

## Empirical Research on the Relationship Between ESG Bond Issuance and Cost of Capital : Evidence from Japan

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(Research Article)

# Empirical Research on the Relationship Between ESG Bond Issuance and Cost of Capital: Evidence from Japan

ESG 債券発行と資本コストとの関連性に関する実証研究

—日本市場を対象に

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Keywords: ESG bond, cost of capital, sustainable finance, Japanese firms

## 1. Introduction

In recent years, sustainable finance has gained significant momentum globally as investors and companies increasingly recognize the importance of environmental, social, and governance (ESG) factors. Within the realm of sustainable finance, ESG bonds have emerged as a prominent instrument for raising capital to fund projects with positive environmental and social impacts. The global ESG bond market has experienced explosive growth, with issuances reaching \$1.6 trillion in 2021, nearly double the amount from 2020 (Climate Bonds Initiative, 2022).

As ESG bonds gain prominence, a critical question for both issuers and investors is how these instruments impact a company's cost of capital. Theoretically, ESG bonds could lower the cost of capital through several mechanisms. By signaling a commitment to sustainability, ESG bonds may reduce reputational and regulatory risks, potentially leading to a lower cost of debt (Flammer, 2021). Additionally, ESG bonds may attract a broader investor base, including environmentally conscious investors, potentially reducing the cost of equity (Pástor et al., 2021). However, the empirical evidence on the relationship between ESG bond issuance and cost of capital remains limited and inconclusive, particularly in the context of Japan.

This study aims to address this gap by empirically investigating the impact of ESG bond issuance on the cost of capital for Japanese firms. Specifically, this study examines whether issuing ESG bonds leads to a reduction in the weighted average cost of capital (WACC). This research contributes to the growing literature on sustainable finance in several ways.

First, while previous studies have largely focused on green bonds in Western markets (e.g., Flammer, 2021; Zerbib, 2019), this paper provides comprehensive evidence on the broader category of ESG bonds in the context of Japan, an important Asian market with unique institutional characteristics. Second, this study employed a robust methodology combining propensity score matching (PSM) with difference-in-differences (DID) analysis to address potential endogeneity concerns and establish a causal relationship between ESG bond issuance and cost of capital. Third, by examining the impact on WACC, this study offers insights into the specific channels through which ESG bonds affect a firm's financing costs.

The findings have important implications for corporate managers, investors, and policymakers. For corporate managers, understanding the potential cost of capital benefits of ESG bonds can inform strategic financing decisions. For investors, the results provide insights into the pricing and valuation of ESG bonds. For policymakers, evidence of the financial benefits of ESG bonds can inform the design of policies to promote sustainable finance.

The remainder of this paper is structured as follows: Section 2 reviews the relevant literature and develops the hypothesis. Section 3 describes the research design, including data sources, variable construction, and empirical methodology. Section 4 presents and discusses the main empirical findings. Section 5 reports the result of robustness tests. Section 6 concludes the paper and discusses its implications. Finally, Section 7 acknowledges the limitations of the present study and suggests directions for future research.

## 2. Literature Review and Hypothesis Development

### 2.1 ESG Bonds and WACC

The relationship between ESG performance and firms' WACC has gained significant attention in recent years. Mathew and Sivaprasad (2024) provide a comprehensive analysis of corporate sustainability bonds and their impact on firm performance. They find that sustainability bond issuance is associated with a reduction in the WACC, suggesting that ESG-related financing decisions can create value for firms.

In the context of Japan, Schumacher et al. (2020) highlight the rapid growth of the green bond market since 2016. They note that the Japanese government has actively promoted green bonds as part of its strategy to achieve the Sustainable Development Goals (SDGs). This governmental support has likely contributed to the expansion of the ESG bond market in Japan and may influence the WACC of firms issuing these bonds.

Zhang et al. (2021), although focusing on the Chinese market, provide insights that may be applicable to other Asian markets, including Japan. They find that green bond issuers experience a reduction in their WACC. This reduction is attributed to several factors, including improved corporate image, increased investor base, and potential risk mitigation associated with sustainable practices.

Su (2024) examines the announcement effect of ESG bond issuance in Japan and finds evidence of positive market reactions. This suggests that ESG bond issuance may convey valuable information to the market, potentially affecting the firm's WACC. The study provides direct evidence from the Japanese market, supporting the notion that ESG financing decisions can impact a firm's overall cost of capital.

## 2.2 Firm Characteristics and WACC

While ESG bond issuance is the primary focus of this study, it is crucial to consider traditional firm characteristics that can affect the WACC. Frank and Shen (2016) examine how various firm-specific factors affect the WACC. They emphasize the importance of considering multiple firm characteristics when assessing the overall impact of financing decisions on firm value.

Fama and French (1993) demonstrate that firm size is a significant factor in explaining stock returns and, by extension, the WACC. Larger firms typically have lower WACC due to better information environments, economies of scale, and lower perceived risk. The impact of leverage on the WACC is complex; while higher leverage can increase financial risk, it can also provide tax benefits that potentially lower the overall WACC (Modigliani and Miller, 1958).

Several operational and financial measures also play a role in determining WACC. Cost savings and efficiency reflect a firm's operational performance, with Novy-Marx (2013) showing that profitability is a significant factor in explaining stock returns and potentially affecting the WACC. Revenue growth can influence investors' perceptions of future cash flows and thus impact the WACC. However, as noted by Fama and French (1992), high-growth firms may also have higher risk, potentially increasing the WACC.

Return on Assets (ROA) is a key measure of a firm's profitability and efficiency in utilizing its assets. Higher ROA may signal better management and lower risk, potentially leading to a lower WACC. Dividend payout ratios can signal a firm's financial health and future prospects, with Allen et al. (2000) arguing that dividends can attract institutional investors and potentially lower the WACC.

Capital expenditures can signal a firm's growth opportunities and future cash flows. However, high capital expenditures can also increase financial risk, potentially affecting the WACC (Titman et al., 2004). Lastly, efficient working capital management can improve a firm's liquidity position and potentially lower its WACC.

## 2.3 ESG Bonds and WACC in Japan

The Japanese ESG bond market has experienced significant growth in recent years. Based on the findings of Schumacher et al. (2020), the Japanese sustainable finance market has experienced significant growth in recent years. They note that sustainably invested assets under management in Japan grew from ¥57 trillion in 2016 to ¥232 trillion in 2018. The green bond market has also evolved rapidly, with Japan's cumulative green bond issuance reaching US\$9.7 billion by the end of 2018, ranking Japan tenth globally. This growth is

supported by various initiatives, including government guidelines, increased institutional investor participation in the Principles for Responsible Investment, regulatory backing from the Japan Financial Services Agency, and growing corporate support for climate-related financial disclosures. These developments suggest that Japanese firms and financial institutions are increasingly recognizing the importance of ESG financing, although Schumacher et al. (2020) note that Japan still has room for improvement in fully mainstreaming sustainability in its financial system.

Su (2024) provides evidence specific to the Japanese market, showing that ESG bond issuance announcements are associated with positive market reactions. This finding suggests that investors view ESG bond issuance favorably, which could translate into a lower WACC for issuing firms.

Moreover, the Japanese government's active promotion of sustainable finance, as highlighted by Schumacher et al. (2020), may create a favorable environment for ESG bond issuers. This supportive regulatory environment could potentially lead to a lower WACC for firms engaging in ESG financing.

## 2.4 Hypothesis Development

Based on the theoretical arguments and empirical evidence discussed above, and considering the specific firm characteristics included in the model, this study expects that ESG bond issuance will be negatively associated with the WACC for Japanese firms, after controlling for traditional firm characteristics. This expectation is driven by the following factors:

- (a) ESG bond issuance may signal a firm's commitment to sustainable practices, potentially leading to a lower perceived risk and WACC (Mathew and Sivaprasad, 2024; Zhang et al., 2021).
- (b) The growing interest in sustainable investments in Japan may increase demand for ESG bonds, potentially lowering the overall WACC for issuing firms (Schumacher et al., 2020; Su, 2024).
- (c) The positive market reactions to ESG bond issuance announcements in Japan suggest that investors view these issuances favorably, which could translate into a lower WACC (Su, 2024).
- (d) The supportive regulatory environment for ESG financing in Japan may create favorable conditions for ESG bond issuers, potentially leading to a lower WACC (Schumacher et al., 2020).

Given these considerations, this study proposes the following hypothesis:

**Hypothesis:** The issuance of ESG bonds is negatively associated with the WACC for Japanese firms, after controlling for traditional firm characteristics.

This hypothesis is consistent with the findings of recent studies on ESG bonds in various markets and builds upon the growing literature on sustainable finance in Japan. By testing this hypothesis while controlling

for a comprehensive set of firm characteristics, this study aims to provide a nuanced understanding of how ESG financing decisions affect the WACC in Japan and a rapidly growing market for sustainable finance.

In the following sections, this study empirically tests this hypothesis using a comprehensive dataset of Japanese firms and a robust methodological approach.

### 3. Research design

#### 3.1 Data Sources and Sample Selection

This study utilizes a comprehensive dataset of Japanese firms listed on the Tokyo Stock Exchange (TSE) from 2016 to 2021. 2016 was selected as the starting point of the sample period as it marks the beginning of significant ESG bond issuance in Japan, following the publication of the Green Bond Guidelines by Japan's Ministry of the Environment in 2017 (Ministry of the Environment, Japan, 2017). This six-year period allows this study to capture the evolution of the ESG bond market in Japan and its potential impact on firms' cost of capital.

Financial data for the analysis is obtained from the QUICK Workstation (Astra Manager). Astra Manager offers comprehensive and reliable financial information for Japanese listed companies, including detailed balance sheet items, income statement data, cash flow statements, and market-based measures. The use of this database ensures high-quality financial data specific to the Japanese market context.

Information on ESG bond issuances is collected from Refinitiv Eikon, which provides detailed data on bond characteristics, including issue date, amount, maturity, coupon rate, and bond type (e.g., green bond, social bond, sustainability bond). This study has meticulously cross-referenced this data with the Japan Exchange Group (JPX) website and individual company announcements to ensure the accuracy and completeness of this ESG bond dataset.

The initial sample includes all non-financial firms listed on the TSE during the study period. This study has excluded financial firms (banks, insurance companies, and other financial institutions) due to their distinct regulatory environment, capital structure, and accounting practices, which could distort the analysis of cost of capital. This exclusion is consistent with previous studies in corporate finance (e.g., Fama & French, 1992).

To ensure the reliability of the analysis, this study applied several data-cleaning procedures:

- (a) Firms with missing data for key variables used were excluded in the main analysis.
- (b) This study winsorized all continuous variables at the 1st and 99th percentiles to mitigate the impact of extreme outliers.
- (c) Firms were required to have at least two consecutive years of data to be included in the sample, allowing for the calculation of year-on-year changes in certain variables.

After applying these criteria, the final sample consists of 19,350 firm-year observations over the six-year period. This large and comprehensive sample allows us to draw robust conclusions about the Japanese corporate landscape and the impact of ESG bond issuance on the cost of capital.

### 3.2 Empirical Model

To test the hypothesis that ESG bond issuance is negatively associated with the cost of capital, this study employed a multivariate regression model. The baseline specification is as follows:

$$\begin{aligned}
 WACC_{i,t} = & \beta_0 + \beta_1 ESG\ bond_{i,t} + \beta_2 Size_{i,t} + \beta_3 Leverage_{i,t} + \beta_4 Cost\ Savings_{i,t} + \\
 & \beta_5 Revenue\ Growth_{i,t} + \beta_6 Asset\ Efficiency_{i,t} + \beta_7 Dividend\ Policy_{i,t} + \\
 & \beta_8 CAPEX_{i,t} + \beta_9 Efficiency_{i,t} + \beta_{10} Accounts\ Payable\ Management_{i,t} + \\
 & Year + Industry + \varepsilon
 \end{aligned} \tag{1}$$

This model was estimated using ordinary least squares (OLS) with industry and year fixed effects. The inclusion of industry fixed effects controls for time-invariant industry characteristics that may affect the cost of capital, while year fixed effects control for macroeconomic factors that may influence all firms' cost of capital in a given year.

Standard errors are clustered at the firm level to account for potential serial correlation in the error terms within firms over time (Petersen, 2009). This approach provides more conservative estimates of statistical significance.

The coefficient of primary interest is  $\beta_1$ , which captures the association between ESG bond issuance and WACC. A negative and statistically significant  $\beta_1$  would support the hypothesis that ESG bond issuance is associated with a lower cost of capital.

In the next section, this study will present and discuss the results of the main regression analysis, providing insights into the relationship between ESG bond issuance and the cost of capital for Japanese firms, while controlling for other relevant factors.

### 3.3 Variable Definitions

#### 3.3.1 Dependent Variable

The primary dependent variable here is the  $WACC_{i,t}$ . *WACC* is a fundamental concept in corporate finance, representing the average rate of return a company expects to pay to its security holders to finance its assets. *WACC* is calculated as the weighted average of a firm's cost of equity and cost of debt, with weights based on the market values of equity and debt. Specifically:

$$WACC = K_e \times \frac{E}{D+E} + K_d \times \frac{D}{D+E} \times (1 - T) \quad (2)$$

where

$K_e$  = Cost of equity

$K_d$  = Cost of debt

$E$  = Market value of equity

$D$  = Market value of debt

$T$  = Corporate tax rate

The market value of equity ( $E$ ) is calculated as the product of the firm's stock price and the number of outstanding shares at the end of each fiscal year. The market value of debt ( $D$ ) is proxied by the book value of total debt, following standard practice in the literature (e.g., Fama & French, 1993).

The cost of equity ( $K_e$ ) is estimated using the Capital Asset Pricing Model (CAPM):

$$K_e = R_f + \hat{\beta}_i(R_m - R_f) \quad (3)$$

where

$R_f$  = risk-free rate, this research uses Japan's 10-year government bond daily yield

$R_m - R_f$  = market risk premium factor, which represents excess return of the market portfolio over risk-free rate

$\hat{\beta}_i$  = Beta of the stock, estimated using weekly returns over the past two years

The cost of debt ( $K_d$ ) is calculated as the ratio of interest expense to total debt, providing a firm-specific measure of borrowing costs.

The corporate tax rate ( $T$ ) is based on the statutory corporate tax rate in Japan for each year in the sample period.

### 3.3.2 Independent Variable

The key independent variable is *ESG bond*<sub>*i,t*</sub>, a dummy variable that takes the value of 1 if a firm has issued an ESG bond in a given year, and 0 otherwise. This information is obtained from Refinitiv Eikon and verified through company announcements. ESG bonds are defined broadly here to include green bonds, social bonds, and sustainability bonds, as classified by the International Capital Market Association (ICMA) principles (ICMA, 2024).

### 3.3.3 Control Variables

Based on prior literature on determinants of cost of capital (e.g., Fama & French, 1993; Botosan, 1997;

Dhaliwal et al., 2011), this study has included the following control variables:

- (a) Size: Natural logarithm of total assets. Larger firms are expected to have lower costs of capital due to lower information asymmetry and perceived risk.
- (b) Leverage: Ratio of total debt to total assets. Higher leverage may increase financial risk and thus the cost of capital.
- (c) Cost Savings: Proxy for operational efficiency, calculated as the ratio of operating expenses to sales. More efficient firms may have lower costs of capital.
- (d) Revenue Growth: Year-on-year growth in revenues. Faster-growing firms may have different risk profiles and costs of capital.
- (e) Asset Efficiency: Return on Assets (ROA), calculated as net income divided by total assets. More profitable firms may have lower costs of capital.
- (f) Dividend Policy: Dividend payout ratio, calculated as dividends per share divided by earnings per share. Dividend policy may signal financial health and affect the cost of capital.
- (g) CAPEX: Capital expenditure scaled by total assets. Investment intensity may influence risk perceptions and the cost of capital.
- (h) Efficiency: Asset turnover ratio, calculated as sales divided by total assets. Higher efficiency may lead to lower costs of capital.
- (i) Accounts Payable Management: Days payable outstanding, calculated as  $(\text{accounts payable} \div \text{cost of goods sold}) \times 365$ . This captures working capital management efficiency.

#### 4. Empirical Findings

The empirical analysis aims to examine the relationship between ESG bond issuance and the WACC for Japanese firms. Table 1 presents the main regression results, which are discussed in detail below.

This study would like to begin with the base model (Model 1), which includes year fixed effects. In this specification, the coefficient on  $ESG\ bond_{i,t}$  was found to be -0.5418 and is statistically significant at the 1% level (t-statistic = -3.69). This result indicates that, on average, firms that issue ESG bonds experience a 54.18 basis point reduction in their WACC compared to non-issuers, controlling for other factors. This finding provides strong initial support for the hypothesis that ESG bond issuance is associated with a lower cost of capital.

The control variables in Model 1 also yield interesting insights. Firm size ( $Size_{i,t}$ ) is positively associated

with WACC (coefficient = 0.098, t-statistic = 10.76), contrary to expectations based on previous literature. This suggests that larger firms in this sample face higher financing costs, possibly due to higher scrutiny or complexity in the Japanese market.  $Leverage_{i,t}$  shows a strong negative association with WACC (coefficient = -1.9944, t-statistic = -22.81), consistent with the tax shield benefits of debt financing. This underscores the importance of capital structure decisions in determining the overall cost of capital.

Table 1: Empirical Results

	Model1	Model2	Model3
$ESG\ bond_{i,t}$	-0.5418 [-3.69]***	-0.4161 [-3.22]***	-0.4161 [-2.85]***
$Size_{i,t}$	0.098 [10.76]***	0.1106 [12.36]***	0.1106 [4.30]***
$Leverage_{i,t}$	-1.9944 [-22.81]***	-1.7834 [-20.34]***	-1.7834 [-13.26]***
$Cost\ Savings_{i,t}$	-0.2151 [-0.70]	0.7796 [2.40]**	0.7796 [1.86]*
$Revenue\ Growth_{i,t}$	1.4543 [10.61]***	1.1668 [8.72]***	1.1668 [6.41]***
$Asset\ Efficiency_{i,t}$	16.0954 [26.88]***	15.5801 [25.39]***	15.5801 [14.72]***
$Dividend\ Policy_{i,t}$	0.1256 [6.67]***	0.1071 [5.80]***	0.1071 [4.96]***
$CAPEX_{i,t}$	0.0086 [0.92]	0.0112 [1.23]	0.0112 [1.20]
$Efficiency_{i,t}$	-0.0045 [-18.24]***	-0.0014 [-4.65]***	-0.0014 [-3.26]***
$Accounts\ Payable\ Management_{i,t}$	-0.0007 [-2.75]***	-0.0002 [-0.88]	-0.0002 [-0.79]
$Constant$	2.7895 [7.96]***	0.1432 [0.39]	2.1407 [3.62]***
Year	YES	YES	YES
Industry	NO	YES	YES
Cluster	NO	NO	YES
R-squared	0.3116	0.3779	0.3779
Adj-R-squared	0.311	0.3763	0.3763
N	19350	19350	19350

\*\*\*, \*\*, \* indicate statistical significance at the 1%, 5%, and 10% level, respectively.

$Revenue\ Growth_{i,t}$  and  $Asset\ Efficiency_{i,t}$  both show positive and significant associations with WACC. The coefficient on  $Revenue\ Growth_{i,t}$  is 1.4543 (t-statistic = 10.61), while the coefficient on  $Asset\ Efficiency_{i,t}$  is 16.0954 (t-statistic = 26.88). These results suggest that faster-growing and more profitable firms face higher costs of capital in the Japanese context, possibly reflecting higher risk perceptions associated with growth and profitability.

To account for industry-specific factors that might influence the cost of capital, the analysis in Model 2 was extended by including industry fixed effects. The coefficient on  $ESG\ bond_{i,t}$  remains negative and significant

at -0.4161 (t-statistic = -3.22), albeit slightly smaller in magnitude compared to Model 1. This suggests that even after controlling for industry-specific factors, ESG bond issuance is associated with a lower cost of capital.

In this model, some changes are observed in the control variables. Notably, the coefficient on *Cost Savings<sub>i,t</sub>* becomes positive and significant (coefficient = 0.7796, t-statistic = 2.40), suggesting that after controlling for industry effects, firms with higher cost efficiency face higher costs of capital. This could indicate that the market expects sustained high performance from efficient firms, leading to higher risk perceptions.

The most robust specification is presented in Model 3, where this study employed two-way clustering of standard errors at the industry and year level. This approach accounts for the potential correlation of residuals within industries and years. The coefficient on *ESG bond<sub>i,t</sub>* remains negative and significant at -0.4161 (t-statistic = -2.85), consistent with the previous models. This provides strong evidence for the hypothesis, even under the most conservative estimation approach.

The consistency of the *ESG bond<sub>i,t</sub>* coefficient across all three models provides compelling evidence for the negative relationship between ESG bond issuance and the cost of capital. The economic magnitude of this effect is substantial, ranging from 41.61 to 54.18 basis points, depending on the model specification. This suggests that firms issuing ESG bonds benefit from a meaningful reduction in their overall financing costs.

Several mechanisms could explain this finding. ESG bond issuance may signal better risk management practices, particularly related to environmental and social risks, leading to lower perceived risk and thus a lower cost of capital. This is particularly relevant in Japan, where environmental concerns have gained significant traction in recent years. Additionally, ESG bonds may attract a broader range of investors, including those with sustainable investment mandates, potentially increasing demand for the firm's securities and lowering the cost of capital.

The control variables in the models employed also provide insights into the determinants of cost of capital in the Japanese context. The positive association between firm size and WACC, contrary to findings in many Western markets, could reflect unique aspects of the Japanese market, such as higher scrutiny of large firms or the historical underperformance of some large conglomerates. The strong negative relationship between leverage and WACC underscores the importance of considering tax shield effects in the Japanese corporate financing context.

The positive associations of revenue growth and asset efficiency with WACC suggest that the Japanese market may perceive growth and profitability as risk factors. This could reflect concerns about the sustainability of performance or increased scrutiny of high-performing firms, possibly linked to cultural factors such as risk aversion or expectations of stable, long-term performance.

In conclusion, the empirical findings here provide strong support for the hypothesis that ESG bond issuance is associated with a lower cost of capital for Japanese firms. This relationship persists across different model

specifications and controls for various firm-level and industry-level factors. These results contribute to the understanding of how ESG initiatives, specifically ESG bond issuance, can impact a firm's financial performance through the cost of capital channel. They also provide insights into the unique characteristics of the Japanese financial market and how various firm-level factors influence the cost of capital in this context.

In the next section, this study will discuss robustness tests to further validate the main findings and explore additional dimensions of the relationship between ESG bond issuance and cost of capital.

## 5. Robustness tests

To ensure the reliability and validity of the main findings, this study conducted a robustness test using Propensity Score Matching (PSM) and Difference-in-Differences (DID) analysis. This test aimed to address potential concerns related to endogeneity and sample selection bias that may arise from firms self-selecting into ESG bond issuance. As presented in Table 2, the results further corroborate the main findings and strengthen the conclusions regarding the relationship between ESG bond issuance and the cost of capital for Japanese firms.

### 5.1 Propensity Score Matching (PSM) and Difference-in-Differences (DID) Analysis

The primary robustness test employed a combination of Propensity Score Matching (PSM) and Difference-in-Differences (DID) analysis. This approach helps address potential endogeneity concerns and selection bias that may arise from firms self-selecting into ESG bond issuance.

#### 5.1.1 PSM Procedure

PSM was first used to create a matched sample of firms that have issued ESG bonds (treatment group) and those that have not (control group). The matching is based on a set of firm characteristics that may influence both the decision to issue ESG bonds and the cost of capital. These characteristics include firm size, leverage, cost savings, revenue growth, asset efficiency, dividend policy, capital expenditure, efficiency, and accounts payable management.

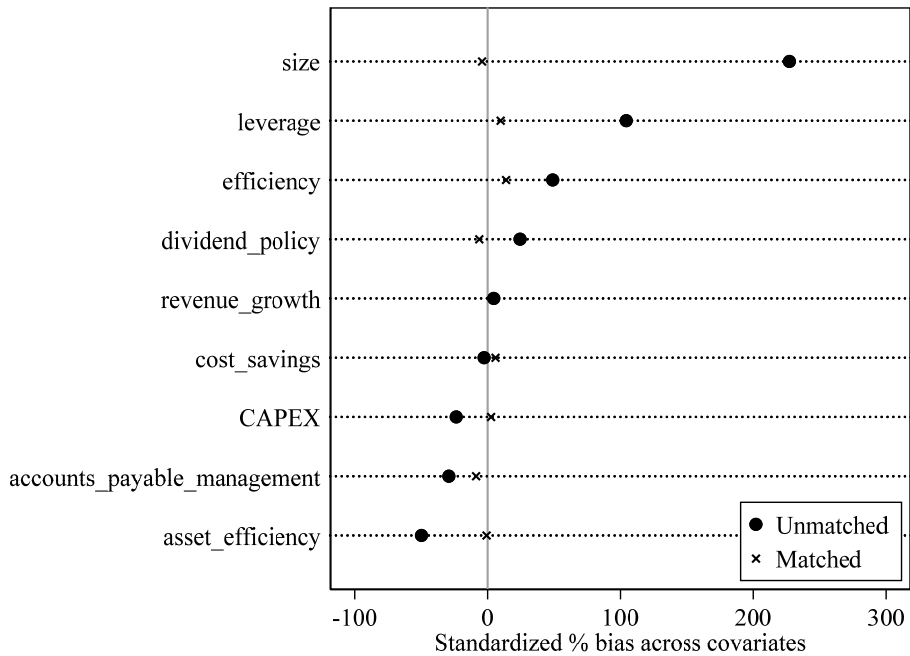
The PSM procedure involves estimating a logit model to predict the probability of a firm issuing an ESG bond based on these characteristics. The nearest-neighbor matching algorithm with a caliper of 0.05 was then used to ensure good match quality. This process results in a matched sample where firms in the treatment and control groups are similar across observable characteristics, except for their ESG bond issuance status.

#### 5.1.2 Balancing Tests

To verify the quality of this matching procedure, balancing tests were conducted. Figure 1 presents the results of these tests. The figure shows that after matching, the standardized differences between the treatment and control groups for all matching variables are substantially reduced. This indicates that this PSM procedure

has successfully created a balanced sample, mitigating concerns about selection bias.

Fig. 1 Balancing tests



### 5.1.3 PSM-DID Results

Using the matched sample, this study then conducted a DID analysis to estimate the causal effect of ESG bond issuance on the cost of capital. Table 2 presents the results of this analysis.

The coefficient on the  $ESG\ bond_{i,t}$  variable in the PSM-DID model is -0.4650, which is statistically significant at the 1% level (t-statistic = -3.45). This result is consistent with the main findings of this study, indicating that ESG bond issuance is associated with a reduction in the cost of capital of approximately 46.50 basis points.

Significantly, the magnitude of this effect is similar to what was found in the main analysis (ranging from 41.61 to 54.18 basis points), providing further confidence in the robustness of these results. The slight difference in magnitude could be attributed to the more stringent matching procedure, which may have eliminated some of the heterogeneity in the sample.

The coefficients on the control variables in the PSM-DID model are largely consistent with the main

analysis. These consistencies across different model specifications provide additional support for the robustness of these findings.

Table 2: PSM-DID Results

	On Support
<i>ESG bond<sub>i,t</sub></i>	-0.4650 [-3.45]***
<i>Size<sub>i,t</sub></i>	0.1847 [11.56]***
<i>Leverage<sub>i,t</sub></i>	-2.1977 [-10.99]***
<i>Cost Savings<sub>i,t</sub></i>	0.7815 [1.62]
<i>Revenue Growth<sub>i,t</sub></i>	1.3779 [6.69]***
<i>Asset Efficiency<sub>i,t</sub></i>	13.8895 [12.16]***
<i>Dividend Policy<sub>i,t</sub></i>	0.1240 [4.088]***
<i>CAPEX<sub>i,t</sub></i>	0.0400 [2.32]**
<i>Efficiency<sub>i,t</sub></i>	-0.0010 [-2.21]**
<i>Accounts Payable Management<sub>i,t</sub></i>	0.0004 [0.97]
Adj-R-squared	0.4347
N	11745

\*\*\*, \*\*, \* indicate statistical significance at the 1%, 5%, and 10% level, respectively.

## 5.2 Implications of Robustness Tests

The results of the PSM-DID analysis provide strong support for the causal interpretation of the main findings. By addressing potential endogeneity and selection bias concerns, this study can more confidently assert that the observed reduction in the cost of capital is indeed attributable to ESG bond issuance, rather than to other confounding factors.

The consistency of the results across different methodological approaches (OLS with fixed effects in the main analysis and PSM-DID in the robustness tests) strengthens the validity of this study's conclusions. This consistency suggests that the negative relationship between ESG bond issuance and the cost of capital is robust to different model specifications and estimation techniques.

Furthermore, the similarity in the magnitude of the effect across different models (ranging from approximately 41 to 54 basis points) provides a reliable estimate of the economic significance of ESG bond issuance on the cost of capital for Japanese firms.

In conclusion, these robustness tests, particularly the PSM-DID analysis, corroborate and strengthen the main findings. They provide additional evidence that ESG bond issuance is causally associated with a reduction in the cost of capital for Japanese firms, even after accounting for potential endogeneity and selection bias. These results enhance confidence in the economic and statistical significance of the relationship between ESG bond issuance and the cost of capital in the Japanese context.

## 6. Conclusion

This study investigates the relationship between ESG bond issuance and the cost of capital for Japanese firms, contributing to the growing literature on sustainable finance and corporate financial performance. This research provides robust evidence that ESG bond issuance is associated with a significant reduction in the WACC for Japanese firms.

The main analysis, employing a panel regression approach with firm and year fixed effects, reveals that ESG bond issuance is associated with a reduction in WACC ranging from 41.61 to 54.18 basis points, depending on the model specification. This finding is both statistically significant and economically meaningful, suggesting that ESG bond issuance provides tangible financial benefits to issuing firms through lower financing costs.

The robustness of these results is further confirmed through PSM-DID analysis, which addresses potential endogeneity and selection bias concerns. The PSM-DID results indicate a reduction in WACC of 46.50 basis points associated with ESG bond issuance, closely aligning with the main findings. This consistency across different methodological approaches strengthens the validity of the conclusions and supports a causal interpretation of the relationship between ESG bond issuance and cost of capital.

Several mechanisms may explain this observed relationship. ESG bond issuance may signal improved risk management practices, particularly concerning environmental and social risks, leading to lower perceived risk and, consequently, a lower cost of capital. Additionally, ESG bonds may attract a broader investor base, including those with sustainable investment mandates, potentially increasing demand for the firm's securities and lowering the cost of capital. In the Japanese context, where corporate reputation is highly valued, ESG bond issuance may also enhance a firm's standing with various stakeholders, leading to more favorable financing terms.

These findings also provide insights into the determinants of cost of capital in the Japanese context. Contrary to findings in many Western markets, a positive association is observed between firm size and WACC, suggesting that larger firms in Japan may face higher financing costs. This could reflect unique aspects of the Japanese market, such as higher scrutiny of large firms or the historical underperformance of some large conglomerates. The strong negative relationship between leverage and WACC underscores the importance of tax shield effects in Japanese corporate financing decisions.

These results have significant implications for corporate managers, investors, and policymakers. For

corporate managers, these findings suggest that ESG bond issuance can be an effective strategy for reducing the overall cost of capital, potentially enhancing firm value. This provides a clear financial incentive for firms to engage in sustainable practices and issue ESG bonds.

For investors, these results highlight the importance of considering ESG factors in investment decisions. The lower cost of capital associated with ESG bond issuance suggests that these bonds may offer an attractive risk-return profile, particularly for investors with long-term horizons or sustainability mandates.

Policymakers can draw on these findings to inform the development of policies that promote sustainable finance. The financial benefits associated with ESG bond issuance provide an economic rationale for policies that incentivize such issuances, potentially accelerating the transition to a more sustainable economy.

In conclusion, this study provides strong evidence that ESG bond issuance is associated with a lower cost of capital for Japanese firms. This relationship is further validated through PSM-DID analysis, supporting a causal interpretation. These findings contribute to the understanding of the financial implications of sustainable finance practices and highlight the potential for ESG initiatives to create value for firms and investors alike. As the sustainable finance market continues to evolve, further research into the long-term impacts of ESG bond issuance and its effects in different institutional contexts will be valuable in deepening the understanding of this important area.

## 7. Limitations

While the present study provides robust evidence on the relationship between ESG bond issuance and the cost of capital for Japanese firms, it is important to acknowledge several limitations that could provide avenues for future research.

Firstly, this study focuses exclusively on the Japanese market. While this allows the provision of in-depth insights into a significant Asian economy with unique institutional characteristics, it may limit the generalizability of these findings to other markets. The Japanese context, with its distinct corporate governance structures, stakeholder relationships, and recent push towards sustainability, may create a unique environment for ESG bond issuance. Future research could extend this analysis to other countries or conduct cross-country comparisons to examine how institutional and cultural factors moderate the relationship between ESG bond issuance and cost of capital.

Secondly, the present study period spans from 2016 to 2021, coinciding with the early development and growth phase of the ESG bond market in Japan. As this market matures, the relationship between ESG bond issuance and cost of capital may evolve. Long-term studies tracking this relationship over extended periods could provide valuable insights into how the impact of ESG bond issuance changes as the market develops and

investors become more sophisticated in pricing these instruments.

Thirdly, while a wide range of firm characteristics was controlled for and robust econometric techniques including PSM-DID were employed, the possibility of omitted variable bias cannot be completely ruled out. Unobservable firm characteristics that influence both the decision to issue ESG bonds and the cost of capital could potentially bias the present results. Future research could explore additional instrumental variable approaches or natural experiments to further strengthen causal inferences.

Fourthly, ESG bonds have been treated as a homogeneous category in this analysis. However, ESG bonds encompass a range of instruments including green bonds, social bonds, and sustainability bonds, each with potentially different focuses and impacts. Future research could explore how different types of ESG bonds affect the cost of capital, and whether certain ESG focus areas (e.g., environmental vs. social) have stronger impacts.

Fifthly, this study does not directly examine the mechanisms through which ESG bond issuance affects the cost of capital. While this study has proposed several potential explanations, such as risk reduction, investor base expansion, and reputational benefits, these channels have not been empirically tested. Future research could delve deeper into these mechanisms, potentially through surveys of investors and corporate managers or more granular analysis of changes in firm risk profiles and investor composition following ESG bond issuance.

Lastly, the present study focuses on the financial implications of ESG bond issuance for issuing firms. However, it does not address the broader question of whether these bonds lead to improved environmental and social outcomes. Future research could explore the link between ESG bond issuance, firms' sustainability performance, and real-world environmental and social impacts.

Despite these limitations, this study provides valuable insights into the relationship between ESG bond issuance and cost of capital in the Japanese context. By acknowledging these limitations, this study hopes to stimulate further research in this important and rapidly evolving field of sustainable finance.

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