

## Abstract

This study examines how retail investors' demand for green bonds responds to different magnitudes of return variation. Using an online survey of Japanese retail investors, we elicit minimum acceptable greenium through a double-bounded dichotomous choice design with interest rates randomly deviated from sovereign bond yields, denominated in either JPY or USD. Both types of return variation encourage GB investment, but through distinct mechanisms: SBY exhibits a non-monotonic inverted U-shaped effect where deviations in either direction reduce required greenium, while USD denomination has more selective effects primarily among return-oriented investors. Social awareness and GB knowledge create contrasting heterogeneity. Social awareness (pro-social orientation) does not amplify return sensitivity, supporting pure rather than impure altruism where pro-social motivation operates independently of financial incentives. By contrast, GB knowledge (environmental finance knowledge) determines which return variation investors respond to: high-knowledge investors respond to SBY while low-knowledge investors respond to USD.

**Keywords:** socially responsible investment; green bond; investment motivation; currency; attitudinal variables

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# Demand for Green Bond among Individual Investors

## -Larger and Smaller Returns and Role of Social Responsibility-

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## 1 Introduction

### 1.1 Background

Recent inflationary episodes have increased the opportunity cost of holding assets in savings accounts, stimulating investors to diversify their portfolio balance. In this context, green bonds (GBs) may attract distinctive demand for their low risk and socially responsible investment (SRI) characteristics. Beyond financial returns, GBs provide non-pecuniary value through their contribution to sustainability, while their yields remain closely tied to sovereign bond benchmarks. Changes in baseline sovereign bond yield (SBY) may fundamentally reshape the trade-off between financial returns and non-financial motives in GB investment. Yet it remains unclear how retail investors adjust their demand for green bonds when SBY changes—whether higher baseline returns crowd out pro-social preferences by increasing the opportunity cost of return sacrifice, or instead relax return constraints and enable greater expression of non-financial values. Reference-dependent preferences (Kahneman and Tversky, 1979; Koszegi and Rabin, 2006) suggest that investors may evaluate yields relative to a familiar benchmark rather than in absolute terms, while salience theory (Bordalo et al., 2012) implies that unusual yield levels may draw attention to alternative investments.

We estimate the demand for GB with respect to sovereign bond yield to evaluate how investors' minimum required return for GB changes in the form of premium compared to the sovereign bond yield

(SBY). We take the current SBY as the standard to see how the deviation may change their minimum premium for GB investment as hypothetical settings to value the role of inflation. We evaluate the premium for GB denominated by JPY and USD for possible differentiated premium compared to the respective current SBY due to the gap in nominal yield. These two sources of variations (SBY and currency) reveal how investors may change their premium in response to the different degree of yield changes.

This question addresses how financial returns motivate retail investors to choose SRI. Døskeland and Pedersen (2016) find that investors are return-seeking rather than purely impact-seeking in SRI decisions. Yet Gutsche et al. (2021) show that investors who value sustainability persist in SRI holdings despite declining returns. These findings raise the question of how pro-social values create heterogeneity in return-seeking behaviour—whether such values amplify or operate independently of return sensitivity. We examine this question through the decision on GB investment when two different magnitudes of variation in return simultaneously.

We furthermore examine how the role of financial incentives may vary with individual characteristics. We test whether social awareness amplifies return sensitivity—a prediction of impure altruism (Andreoni, 1990)—or operates independently of financial incentives. We also examine whether GB knowledge (environmental finance knowledge) moderates which return signals investors respond to, extending the financial literacy literature (Lusardi and Mitchell, 2014) to sustainable investment.

We investigate this to understand the mechanism of non-pecuniary motivation for SRI. Previous studies find that social awareness is associated with higher share of SRI in their portfolio and future SRI (Lau et al., 2022; Bauer et al., 2021; Luz et al., 2024). However, it remains unclear if they are willing for SRI for pecuniary reason (i.e. impure altruism) or not. We evaluate how such attitudinal variables associate with return in their SRI decision making.

We collect data through an online survey asking respondents about their investment choice for hypothetical corporate GB. The survey asks one whether to invest in the GB whose interest rate is equivalent to SBY randomly deviated from the current level. We obtain stated preferences as categorical form that classifies one’s minimum premium for GB as lower or higher than the presented SBY.

## 1.2 Main Findings

We find that higher returns play a role in lowering the premium for GB but the role differs depending on the sources of the return change. SBY exhibits a non-monotonic (inverse U-shaped) effect: deviations from the contemporaneous yield—both higher and lower—reduce the required greenium, with the highest greenium observed at the current SBY level. This pattern is consistent with reference-dependent preferences (Kahneman and Tversky, 1979; Koszegi and Rabin, 2006) and salience theory (Bordalo et al., 2012). The denomination by USD (compared to JPY) lowers the premium significantly but the degree

shrinks as one has lower premium. Comparatively, the SBY has a larger effect on the premium than USD does, even though USD (compared to JPY) creates a larger return variation.

About heterogeneity by social awareness, we find little evidence of impure altruism (Andreoni, 1990) in either altruistic devotion or environmental awareness. Therefore, having higher social awareness does not amplify the sensitivity to pecuniary return in GB investment choice. The results suggest that social awareness is purely altruistic rather than a return-seeking quality of personal characteristics.

We also turn to examine the role of GB knowledge as an indicator of environmental finance knowledge by dividing the sample into two. We find it creates significant heterogeneity in the financial incentive, extending the financial literacy literature (Lusardi and Mitchell, 2014). SBY has a stronger effect among those with high GB knowledge, while USD denomination has a stronger effect among those with low GB knowledge. Still, social awareness does not amplify the financial incentives in either subsample. These results distinguish the role of individual awareness in economy, environment, and altruism.

### 1.3 Contributions

This study contributes to literature on pecuniary motivation in SRI. While the literature finds the association between return expectation from SRI and SRI decisions, the causal inferences remain unclear (Brodback et al., 2019; Døskeland and Pedersen, 2016; Gutsche et al., 2023). Our results show how retail investors respond positively to SRI when facing return variation. The return variation stimulates one to want SRI through the case of GB. Still, we find that the reduction does not follow the magnitude of the return variation and the effect depends on one’s desired minimum premium. This contributes to the studies about non-pecuniary motivations in SRI (Bauer et al., 2021; Bonnefon et al., 2025) by demonstrating how SRI may only partially be encouraged by financial returns. Compared to these studies, we demonstrate differentiated response to the return depending on one’s minimum premium.

This study also contributes to research on impure altruism and social preferences in sustainable investment decision-making. Several papers highlight the importance of social awareness and sustainability beliefs in driving participation (Bauer and Smeets, 2015; Riedl and Smeets, 2017), but leave open whether such motivations interact with financial incentives. Our findings show that general social awareness (environmental concern, altruism) does not amplify return sensitivity, consistent with pure altruism theory. However, investment-specific awareness (GB knowledge) creates significant heterogeneity in responses to financial incentives. We also find limited evidence of motivation crowding-out (Frey and Oberholzer-Gee, 1997; Bénabou and Tirole, 2006) among knowledgeable investors when environmental investment is framed in financial terms.

The remainder of this paper is organized as follows. Section 2 presents our theoretical framework and empirical methodology, including the double-bounded choice model and generalized ordered probit specification. Section 3 describes the survey design, sample characteristics, and variable definitions.

Section 4 reports our main findings on the effects of SBY and USD denomination on greenium, heterogeneity analysis by GB knowledge, and tests for impure altruism. Section 5 concludes with a discussion of implications and directions for future research.

## 2 Theory and Methodology

### 2.1 Theoretical Framework

Investors derive utility from green bond investment through two channels: financial returns and environmental contribution (Andreoni, 1990; Barreda-Tarazona et al., 2011; Kahneman and Tversky, 1979). We define  $\underline{r}_{i,U}$  as the minimum interest rate at which investor  $i$  is indifferent between investing in green bond  $U$  and their next-best alternative investment. This indifference condition can be expressed as:

$$V(q, -\underline{r}, y + \underline{r}; \theta) = V(0, -r_0, y + r_0; \theta) \quad (1)$$

where  $V(\cdot)$  is the indirect utility function where  $q$  is the additional environmental contribution from GB investment (assumed constant across bonds),  $\underline{r}$  is the minimum acceptable return,  $r_0$  is the return from the alternative investment,  $y$  is income, and  $\theta$  represents individual characteristics.

Since retail investors find it difficult to differentiate sustainability impact across green bonds (Hartzmark and Sussman, 2019; Heeb et al., 2022), we perceive  $q$  as constant. The minimum acceptable return  $\underline{r}_{i,U}$  varies across individuals based on their financial situation, environmental attitudes, and demographic characteristics. Our empirical approach elicits these individual-specific thresholds through a double-bounded choice experiment and relates them to observable characteristics.

### 2.2 Empirical Framework 1: Double-Bounded Choice Model

We use a double-bounded dichotomous-choice (DBDC) approach to elicit minimum interest rates. Each respondent  $i$  faces two sequential questions about investing in green bonds (Japanese GB when  $U = 0$ , US GB when  $U = 1$ ) at different interest rates.

Respondents are randomly assigned an SBY  $B_k$  from five levels ( $k = 1, 2, 3, 4, 5$ ) spanning 60% to 140% of a baseline ( $B_3 = 0.5\%$  for Japanese GB,  $B_3 = 4.0\%$  for US GB). If they accept the initial offer, the second question offers  $0.85B_k$ ; if they reject, it offers  $1.15B_k$ . This generates four response patterns revealing the investor's "greenium"—willingness to accept lower returns for green bonds:

$$\left. \begin{array}{ll} response_{i,U} = 4 \text{ (no, no):} & \text{Large positive greenium} \\ response_{i,U} = 3 \text{ (no, yes):} & \text{Moderate positive greenium} \\ response_{i,U} = 2 \text{ (yes, no):} & \text{Moderately negative greenium} \\ response_{i,U} = 1 \text{ (yes, yes):} & \text{Largely negative greenium} \end{array} \right\} \quad (2)$$

We model the minimum interest rate  $r_{i,U}$  as:

$$r_{i,U} = \beta' X_i + \gamma U + e_{i,U} \quad (3)$$

where  $X_{i,U}$  includes financial variables (SBY, bond origin) and prosocial attitudes (environmental concern, social responsibility, GB knowledge),  $\theta_i$  contains demographic controls, and  $e_{i,U} \sim N(0, \sigma_U^2)$ . Standardizing  $B_k = 1$  allows estimation on the same scale across bond types. The probability of observing each response is:

$$\left. \begin{array}{l} \Pr(response_{i,U} = 1) = 1 - \Phi \left( \frac{0.85 - \beta' X_{i,U} - \tau' \theta_i}{\sigma_U} \right) \\ \Pr(response_{i,U} = 2) = \Phi \left( \frac{0.85 - \beta' X_{i,U} - \tau' \theta_i}{\sigma_U} \right) - \Phi \left( \frac{1 - \beta' X_{i,U} - \tau' \theta_i}{\sigma_U} \right) \\ \Pr(response_{i,U} = 3) = \Phi \left( \frac{1 - \beta' X_{i,U} - \tau' \theta_i}{\sigma_U} \right) - \Phi \left( \frac{1.15 - \beta' X_{i,U} - \tau' \theta_i}{\sigma_U} \right) \\ \Pr(response_{i,U} = 4) = \Phi \left( \frac{1.15 - \beta' X_{i,U} - \tau' \theta_i}{\sigma_U} \right) \end{array} \right\} \quad (4)$$

where  $\Phi$  denotes the standard normal CDF. We estimate  $\beta$  and  $\tau$  by maximum likelihood:

$$\ln L(\beta, \tau) = \sum_{U=0}^1 \sum_{i=1}^n \sum_{j=1}^4 d_{i,U}^j \ln \Pr(response_{i,U} = j) \quad (5)$$

where  $d_{i,U}^j$  equals 1 if respondent  $i$  gives response  $j$  for bond  $U$ , and 0 otherwise.

### 2.3 Empirical Framework 2: Generalized Ordered Probit

While the first model estimates continuous minimum interest rates, our second approach directly models the four categorical responses using a generalized ordered probit (Pudney and Shields, 2000). Lower response values indicate higher greenium.

We model responses as determined by a latent variable  $y_{i,U}^*$  and covariate-dependent thresholds  $\lambda_j$ . Let  $Z_i$  denote the vector of all covariates (including USD, SRAS, ENV, SBY, and controls). The latent propensity is:

$$y_{i,U}^* = \beta' Z_i + \epsilon_{i,U}, \quad \epsilon_{i,U} \sim N(0, \omega^2) \quad (6)$$

The observed response is determined by which threshold interval contains  $y_{i,U}^*$ :

$$response_{i,U} = j \quad \text{if} \quad \lambda_{j-1,i} < y_{i,U}^* \leq \lambda_{j,i} \quad (7)$$

where thresholds depend on covariates:

$$\lambda_{j,i} = q_j + \delta_j' Z_i, \quad j = 1, 2, 3 \quad (8)$$

This specification allows variable effects to differ across response categories. The probability of observing response greater than category  $k$  is:

$$\Pr(response_{i,U} > k) = \Pr(y_{i,U}^* > \lambda_{k,i}) = \Pr(\epsilon_{i,U} > \lambda_{k,i} - \beta' Z_i) = 1 - \Phi\left(\frac{q_k + (\delta_k - \beta)' Z_i}{\omega}\right) \quad (9)$$

The probability of each response category is:

$$\Pr(response_{i,U} = j) = \Phi\left(\frac{q_j + (\delta_j - \beta)' Z_i}{\omega}\right) - \Phi\left(\frac{q_{j-1} + (\delta_{j-1} - \beta)' Z_i}{\omega}\right) \quad (10)$$

where  $\Phi$  is the standard normal CDF. We estimate  $\beta - \delta_j$  ( $j = 1, 2, 3$ ) by maximum likelihood.<sup>1</sup>

The key advantage of this generalized specification is that it allows the marginal effects of covariates to vary across thresholds. We test whether coefficients are constant across thresholds using Brant's Wald test:

$$H_0 : \beta - \delta_1 = \beta - \delta_2 = \beta - \delta_3$$

Rejection indicates that some variables have heterogeneous effects across the response distribution (Pudney and Shields, 2000).

### 3 Survey Design and Variable Descriptions

#### 3.1 Survey Design

Data was collected via an online survey conducted by Rakuten Insight Inc., a private survey agent. The sample was randomly drawn from individuals registered on their platform and living in two metropolitan areas (Kanto and Kansai) in Japan. Respondents proceeded to a questionnaire about GB if they were not excluded by two screening questions.<sup>2</sup> In total, data were collected from 1400 respondents between August 31 and September 1, 2023. As with DBDC questions, investors were asked if they would like to buy GB at various yearly interest rates in a double-bounded setting.

There are several notes on this sampling. Firstly, a respondent is excluded if they indicate that they

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<sup>1</sup>Individual identification of  $\beta$  and  $\delta_j$  is not possible (Pudney and Shields, 2000).

<sup>2</sup>The first screening excludes those who do not invest, and the second excludes those who have no interest in GB.

will never be interested in GB investment. Additionally, each GB for this survey were presumed to be 10-year bonds with each fixed interest rate and given the same rank of credit as the corresponding sovereign bond. The baseline *SBY* for each GB was determined by the interest rate for Japanese or US treasury bonds as of August 2023 (0.5% and 4.0% each). Based on this, each respondent was offered both J-GB and U-GB with assigned level of interest rate level out of the five levels. For example, if a respondent was offered the highest level of SBY, the *SBY* is 0.7% for J-GB and 5.6% for U-GB.

**Table 1:** DBDC responses for J-GB and U-GB

|                     | $response_{i,0}$      |                      |                      |                     | $response_{i,1}$      |                      |                      |                     |
|---------------------|-----------------------|----------------------|----------------------|---------------------|-----------------------|----------------------|----------------------|---------------------|
|                     | $j = 1$<br>(yes, yes) | $j = 2$<br>(yes, no) | $j = 3$<br>(no, yes) | $j = 4$<br>(no, no) | $j = 1$<br>(yes, yes) | $j = 2$<br>(yes, no) | $j = 3$<br>(no, yes) | $j = 4$<br>(no, no) |
| Highest( $k = 5$ )  | 53<br>18.93%          | 35<br>12.50%         | 20<br>7.14%          | 172<br>61.43%       | 46<br>16.43%          | 58<br>20.71%         | 23<br>8.21%          | 153<br>54.64%       |
| Higher( $k = 4$ )   | 43<br>15.36%          | 43<br>15.36%         | 14<br>5%             | 180<br>64.29%       | 43<br>15.36%          | 44<br>15.71%         | 27<br>9.64%          | 166<br>59.29%       |
| Baseline( $k = 3$ ) | 30<br>10.71%          | 37<br>13.21%         | 18<br>6.43%          | 195<br>69.64%       | 35<br>12.50%          | 45<br>16.07%         | 24<br>8.57%          | 176<br>62.86%       |
| Lower( $k = 2$ )    | 39<br>13.93%          | 31<br>11.07%         | 30<br>10.71%         | 180<br>64.29%       | 35<br>12.50%          | 34<br>12.14%         | 30<br>10.71%         | 181<br>64.64%       |
| Lowest( $k = 1$ )   | 43<br>15.36%          | 43<br>15.36%         | 14<br>5%             | 180<br>64.29%       | 49<br>17.50%          | 40<br>14.29%         | 25<br>8.93%          | 166<br>59.29%       |
| Total               | 208                   | 189                  | 96                   | 907                 | 208                   | 221                  | 129                  | 842                 |

Notes: The same  $k$  is assigned for J-GB and U-GB randomly for each respondent. The number of respondents assigned to each  $k$  is equal (at 280) across  $k = 1, 2, 3, 4, 5$ .

Table 1 shows the distribution of  $response_{i,U}$  created by the DBDC responses for J-GB and U-GB. It shows that the order of frequency in  $response_{i,U}$  is the same between the two tables. The (no, no) category is by far the most dominant, occupying the majority of responses. More than half of the respondents did not want to invest in GB under either setting. The second-largest group includes both the (yes, yes) and (yes, no) categories, each amounting to 10-20%. These groups consist of investors who chose to invest in the first round, with roughly equal proportions of respondents answering no or yes in the follow-up round. Lastly, the (no, yes) category is clearly the smallest. Most investors who answered no in the first round persisted with a no in the follow-up question.

A higher  $SBY$  does not encourage more positive responses for either bond. This suggests that the interest rate may not be a highly determining factor in their responses. There are slight differences in distribution between J-GB and U-GB. The (no, no) category is more frequent in J-GB, and more respondents answered yes to the first question for U-GB. This indicates that U-GB promotes more positive responses. However, the number of (yes, yes) responses is equal between the bonds. This implies that U-GB is not a strong enough factor for relatively J-GB investors with higher  $response_{i,U}$  to shift to the (yes, yes) category for U-GB. The equal number of (yes, yes) responses suggests that respondents who shifted from (yes, yes) to other categories (such as (no, yes) and (yes, no)) balance out the totals.

### 3.2 Variable Descriptions

This study classifies explanatory variables into 3 groups of variables based on Gutsche et al. (2021). Namely, they are (1) financial attributes, (2) economic variables, (3) pro-social variables and (4) demographic variables. Full variable descriptions are provided in Appendix 3. The financial category represents 2 attributes attached to the offered GB in the DBDC questions;  $SBY$  and  $USD$ .  $SBY$  determines the level of interest rate that each respondent was offered out of 5 different ones.  $USD$  is a dummy

variable that takes on 1 when the respondent is offered U-GB. The two different financial attributes play a role in finding out how investors respond to the choices differently when the offered interest rate changes slightly with the variation in return by *SBY* and largely by *USD*.<sup>3</sup>

The economic category covers variables that capture preferences on investment such as risk tolerance and investment resources such as investment risk aversion and investment knowledge. Specifically, knowledge on GB, investment frequency, volatility risk aversion, wealth, and information preference are adopted. Knowledge on GB, labeled as *GB knowledge*, measures how much the respondent knows about GB. Environmental knowledge is often positively significantly associated with  $response_{i,U}$  for environmental goods and SRI Aruga and Bolt (2023); Aruga and Bolt (2023). *investment frequency*, *volatility risk aversion*, and *currency risk aversion* capture their experience and preference on investment. *investment frequency* is included to capture more generic investment knowledge than GB knowledge, which is reported as rather significant on SRI investment than insignificant (although quite heterogeneous) among Riedl and Smeets (2017), Gutsche et al. (2021) and Aruga (2024). Still, this inclusion would play an important role in differentiating the impact of GB knowledge from that of general investment knowledge Gutsche and Ziegler (2019).

*volatility risk aversion* and *currency risk aversion* are included to measure investment risk tolerance as studies show factors such as volatility and currency affect GB investment decisions (Lau et al. (2022); Ando et al. (2024)). So these variables measure how much one is averse to price changes and currency risk in investment. Lastly, *information certainty* measures how much one values information provided by authoritative source when buying something.<sup>4</sup>. This inclusion helps to associate GB investment with investors' preference over certainty on information as the demand for GB varies whether the issuer has a certification for GB or discloses relevant information (Caramichael and Rapp, 2024; Jankovic et al., 2022; Tang et al., 2023)

The pro-social group of variables is included to control for investors pro-social aspects as these encourage people to pay significantly more for socially-responsible goods. This study includes two variables for this category. Firstly, *alt* captures how much each respondent are committed to helping other people using an indicator based on Aruga and Bolt (2023). Positive association between GB investment is expected based on Aruga and Bolt (2023) and Brodbeck et al. (2019). The second variable is *env*, which captures the awareness of global and local environmental issues. This variable is formed by averaging 4 questions' answer, each of which is on the scale from 1 to 5 (See Appendix 2). Both the pro-social variables are expected to be positively associated with the  $response_{i,U}$  as are often statistically significant in estimating determinants for buying environmental goods (Apostolakis et al., 2018; Gutsche et al., 2021).

Lastly, the demographic category contains individual fundamental variables that would be expected

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<sup>3</sup>Maturity is fixed with 10 years as 10-year GB were offered. Other attributional factors as rating and certifications are included in this study as the main focus in this aspect is interest rate

<sup>4</sup>This variable is a "nudge" indicator used in behavioral economics. The variable for information respect known as "messenger" in that area is adopted from a series of indicators called "mindspace" Gutsche et al. (2021)

to be less deterministic but conventionally included in similar papers such as Apostolakis et al. (2018). This study accounts for the following six variables: income, having a dependent family no older than 40 years old, marital status, age, gender, income, and university degree.

Summary statistics for all the explanatory variables are shown in Table 3, which combines whole sample statistics (left) with subsample comparisons by GB knowledge level (right).

**Table 2:** Summary Statistics

| Variable                        | Whole Sample |      | GB Knowledge       |      | Diff              |      |          |
|---------------------------------|--------------|------|--------------------|------|-------------------|------|----------|
|                                 | (N = 1,400)  |      | Low<br>(N = 1,080) |      | High<br>(N = 320) |      |          |
|                                 | mean         | SD   | mean               | SD   | mean              | SD   |          |
| <b>Financial</b>                |              |      |                    |      |                   |      |          |
| <i>SBY</i>                      | 3.00         | 1.41 | 3.00               | 1.42 | 2.98              | 1.40 | 0.02     |
| <i>USD</i>                      | 0.00         | 0.00 | 0.00               | 0.00 | 0.00              | 0.00 | 0.00     |
| <b>Social awareness</b>         |              |      |                    |      |                   |      |          |
| <i>GB knowledge</i>             | 1.81         | 1.03 | 1.33               | 0.47 | 3.46              | 0.64 | -2.13*** |
| <i>env</i>                      | 3.32         | 0.88 | 3.26               | 0.87 | 3.52              | 0.89 | -0.26*** |
| <i>sras</i>                     | 2.63         | 0.67 | 2.57               | 0.64 | 2.84              | 0.70 | -0.27*** |
| <b>Economic</b>                 |              |      |                    |      |                   |      |          |
| <i>investment frequency</i>     | 1.73         | 0.71 | 1.68               | 0.69 | 1.88              | 0.76 | -0.20*** |
| <i>volatility risk aversion</i> | 3.57         | 0.99 | 3.56               | 0.98 | 3.58              | 1.01 | -0.02    |
| <i>currency risk aversion</i>   | 3.53         | 1.00 | 3.49               | 1.01 | 3.67              | 0.98 | -0.18*** |
| <i>messenger</i>                | 2.65         | 0.91 | 2.60               | 0.91 | 2.81              | 0.89 | -0.20*** |
| <b>Demographic</b>              |              |      |                    |      |                   |      |          |
| <i>child</i>                    | 1.92         | 1.15 | 1.89               | 1.15 | 2.04              | 1.13 | -0.15**  |
| <i>married</i>                  | 0.68         | 0.47 | 0.68               | 0.47 | 0.70              | 0.46 | -0.02    |
| <i>age tier</i>                 | 3.83         | 1.47 | 3.92               | 1.44 | 3.53              | 1.54 | 0.39***  |
| <i>male</i>                     | 0.70         | 0.46 | 0.69               | 0.46 | 0.76              | 0.43 | -0.07*** |
| <i>wealthy</i>                  | 0.17         | 0.37 | 0.16               | 0.36 | 0.21              | 0.41 | -0.05**  |
| <i>uni</i>                      | 0.66         | 0.47 | 0.65               | 0.48 | 0.72              | 0.45 | -0.08*** |
| <b>Choice shares (%)</b>        |              |      |                    |      |                   |      |          |
| <i>JGB choice = 1</i>           | 14.9         |      | 10.9               |      | 28.1              |      | -17.2    |
| <i>USGB choice = 1</i>          | 14.9         |      | 11.7               |      | 25.6              |      | -14.0    |
| <i>JGB choice = 2</i>           | 13.5         |      | 12.1               |      | 18.1              |      | -6.0     |
| <i>USGB choice = 2</i>          | 15.8         |      | 14.3               |      | 20.9              |      | -6.7     |
| <i>JGB choice = 3</i>           | 6.9          |      | 6.5                |      | 8.1               |      | -1.6     |
| <i>USGB choice = 3</i>          | 9.2          |      | 8.1                |      | 13.1              |      | -5.1     |
| <i>JGB choice = 4</i>           | 64.8         |      | 70.5               |      | 45.6              |      | 24.8     |
| <i>USGB choice = 4</i>          | 60.1         |      | 66.0               |      | 40.3              |      | 25.7     |

*Notes:* Whole sample:  $N = 1,400$ ; Low GB Knowledge:  $gb\_know < 3$  ( $N = 1,080$ ); High GB Knowledge:  $gb\_know \geq 3$  ( $N = 320$ ). Difference column shows mean differences (Low GB Knowledge - High GB Knowledge) with significance stars: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . *USD* is dummy (1=US bond, 0=Japan bond). *env* is environmental concern (1-5). *sras* is social responsibility scale. *GB knowledge* is green bond knowledge. *investment frequency* measures investment activity. *volatility risk aversion* and *currency risk aversion* measure risk preferences. *messenger* is messenger treatment. *child*, *married*, *male*, *wealthy*, *uni* are binary. *age tier* is categorical age. *JGB choice* (g4 when *USD* = 0) and *USGB choice* (g4 when *USD* = 1) are ordered outcomes (1-4). Choice shares show percentage distribution across choice categories.

## 4 Results

### 4.1 Double-Bounded CVM Estimation

**Table 3:** Double-Bounded Panel CVM Estimation

|           | (1)<br>Financial           | (2)<br>Purchasing          | (3)<br>Full Model          |
|-----------|----------------------------|----------------------------|----------------------------|
| usd       | -0.057*<br>(0.033)         | -0.057*<br>(0.033)         | -0.057*<br>(0.033)         |
| child     | -0.039**<br>(0.017)        | -0.034**<br>(0.017)        | -0.032*<br>(0.017)         |
| married   | -0.079*<br>(0.044)         | -0.040<br>(0.044)          | -0.039<br>(0.044)          |
| age_tier  | 0.087***<br>(0.013)        | 0.062***<br>(0.013)        | 0.068***<br>(0.013)        |
| male      | 0.025<br>(0.039)           | 0.035<br>(0.039)           | 0.009<br>(0.040)           |
| uni       | -0.031<br>(0.037)          | -0.001<br>(0.037)          | 0.004<br>(0.037)           |
| wealthy   | -0.186***<br>(0.045)       | -0.150***<br>(0.045)       | -0.096**<br>(0.048)        |
| gb_know   |                            | -0.174***<br>(0.016)       | -0.154***<br>(0.017)       |
| inv_fre   |                            | -0.036<br>(0.024)          | -0.030<br>(0.025)          |
| q11       |                            | 0.035**<br>(0.017)         | 0.044**<br>(0.017)         |
| messenger |                            | -0.079***<br>(0.019)       | -0.064***<br>(0.019)       |
| env       |                            |                            | -0.030<br>(0.021)          |
| sras      |                            |                            | -0.125***<br>(0.028)       |
| Constant  | 1.331***<br>(0.064)        | 1.825***<br>(0.113)        | 2.121***<br>(0.133)        |
| Greenium  | 1.472***<br>[1.431, 1.513] | 1.479***<br>[1.438, 1.520] | 1.482***<br>[1.441, 1.523] |
| <i>N</i>  | 2800                       | 2800                       | 2800                       |

Standard errors in parentheses. Greenium: 95% CI in brackets.

Double-bounded dichotomous choice with robust standard errors.

Positive coef = higher greenium required; Greenium = premium above baseline.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

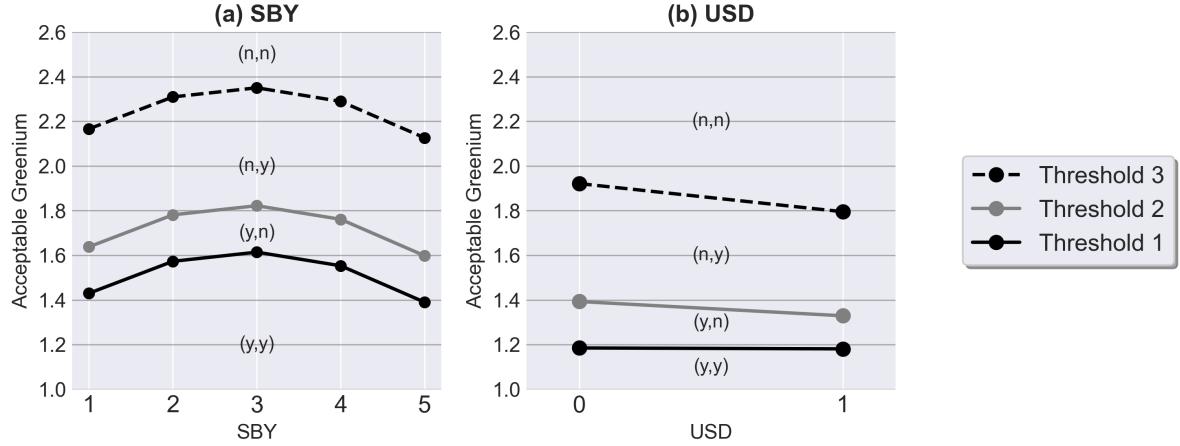
**Table 4:** Partial Proportional Odds Models - Base and Heterogeneous Treatment Effects

|                         | Base                 |                      | Heterogeneity       |                      |
|-------------------------|----------------------|----------------------|---------------------|----------------------|
|                         | (1)<br>Linear        | (2)<br>Quadratic     | (3)<br>SRAS         | (4)<br>ENV           |
| SBY                     | -0.011<br>(0.021)    | 0.296***<br>(0.110)  | -0.146<br>(0.472)   | 0.415<br>(0.471)     |
| SBY <sup>2</sup>        |                      | -0.051***<br>(0.018) | 0.001<br>(0.076)    | -0.044<br>(0.075)    |
| USD (3)                 | -0.125***<br>(0.030) | -0.126***<br>(0.031) | -0.154<br>(0.112)   | -0.125<br>(0.102)    |
| USD (2)                 | -0.065**<br>(0.033)  | -0.064**<br>(0.033)  | -0.154<br>(0.112)   | -0.125<br>(0.102)    |
| USD (1)                 | -0.005<br>(0.042)    | -0.004<br>(0.042)    | -0.154<br>(0.112)   | -0.125<br>(0.102)    |
| SRAS                    | -0.220***<br>(0.049) | -0.224***<br>(0.049) | -0.519**<br>(0.230) | -0.229***<br>(0.049) |
| ENV                     | -0.057<br>(0.039)    | -0.053<br>(0.039)    | -0.054<br>(0.039)   | 0.081<br>(0.182)     |
| SBY × SRAS              |                      |                      | 0.168<br>(0.169)    |                      |
| SBY <sup>2</sup> × SRAS |                      |                      | -0.020<br>(0.027)   |                      |
| USD × SRAS (3)          |                      |                      | 0.009<br>(0.040)    |                      |
| USD × SRAS (2)          |                      |                      | 0.033<br>(0.040)    |                      |
| USD × SRAS (1)          |                      |                      | 0.057<br>(0.040)    |                      |
| SBY × ENV               |                      |                      |                     | -0.039<br>(0.136)    |
| SBY <sup>2</sup> × ENV  |                      |                      |                     | -0.002<br>(0.022)    |
| USD × ENV (3)           |                      |                      |                     | 0.001<br>(0.030)     |
| USD × ENV (2)           |                      |                      |                     | 0.017<br>(0.030)     |
| USD × ENV (1)           |                      |                      |                     | 0.033<br>(0.031)     |
| Constant (3)            | 2.270***<br>(0.265)  | 1.921***<br>(0.295)  | 2.695***<br>(0.696) | 1.362**<br>(0.664)   |
| Constant (2)            | 1.743***<br>(0.255)  | 1.393***<br>(0.287)  | 2.166***<br>(0.687) | 1.012<br>(0.657)     |
| Constant (1)            | 1.536***<br>(0.252)  | 1.185***<br>(0.284)  | 1.961***<br>(0.685) | 0.844<br>(0.653)     |
| N                       | 2800                 | 2800                 | 2800                | 2800                 |
| Brant-Wald $\chi^2$     | 19.81                | 21.12                |                     |                      |
| p-value                 | 0.4697               | 0.5136               |                     |                      |

Standard errors clustered at individual level in parentheses.

Parallel variables shown once; non-parallel stacked as Var(1), Var(2), Var(3).

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



**Figure 1:** Threshold Effects: SBY and USD Denomination

*Notes:* Panel (a) shows the inverted U-shaped relationship between SBY and required greenium thresholds across four investor types. Panel (b) shows that USD denomination uniformly lowers required greenium across all investor types.

**Derivation:** Thresholds estimated from generalized ordered logit model (Table 4, Column 2). Panel (a):  $y_k^* = c_k + 0.296 \times \text{SBY} - 0.051 \times \text{SBY}^2$  where  $c_3 = 1.921$ ,  $c_2 = 1.393$ ,  $c_1 = 1.185$ . Panel (b):  $y_k^* = c_k + \delta_k \times \text{USD}$  where  $\delta_3 = -0.126$ ,  $\delta_2 = -0.064$ ,  $\delta_1 = -0.004$ . All other variables held at means.

Table 3 presents double-bounded panel CVM estimates of investors' minimum required greenium. Positive coefficients indicate higher greenium requirements. Column (1) includes only demographic controls, column (2) adds economic characteristics, and column (3) incorporates social awareness variables. The bottom row reports the estimated average greenium at sample means, approximately 1.48. This indicates that investors require yields 1.48 times the current 5-year SBY. For JPY bonds (the current SBY being 0.5%), this translates to a required premium of  $0.5\% \times 1.48 = 0.74\%$ . USD denomination significantly reduces greenium by 0.057 percentage points, resulting in a required yield of approximately  $4.0\% \times (1.48 - 0.057) = 5.69\%$ , which remains well above the current 5-year SBY in USD. GB knowledge and altruistic devotion (SRAS) are strongly negatively associated with required greenium—these investors accept lower premiums. Older investors require significantly higher greenium.

**Table 5:** GB Knowledge Subsample Analysis - Base and Heterogeneous Treatment Effects

|                         | Low GB Knowledge     |                    |                      | High GB Knowledge    |                     |                      |
|-------------------------|----------------------|--------------------|----------------------|----------------------|---------------------|----------------------|
|                         | (1)<br>Base          | (2)<br>SRAS        | (3)<br>ENV           | (4)<br>Base          | (5)<br>SRAS         | (6)<br>ENV           |
| SBY                     | 0.221*<br>(0.128)    | 0.032<br>(0.557)   | 0.400<br>(0.553)     | 0.552**<br>(0.220)   | -0.350<br>(0.878)   | 1.328<br>(0.939)     |
| SBY <sup>2</sup>        | -0.036*<br>(0.021)   | -0.010<br>(0.090)  | -0.054<br>(0.088)    | -0.097***<br>(0.035) | -0.026<br>(0.145)   | -0.113<br>(0.148)    |
| USD (3)                 | -0.103***<br>(0.033) | -0.171<br>(0.127)  | -0.056<br>(0.120)    | -0.147**<br>(0.067)  | -0.164<br>(0.255)   | 0.167<br>(0.272)     |
| USD (2)                 | -0.103***<br>(0.033) | -0.171<br>(0.127)  | -0.056<br>(0.120)    | 0.046<br>(0.070)     | -0.164<br>(0.255)   | -0.965***<br>(0.340) |
| USD (1)                 | -0.103***<br>(0.033) | -0.171<br>(0.127)  | -0.056<br>(0.120)    | 0.078<br>(0.066)     | -0.164<br>(0.255)   | -1.053***<br>(0.333) |
| SRAS                    | -0.217***<br>(0.058) | -0.334<br>(0.271)  | -0.219***<br>(0.057) | -0.337***<br>(0.094) | -1.044**<br>(0.412) | -0.364***<br>(0.096) |
| ENV                     | -0.067<br>(0.044)    | -0.068<br>(0.044)  | 0.050<br>(0.222)     | -0.061<br>(0.101)    | -0.080<br>(0.102)   | 0.367<br>(0.331)     |
| SBY × SRAS              |                      | 0.073<br>(0.205)   |                      |                      | 0.331<br>(0.301)    |                      |
| SBY <sup>2</sup> × SRAS |                      | -0.010<br>(0.033)  |                      |                      | -0.028<br>(0.049)   |                      |
| USD × SRAS (3)          |                      | 0.026<br>(0.046)   |                      |                      | 0.001<br>(0.089)    |                      |
| USD × SRAS (2)          |                      | 0.026<br>(0.046)   |                      |                      | 0.077<br>(0.087)    |                      |
| USD × SRAS (1)          |                      | 0.026<br>(0.046)   |                      |                      | 0.084<br>(0.086)    |                      |
| SBY × ENV               |                      |                    | -0.055<br>(0.162)    |                      |                     | -0.217<br>(0.260)    |
| SBY <sup>2</sup> × ENV  |                      |                    | 0.005<br>(0.026)     |                      |                     | 0.005<br>(0.041)     |
| USD × ENV (3)           |                      |                    | -0.014<br>(0.036)    |                      |                     | -0.107<br>(0.076)    |
| USD × ENV (2)           |                      |                    | -0.014<br>(0.036)    |                      |                     | 0.297***<br>(0.092)  |
| USD × ENV (1)           |                      |                    | -0.014<br>(0.036)    |                      |                     | 0.330***<br>(0.092)  |
| Constant (3)            | 1.373***<br>(0.362)  | 1.672**<br>(0.812) | 1.010<br>(0.795)     | 1.807***<br>(0.624)  | 3.842***<br>(1.286) | 0.136<br>(1.292)     |
| Constant (2)            | 0.899***<br>(0.333)  | 1.200<br>(0.795)   | 0.533<br>(0.781)     | 1.943***<br>(0.580)  | 3.746***<br>(1.248) | 0.292<br>(1.275)     |
| Constant (1)            | 0.853***<br>(0.327)  | 1.154<br>(0.793)   | 0.487<br>(0.779)     | 0.957*<br>(0.574)    | 2.785**<br>(1.237)  | 0.224<br>(1.259)     |
| <i>N</i>                | 2160                 | 2160               | 2160                 | 640                  | 640                 | 640                  |

Standard errors clustered at individual level in parentheses.

Parallel variables shown once; non-parallel stacked as Var(1), Var(2), Var(3).

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## 4.2 Generalized Ordered Probit Model: Whole Sample Analysis

We now estimate greenium categorically using a generalized ordered probit model, allowing SBY to enter as an explanatory variable and permitting the effects of financial variables to vary across different greenium acceptance thresholds. Table 4 displays the impact of return variables on individual minimum greenium. The model estimates coefficients  $\beta - \delta_j$  for each threshold  $j$ , representing how each variable shifts the latent greenium relative to threshold  $j$ . A negative coefficient ( $\beta - \delta_j < 0$ ) indicates that the variable reduces required greenium below the threshold, making investors more willing to accept lower premiums. When parallel restrictions are imposed,  $\beta - \delta_j$  remains constant across all response categories  $response_{i,U}$  ( $j = 1, 2, 3$ ); otherwise, the effect varies by greenium acceptance level.

Column (1) of Table 4 includes SBY linearly, showing insignificant effects, while column (2) includes both linear and quadratic terms, which are jointly significant. The financial impact of SBY on greenium is therefore non-monotonic, following an inverted U-shape as visualized in the left panel of Figure 1. This shows that contemporaneous SBY represents the least preferred yield level, while deviations in either direction—higher or lower yields—reduce required greenium. These effects are constant across all response categories as the coefficients satisfy parallel restrictions across  $j = 1, 2, 3$ .

By contrast, USD has varying coefficients across  $response_{i,U}$ , indicating that its effects differ by the range of greenium. Its coefficient is more strongly negative for those who need more positive greenium; in other words, its effect decays as one holds lower greenium. This is illustrated in the right panel of Figure 1 with a less steep slope to hold lower  $response_{i,U}$ . This indicates that USD denomination more strongly encourages those who expect higher return from GB investment compared to the sovereign bond.

Lastly, social awareness variables (SRAS and ENV) are negatively associated with acceptable greenium, meaning investors with higher altruism and environmental concern accept lower premium in investing in GB.

Columns (3) and (4) examine the heterogeneity of return variable effects with respect to social awareness (SRAS and ENV). These columns include interaction terms between financial variables and social awareness measures. The results reveal that social awareness does not significantly amplify the impact of financial variables for either SBY or USD. This indicates that investors with higher social awareness respond to financial incentives similarly to those with lower social awareness. In other words, their return sensitivity does not differ based on pro-social orientation.

## 4.3 Subsample Analyses by GB knowledge

In contrast to social awareness, GB knowledge creates significant heterogeneity in financial return sensitivity. Table 5 decomposes the sample by GB knowledge level. Columns (1) and (4) contrast the effects of the two types of financial incentive between subsamples. The low-GB-knowledge subsample shows that USD denomination more strongly reduces greenium, while the high-GB-knowledge subsample finds SBY more impactful. SBY remains quadratically significant in both subsamples, but the high-GB-knowledge group exhibits steeper curvature, indicating greater sensitivity to yield spreads. USD is consistently significant across all response categories in the low-knowledge subsample, but only significant for  $response_{i,U} = 4$  (reject both offers) in the high-knowledge subsample.

Columns (2), (3), (5), and (6) examine heterogeneity by social awareness within each GB knowledge subsample, testing interactions with SRAS and ENV respectively. The results confirm that social awareness remains

statistically insignificant in amplifying financial incentives even when conditioning on GB knowledge level. Social awareness does not amplify return-seeking sensitivity in either subsample. However, the high-GB-knowledge subsample reveals that investors with environmental concerns are less likely to invest in GB denominated by USD despite it returning a higher yield.

Binarizing SBY confirms its non-monotonic impact and broader reach compared to currency denomination. We compare the effects of SBY and USD by converting SBY into binary indicators (high/low) in Tables 6 and 7. Table 6 presents results where both SBY and USD are dummy-coded. Both high SBY and low SBY significantly reduce investors' minimum required greenium compared to the contemporaneous baseline, with the high SBY dummy showing a larger effect. This pattern holds across GB knowledge subsamples, confirming that deviations from the current yield level—particularly upward deviations—reduce greenium requirements most strongly. Columns (2), (4), and (6) test whether USD denomination amplifies the SBY effect. We find no such interaction in the full sample, while the low-GB-knowledge subsample shows that the SBY effect attenuates under USD denomination (compared to JPY). Overall, SBY has a broader and stronger impact on greenium than USD denomination, despite USD offering larger absolute return differences.

Marginal effects reveal that financial incentives operate differently across GB knowledge levels. Table 7 presents discrete probability changes for three treatment variables: high SBY, low SBY, and USD denomination. Panel A shows  $\Delta Pr(\text{response} \leq 3)$ , the change in probability of accepting mildly positive greenium or less. Panel B shows  $\Delta Pr(\text{response} \leq 2)$ , the change in probability of accepting negative greenium. Column (1) reports full-sample estimates: both high SBY and USD significantly increase acceptance probabilities. However, subsample analyses reveal heterogeneous effects. Among low-GB-knowledge investors (Column 2), the high SBY effect disappears. Among high-GB-knowledge investors (Column 3), the USD effect becomes insignificant. This contrast indicates that financial incentives operate through different mechanisms depending on investors' familiarity with green bonds.

## 5 Discussion

### 5.1 Do investors want return from SRI?

Yes, investors respond to financial returns in GB investment, but the relationship is non-monotonic and depends on return magnitude. We find that both SBY and USD reduce required greenium, but through different mechanisms.

The effect of SBY follows an inverted U-shape: contemporaneous SBY represents the least preferred yield level, while deviations in either direction—higher or lower yields—reduce required greenium. In practical terms, when sovereign yields are at their familiar baseline level (around 0.5% for JPY, 4–5% for USD during our survey period), investors are most reluctant to accept green bond premiums. But when yields deviate from this reference point—whether rising to higher levels or falling to lower levels—investors become more flexible about accepting greenium. This pattern is consistent with reference-dependent preferences (Kahneman and Tversky, 1979; Koszegi and Rabin, 2006): the contemporaneous yield serves as a psychological anchor, and deviations from this anchor increase willingness to consider alternative investments. Salience theory (Bordalo et al., 2012) offers an alternative interpretation: unusual yield levels may increase attention to GB as an investment option, making the green bond more salient when yields deviate from normal ranges. This effect is broadly significant across all investor types regardless of their greenium acceptance level.

**Table 6:** Spread Dummy Decomposition by GB Knowledge

|                | Full Sample          |                      | Low GB Knowledge     |                      | High GB Knowledge    |                     |
|----------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------------|
|                | (1)<br>Base          | (2)<br>+Int          | (3)<br>Base          | (4)<br>+Int          | (5)<br>Base          | (6)<br>+Int         |
| 1[SBY>3]       | -0.198**<br>(0.080)  | -0.244***<br>(0.093) | -0.159*<br>(0.095)   | -0.246**<br>(0.112)  | -0.420***<br>(0.152) | -0.349**<br>(0.167) |
| 1[SBY<3]       | -0.162**<br>(0.081)  | -0.224**<br>(0.092)  | -0.148<br>(0.096)    | -0.242**<br>(0.111)  | -0.328*<br>(0.181)   | -0.224<br>(0.198)   |
| 1[SBY>3] × USD |                      | 0.087<br>(0.081)     |                      | 0.166*<br>(0.096)    |                      | 0.103<br>(0.174)    |
| 1[SBY<3] × USD |                      | 0.118<br>(0.077)     |                      | 0.179*<br>(0.094)    |                      | -0.017<br>(0.144)   |
| USD (3)        | -0.124***<br>(0.030) | -0.165**<br>(0.066)  | -0.103***<br>(0.033) | -0.244***<br>(0.080) | -0.172***<br>(0.066) | 0.018<br>(0.123)    |
| USD (2)        | -0.065**<br>(0.032)  | -0.165**<br>(0.066)  | -0.103***<br>(0.033) | -0.244***<br>(0.080) | 0.068<br>(0.069)     | 0.018<br>(0.123)    |
| USD (1)        | -0.005<br>(0.041)    | -0.165**<br>(0.066)  | -0.103***<br>(0.033) | -0.244***<br>(0.080) | 0.089<br>(0.067)     | 0.018<br>(0.123)    |
| N              | 2800                 | 2800                 | 2160                 | 2160                 | 640                  | 640                 |

Generalized ordered probit (gologit2) with autofit and probit link.

Spread dummies: parallel. USD: non-parallel (except Low GB Know). Clustered SEs.

Reference: SBY = 3 (no spread). \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ **Table 7:** Marginal Effects on Cumulative Probabilities by GB Knowledge

|  | (1)<br>Whole Sample | (2)<br>Low GB Knowledge | (3)<br>High GB Knowledge |
|--|---------------------|-------------------------|--------------------------|
| <i>Panel A: Pr(response≤3) — Accept Mildly Positive Greenium or Less</i> |                     |                         |                          |
| 1(SBY > 3)   | 0.070**<br>(0.030)  | 0.046<br>(0.033)        | 0.170***<br>(0.057)      |
| 1(SBY < 3)   | 0.036<br>(0.031)    | 0.030<br>(0.034)        | 0.076<br>(0.060)         |
| USD  | 0.031***<br>(0.010) | 0.036***<br>(0.011)     | 0.012<br>(0.020)         |
| <i>Panel B: Pr(response≤2) — Accept Negative Greenium</i>                |                     |                         |                          |
| 1(SBY > 3)   | 0.063**<br>(0.027)  | 0.040<br>(0.030)        | 0.172***<br>(0.058)      |
| 1(SBY < 3)   | 0.033<br>(0.028)    | 0.026<br>(0.030)        | 0.077<br>(0.061)         |
| USD  | 0.028***<br>(0.009) | 0.031***<br>(0.010)     | 0.012<br>(0.020)         |
| N  | 2800                | 2160                    | 640                      |

Standard errors in parentheses

Average marginal effects from ordered probit. Standard errors clustered at individual level.

Reference: SBY = 3, JPY bond. Low GB Knowledge: gb\_know &lt; 3; High: gb\_know ≥ 3.

Pr(response≤3) = 1 - Pr(no,no): Accept mildly positive greenium or less.

Pr(response≤2) = Pr(yes,yes) + Pr(yes,no): Accept negative greenium.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

By contrast, USD denomination has heterogeneous effects: it significantly reduces greenium for return-oriented investors who require positive or mildly negative greenium, but becomes insignificant for investors who accept largely negative greenium. Practically, this means that higher USD yields (3–5% vs. 0.3–0.7% for JPY) attract investors who are seeking returns, but do not sway investors who are already willing to sacrifice returns for environmental impact.

Comparing the two sources of return variation, SBY has a broader and stronger impact on greenium than USD denomination, despite USD offering larger absolute return differences. This suggests that investors respond more consistently to yield variations around familiar benchmarks than to larger but less comparable cross-currency differences. These findings align with Døskeland and Pedersen (2016) that financial returns matter for SRI decisions, but extend this by demonstrating that the relationship is non-linear and that the magnitude of return variation shapes who responds, not just whether investors respond.

## 5.2 Role of GB Knowledge

GB knowledge (environmental finance knowledge) creates significant heterogeneity in how investors respond to financial incentives, in contrast to social awareness (pro-social orientation) which does not amplify return sensitivity. Table 5 reveals distinct response patterns between knowledge subsamples.

High-GB-knowledge investors are more responsive to SBY variation, exhibiting steeper quadratic curvature that indicates greater sensitivity to yield spreads around the benchmark. However, they are less responsive to USD denomination—the USD effect is only significant for investors who reject both offers ( $response_{i,U} = 4$ ). By contrast, low-GB-knowledge investors show stronger response to USD denomination, with consistently significant effects across all response categories, while their SBY response attenuates.

This pattern suggests that environmental finance knowledge enables investors to differentiate between types of return variation. Knowledgeable investors can evaluate nuanced yield differences around sovereign benchmarks—a task requiring understanding of bond pricing and yield curves. Less knowledgeable investors lack this capacity and instead respond to larger, simpler return signals like currency denomination, which requires only basic comparison of interest rates across currencies. This extends the financial literacy literature (Lusardi and Mitchell, 2014) by demonstrating that environmental finance knowledge—not just general financial literacy—shapes investment behavior. While Riedl and Smeets (2017) examine how investor characteristics affect SRI participation, our finding reveals that knowledge determines *which* financial signals investors respond to, not merely *whether* they respond to returns.

## 5.3 Social Awareness and (Im)pure Altruism

This study demonstrates that social awareness operates independently of financial incentives in GB investment, supporting pure rather than impure altruism. Neither altruistic devotion (SRAS) nor environmental concerns (ENV) significantly amplifies the effects of SBY or USD on greenium acceptance. The interaction terms between financial variables and social awareness measures are statistically insignificant in both whole-sample and subsample analyses.

This finding speaks directly to the theoretical debate between pure and impure altruism in charitable giving (Andreoni, 1990). Under impure altruism (warm-glow giving), pro-social investors would derive utility from both the environmental impact *and* the act of sacrificing returns, implying that higher social awareness should amplify

return sensitivity. Our null interaction effects reject this prediction: social awareness does not make investors more responsive to financial incentives. Instead, our results support pure altruism, where social and financial motives operate in separate utility channels.

This finding aligns with Bauer et al. (2021), who show that retail investors concerned with SDGs do not withdraw from sustainable mutual funds when yields decline. Similarly, Luz et al. (2024) find that sustainability beliefs drive SRI participation independently of return expectations. Our results extend these findings by demonstrating that social awareness does not amplify return-seeking behavior—investors with higher pro-social orientation respond to financial incentives similarly to those with lower social awareness.

One notable exception emerges in the high-GB-knowledge subsample: investors with environmental concerns are less likely to invest in USD-denominated GB despite the higher yields. This pattern is consistent with motivation crowding-out (Frey and Oberholzer-Gee, 1997; Bénabou and Tirole, 2006): when environmental investment is framed in terms of foreign currency returns, the financial framing may undermine the intrinsic pro-environmental motivation for knowledgeable investors who recognize the tension. However, this effect does not generalize to the broader sample.

The key contribution is demonstrating that while financial returns affect SRI demand, social preferences do not amplify this effect. Pro-social motivation in GB investment operates as pure altruism—orthogonal to financial incentives—rather than impure altruism that would interact with return considerations.

## 5.4 Limitations

This study holds several limitations. First, USD denomination does not purely represent return variation—it also involves home currency bias and exchange rate expectations. Investors may respond differently to foreign currency bonds for reasons unrelated to yield differences. Second, the contingent valuation method captures hypothetical willingness-to-pay rather than actual investment behavior; real investment decisions with financial consequences may differ from stated preferences. Third, the sample is limited to Japanese investors in the Kanto and Kansai metropolitan areas, which may not generalize to rural populations or investors in other countries. Fourth, the findings pertain specifically to bonds as fixed income securities; generalizability to other SRI products such as mutual funds or ESG stocks may be limited given the distinct characteristics of equity investments.

## 5.5 Conclusion

This study examines how retail investors' demand for green bonds responds to different magnitudes of return variation. Using an online survey of Japanese retail investors, we elicit minimum acceptable greenium through a double-bounded dichotomous choice design. Respondents were asked whether to invest in hypothetical green bonds with interest rates randomly deviated from sovereign bond yields, denominated in either JPY or USD. SBY deviation represents smaller return variation around a familiar benchmark, while USD denomination creates larger return variation through absolute yield differences.

We find that both types of return variation encourage GB investment, but through distinct mechanisms. SBY exhibits a non-monotonic inverted U-shaped effect: contemporaneous yields are least preferred, while deviations in either direction reduce required greenium. This effect is broadly significant across all investor types. USD denomination has more selective effects, primarily reducing greenium among return-oriented investors who require positive or mildly negative premiums. Notably, SBY has broader impact than USD despite offering smaller

absolute return differences, suggesting investors respond more consistently to benchmark-referenced variations than to cross-currency comparisons.

GB knowledge (environmental finance knowledge) emerges as a key source of heterogeneity. High-knowledge investors are more sensitive to SBY variation but less responsive to USD denomination, while low-knowledge investors show the opposite pattern. This indicates that environmental finance knowledge shapes which return variation investors respond to.

Finally, we find no evidence that social awareness (pro-social orientation) amplifies return sensitivity. Neither altruistic orientation nor environmental concern amplifies the effects of financial variables, indicating that pro-social motivation operates independently of financial incentives. This supports pure rather than impure altruism in sustainable investment: investors with pro-social preferences do not become more return-seeking, and their social motivation remains orthogonal to financial considerations.

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