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Research article

Assessing investor preferences for environmental and sustainability bonds in Japan: A discrete choice experiment approach

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Abstract: This study examined how the focus of environmental and sustainability bonds (ESBs) influences investor preferences, particularly in relation to return rates and risk perceptions. A labeled discrete choice experiment was conducted on Japanese retail investors to examine their preference among the ESBs: green, sustainability, and blue bonds. The present study found that with low return rates, investors were indifferent among the three ESBs. However, higher return rates led investors to favor sustainability bonds. Furthermore, ESBs were less preferable to government bonds when the benchmark return rate was high, underscoring the need to set a relatively low benchmark return rate to attract investors to ESBs. Risk-averse investors were hesitant to choose ESBs when the return rates were low, emphasizing the importance of accurate risk information. The study highlighted the critical role of credit ratings, third-party certification, and transparent reporting for ESBs, suggesting that providing clear risk information is vital for expanding the ESB market.

Keywords: Green bond; sustainability bond; blue bond; return rate; risk tolerance; discrete choice experiment

JEL Codes: C25, D64, G11, Q51

1. Introduction

Japan has emerged as a leading figure in the sustainable finance sector, particularly in the green, sustainability, and blue bond markets (Schumacher et al., 2020; Environmental Finance, 2024). Following the launch of the very first green bond in the world, known as the Climate Awareness Bond (CAB), by the European Investment Bank (EIB) in 2007 (European Investment Bank, 2021), Japan has emerged as a pioneering nation in green bond issuance within Asia (Tolliver et al., 2021). In recent years, Japan's green bond market has seen remarkable growth, with issuances rising from JPY 34 billion in 2014 to surpass JPY 1 trillion by 2020 (Ministry of the Environment, Government of Japan (MOE, 2021). Sustainability bonds are instruments with proceeds exclusively allocated for financing or refinancing a mix of green and social projects. In 2014, the Development Bank of Japan (DBJ) was the first issuer in Japan to launch a green bond. Since 2015, DBJ has issued DBJ sustainability bonds annually. A blue bond is a special kind of green bond that funds projects focused on environmental issues, specifically targeting marine pollution prevention and the sustainable management of marine resources. Mitsui O.S.K. Lines (MOL), a major shipping company in Japan, is set to issue blue bonds through a public offering in the domestic market in January 2024. This is noteworthy as it will be the trailblazing blue bonds offered by a shipping company. The bonds will amount to JPY 10 billion (around $70.45 million) and will have a maturity period of five years, according to the company (Offshore Energy, 2023).

In recent years, retail investors, fund managers, and banks have increasingly incorporated climate and sustainability-related factors into their investment decisions (Ahmad et al., 2023). Investors increasingly realize the importance of adjusting their portfolios to address the risks associated with declining profitability when environmental and sustainability issues are not reflected in their economic activities. Thus, studies have been conducted to identify how firms improve their environmental and sustainability scores (Rajesh, 2020; Khaled et al., 2021; Gebhardt et al., 2023). Financial institutions and governments also emphasize their crucial role in mitigating environmental impact. Such organizations are now issuing bonds specifically aimed at reducing environmental impact or promoting sustainable economic activities.

The body of literature on environmental and sustainability bonds (ESBs) has also grown since the European Investment Bank launched the first green bond in 2007 (Akomea-Frimpong et al., 2021). While a plethora of studies cover how green and sustainability bonds relate to environmental and sustainability issues (Zerbib, 2019; Maltais and Nykvist, 2020; Flammer, 2021; Kumar, 2022), there are still very few that investigate the differences in preference among various types of ESBs. Recently, several studies have focused on blue bonds (Thompson, 2022; March et al., 2023; March et al., 2024).

However, very few studies have compared how investors perceive the differences between this type of new thematic bond and the more widely issued and well-known green and sustainability bonds.

While some studies suggest that green bonds often carry premiums, referred to as greeniums (Nanayakkara and Colombage, 2019; Löffler et al., 2021; MacAskill et al., 2021), other studies such as Larcker and Watts (2020) and Agliardi and Agliardi (2021) suggest that the existence of a greenium depends on the return rate and risk of the bonds. Most of these studies test the effect of return rate and risk of ESBs using existing data. However, little research has been conducted on how investors assess return rates and risks when investing in ESBs, particularly through direct analysis of their perceptions using survey data.

The Japanese government has made substantial commitments to reach carbon neutrality by 2050, which has catalyzed the expansion of ESBs. However, the contribution of ESBs to reducing greenhouse gas emissions remains limited. Further development of these bond markets, alongside Japan's sustainable finance framework, will be crucial for transitioning to a lower-emission economy. This article presents an early survey focusing on various types of ESBs, including green, sustainability, and blue bonds, which are relevant to the Japanese market. By focusing on Japan, we aim to examine how investor preferences in this specific context reflect broader trends in sustainable finance, making our findings relevant not only to Japan but also to other regions exploring similar initiatives.

To cover the above research gaps, the first goal of the current study is to examine how variations in bond themes influence individuals' preferences for ESBs. To achieve this, it uses the labeled discrete choice experiment (DCE) method to analyze how the differences among three types of ESBs—green, sustainability, and blue bonds—affect investors' choices. Aruga (2024a) revealed that individuals are more likely to invest in green bonds with lower returns than in sustainability bonds. Additionally, investors required a higher interest rate for blue bonds when their return rate was high. Aruga (2024a) suggests that the reason that blue bonds are less preferred than green and sustainability bonds is likely related to the fact that blue bonds are not well-known by investors. Thus, we expect to reveal differences in preference among the three ESBs in this study.

The second objective is to test how investors' perceptions of return rates are affected by examining preferences for bonds issued in Japanese Yen (JPY) versus US Dollars (USD). Since the interest gap between the 10-year Japanese bond yield and the US bond yield in 2023 was nearly five-fold, we consider this gap as an anchoring effect. While Aruga (2024a) primarily focused on Japanese investors' willingness to invest based on the environmental scope of various ESBs, our study expands on this by specifically examining how return rates and risk perceptions influence these preferences. Our research is designed to assess how return rates, particularly when expressed in different currency contexts—Japanese Yen (JPY) versus US Dollar (USD)—affect investor choices. The notable interest rate gap in 2023 between Japanese and US bonds acts as an anchoring effect in our analysis. Prior research on DCE highlights that such anchoring effects can significantly influence respondents' choices and their willingness-to-pay (WTP) estimates (Contini et al., 2019; Glenk et al., 2019; Lemos et al., 2022). By incorporating this anchoring effect, we aim to understand how these economic factors shape bond

preferences specifically within the Japanese market. Furthermore, we consider the types of bonds as an attribute in our analysis, a perspective not explored in previous studies, including Aruga (2024a). This distinct focus on the various types of sustainable bonds and their impact on investor preferences fills a critical gap in related studies and provides a thorough understanding of investor behavior in the ESB market.

Thus, prior to this study, little research has been conducted on how differences in the anchor return rate affect investors' investing decisions. We set the interest rates for ESBs issued in JPY to match the low rates of the Japanese 10-year bond yield, while the rates for ESBs issued in USD are set higher. We expect that, because higher return rates are often associated with higher-risk investments, risk-averse investors will tend to prefer ESBs issued in JPY over those issued in USD.

The third objective is to analyze the effects of investors' risk perception on their preference for ESBs. To achieve this, we assess investors' risk tolerance levels and examine how differences in risk perception affect their preference for ESBs. We determine investors' risk tolerance levels by asking about their perceptions of return risk, issuer credibility, volatility, and currency rate risks. We measure investors' risk tolerance using their responses to these questions.

In addition to these objectives, the study also examines how various factors influence preferences for ESBs, including the bonds' credit ratings, issuer type, third-party certification, and reporting of the proceeds. Furthermore, we investigate how investors' attitudes toward investing, relationships with ESBs, perceptions of social responsibility, and socio-demographic characteristics affect their preferences for ESBs. Although Aruga and Bolt (2023) partially addressed some of these factors, their study focused only on green bonds. No studies have explored these influences across different types of ESBs using the DCE.

Therefore, the study offers several key contributions. First, it is one of the initial labeled DCE (see Esther et al., 2010) conducted on a financial product, exploring investors' preferences among different types of ESBs. Second, the study examines how investor choices are affected by different anchor return rates. Third, the study investigates how individuals' levels of investing risk tolerance impact their preference for ESBs. Incorporating these new elements into the DCE for analyzing investors' preferences for a financial product is expected to provide useful insights into understanding investor behavior in conditions that more closely resemble real-world bond investment decisions. Therefore, the study is expected to provide ESB participants with guidance on which types of ESBs are preferred and which types of investors are likely to engage in the ESB market.

In the next section, we describe the design of the DCE and provide details about the survey sample. The third section explains the theoretical foundation and econometric methods. The fourth section presents the results of our analyses with some discussions, followed by the conclusion in the final section.

2. Experiment design and sample respondents

The key attributes of the DCE were chosen based on the work of Aruga and Bolt (2023), applying the DCE to identify factors affecting investment in Japanese green bonds. Table 1 outlines the attributes of the choice experiment featured in this study, along with the sources justifying their inclusion. The first attribute is the bonds' type. This was added to see how different types of thematic bonds affect the preference for ESBs. In the study, we consider three ESBs: green, sustainability, and blue bonds. These ESBs are three of the top four most popularly invested ESBs (Hussain and Dill 2022).[1] We described the definition of three bonds before the choice experiment to inform the respondents regarding the differences in the scope of the three bonds (see Appendix A).

Table 1. Attributes and levels used in the choice experiment.

Attributes	Levels	Variable name	Sources supporting the inclusion of attributes
Type of bonds	Green, sustainability, blue bonds	gb (green bond), bb (blue bond)[b]	Aruga (2024a)
Rating	AA, AA-, A+, A, A-	Rating	Aruga & Bolt (2023)
Issuer	Private company, local government	Local	Sangiorgi & Schopohl, (2021); Aruga & Bolt (2023)
Third-party certification	Yes, No	Certify	MacAskill et al. (2021); Li et al. (2020)
Reporting	Yes, No	Report	CBI (2019); Fatica and Panzica (2020)
Interest rate[a]	−40%, −20%, base, +20%, +40%	Interest	Aruga & Bolt (2023); Aruga (2024b)

Note: [a] The base interest rate issued in JPY and USD are set to 1% and 5%, respectively. Based on these base interest rates, the levels for bonds issued in JPY are set to 0.6%, 0.8%, 1%, 1.2%, and 1.4%, and those issued in USD are set to 3%, 4%, 5%, 6%, and 7%, respectively.
[b] gb and bb are dummy variables where the sustainability bond was set as the base bond.

The second attribute is the credit rating. This attribute was included because the Green Bond Principles (GBP) highlight the significance of issuers offering clear, standardized information to help the investors assess the ESBs. Additionally, previous studies have consistently found that credit ratings are crucial for investment valuation (Apergis et al., 2022; Arat et al., 2023; Aruga and Bolt, 2023). Since the credit rating provided by S&P Global for the 10-year Japanese government bond (JGB) is A+ as of September 2023, this rating is used as a reference point. The credit rating levels in this choice experiment are as follows: two ranks higher (AA), one rank higher (AA-), equivalent to the JGB (A+), one rank lower (A), and two ranks lower (A-).

The third feature pertains to the type of ESB issuer. This attribute is crucial because the credibility and reputation of the issuer are also known to influence investors' decisions (Aruga and Bolt, 2023;

[1] Although social bonds were among the top four ESBs issued, we included the contents covered by these bonds in the sustainability bonds.

Sangiorgi and Schopohl, 2021). For this attribute, the levels were local governments and private companies, as ESBs in Japan are presently issued only by local regional governments or private companies.

The fourth feature, third-party certification, ensures that the bond meets established standards for credibility. The importance of this attribute is explained in sources such as the Climate Bonds Initiative (CBI) (2019), Li et al. (2020), and Aruga and Bolt (2023). This attribute is essential because third-party certification provides an additional layer of assurance to investors regarding the bond's compliance with recognized environmental and sustainability standards (Li et al., 2020; Zirek and Unsal, 2023). It promotes transparency and trust, helping to alleviate concerns about greenwashing or misleading claims regarding the environmental benefits of the projects financed by the bonds (Zhu et al., 2024). This attribute's inclusion reflects the growing demand for accountability and reliability in the rapidly expanding market for ESBs (Aruga and Bolt, 2023).

The fifth attribute, reporting, specifically addresses transparency around the ongoing use of funds. Reporting is a core requirement of the Green Bond Principles (ICMA, 2021) and the Climate Bonds Standard (CBI, 2019), highlighting its role as a separate component critical to maintaining investor trust over time. Fatica and Panzica (2020) underscore that mandatory reporting enhances bond credibility by providing investors with detailed information on how funds are allocated and managed, thus maintaining transparency throughout the bond's lifecycle. In our study, we explained to participants that a "yes" indicated the issuer had provided a report on fund usage, while a "no" meant no such report was available. By distinguishing between third-party certification and reporting, we acknowledge that certification validates the bond's credibility at the outset, while reporting ensures continued transparency, allowing investors to track whether funds are managed according to their initial purpose.

Finally, the experiment included interest rates to reflect the average annual return rate from investing in ESBs. Interest rates play a fundamental role for investors in evaluating potential investment returns. For bonds issued in JPY and USD, the base interest rates are set at 1% and 5%, respectively, in line with the 10-year treasury yields for Japan and the US in October 2023.[2] We adjusted the interest levels by ±20% and ±40% using these base interest rates, and thus the levels presented to the respondents for JPY-denominated bonds were set to 0.6%, 0.8%, 1%, 1.2%, and 1.4%, while USD-denominated bonds were set to 3%, 4%, 5%, 6%, and 7%. The respondents were randomly assigned to answer questions about ESBs issued in JPY or USD. The main attributes provided in the DCE for EBSs issued in JPY and USD were all the same except for the interest rate attribute.

Table 2 illustrates a sample choice card utilized in our choice experiment. The table shows that the respondents were provided with three options: two types of ESBs and an opt-out choice. For the JPY bonds, the opt-out choice was assumed to be the 10-year Japanese government bond, while the USD bond was represented by a hypothetical bond called the 10-year global developed sovereign index (GDSI) bond. Prior to the experiment, participants were informed that the 10-year government bond referred to "a 10-year national bond issued by the Japanese government with an assumed fixed return

[2] On October 31, 2024, the Japanese 10-year bond yield was 0.95%, and the US 10-year bond yield was 4.9%.

rate of 1%", while the GDSI was "a 10-year index bond issued by governments of developed countries having a fixed return rate of 5%".

Table 2. An example of the choice card.

(a) Japanese governmental bond

Attributes	Green bond	Sustainability bond	Japan 10-year government bond
Bond credit rating	A+	AA-	A+
Issuer	Local government	Private company	Japanese government
Third-party certification	Yes	No	Not applicable
Reporting	Yes	No	Not applicable
Average annual investment returns	0.6%	1.0%	1.0%
Choices:	□	□	□

(b) GDSI bond

Attributes	Green bond	Sustainability bond	10-year global developed sovereign index (GDSI) bond
Bond credit rating	A+	AA-	A+
Issuer	Local government	Private company	Governments of developed countries other than Japan
Third-party certification	Yes	No	Not applicable
Reporting	Yes	No	Not applicable
Average annual investment returns	3.0%	5.0%	5.0%
Choices:	☐	☐	☐

The survey for the choice experiment was carried out online from December 13 to December 15, 2023, in partnership with Rakuten Insight, Inc., a private survey company in Japan. Initially, 20,000 respondents from the Kanto and Kansai regions, Japan's two major metropolitan areas, were selected for screening. This selection was based on the latest Japanese population distribution data from 2022, considering age and gender, among the 2.2 million Rakuten Insight registered users residing in Japan. Then, a screening survey was conducted to select respondents who invest in bonds at least once a year and in the stock market once a year and are interested in investing in ESBs if they have the opportunity.

Initially, the full factorial design of the DCE encompassed $5^2 \times 3 \times 2^3$ potential combinations, which were then condensed to 30 choices. The AlgDesign package in R software was used for this purpose. 5^2 represents the rating and interest rate attributes. Each of these attributes has five levels; three indicates the type of bonds attribute, and 2^3 corresponds to the three binary attributes, each with two levels such as issuer, third-party certification, and reporting.

To streamline the experiment, we used the AlgDesign package in R, a tool commonly used in DCE design to create a more manageable subset of combinations. This package applies statistical methods to select a fractional factorial design—a reduced set of profiles that still captures the essential variability and effects of all attributes and levels. In this case, the AlgDesign package condensed the 600 potential profiles into a more practical set of 30 representative choices. This smaller, optimized subset allows us to obtain robust and generalizable data on investor preferences while minimizing respondent fatigue and maintaining the experiment's statistical validity. The base choice set employed an orthogonal main-effects design, achieving a D-efficiency score of 95.0%. Alternative options for

each choice were created using the mod-shift method. The 30 choice sets were divided into six blocks, each containing five-choice questions. We also ensured that in each block, three of the five-choice cards covered all possible combinations among the three types of bonds: (green, blue), (green, sustainability), and (blue, sustainability).

Respondents were provided with these five-choice questions for bonds issued in JPY and USD. Respondents were separated into those who answered questions for the JPY and USD, and since both bonds contained six blocks, there was a total of 12 segments. After the screening survey was performed, we conducted a random sampling to pick 180 respondents for each of the 12 segments, totaling 2,160 respondents. Alongside the choice experiment questions, we also inquired about the respondents' socio-demographic information, experience with ESB purchases, investment frequency, risk tolerance, level of altruism, and awareness of environmental and sustainability issues.

Tables 3–5 summarize the main variables obtained through the survey. Table 3 summarizes the description and distribution of demographic variables, respondents' attitudes toward ESBs, and their investing frequency. It is evident from the socio-demographic variables that our sample had a higher proportion of males (71%) and elderly individuals (31%), which is similar to the sample of Aruga (2024a) obtained for investors in Japan.[3] Table 3 also reveals that less than 10% of the sample respondents had investing experiences in ESBs. The ESB shares depict the distribution of the shares the respondents were willing to put as a new investment based on their picks in the DCE. The table shows that most of the survey respondents were unwilling to put more than 25% of the new investments into ESBs for both JPY and USD bonds.

[3] As highlighted in Aruga (2024a), Japanese investors are dominated by males and have a higher percentage of elderly investors.

Table 3. Description of the variables and their distribution.

Variable	Description	Obs	%	Mean	SD
Age	1. Age below 40	498	23.06	2.08	0.73
	2. Aged between 40 and 60	994	46.02		
	3. Aged above 60	668	30.93		
Gender (*male*)	1. Male	1,539	71.25	0.71	0.45
	0. Female	621	28.75		
Education (*edu*)	1. Attained a high school degree or below	262	12.13	2.69	0.81
	2. Attended junior college or vocational college	364	16.85		
	3. Attained a bachelor's degree	1,320	61.11		
	4. Attained a master's degree or above	214	9.91		
Own house (*house*)	1. Own a house	1481	68.56	0.69	0.46
	0. Other	679	31.44		
Children (*child*)	1. Have a child	1,176	54.44	0.54	0.50
	0. Do not have a child	984	45.56		
Married (*marry*)	1. Married	1,379	63.84	0.64	0.48
	0. Not married	781	36.16		
Income	1. Below 4 million JPY	528	24.44	2.93	1.69
	2. Between 4 and 6 million JPY	497	23.01		
	3. Between 6 and 8 million JPY	427	19.77		
	4. Between 8 and 10 million JPY	320	14.81		
	5. Between 10 and 12 million JPY	188	8.7		
	6. Between 12 and 15 million JPY	98	4.54		
	7, Above 15 million JPY	102	4.72		
ESB experience (*exp*)	1. I have never bought ESBs and have only a slight interest in investing in them.	1,131	52.36	1.75	0.93
	2. I have never bought ESBs but I am interested in investing in them.	591	27.36		
	3. I have never bought ESBs but I am very interested and might consider purchasing them.	290	13.43		
	4. I have experience with ESBs or currently own some.	148	6.85		
ESB share for JPY (*share*)	1. The percentage of shares to invest in ESBs is equal to or lower than 25%.	10089	62.28	1.56	0.88
	2. The percentage of shares to invest in ESBs is between 25% to 50%.	4359	26.91		
	3. The percentage of shares to invest in ESBs is between 50% to 75%.	474	2.93		
	4. The percentage of shares to invest in ESBs is equal to or above 75%.	1278	7.89		
ESB share for USD (*share*)	1. The percentage of shares to invest in ESBs is equal to or lower than 25%.	10494	64.78	1.47	0.76
	2. The percentage of shares to invest in ESBs is between 25% to 50%.	4431	27.35		
	3. The percentage of shares to invest in ESBs is between 50% to 75%.	585	3.61		
	4. The percentage of shares to invest in ESBs is equal to or above 75%.	690	4.26		
Investing frequency (*invfreq*)	1. Invest in the stock or bond markets less than once a month.	807	37.36	4.25	1.72
	2. Invest in the stock or bond markets at least once a month.	696	32.22		
	3. Invest in the stock or bond markets more than two to three times a month.	657	30.42		

Note: The parentheses denote the variable name used in the analysis.

Table 4 illustrates the descriptions of indices used in the study, which were based on multiple questions designed to create them. The inclusion of these variables is crucial as it captures the extent

to which investors are motivated by social and environmental concerns, which is particularly relevant in the context of ESBs.

Table 4. Description of the index variables.

Variable	Questions asked for the indices	Cronbach's alpha	Mean	SD
Investment risk tolerance (*inv. risk*)	1. The return earned from a bond or stock will fluctuate because of changes in interest rates or prices. 2. The credit rating of the institution issuing the bond or stock decreases due to poor management or financial difficulties. 3. The risk of being unable to sell or buy the bond or stock at the desired time. 4. The value of bonds or stocks denominated in foreign currencies may decrease due to fluctuations in exchange rates.	0.77	3.62	0.70
SRAS (*sras*)	1. You have provided information (such as directions to a destination, purchasing a ticket, knowledge, etc.) to a stranger (including information obtained online). 2. You have donated money through a charitable organization. 3. You have helped open and close a door (including an elevator door) for a stranger. 4. When a cashier at a store mistakenly gave you extra change, you pointed out the error and returned the correct amount. 5. You have donated blood. 6. You have let a stranger go ahead of you when standing in line at a store or event. 7. You have participated in volunteer activities. 8. You have helped a disabled or elderly stranger cross a street. 9. You have given up your seat on a train or a bus to a stranger. 10. You have picked up a stranger's bicycle that had fallen on the ground.	0.81	2.79	0.68
Environmental awareness (*env*)	1. Environmental issues such as increases in greenhouse gas emissions and climate change. 2. Environmental issues such as deforestation and its adverse effects on the ecosystem. 3. Marine pollution, microplastics, and other marine environmental issues. 4. Environmental degradation, especially around the local area, such as drinking water contamination and garbage problems in the community.	0.90	3.59	0.83
Sustainability awareness (*sustain*)	1. Issues to sustain social and economic infrastructure, such as disaster prevention measures and the development of infrastructure such as roads, sanitation, and sewage systems. 2. Issues related to social welfare, such as maintaining health, supporting people with disabilities, and enhancement of education. 3. Poverty reduction and income disparity.	0.78	3.53	0.75

Note: The parentheses denote the variable name used in the analysis.

The first index in Table 4 represents investors' level of investment risk tolerance, encompassing risks such as price or interest rate fluctuations, credit risk, liquidity risk, and exchange rate risk. The second index is the self-report altruism scale (SRAS), which captures individuals' level of altruism. The ten items in the table are created based on Rushton et al. (1981) and Aruga and Bolt (2023). The third and fourth indices are the environmental awareness index and the sustainability awareness index, which assess individuals' levels of awareness of these topics. The questions used for creating these

indices are based on Aruga (2024a).[4]

Altruistic investors are more likely to prioritize the social and environmental impacts of their investments (Aruga, 2020), influencing their preferences for ESBs over traditional financial instruments. Previous research has found that respondents with a high level of environmental concern and high levels of altruism were inclined to invest in green bonds (GBs) even when the return rate was lower than that of national bonds (Aruga and Bolt, 2023). By assessing levels of altruism, we can better understand how this trait interacts with other factors such as return rates and risk perceptions, thereby providing deeper insights into the motivations behind investor decision-making in sustainable finance. All the questions to create the indices in Table 4 are assessed using a 5-point Likert scale, with 1 representing the least likely and 5 representing the most likely. The Cronbach's alpha, which tests the reliability of the items used to form the indices, were all above 0.7. This suggests that the items used to create the four indices in Table 4 are considered acceptable (Raharjanti et al., 2022).

Table 5. Level of knowledge in the three bonds.

Knowledge level	GB		SB		BB	
	Obs.	%	Obs.	%	Obs.	%
1. I have not heard of it at all.	853	39.49	912	42.22	1,107	51.25
2. I have heard of the name.	685	31.71	656	30.37	547	25.32
3. I knew it partly.	319	14.77	295	13.66	259	11.99
4. I knew roughly what was written in the description.	236	10.93	221	10.23	193	8.94
5. I knew enough to explain more than what was written in the description.	67	3.10	76	3.52	54	2.50
Mean of the average knowledge level for the three bonds (*avg. know*)	1.97					
Standard deviation of the average knowledge level	1.04					

Note: GB, SB, and BB represent green, sustainability, and blue bonds, respectively. The parenthesis denotes the variable name used in the analysis.

Finally, Table 5 shows the extent of investors' knowledge about the three types of ESBs. We employed a 5-point Likert scale to assess the knowledge about green, sustainability, and blue bonds individually. The majority of respondents indicated they had not heard of any of these types. Among the three, awareness of blue bonds was the lowest, with 51.25% reporting no knowledge, compared to 39.49% for green bonds and 42.22% for sustainability bonds. The average Likert scale scores for the three bonds (*avg. know*) are used in our model analyses to represent the respondents' level of knowledge in ESBs.

3. Methods

The DCE model is derived from the random utility model (RUM) (McFadden, 1973), which can be represented by Equation (1):

[4] The reference source of the questions included in the table is explained in the supplementary file of Aruga (2024a).

$$U_{mi} = \beta X_{mi} + \varepsilon_{mi} \quad (1)$$

Here, U_{mi} denotes the utility derived by an individual m from selecting an alternative i. X_{mi} is the attribute vector of the alternative i, representing the observable part of the utility function for individuals. The error term ε_{mi} signifies an unobservable and stochastic component that is assumed to be independently and identically distributed (IID). To capture preference heterogeneity, the RUM is estimated using the random parameter (RP) model, with the utility function given by:

$$U_{mi} = \beta_m X_{mi} + \varepsilon_{mi} = (\alpha + \delta_m) X_{mi} + \varepsilon_{mi} \quad (2)$$

where α is the fixed parameter and δ_m is the random parameter. δ_m is a vector expressing the deviation from the mean and is assumed to follow a multivariate normal distribution. The probability of selecting an alternative i under the RP model is presented in Equation (3):

$$P_{mi} = \int \frac{\exp(\beta_m X_{mi})}{\sum_{i=1}^{I} \exp(\beta_m X_{mi})} f(\beta|\phi) d\beta \quad (3)$$

Where $f(\beta)$ is the density function of the coefficient vector β, and ϕ refers to the set of parameters that define the distribution of β. According to Fiebig et al. (2009), individual heterogeneity is influenced by both their preferences and idiosyncratic errors. To ensure the robustness of our estimation, we also utilized the generalized multinomial logit model (G-MNL). This model generalizes the individuals' heterogeneity, which can be expressed as:

$$U_{ijt} = [\sigma_i \beta + \gamma \eta_i + (1 - \gamma)\sigma_i \eta_i] X_{ijt} + \varepsilon_{ijt} \quad (4)$$

In Equation (4), σ_i denotes the random scale parameter specific to the individual, associated with the idiosyncratic error. It can be defined as $\sigma_i = \exp(\bar{\sigma} + \tau \varepsilon_{0i})$, where τ is a parameter that accounts for the unobserved variation in scale heterogeneity where $\varepsilon_{0i} \sim N(0,1)$.[5] γ is the scaling parameter related to the variance of β_i.

Denoting ESB_{ij} as the alternative specific constant, which takes the value 1 when the respondents chose either one of the ESBs and 0 if they chose the opt-out option, the RP and MIXL models were initially estimated by only including the main attributes as follows:

$$\begin{aligned} U_{ijt} = ESB_{ij} + \beta_{1i} gb_{ijt} + \beta_{2i} bb_{ijt} + \beta_{3i} rating_{ijt} + \beta_{4i}\, local_{ijt} + \beta_{5i} certify_{ijt} \\ + \beta_{6i} report_{ijt} + \beta_{7i} interest_{ijt} \end{aligned} \quad (5)$$

In Equation (5), *gb* and *bb* represent the dummy variables for cases when green and blue bonds were present on the choice card, with the sustainability bond serving as the base dummy variable.

Then, we also estimated how respondents' attitudes toward investing, relationship with ESBs, level of social responsibility, and socio-demographic characteristics influence the preference toward ESBs using Equation (6):

[5] $\bar{\sigma}$ is set to $-\tau^2/2$ for normalizing σ_i.

$$U_{ijt} = ESB_{ij} + \beta_{1i} gb_{ijt} + \beta_{2i} bb_{ijt} + \beta_{3i} rating_{ijt} + \beta_{4i}\, local_{ijt} + \beta_{5i} certify_{ijt} + \beta_{6i} report_{ijt} + \beta_{7i} interest_{ijt} + \beta_{8i} investing\ attitude_i \cdot ESB_{ijt} + \beta_{9i} relationship\ with\ ESB_i \cdot ESB_{ijt} + \beta_{10i} social\ responsibility_i \cdot ESB_{ijt} + \beta_{11i} demographic_i \cdot ESB_{ijt} + \varepsilon_{ijt} \quad (6)$$

In Equation (6), *investing attitude* consists of investing frequency and investment risk tolerance (see Tables 3 and 4), and *relationship with ESB* contains ESB experience, ESB share for JPY or USD, and average knowledge in EBS *(avg. know*) (see Tables 3 and 5). The *social responsibility* part includes variables to capture individuals' level of altruism (*sras*) and environmental and sustainability awareness (*env* and *sustain*) (see Table 4). To avoid collinearity among the *sras*, *env*, and *sustain* variables, Equation (6) was estimated under three separate models by including them individually. Finally, the *demographic* consists of respondents' age, education, gender, income level, and variables to examine the difference in the effect if they own a house, have children, and are married (see Table 3).

Equations (5) and (6) are analyzed separately for bonds issued in JPY and USD, with each having different anchor interest rate levels, as previously explained. In line with Aruga and Bolt (2023), the RP and G-MNL models were fitted by holding the main attributes constant, while having the ESB variable and other interaction variables as random across respondents. The marginal WTP was also calculated using the RP model specified in the WTP space (see Train and Weeks, 2005). All model estimations were conducted using Stata 18.

4. Results and discussion

First, we will discuss the results regarding how labeling the ESBs with different types affects investors' preferences. Table 6 shows the outcomes of the RP and G-MNL estimations when only the main attributes in Table 1 are considered. The standard deviation estimates indicate that the coefficient is significant, implying the presence of unobservable heterogeneity among the respondents. This suggests the importance of using RP and G-MNL models. It is evident from the table that in the JPY model, investors were indifferent about investing in the three ESBs. On the other hand, they showed a tendency to prefer sustainability bonds over green and blue bonds in the USD model. Since higher interest rates are often associated with higher risk in investing, it is likely that when bond interest rates are high, investors tend to avoid ESBs with a more focused theme and favor those that address broader social issues, such as installing social infrastructure or alleviating poverty. This could be because, when the investment risk is high, investors want to avoid the additional risk of ESBs failing to have an impact. Therefore, they favor ESBs that address broader issues, such as sustainability bonds, which can be seen as diversifying the risk of failure in investing in ESBs.

Table 6. Estimation results with the main attributes.

Mean	JPY			USD		
	RP	WTP	G-MNL	RP	WTP	G-MNL
esb	0.305***	0.116**	0.146	0.109	−0.164	−0.684***
	(2.73)	(2.46)	(0.59)	(1.14)	(−0.45)	(−2.83)
gb	0.0184	0.00105	−0.259*	−0.102**	−0.584***	−0.520***
	(0.37)	(0.04)	(−1.68)	(−2.09)	(−3.03)	(−2.65)
bb	−0.0530	−0.00576	−0.185	−0.232***	−0.795***	−0.457***
	(−1.05)	(−0.24)	(−1.19)	(−4.68)	(−3.88)	(−2.94)
rating	0.130***	0.0648***	0.477***	0.159***	0.586***	0.452***
	(7.75)	(9.46)	(4.45)	(9.53)	(9.42)	(3.53)
local	0.0164	0.0326*	0.0944	0.0396	0.380**	0.545***
	(0.44)	(1.66)	(0.77)	(1.08)	(2.49)	(2.84)
certify	0.0998***	0.0618***	0.249*	0.103***	0.487***	0.674***
	(2.68)	(3.23)	(1.85)	(2.84)	(3.36)	(3.60)
report	0.140***	0.0685***	0.471***	0.0225	−0.118	−0.430**
	(3.75)	(3.07)	(2.66)	(0.62)	(−0.69)	(−2.39)
interest	1.946***	0.748***	7.358***	0.245***	−1.457***	0.943***
	(25.79)	(11.50)	(4.79)	(16.84)	(−17.61)	(3.82)
SD						
esb	2.771***	1.409***	2.526**	2.353***	9.265***	4.871***
	(22.34)	(14.48)	(2.13)	(23.00)	(11.02)	(2.65)
interest		1.321***			1.095***	
		(11.62)			(8.69)	
tau			2.318***			2.344***
			(11.21)			(8.52)
gamma			−1.404**			−0.555**
			(−2.02)			(−2.29)
Obs	16200	16200	16200	16200	16200	16200
AIC	9581.4	9419.7	9334.5	10157.7	10082.9	10092.4
BIC	9650.7	9496.6	9419.1	10226.9	10159.8	10177.0

Note: ***, **, and * denote significance at the 1%, 5%, and 10%, respectively. RP, WTP, and GMNL represent the results of the random parameter, WTP space, and generalized multinomial logit model estimations. The values in parentheses denote the z-score.

Second, we explain the results of how differences in the return rate influence the preference for ESBs by comparing the JPY and USD models, in which we presented different base interest rates to the respondents. It is discernible from the direction of coefficients of ESB in Table 6 that investors are more inclined to invest in ESBs in the JPY model than in the USD model. ESB is positively significant in the RP model of JPY bonds while negatively significant in the G-MNL model of USD bonds. Thus, investors tend to invest in ESBs when the anchoring interest rate is low. In contrast, when interest rates on bonds are high, investors prefer government bonds (10-year global developed sovereign index) over ESBs, seeking to avoid the associated risks. The study incorporated the anchoring effect of the substantial interest rate difference between Japanese and US bonds in 2023, examining how such economic factors, influenced by currency contexts (JPY vs. USD), shape investor choices in the Japanese market. When return rates are low, risk-averse investors might favor ESBs due to their added non-monetary benefits, such as environmental and social impacts. Such investors might be willing to accept a lower financial return in exchange for supporting projects aligned with their values. This

aligns with the "warm glow" effect observed in socially responsible investing, where the satisfaction of contributing to societal goals partially compensates for a lower return (Lee & Singh, 2020).

The observed trend—that investors prefer ESBs when return rates are low but shift toward government bonds at higher rates—aligns with findings on risk aversion and investment behavior. When the anchoring interest rate is high, as with the US bond yield relative to Japan's in 2023, risk-averse investors may perceive government bonds as safer, offering a more stable alternative to ESBs. This is likely due to the fact that government bonds are traditionally seen as lower-risk investments, especially during times of elevated returns. In contrast, when returns are lower, investors may opt for ESBs to align with their values on sustainability, as the opportunity cost of prioritizing environmental and social goals over returns is relatively small.

Table 6 also shows the effect of the other main attributes on the preference. ESBs with high credit ratings, third-party certification, and reporting on their proceeds increased the probability of investing in ESBs issued in JPY. The issuer attribute (*local*) was significant only in the USD model and had a positive influence, suggesting that when the interest rate is high, investors prefer ESBs issued by local governments over those issued by private companies. In all RP and G-MNL model estimations, the interest rate was positively significant, suggesting that investors preferred EBSs with higher interest rates. The effects of these attributes on ESBs were consistent with previous studies (Aruga and Bolt, 2023; Baldi and Pandimiglio, 2022; Brach et al., 2018; Li et al., 2020; MacAskill et al., 2021), and not much difference became apparent between the ESBs issued in JPY and USD.

Third, we explore our third objective: how investors' risk perceptions influence their preference for ESBs. Tables 7(a) and 8(a) present the findings of the cross-effects estimation, where the characteristics of respondents are to be examined for their effects on the preference regarding ESBs. These items were estimated by interacting the variables of interest with the ESB variable.[6] Tables 7(b) and 8(b) show the standard deviation estimates of the models, suggesting the importance of applying the RP and G-MNL models. Comparing the results for the respondents' risk tolerance variable (*inv. risk*), it is noticeable that the direction of the effect on ESB preference was contrastive between ESBs issued in JPY and USD. When the risk tolerance variable was significant, it positively influenced the preference for ESBs issued in JPY, while it had a negative impact on the preference for ESBs issued in USD. This implies that investors who are less tolerant of investment risk prefer to invest in ESBs issued in USD rather than in JPY. This could be because risk-averse investors seek a greater return when investing in ESBs, as the risk associated with ESBs is less certain compared to government bonds.

[6] To prevent the table from becoming too large, the results of the estimations for the main attributes are provided in Tables B1 and B2 in Appendix B.

Table 7(a). Estimation results of cross-effect variables for the JPY model (mean).

	RP			WTP space			GMNL		
	SRAS	Env	Sustain	SRAS	Env	Sustain	SRAS	Env	Sustain
Investing attitude									
esb*inv. risk	0.0188	−0.166	−0.117	0.00231	−0.0829**	−0.0755**	−0.264**	−1.106***	−0.717***
	(0.15)	(−1.09)	(−0.87)	(0.07)	(−2.11)	(−2.11)	(−2.02)	(−3.85)	(−4.03)
esb*invfreq	−0.126	−0.184	−0.168	−0.0261	−0.141***	−0.107**	−0.125	−0.231*	−0.582***
	(−0.96)	(−1.54)	(−1.32)	(−0.75)	(−3.76)	(−2.38)	(−0.94)	(−1.68)	(−3.40)
Relationship with ESB									
esb*exp	0.513***	0.384***	0.494***	0.344***	0.212***	0.247***	0.492***	1.343***	0.248*
	(3.71)	(3.35)	(4.29)	(8.67)	(4.92)	(6.35)	(2.85)	(5.01)	(1.79)
esb*share	−0.391***	−0.354***	−0.377***	−0.184***	−0.241***	−0.200***	−0.638***	−1.130***	−0.544***
	(−4.27)	(−3.99)	(−4.27)	(−8.06)	(−7.71)	(−7.08)	(−3.14)	(−4.72)	(−3.78)
esb*avg. know	0.195*	0.269***	0.223**	0.0686**	0.0900***	0.111***	0.433**	0.359**	0.482***
	(1.92)	(2.69)	(2.26)	(1.98)	(2.94)	(3.88)	(2.54)	(2.37)	(3.20)
Social responsibility									
esb*sras	0.278**			0.307***			0.179		
	(2.02)			(6.74)			(1.26)		
esb*env		0.721***			0.454***			1.774***	
		(5.90)			(9.87)			(4.66)	
esb*sustain			0.507***			0.181***			1.329***
			(3.90)			(4.67)			(4.56)
Demographic									
esb*age	−0.0515	−0.193	−0.0853	−0.00722	−0.0769	−0.0893**	0.271	−0.417*	−0.277*
	(−0.35)	(−1.23)	(−0.58)	(−0.26)	(−1.29)	(−2.02)	(1.42)	(−1.91)	(−1.65)
esb*male	−0.315	−0.290	−0.285	−0.181***	−0.202***	−0.0834	−0.769**	−1.476***	−0.959***
	(−1.29)	(−1.34)	(−1.25)	(−3.63)	(−3.13)	(−1.33)	(−2.40)	(−3.94)	(−3.54)
esb*edu	0.0663	0.0670	0.0671	0.0572**	0.0631**	0.0446	0.169	0.219	0.119
	(1.23)	(1.24)	(1.24)	(2.15)	(2.19)	(1.64)	(1.05)	(1.25)	(0.86)
esb*house	0.333	0.259	0.341	0.108**	−0.0676	0.0158	−0.190	0.991***	0.432*
	(1.51)	(1.21)	(1.61)	(2.09)	(−1.01)	(0.22)	(−0.72)	(2.97)	(1.89)
esb*child	0.334	0.269	0.302	0.166***	0.113	0.0567	0.936***	1.823***	0.308
	(1.35)	(1.03)	(1.22)	(2.73)	(0.83)	(0.80)	(2.71)	(3.45)	(1.11)
esb*marry	−0.545**	−0.518**	−0.535**	−0.366***	−0.0937	−0.145*	−1.144***	−2.806***	−1.002***
	(−2.16)	(−1.97)	(−2.09)	(−5.71)	(−0.76)	(−1.92)	(−3.02)	(−4.14)	(−2.79)
esb*income	0.177***	0.181***	0.197***	0.0588***	0.0905***	0.0701***	0.363***	0.662***	0.389***
	(2.98)	(3.09)	(3.24)	(4.20)	(4.81)	(3.61)	(3.72)	(4.26)	(3.89)
tau							2.293***	2.171***	2.284***
							(10.09)	(11.81)	(10.87)
gamma							−1.386*	−0.351***	−1.660**
							(−1.70)	(−3.57)	(−1.97)
Obs	16200	16200	16200	16200	16200	16200	16200	16200	16200
AIC	9481.0	9454.8	9469.4	9388.9	9363.0	9396.4	9329.7	9280.4	9307.3
BIC	9750.2	9724.0	9738.6	9665.9	9639.9	9673.3	9614.4	9565.0	9591.9

Note: ***, **, and * denote significance at the 1%, 5%, and 10%, respectively. RP and GMNL represent the results of the random parameter and generalized multinomial logit model estimations. The values in parentheses denote the z-score.

Finally, Tables 7(a) and 8(a) illustrate how other characteristics of investors impact their preference for ESBs. Investing frequency (*invfreq*) coefficients had a negative impact on the choice when statistically significant, suggesting that individuals who frequently invest in the stock or bond market are more reluctant to invest in ESBs. In both the JPY and USD models, experience in ESB investing (*exp*) and knowledge in ESB (*avg. know*) were associated with an increase in the probability of investing in ESBs. The share of ESBs within new investments had a negative impact on ESB preference for ESBs issued in JPY. This suggests that investors are less willing to allocate their new investments to ESBs compared to the Japan 10-year government bond.

Table 7(b). Estimation results of cross-effect variables for the JPY model (SD).

	RP			WTP space			GMNL		
	SRAS	Env	Sustain	SRAS	Env	Sustain	SRAS	Env	Sustain
esb*inv. risk	0.228**	0.414***	0.223***	0.377***	0.233***	0.309***	0.268*	−1.370***	0.403**
	(2.46)	(6.63)	(2.59)	(12.95)	(12.72)	(13.80)	(1.83)	(−4.03)	(2.10)
esb*invfreq	−0.125	−0.0886	−0.159*	0.0850***	0.0117	0.107***	0.366*	0.763***	0.400**
	(−1.24)	(−1.08)	(−1.86)	(6.09)	(0.98)	(5.36)	(1.81)	(3.87)	(2.08)
esb*exp	0.0726	0.0687	0.0500	0.00260	−0.0303*	0.0790***	0.00314	0.641***	−0.120*
	(0.74)	(0.69)	(0.62)	(0.23)	(−1.85)	(3.47)	(0.10)	(3.72)	(−1.85)
esb*share	0.427***	0.381***	0.408***	0.0918***	0.176***	0.0835***	0.822*	0.937***	0.264**
	(5.00)	(3.03)	(4.35)	(6.82)	(7.93)	(3.82)	(1.88)	(3.90)	(2.00)
esb*avg. know	0.100	−0.0164	0.112	0.135***	0.0890***	−0.0545***	−0.116	0.345***	0.0228
	(0.52)	(−0.22)	(0.99)	(8.99)	(5.63)	(−3.10)	(−1.63)	(3.81)	(0.99)
esb*sras	0.0199			0.0326***			0.401*		
	(0.27)			(3.87)			(1.82)		
esb*env		0.121**			0.120***			1.328***	
		(2.34)			(9.29)			(3.99)	
esb*sustain			0.00800			0.0732***			0.165**
			(0.10)			(8.49)			(2.06)
esb*age	1.093***	0.862***	1.081***	0.231***	0.388***	0.271***	0.481*	−0.306***	0.217**
	(12.89)	(8.80)	(12.07)	(10.61)	(13.12)	(11.77)	(1.90)	(−3.64)	(2.04)
esb*male	0.445	0.269	0.447*	0.114***	0.460***	0.285***	0.405*	0.651***	0.233**
	(1.25)	(0.90)	(1.80)	(3.33)	(8.72)	(5.82)	(1.86)	(3.06)	(2.01)
esb*edu	−0.0210	−0.0158	−0.0190	0.0152	0.0323**	−0.0159	−0.0471	0.270***	−0.0840*
	(−0.15)	(−0.15)	(−0.14)	(1.37)	(2.30)	(−1.03)	(−1.46)	(3.11)	(−1.87)
esb*house	0.619***	0.879***	0.664***	0.000978	0.00533	−0.601***	1.042*	3.029***	0.854**
	(2.69)	(3.51)	(2.65)	(0.03)	(0.19)	(−10.01)	(1.87)	(4.07)	(2.08)
esb*child	−0.114	−0.255	−0.198	0.0597**	0.0810**	−0.0284	0.142*	0.238	0.686**
	(−0.49)	(−1.00)	(−0.75)	(2.19)	(2.46)	(−0.84)	(1.65)	(1.61)	(2.04)
esb*marry	0.0365	−0.234	0.0540	0.283***	0.0166	0.128***	0.877*	1.299***	0.528**
	(0.07)	(−0.89)	(0.11)	(7.03)	(0.51)	(3.40)	(1.93)	(3.77)	(2.11)
esb*income	0.104*	0.0625	0.0933	−0.0171***	−0.111***	0.00369	0.144*	0.378***	0.0490*
	(1.91)	(1.21)	(1.56)	(−2.78)	(−8.96)	(0.44)	(1.82)	(3.87)	(1.95)

Note: ***, **, and * denote significance at the 1%, 5%, and 10%, respectively. RP and GMNL represent the results of the random parameter and generalized multinomial logit model estimations. The values in parentheses denote the z-score.

Table 8(a). Estimation results of cross-effect variables for the USD model (mean).

	RP			WTP space			GMNL		
	SRAS	Env	Sustain	SRAS	Env	Sustain	SRAS	Env	Sustain
Investing attitude									
esb*inv. risk	0.401***	0.285**	0.335**	1.416***	0.535**	1.685***	0.730***	0.324*	0.523**
	(3.26)	(2.14)	(2.55)	(3.13)	(2.10)	(5.06)	(3.47)	(1.93)	(2.44)
esb*invfreq	−0.228**	−0.181*	−0.190*	−0.713*	−0.709**	−1.698***	−0.392***	−1.095***	−0.331*
	(−2.13)	(−1.70)	(−1.79)	(−1.83)	(−2.15)	(−4.52)	(−3.19)	(−3.38)	(−1.84)
Relationship with ESB									
esb*exp	0.482***	0.492***	0.484***	1.712***	1.656***	2.185***	0.623***	0.776***	0.567***
	(4.83)	(4.96)	(5.19)	(3.04)	(3.52)	(4.63)	(2.93)	(3.82)	(2.82)
esb*share	−0.0253	−0.000630	−0.0300	−0.363	−0.191	−0.726**	0.345*	−0.688***	0.796***
	(−0.24)	(−0.01)	(−0.26)	(−1.63)	(−0.89)	(−2.53)	(1.81)	(−2.87)	(3.34)
esb*avg. know	0.0249	0.110	0.0955	0.463*	0.858***	0.514*	0.213**	0.399**	0.464**
	(0.28)	(1.31)	(1.13)	(1.81)	(2.94)	(1.90)	(2.23)	(2.49)	(2.09)
Social responsibility									
esb*sras	0.380***			0.866**			0.728**		
	(2.78)			(2.00)			(2.50)		
esb*env		0.290**			1.486***			1.078***	
		(2.57)			(4.90)			(3.41)	
esb*sustain			0.218*			0.920***			0.580**
			(1.79)			(2.85)			(2.35)
Demographic									
esb*age	0.101	0.0853	0.112	0.557	0.313	0.478	0.508**	0.594***	0.934***
	(0.76)	(0.64)	(0.86)	(1.06)	(1.06)	(1.49)	(1.98)	(2.83)	(2.67)

Continued on next page

	RP			WTP space			GMNL		
	SRAS	Env	Sustain	SRAS	Env	Sustain	SRAS	Env	Sustain
esb*male	−0.0892	−0.153	−0.0886	−0.981	−0.887*	−2.069***	−0.581***	−0.163	−0.248
	(−0.47)	(−0.79)	(−0.48)	(−1.51)	(−1.82)	(−3.93)	(−2.95)	(−0.66)	(−1.07)
esb*edu	0.0146	0.0169	0.0189	0.0989	0.0905	0.223	−0.167	0.0959	0.0885
	(0.27)	(0.32)	(0.35)	(0.53)	(0.49)	(1.17)	(−1.34)	(0.94)	(0.80)
esb*house	0.154	0.0991	0.280	1.667**	0.639	0.767	0.413*	1.085***	0.160
	(0.79)	(0.52)	(1.50)	(2.02)	(1.08)	(1.43)	(1.68)	(3.09)	(0.57)
esb*child	0.0953	0.103	0.0780	−0.0161	0.241	1.225**	0.112	−0.240	0.693**
	(0.42)	(0.46)	(0.35)	(−0.02)	(0.31)	(2.02)	(0.38)	(−0.87)	(2.04)
esb*marry	−0.00124	0.0891	−0.0686	0.606	−0.925	0.0244	−0.580	−0.358	−1.146**
	(−0.01)	(0.41)	(−0.32)	(0.94)	(−1.55)	(0.04)	(−1.19)	(−1.33)	(−2.47)
esb*income	0.0245	0.0316	0.0221	0.111	0.309**	0.266***	0.0352	0.175**	0.0613
	(0.46)	(0.56)	(0.41)	(0.88)	(2.30)	(2.85)	(0.61)	(2.36)	(0.76)
tau							2.437***	2.287***	2.549***
							(9.22)	(8.60)	(7.93)
gamma							−0.862**	−0.461**	−0.887*
							(−2.24)	(−2.43)	(−1.70)
Obs	16200	16200	16200	16200	16200	16200	16200	16200	16200
AIC	10116.8	10112.2	10122.7	10073.4	10070.2	10093.9	10036.7	10031.0	10018.1
BIC	10386.0	10381.5	10391.9	10350.3	10347.1	10370.8	10321.4	10315.7	10302.8

Note: ***, **, and * denote significance at the 1%, 5%, and 10%, respectively. RP and GMNL represent the results of the random parameter and generalized multinomial logit model estimations. The values in parentheses denote the z-score.

Table 8(b). Estimation results of cross-effect variables for the USD model (SD).

	RP			WTP space			GMNL		
	SRAS	Env	Sustain	SRAS	Env	Sustain	SRAS	Env	Sustain
esb*inv. risk	0.401***	0.364***	0.165**	1.339***	2.184***	1.403***	0.550**	0.169***	0.0805*
	(8.21)	(7.16)	(2.41)	(9.49)	(10.95)	(10.17)	(2.50)	(2.82)	(1.70)
esb*invfreq	0.221**	−0.127	0.128	0.770***	0.794***	1.073***	0.150**	0.392***	0.227*
	(2.36)	(−1.56)	(1.41)	(6.94)	(5.94)	(7.88)	(2.31)	(2.79)	(1.82)
esb*exp	0.0639	0.130	0.121	1.268***	0.775***	0.780***	−0.166**	−0.0349	0.00761
	(0.74)	(1.58)	(1.40)	(6.12)	(4.23)	(5.72)	(−2.13)	(−0.81)	(0.25)
esb*share	0.879***	0.874***	0.888***	0.0780	−0.121	−0.763***	1.358**	1.876***	1.490*
	(8.31)	(9.00)	(7.73)	(0.46)	(−0.85)	(−4.49)	(2.50)	(2.81)	(1.87)
esb*avg. know	−0.123*	0.119	−0.0964	1.435***	1.662***	1.117***	0.391**	0.234**	0.434*
	(−1.66)	(1.05)	(−1.00)	(4.38)	(8.37)	(6.69)	(2.45)	(2.54)	(1.83)
esb*sras	−0.144**			0.948***			0.296**		
	(−1.97)			(5.53)			(2.46)		
esb*env		0.0390			0.600***			0.893***	
		(0.63)			(6.94)			(2.86)	
esb*sustain			0.217***			1.434***			0.464*
			(3.81)			(10.03)			(1.88)
esb*age	0.423***	0.517***	0.657***	0.273**	0.900***	2.522***	0.179**	−0.789***	0.229*
	(5.11)	(3.68)	(5.61)	(2.40)	(5.20)	(10.57)	(2.29)	(−2.78)	(1.90)
esb*male	0.193	0.0805	0.395*	2.541***	2.497***	3.391***	−0.525**	2.684***	0.873*
	(0.88)	(0.35)	(1.68)	(3.97)	(7.41)	(8.55)	(−2.00)	(2.85)	(1.78)
esb*edu	−0.0670	−0.0416	0.0308	0.0727	0.0826	0.191**	−0.0274	0.100**	0.0485*
	(−1.09)	(−0.50)	(0.26)	(0.74)	(0.92)	(1.99)	(−0.71)	(2.22)	(1.76)
esb*house	−0.177	0.544*	1.093***	5.677***	1.763***	1.531***	0.0539	0.200	0.680*
	(−0.72)	(1.71)	(4.14)	(8.48)	(4.07)	(4.01)	(0.46)	(1.53)	(1.87)
esb*child	0.667***	−0.457	0.180	0.777**	−2.010***	1.550***	0.153*	2.031***	0.104
	(3.08)	(−1.45)	(0.64)	(2.10)	(−6.51)	(4.53)	(1.87)	(2.85)	(0.96)
esb*marry	−0.166	−0.174	−0.117	1.398**	−0.586*	−0.353**	0.111	0.199	0.167
	(−0.60)	(−0.62)	(−0.40)	(2.08)	(−1.85)	(−1.99)	(1.52)	(1.57)	(1.48)
esb*income	0.0714	0.0217	−0.0362	0.205***	−0.379***	0.600***	0.281**	0.172***	0.0679
	(1.18)	(0.38)	(−0.66)	(3.38)	(−6.30)	(7.22)	(2.52)	(2.70)	(1.56)

Note: ***, **, and * denote significance at the 1%, 5%, and 10%, respectively. RP and GMNL represent the results of the random parameter and generalized multinomial logit model estimations. The values in parentheses denote the z-score.

Moreover, investors' level of social responsibility tended to affect positively the ESB preference. SRAS, environmental, and sustainability awareness indices were mostly positively significant, suggesting that individuals with high social responsibility are more likely to invest in ESBs. This result is consistent with previous studies testing the impact of individuals' social responsibility levels on their preference for green bonds (Zerbib, 2019; Cortellini and Panetta, 2021; Aruga and Bolt, 2023; Aruga, 2024b).

Finally, several socio-demographic trends emerged. For instance, male respondents preferred ESBs less than female respondents, which aligns with the results of Zhao et al. (2021). In the G-MNL USD model, older investors showed a higher inclination toward ESBs. Homeowners were more inclined to invest in ESBs in the G-MNL environmental awareness model. Having children positively impacted ESB choice in the G-MNL model, while being married had a negative influence. Higher-income levels also positively influenced ESB choice, suggesting that financially stable individuals with a higher tolerance for risk are more prone to include ESBs in their portfolios. This result aligns with Aruga (2024b), indicating that investors with higher income levels are more willing to invest in green bonds.

5. Conclusions and policy implications

While not much has been investigated on how investors consider the differences in the focus of the bonds when investing in ESBs, this study examined the effect of such differences among the types of bonds on investor preferences regarding ESBs. As ESBs are financial products, the study also explored how return rates and investors' risk perceptions impact preferences toward ESBs.

The study findings showed that when the ESBs' return rate is low, investors do not exhibit a specific preference for any particular type of ESBs. However, when the return rate is high, they tend to prefer sustainability bonds, which are a more comprehensive type of ESBs compared to green and blue bonds. We conjecture that when the return rate is high, the risk of investing is also high, and thus, investors prefer ESBs that cover diverse topics to reduce the risk of not achieving environmental and sustainable goals. The results of the study also suggested that when the return rate is low, investors are more inclined to invest in ESBs. In contrast, when the return rate is high, they tend to prefer government bonds. This highlights the significance of securing a lower interest rate when issuing ESBs.

The results regarding how investors' risk perceptions affect ESB preferences indicated that highly risk-averse investors tended to be hesitant to invest in ESBs unless they received a higher return. This underscores the importance of ESB issuers to provide investors with accurate information about the risks involved in ESB investing. In addition to the above findings, the study also revealed that factors identified as important in previous research (Aruga and Bolt, 2023), such as credit ratings, third-party certification, and reporting on the use of proceeds, are similarly crucial when issuing ESBs. We also confirmed that socially responsible investors who had high altruism levels and high environmental and sustainability awareness tended to have a higher preference to invest in ESBs.

Given that the ESB market is still immature and small in scale, this research is valuable for developing future growth strategies. It clarifies the appropriate balance of yields and risks and identifies the target investor groups for promotion, which will be useful for shaping policies aimed at expanding the market. The limitation of this study is that our choice experiment only covered one type of adjustment of interest rate to set a range reflecting typical market conditions and provide a realistic basis for comparison. However, this limited range may not fully capture investor preferences, especially among those more sensitive to return rate variations. Expanding the range of return rates in this way could offer valuable insights into how varying return levels impact investor preferences for green, sustainability, and blue bonds.

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Data Availability Statement

The data source is available upon request.

Author contributions

All authors have contributed equally to the development and writing of this article.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare no conflicts of interest in this paper.

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