

Are retail investors willing to buy green bonds? A case for Japan

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Abstract

With the growing importance of the financial sector to contribute to mitigating environmental pressure, many financial institutions began to issue green bonds (GBs). This study investigated the retail investors' willingness to pay (WTP) toward green bond (GB) using the double-bounded dichotomous choice contingent valuation method (CVM). From the CVM survey performed on Japanese respondents, the study finds that on average the respondents are willing to buy green bonds when it was offered with annual interest of around 1.1%. The study also identifies respondents with higher altruism and environmental awareness levels, information about GB, and investing frequently have a higher preference toward buying GB. The results suggest the importance of financial institutions to provide information about how the GB can help reduce environmental pressure and to raise investors' awareness of GB.

Keywords: green bond, CVM, WTP, altruism, environmental awareness

JEL classification: D61, G11, Q42, Q51

1 Introduction

As it is becoming crucial to take actions to reduce greenhouse gas emissions at the global level, financial institutions have begun to promote activities to curtail greenhouse gas emissions. Since the International Capital Market Association (ICMA) formulated the Green Bond Principle (GBP) in 2014, many financial institutions have started to issue a green bond (GB), which is earmarked to raise money for investigating to new and existing projects with environmental benefits. Involving the financial sector to contribute to the reduction of greenhouse gas emissions is becoming highly important for countries to achieve their plans for carbon neutrality.

Studies have suggested that the volatility of GB tends to be lower than that of existing bonds and that some investors are willing to pay a premium for GBs because they are often less risky financial assets than the existing bonds (Zerbib, 2019; Nanayakkara and Colombage, 2019). Such investment premium where GB is traded at higher prices than regular bonds or sold with a lower interest rate to the investors is called “greenium.” On the other hand, studies such as Larcker and Watts (2020), and Partridge and Medda (2020) suggest that no such premium sustains for GB and whether there is a greenium remains inconclusive among previous studies. These previous studies test for the existence of greenium by analyzing the difference in prices between conventional and green bonds using data from the existing bond markets (MacAskill et al., 2021). Among few existing studies that perform a survey to identify the individual’s perception toward GB, Sandgiorgi and Schopohl (2021) find that issuers of GB see the benefit of GB issuance due to higher levels of investor demand generated from GB. However, at the moment there are very few studies that investigate the perceptions on GB from the buyers’ perspective.

To shed light on this issue, this study is expected to be the first study to analyze investors’ willingness to purchase green bonds. For this purpose, the study applies the contingent valuation method (CVM) to estimate the investor’s willingness to pay (WTP) toward a hypothetical GB presented in the survey. Using the obtained survey data, the study also identifies factors that are likely to influence the investor’s WTP toward GBs.

It is pointed out that investors of GBs not only buy them because of their attractiveness as financial assets for hedging risks and gaining yields but also from the perspective of social responsibility (Panda, 2017). As most GBs are issued to mitigate human-driven environmental pressures, it could be that the investors are hoping to contribute to environmental issues through investing in GBs. It is known that individuals that are behaving altruistically in their ordinary life are more likely to show an interest in environmental problems (Aruga, 2020). Thus, this study particularly investigates if investors’ differences in their degree of altruism and environmental awareness have impacts on their WTP toward GBs expecting that individuals with higher altruism and environmental awareness levels have a larger WTP toward GB.

Up until now, not much has been studied to understand the investor’s perceptions on

GB, and I believe estimating the investors' WTP toward GB and identifying the factors affecting the WTP will provide important information for financial institutions and governments that are trying to promote and utilize GBs to reduce greenhouse gas emissions. Furthermore, the study could help increase the opportunities for energy companies seeking funds for developing renewable energy facilities to obtain funds for their projects through GBs.

In the next section, the methods of the study are described. The third section presents the results of the analyses. Finally, in the final section, the paper concludes with discussions.

2 Methods

2.1 Survey sample

Since the issuance of the first GB by the World Bank in 2008, Japan has been one of the leading countries for GB issuance in Asia (Tolliver et al., 2020). Furthermore, the issuance of GB in Japan is recently growing rapidly. Although the total issuance of GB in Japan was only JPY 34 billion in 2014, it exceeded JPY 1 trillion in 2020 (MOE, 2021). For these reasons, the Japanese residents are used as the survey sample in this study.

The double-bounded contingent valuation (DBCV) method is used to identify the investors' WTP toward GB. As Japan's all top five prefectures whose average income is above the national average locates in the three major metropolitan areas (MHLW, 2022), the survey is performed on the residents of these metropolitan areas.¹ Initially, a screening survey was conducted to only pick individuals living in these areas and those having interests in investing.

Before the CVM survey, brief information was provided for the type of GB presented in the survey (see Appendix A). Then in the first round of the DBCV questions, the respondents were asked to answer whether they are willing to buy a GB if its annual percentage yield (APY) was the same level as the conventional bond. The initial bids were offered as interest rates obtained from investing in the GB. These interest rates were assumed to be the APY of the GB and they were presented in percentages taking 0.6%, 0.8%, 1.0%, 1.2%, and 1.4%. Since the DBCV method requires to contain an equal number of samples for the initial bids (Xiao et al., 2022), the study used a stratified random sampling method to obtain 300 samples for these five initial bids. To have the ratio of ages of the sample respondents in the initial bid groups to be consistent, the bid groups were stratified by age 20-40, 40-50, and 50 or over. After sampling in this way, the ratio of these age tiers contained one-third of each within the five initial bid groups. The initial sample data contained 1,500 samples but since the study was interested in testing how income levels have impacts on the WTP toward GB, the study dropped those samples who were not willing to disclose their income levels. Hence, the number of valid respondents ended up

¹ The survey was distributed to citizens of Kanto (Tokyo, Kanagawa, Saitama, and Chiba), Chukyo (Aichi, Mie, and Gifu), and Kansai (Osaka, Hyogo, Kyoto, Shiga, and Wakayama) areas.

totaling 1,346.

Table 1 illustrates our sample distribution. Although the sample percentage of the regions was different from the expected numbers from the 2020 population census of Japan, the order of the sample size for the three metropolitan areas was the same as the population census. Table 2 summarizes the sample demographics. As seen in the table, the sample contained more male respondents. This result is likely related to the gender gap for interests in investing. A survey conducted on 4,127 Japanese residents in August 2021 indicates that in all age groups from the 20s to 60s, the percentage of people with investment experience was much higher for men than women (SIIF, 2021). Therefore, our sample having more male respondents is likely related to the gender gap for interests in investing since the screening of the sample was based on interests in investing. The sample's age group percentages were near one-third since as explained previously all our initial bid groups were stratified to contain one-third each.

In the survey, I also obtained data to collect indices for the respondents' degree of environmental awareness and altruism. For the environmental awareness index, two indices were obtained based on the questions described in Table 3: local and global environmental awarenesses. Individuals' altruism level was calculated based on the Japanese version of the self-report altruism scale (SRAS) developed by Aruga (2020). Ten items asking individuals' behaviors related to altruism in their daily life is questioned. Estimating the Cronbach's alpha for these 10 items included for evaluating the individual's SRAS levels, the reliability coefficient was 0.82. As Cronbach's alpha greater than or equal to 0.8 indicates that the survey items are statistically reliable (Knight et al., 2010), our test result suggests that the items used for measuring the individual's SRAS levels were statistically reliable.

Besides the questions related to environmental awareness and altruism indices, it was asked whether the respondents have heard about GB and the frequency of their investment. *GB knowledge* and *Investor* in Table 3 are variables created from these questions.

2.2 Contingent valuation method

In the DBCV survey, each respondent met two bids: first and second bids. If the respondents agreed to buy the GB presented in the first bid, a higher bid was presented in the second bid. If they refused the first bid in the first round of the CVM survey, a lower bid was placed. Let B^F denote the bid level presented in the first bid, and B^u and B^l be the upper and lower bids presented in the second bid. Based on Loomis et al. (2000), the probability of the respondents to accept the bid $P(y)$ is assumed to have the logistic function form:

$$P(y) = 1 - \left[1 + e^{(\beta_0 + \beta_1 B^u + \sum_k \gamma_k X_k)} \right]^{-1} \quad (1)$$

where β_0 , β_1 , and γ_k are the parameters to be estimated and X_k represents the factors that

affect the respondents' WTP other than the bid.

Next, let the probability of answering “yes” to both the first and second bids, “yes” to the first and “no” to the second, “no” to the first and “yes” to the second, and “no” to both bids as P^{yy} , P^{yn} , P^{ny} , and, P^{nn} , respectively. Then, the four possible outcomes of the DBCV questionnaire can be expressed as:

$$P^{yy} = 1 - \left[1 + e^{(\beta_0 + \beta_1 B^u + \sum_k \gamma_k X_k)} \right]^{-1} \quad (2)$$

$$P^{yn} = \left[1 + e^{(\beta_0 + \beta_1 B^u + \sum_k \gamma_k X_k)} \right]^{-1} - \left[1 + e^{(\beta_0 + \beta_1 B^F + \sum_k \gamma_k X_k)} \right]^{-1} \quad (3)$$

$$P^{ny} = \left[1 + e^{(\beta_0 + \beta_1 B^F + \sum_k \gamma_k X_k)} \right]^{-1} - \left[1 + e^{(\beta_0 + \beta_1 B^l + \sum_k \gamma_k X_k)} \right]^{-1} \quad (4)$$

$$P^{nn} = \left[1 + e^{(\beta_0 + \beta_1 B^l + \sum_k \gamma_k X_k)} \right]^{-1} \quad (5)$$

Using Equations (2) through (5), the parameters affecting the WTP are estimated by the following log-likelihood function:

$$\ln L = \sum_{i=1}^n \ln [D_i^l D_i^u P^{yy} + D_i^l (1 - D_i^u) P^{yn} + (1 - D_i^l) D_i^l P^{ny} + (1 - D_i^l)(1 - D_i^l) P^{nn}] \quad (6)$$

In the equation, D_i^l , D_i^u , D_i^l are dummy variables taking 1 when the respondents accept the first bid or the corresponding follow-up bids in the second round CVM survey and zero otherwise. Using Equation (6), the individual's mean WTP value for GB is estimated as:

$$WTP = - \frac{\beta_0 + \sum_k \gamma_k \bar{X}_k}{\beta_1} \quad (7)$$

where \bar{X}_k is the mean of X_k .

To identify the effects of factors affecting the willingness to buy (WTB) GBs when the respondents faced the bids in each round, the study applied the following logit model:

$$\ln \frac{P_i}{1 - P_i} = \beta_0 + \beta_1 Bid_i + \sum_k \gamma_k X_k \quad (i = 1, 2) \quad (8)$$

where P_i is the probability of answering “yes” to the bids, and Bid_i is the amount of bids presented in the first and second rounds of the CVM survey. X_k contains all the explanatory variables presented in Table 3 except that two models are created to include the local and global environment variables separately to avoid multicollinearity since they were highly correlated.²

Finally, to avoid the effects of multicollinearity the study checked the variance inflation factors (VIF) of the models, and all our VIF values in the models were near 1.

² Pearson's r between the local and global environment variables was 0.74.

3 Results

Since the bids in the CVM survey were the APYs from the investment on GB, the interest rate presented in the survey is the level of the return obtained from investing in the GB. Thus, the WTP estimated in this study is the negative WTP values for GB and that the individual's WTP is considered as high when these interest rates approach zero since near-zero interest rate means that the individuals are willing to buy GBs without receiving any returns. Table 4 depicts the bids presented in the survey and the distribution of the bid responses of the sample. It is noticeable from the table that only 12% of the respondents accepted to buy the GB in both the first and second round of the CVM survey and around 31% of the respondents were refusing to buy the GB in both rounds.

Table 5 depicts the results of the maximum likelihood estimation for identifying the factors affecting the WTP toward GB. The mean WTP is estimated using this result. It is discernible from the table that SRAS and environmental awareness have positive impacts on the WTP in both Models 1 and 2 indicating that people with higher altruism levels and higher interests in environmental issues are more willing to buy GB with a lower interest rate. Since respondents with high SRAS scores are those helping others in their ordinary life, they might be more willing to spend money on GBs thinking that their investment in GBs will contribute to reducing greenhouse gas emissions. Similarly, the reason for respondents having high environmental awareness reacting positively about investing in GB is that as shown in Appendix A the green bond provided in the survey hypothesized that the money gathered through the bond will be mainly spent for developing renewable energy generation facilities that mitigate environmental impacts. The table also reveals that respondents' educational achievement and annual income have positive impacts on the WTP. The reason that the education and income tend to increase the WTP is likely related to the difference in their GB knowledge. Indeed, among those who have heard of GBs, 76% had a bachelor's degree and respondents' that have heard of GB tend to have a higher income level compared to those who never heard of GB.³ Finally, the result of the *Investor* in the table suggests that respondents who invest more frequently have a higher WTP toward GB. This might be implying that as suggested by Nanayakkara and Colombage (2019), frequent investors are more willing to pay a premium for GB.

The result of the logit model estimation in Table 6 also had a similar result except that here the independent variables were whether the respondents are WTB the presented GB. Round 1 in the table shows the effects of factors on WTB GB when the initial bid was presented and Round 2 illustrates those for the second bid. It is apparent here too that SRAS and environmental awareness indices all had positive impacts on the WTB indicating that respondents that are

³ Among the respondents that have heard of GB, 31% of them had income above JPY 8 million while such high-income respondents were only 17% of those who have not heard of GB.

altruistic and have high environmental awareness are more likely to buy GB. *GB knowledge* too had a positive influence on the WTB in all models implying that having heard of GB increases the respondents' probability of investing in GB. *Education* and *Income* were positively significant in the Round 1 models, but they did not influence the WTB in the Round 2 models. The *investor* variable was only significant in Round 2 indicating that respondents that invest more frequently are more responsive to a situation when the returns from the GB changes at a wider range. Finally, the amount of bids which were the interests obtained from investing to GB had a negative direction except that they were not significant in the Round 1 models. Since the bids are defined as negative interest rates, the results of the coefficients being negative for the bids suggest that a higher interest rate leads to an increase in the WTB.

In the end, I would like to discuss the results of the mean WTP estimations depicted in Tables 5 and 6. Although *bid 1* was not significant in the Round 1 models in Table 6, the Mean WTP was much larger or less negative in the first bid than the second bid. When the first and second bids are incorporated together in the estimation model, the Mean WTP was around -1.13% (see Table 5) which is in the middle of the mean WTPs for the Round 1 and 2 models. Since this WTP is very close to the medium interest rate for the initial bid (1%) set in our CVM survey, I believe many of the respondents were willing to buy GB when the level of interest was not so apart from this medium interest rate.

4 Conclusions

To evaluate the investor's WTP toward GB and to identify factors that influence the WTP, the study conducted a CVM survey on Japanese retail investors who resides in the three major metropolitan areas of Japan. Based on a double-bounded dichotomous choice CVM estimation, the study found that the sample respondents are willing to purchase for GB when the annual return rate is around 1.1%. According to Green Finance Portal (2022), an institute providing information for the situation of Japanese GB managed by the Ministry of Environment Government of Japan, most of the dollar-denominated GBs issued by Japanese financial institutions provide GB with an above 1.5% interest rate. Hence, our estimation based on the CVM shows that the average survey respondent's WTP toward GB was a similar or lower level of returns compared to many of the currently issued GBs in Japan.

The study also revealed that investors with a high altruism level and interests in environmental problems tend to have a higher WTP toward GB. The results for testing these factors on the probability of buying GB also turned out to be positive indicating that the investor's WTP toward GB is affected by their awareness of social responsibility. This suggests the importance of financial institutions selling GB to provide information about how GB can contribute to reducing environmental pressure and to explain how it can lead to help the society

to cope with environmental problems for the retail investors. Furthermore, the study results showed that investors who have heard of the word GB had a higher WTP, implying that the government and financial institutions need to advertise and spread more information about GB to raise the investors' awareness of GB.

Appendix A. Information provided about the type of green bond

Assume that the funds raised by a particular bond are intended to reduce greenhouse gases (such as carbon dioxide) and will be used primarily for developing renewable energy generation facilities such as solar and wind power. Please answer the following questions regarding green bonds that are issued to implement projects to remedy such environmental problems.

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Table 1 Sample distribution

Regions	Sample	%	Expected	Population census	%	Chi-square
Kanto	762	56.6%	723	36,728,000	53.7%	
Chukyo	176	13.1%	221	11,320,000	16.4%	11.36***
Kansai	408	30.3%	402	20,527,000	29.9%	

Note: *** denotes significance at the 1% level. The *chi-square* represents Pearson's chi-squared test statistics. The population census is based on the 2020 census (Statistics Bureau of Japan, 2021).

Table 2 Sample demographics

Attributes	Obs.	%
Gender		
Male	947	70.4%
Female	399	29.6%
Age		
20-40	462	34.3%
40-50	449	33.4%
50 above	435	32.3%
Education		
Have a bachelor's degree	935	68.0%
Does not have a bachelor's degree	441	32.0%
Income		
Below JPY 4 million	447	33.2%
JPY 4-8 million	589	43.8%
Above JPY 8 million	310	23.0%

Table 3 Variable description

Variable	Definition	Mean	Std. Dev.	Min	Max
<i>SRAS</i>	Average self-reported altruism score.	2.842	0.664	1	5
<i>Loc. env.</i>	5-point Likert scale (with 1 'not interested' and 5 = 'strongly interested') asking the degree of interest in global environmental problems such as climate change and deforestation of rainforests.	3.372	1.056	1	5
<i>Glob. env.</i>	5-point Likert scale (with 1 'not interested' and 5 = 'strongly interested') asking the degree of interest in local environmental problems such as water pollution occurring nearby.	3.368	1.079	1	5
<i>Gender</i>	1 if male and 0 if female.	0.704	0.457	0	1
<i>Age</i>	1 if 20-40, 2 if 40-50, and 3 if 50 or order.	1.980	0.816	1	3
<i>Education</i>	1 if earned a bachelor's degree and 0 otherwise.	0.695	0.461	0	1
<i>Income</i>	1 if one's annual income was below JPY 4 million, 2 if it was between JPY 4 to 8 million, and 3 if it was JPY 8 million or above.	1.898	0.743	1	3
<i>GB knowledge</i>	1 if the respondent at least heard about green bond and 0 otherwise.	0.429	0.495	0	1
<i>Investor</i>	1 if the respondent usually invests at least more than a few times a week and 0 otherwise.	0.208	0.406	0	1

Table 4 Distribution for the bid responses

1st bid	2nd bid (B^u/B^l)	y/y	y/n	n/y	n/n	Total respondents
-1.4%	-0.7% / -2.1%	31	123	45	72	271
		11.4%	45.4%	16.6%	26.6%	100.0%
-1.2%	-0.6% / -1.8%	31	114	30	92	267
		11.6%	42.7%	11.2%	34.5%	100.0%
-1.0%	-0.5% / -1.5%	37	110	37	88	272
		13.6%	40.4%	13.6%	32.4%	100.0%
-0.8%	-0.4% / -1.2%	30	101	39	87	257
		11.7%	39.3%	15.2%	33.9%	100.0%
-0.6%	-0.3% / -0.9%	36	120	49	74	279
		12.9%	43.0%	17.6%	26.5%	100.0%
Total respondents		165	568	200	413	1346
		12.3%	42.2%	14.9%	30.7%	

Note: B^u and B^l for the 2nd bid denote the upper and lower bids when the respondents answered yes and no to the first bid.

Table 5 Maximum likelihood estimation and mean WTP

Variable	Model 1			Model 2		
	Coef.		SE	Coef.		SE
Constant	-2.457	***	0.126	-2.488	***	0.126
SRAS	0.139	***	0.034	0.151	***	0.033
Loc. env.	0.189	***	0.021		na	
Glob. env.		na		0.195	***	0.021
Gender	-0.005		0.051	0.028		0.052
Age	-0.013		0.027	-0.029		0.027
Education	0.095	**	0.047	0.084	*	0.047
Income	0.070	**	0.031	0.073	**	0.031
GB knowledge	0.220	***	0.044	0.201	***	0.045
Investor	0.155	***	0.052	0.140	***	0.052
Mean WTP	-1.127	***	0.021	-1.127	***	0.021

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels.

SE denotes the standard error.

Table 6 Logit model estimation and mean WTP

Variable	Round 1							Round 2					
	Model 1			Model 2				Model 1			Model 2		
	Coef.	SE	ME	Coef.	SE	ME	Coef.	SE	ME	Coef.	SE	ME	
Constant	-3.788 ***	0.440	na	-3.912 ***	0.445	na	-2.798 ***	0.432	na	-2.834 ***	0.436	na	
Bid 1	-0.291	0.209	-0.062	-0.276	0.210	-0.058	na	na	na	na	na	na	
Bid 2	na	na	na	na	na	na	-0.559 ***	0.114	-0.105	-0.564 ***	0.114	-0.106	
SRAS	0.338 ***	0.098	0.072	0.372 ***	0.097	0.079	0.226 **	0.102	0.042	0.235 **	0.101	0.044	
Loc. env.	0.549 ***	0.062	0.117	na	na	na	0.141 **	0.065	0.027	na	na	na	
Glob. env.	na	na	na	0.578 ***	0.062	0.122	na	na	na	0.145 **	0.064	0.027	
Gender	-0.095	0.146	-0.020	0.006	0.147	0.001	0.061	0.157	0.012	0.083	0.158	0.016	
Age	0.051	0.076	0.011	0.005	0.077	0.001	-0.174 **	0.082	-0.033	-0.184 **	0.082	-0.035	
Education	0.377 ***	0.133	0.080	0.345 **	0.134	0.073	-0.104	0.143	-0.020	-0.109	0.143	-0.020	
Income	0.185 **	0.088	0.040	0.197 **	0.089	0.042	0.090	0.094	0.017	0.094	0.094	0.018	
GB knowledge	0.513 ***	0.126	0.109	0.453 ***	0.127	0.096	0.475 ***	0.136	0.089	0.461 ***	0.136	0.087	
Investor	0.099	0.152	0.021	0.060	0.153	0.013	0.491 ***	0.151	0.092	0.483 ***	0.151	0.091	
Mean WTP	-0.303	0.537		-0.270	0.594		-2.820 ***	0.382		-2.802 ***	0.376		

Note: *** and ** indicate significance at the 1% and 5% levels. SE and ME denote the standard error and marginal effects, respectively.