag{4}$$

$$P_r(no, yes) = \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) \tag{5}$$

$$P_r(no, no) = 1 - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right) \tag{6}$$

Summing up Equations (3)–(6), we obtain:

$$\begin{aligned}\sum_{i=1}^{N}\Big[d_i^{yesno}\ln(\Phi & \left(z_i'\frac{\beta}{\sigma}-\frac{t^1}{\sigma}\right)-\Phi\left(z_i'\frac{\beta}{\sigma}-\frac{t^2}{\sigma}\right)\Big)\\ &+d_i^{yesyes}\ln\left(\Phi\left(z_i'\frac{\beta}{\sigma}-\frac{t^2}{\sigma}\right)\right)\\ &+d_i^{noyes}\ln\left(\Phi\left(z_i'\frac{\beta}{\sigma}-\frac{t^2}{\sigma}\right)-\Phi\left(z_i'\frac{\beta}{\sigma}-\frac{t^1}{\sigma}\right)\right)\\ &+d_i^{nono}\ln\left(1-\Phi\left(z_i'\frac{\beta}{\sigma}-\frac{t^2}{\sigma}\right)\right)\Big]\end{aligned} \tag{7}$$

Let d_i^{yesno}, d_i^{yesyes}, d_i^{noyes}, and d_i^{nono} be two-choice indicator variables that take the value of 1 or 0 depending on the relevant case. That is, each choice variable contributes to the logarithm of the likelihood function in only one of the four parts.

Finally, denoting $\hat{\alpha}$ as the vector of coefficients associated with each one 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 as the following equation:

$$\overline{WTP}=\tilde{z}'\left[-\frac{\hat{\alpha}}{\hat{\delta}}\right] \tag{8}$$

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

3.8. Variables for Analyzing the Effectiveness of the Greenium

The second objective of this research is to assess the effectiveness of variables to the greenium by selecting explanatory variables from the previous literature. Zerbib (2019) investigates the impact of environmental protection preferences on bond prices in a study serving as the precursor to many subsequent greenium studies, and Wang et al. (2020) presented one of the few papers to examine the greenium in China; therefore, we followed the variables used by Zerbib (2019) and Wang et al. (2020). The dependent variable was the greenium, while the explanatory variables were the issuers' credit, type of business, green rating, liquidity of the bond, redemption term of the bond, label, and the currency of the bond, as shown in Table 1.

Table 1. Explanatory variables and variable names.

Explanatory Variables	Variable Names
Green bond issuer's credit rating/credibility	Credit
The type of business of the green bond issuer (e.g., government, municipality, or industry in the case of a company)	Issuer
Green bond issuer's green rating and contribution to the environment	Green rating
Amount of green bond issued and liquidity of the bond	Liquidity
Redemption term of the green bond	Term
Proof of the label	Label
Currency of the green bond	Currency
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)	ans1
A dummy variable representing the answer to the second question (yes = 1, no = 0)	ans2

3.9. Factors Affecting the Willingness to Buy Green Bonds

The effects of the explanatory variables in Table 1 on the WTP were analyzed, along with the likelihood estimation based on Equation (7), but we also estimated the effects of these variables on the probability of the respondents accepting the bids presented in the first and second rounds of the CVM survey. We define these probabilities of respondents buying the green bonds presented in the survey as the willingness to buy (WTB). For this purpose, we applied a logit model using *ans1* and *ans2* (see Table 1) as the dependent variables for

the two models. The first model (Model 1) shows WTB without any explanatory variables besides the intercept, Which can be stated as follows:

$$\ln(ans_i) = \beta_0 + \mu_{ans} \ (i = 1, \ 2) \tag{9}$$

where ans_i is the probability of answering "yes" to the bids, β_0 is the constant and μ_{ans} is an error term.

The second model (Model 2) includes all the explanatory variables, selected as those used in the previous literature, such as Zerbib (2019) and Wang et al. (2020), examined in the study, which can be stated as follows:

$$\begin{gathered}\ln(ans_i) = \beta_0 + \beta_1 credit + \beta_2 issuer + \beta_3 green\ rating + \\ \beta_4 liquidity + \beta_5 term + \beta_6 label + \beta_7 currency + \mu_{ans} \ (i = 1, \ 2)\end{gathered} \tag{10}$$

where β_1 through β_7 are the coefficients of the core explanatory variables.

4. Results

4.1. Sample Description

We also surveyed socioeconomic and demographic variables, such as respondents' gender, age, workplace, and total investment amount, as shown in Table 2.

Table 2. Demographic statistics of survey respondents (n = 600).

Variables	Samples Frequency	Percentage (%)
Respondent's gender		
1. Female	245	40.83
2. Male	355	59.17
Respondent's age (year)		
Age (20–29)	44	7.33
Age (30–39)	266	44.33
Age (40–49)	249	41.50
Age (50–59)	41	6.83
Respondent's workplace		
Bank	42	7.00
Securities firm	115	19.17
Asset management company	139	23.17
Investing company	99	16.50
Others	205	34.17
Respondent's total investing amount		
RMB 1–RMB 1 million	97	16.17
RMB 1 million–RMB 3.5 million	170	28.33
RMB 3.5 million–RMB 6.5 million	213	35.50
RMB 6.5 million–RMB 32.5 million	120	20.00
RMB 32.5 million–RMB 65 million	0	0
RMB 65 million or more	0	0

In terms of gender, 40.8% of the respondents were female and 59.2% were male; 85.8% of the respondents were between 30 and 49 years of age; 65.8% of the respondents worked for banks, securities companies, asset management companies, and investment companies. Among these, those working for asset management companies accounted for 23.2% of the total sample. The "Others" category, includes insurance companies, pension funds, etc. (Lin and Puchniak 2022), which accounted for 34.2% of the respondents. The total investment amount of the respondents was between RMB 3.5 million–RMB 6.5 million (about USD 0.5 million–USD 1 million), which was the highest at 35.5%.

4.2. Description of Greenium Explanatory Variables

Table 3 presents the summary of the seven explanatory variables used in this research. More than 70% of the respondents answered YES to six variables, excluding currency, and 81% of the respondents identified the issuer's rating as a criterion for investment decisions. The summary indicates that more than 60% of the respondents answered YES to currency, but in comparison to the remaining six variables, the institutional investors' frequency of YES responses was lower.

Table 3. Summary of the variables of the sample respondents (n = 600).

Questions	Variables	Answers	Samples Frequency	Percentage (%)
Is the "credit rating" of the issuer of the green bond the criterion for the decision?	credit	YES = 1	488	81.33
		NO = 0	112	18.67
Is the "business category" of the issuer of the green bond the criterion for the decision?	issuer	YES = 1	465	77.5
		NO = 0	135	22.5
Is the "green rating" of the issuer of the green bond the criterion for the decision?	green rating	YES = 1	451	75.17
		NO = 0	149	24.83
Is the "amount" and the "liquidity" of the green bond the criterion for the decision?	liquidity	YES = 1	443	73.87
		NO = 0	157	26.17
Is the "term" of the green bond the criterion for the decision?	term	YES = 1	425	70.83
		NO = 0	175	29.17
Is the "label" the green bond the criterion for the decision?	label	YES = 1	454	75.67
		NO = 0	146	24.33
Is the "currency" of the green bond the criterion for the decision?	currency	YES = 1	365	60.83
		NO = 0	235	39.17

4.3. Respondents' Level of Interest in Environmental Issues and Understanding of Green Bonds

In this survey, we asked respondents about their level of interest in global environmental issues and their level of understanding of green bonds. Table 4 shows that 88.0% of the total respondents answered "very concerned" or "concerned a little" about global warming. The survey suggests that institutional investors in Shanghai are highly concerned about global warming.

Table 4. Institutional investors in Shanghai's interest in global environmental issues (n = 600).

Question and Answers	Samples Frequency	Percentage (%)
Are you concerned about "anathermal" or "global warming"?		
Very concerned	192	32.00
Concerned a little	336	56.00
Cannot say either	59	9.83
Not concerned very much	12	2.00
Not concerned at all	1	0.17

Table 5 presents the responses to the questions regarding the level of understanding of green bonds. Although some of the questions required technical knowledge, only two out of the 600 respondents indicated that they did not know any of the questions. This suggests that institutional investors in Shanghai generally have an in-depth knowledge of green bonds.

Table 5. Results of the understanding of green bonds (n = 600).

Questions	Answers	Samples Frequency	Percentage (%)
Do you know that green bonds are used for the construction of power plants and buildings that use clean energy such as solar thermal and wind power in China?	YES = 1 NO = 0	284 316	47.33 52.67
Do you know that "the Green Bond Endorsed Project Catalogue" prepared by the Committee of Green Finance Specialists of the Chinese Society of Finance was revised in 2021 and coal was removed from the catalog in China?	YES = 1 NO = 0	358 242	59.67 40.33
Do you know that after President Xi Jinping's report at the 19th National Congress of the Communist Party of China in 2017, the development of green finance, including green bonds, has been raised to the national strategic level in China?	YES = 1 NO = 0	364 236	60.67 39.33
Do you know that China has been focusing on market reforms, such as the implementation of the "Green Bond Index" in collaboration with the Luxembourg Stock Exchange?	YES = 1 NO = 0	314 286	52.33 47.67
Do you know that China promotes product innovations such as "Green Covered Bonds" and "Green ABS"?	YES = 1 NO = 0	285 315	47.50 52.50
Do you know that the yield of green bonds issued by Chinese financial institutions is often less than the yield of non-green bonds or conventional bonds, issued by the same financial institutions over the same period?	YES = 1 NO = 0	135 465	22.50 77.50
Are you ignorant about the green bonds mentioned above?	YES = 1 NO = 0	2 598	0.33 99.67

4.4. Analysis of Responses Regarding WTP

Table 6 presents the structure of the bid responses among the five groups of respondents. First, about 10% of the 600 respondents rejected both the initial and the higher follow-up bids for choosing green bonds, which are indicated as n/n. This means that about 90% of the respondents gave a positive response to WTP for green bonds. Notably, nearly 73% of the respondents responded YES for the initial bids, indicated as y/y and y/n, choosing green bonds over conventional bonds.

Table 6. Distributions for the bid responses among the five groups of respondents (n = 600).

1st Bid	2nd Bid (B^l/B^u)	y/y	y/n	n/y	n/n	Total Respondents
0.50%	+0.25%/+1.00%	89 74.20%	12 10.00%	14 11.70%	5 4.20%	120 100.00%
0.25%	±0.00%/+0.50%	76 63.30%	19 15.80%	17 14.20%	8 6.70%	120 100.00%
±0.00%	−0.25%/+0.25%	61 50.80%	32 26.70%	18 15.00%	9 7.50%	120 100.00%
−0.25%	−0.50%/±0.00%	43 35.80%	27 22.50%	40 33.30%	10 8.30%	120 100.00%
−0.50%	−1.00%/−0.25%	55 45.80%	23 19.20%	17 14.20%	25 20.80%	120 100.00%
Total respondents		324 54.00%	113 18.80%	106 17.70%	57 9.50%	600

B^l denotes the lower bids when the respondents answered YES to the first bids. B^u the upper bids when the respondents answered NO to the first bids.

4.5. Maximum Likelihood Estimation and Mean WTP

Table 7 also presents Model 1 with the maximum likelihood estimation and the mean WTP without explanatory variables, Model 2 with the maximum likelihood estimation, and the mean WTP with the seven significant explanatory variables of credit, issuer, green rating, liquidity, term, label, and currency. The mean WTP without the explanatory variables (Model 1) is 0.47%, indicating that the institutional investors in Shanghai will choose green bonds until the difference between the yield on green bonds and the yield on conventional bonds exceeds 0.47%.

Table 7. Maximum likelihood estimation and mean WTP.

	Model 1		Model 2	
Variable	**Coef.**	**SE**	**Coef.**	**SE**
Constant	0.680 ***	0.034	0.624 ***	0.031
Credit	n.a.		0.429 ***	0.080
Issuer	n.a.		0.076	0.076
Green rating	n.a.		0.118	0.073
Liquidity	n.a.		0.070	0.073
Term	n.a.		0.094	0.070
Label	n.a.		0.089	0.071
Currency	n.a.		0.187 ***	0.644
Mean WTP	0.466 ***	0.036	0.472 ***	0.034

*** indicates significance at the 1% level. SE denotes the standard error.

In Model 2, including the seven explanatory variables, the mean WTP was 0.47%. Compared to the mean WTP without the explanatory variables, the difference in yield to choose green bonds was less than 0.01%.

4.6. Factors Affecting the Respondents' WTB

For our second objective, we analyzed the impact of the explanatory variables on the WTB green bonds using the logistic regression model. As shown in Table 8, the credit and the currency of the bond have a significantly positive effect on WTB at both Stage 1 and Stage 2.

Table 8. Logit model estimation for Model 2.

	Stage 1		Stage 2	
Variable	**Coef.**	**SE**	**Coef.**	**SE**
Constant	−0.754 **	0.301	−0.605 **	0.291
bid1	−1.490 ***	0.293	n.a.	
bid2	n.a.		−0.756 ***	0.211
Credit	1.143 ***	0.249	0.556 **	0.248
Issuer	0.075	0.241	0.202	0.231
Green rating	0.310	0.226	0.346	0.219
Liquidity	0.055	0.230	0.347	0.219
Term	0.260	0.219	0.145	0.213
Label	0.130	0.227	0.294	0.215
Currency	0.559 ***	0.203	0.429 **	0.197

*** and ** indicate significance at the 1% and 5% levels respectively. SE denotes the standard error.

5. Discussion

5.1. Institutional Investors' WTP for Green Bonds

Most of the previous research used trade data from existing green bond markets to estimate the premium of green bonds. The results of these studies have been inconsistent; some studies identify a greenium while others deny the presence of such a premium. In this study, we used data obtained from a survey directly conducted on institutional investors

and analyzed the results from the investors' perspective. Our study shows that there is a greenium in the Chinese green bond market. The greenium of 0.47% estimated in our study is higher than the greenium of 0.33% or 0.34% estimated by Wang et al. (2020), who examined the greenium of green bonds for China. Thus, this indicates that the institutional investors in Shanghai can allow for a lower yield than the greenium shown by Wang et al. (2020).

One reason for this could be that our study estimated the greenium based on survey data while Wang et al. (2020) assessed the greenium using the existing data with a matching method. The second reason could be that the data used by Wang et al. (2020) was earlier than ours. Their study was based on samples from January 2016 to June 2019, which was still at an early stage for the Chinese bond market. In contrast, our survey was conducted in 2021, when the Chinese government and the relevant authorities began to focus on developing the green bond market, leading its market becoming one of the largest green bond markets in the world.

5.2. Variables Affecting the Institutional Investors' WTB Green Bonds

Our second objective is to analyze the effect of the variables that appear in previous greenium studies. As indicated in Model 2 in Table 8, among seven explanatory variables, credit and the currency of the bonds are significant and have a positive effect on WTB. This result suggests that when investing in green bonds, institutional investors in Shanghai may place more emphasis on issuers' creditworthiness and prefer green bonds from issuers with high creditworthiness. While the credit rating is an important indicator of potential risks for investors to invest in green bonds, as well as in conventional bonds (Li et al. 2020), green bonds indirectly contribute to improving the creditworthiness of the issuer (Agliardi and Agliardi 2021). Our study confirms that creditworthiness is an important element for investing in green bonds from the investors' perspective.

As for the significance of the currency, this survey does not confirm whether investors prefer RMB or foreign currencies, but it can be assumed that institutional investors emphasize the currency of the bond when investing in green bonds. Whether they prefer RMB or foreign currency is left for future research. If they prefer RMB, it is assumed that they want to avoid exchange rate risk between foreign currencies and RMB. Although the impact of this survey on the WTB is limited, we can advocate that issuers' credit is important and they should examine the currency of the bonds before issuing green bonds.

6. Conclusions

A DBDC contingent valuation survey was performed on 600 institutional investors in Shanghai, China, to estimate their WTP for green bonds. We found that the level of greenium, which is the yield difference between green bonds and conventional bonds, is estimated to be 0.47% for Shanghai investors. A study analyzing the greenium for the whole Chinese green bond market suggests that the greenium is around 0.33% or 0.34% (Wang et al. 2020). Our study also indicated that the investors are willing to accept a greenium, implying that there are chances to issue green bonds at a lower yield than conventional bonds. However, more studies like ours need to be conducted for other Chinese regions to further understand the levels of greenium in China.

The study also investigated the effect of the explanatory variables on the WTB for green bonds that were suggested to be important in previous studies. Among these variables, we found that the issuers' credibility and the currency of the green bond have statistically significant and positive impacts on the WTB. Therefore, raising the credibility of the issuers of green bonds and considering the types of currency used to issue green bonds are critical factors for expanding the green bond market in China.

This study is one of the first studies to use CVM to determine greenium in the Chinese bond market, but the study likely contains some biases. First, since the study result is obtained from survey data, the result only reflects the greenium based on a hypothetical

condition. Second, the results might differ if the survey is implemented in other cities or regions of China.

In April 2021, the People's Bank of China, the National Development and Reform Commission, and the China Securities Regulatory Commission released "the Green Bond Endorsed Project Catalogue (2021 Edition)" (PBC 2021) which was implemented in July 2021 (CBI 2021b). The first edition of this catalog was introduced in 2015, which can be considered as substantive rules or a manual for managing green bonds in China. What is noteworthy about this revision is that the definition of a green bond in China, which was raised as an issue in previous studies on China's green bonds with proposed revisions, was almost the same as the European definition of green bonds by eliminating "the gray definition." In Europe, to revive the economy from the COVID-19 recession, the European Commission (EC) has a primary influence through financing and employs sustainable finance including green bonds. On 12 October 2021, a green bond of EUR12 billion, the largest amount ever issued, was issued, with a redemption term of 15 years. The EC plans to issue EUR250 billion in green bonds in succession by the end of 2026, making Europe the leader in green bond issuance for the upcoming years.

If the results of investors' awareness obtained in this study were shared with issuers and other green bond market players, this could be a stepping stone to increasing issuance in China's green bond market, which may help to solve the supply–demand imbalance.

As the study identifies that the issuer's credit rating and type of currency used to issue green bonds affect the greenium, further research is required to understand the reasons for these factors' impact on the investors' purchase behavior for green bonds. Although we have not been able to fully utilize the data in this study, we may be able to use those data to conduct further research on institutional investors interested in green bonds from a different angle, such as examining the difference between the types of institutions involved in the green bond market. Furthermore, the authors hope that this study will catalyze the expansion of the global green bond market and its study.

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