Title

Plug and play policy tool for green financial market development? Insights from Japan's green bond subsidy program

Abstract

Policymakers worldwide face significant challenges in closing the climate finance gap while ensuring economic stability. This study explores green bond subsidies as a tool to finance the path to net-zero by 2050. Aligned with this goal, Japan introduced the Financial Support Programme for Green Bond Issuance in April 2018, marking a strategic, easily transferable policy aimed at bolstering its green bond market. Using the synthetic control method, we empirically assess the subsidy`s impact on green bond issuance dynamics. Our findings reveal a substantial increase in the number of green bonds issued, market volume, and issuer diversity following the subsidy's implementation, suggesting the effectiveness of the program. However, as the average green bond size decreases post-subsidy, efficiency concerns about the program's design remain. These findings hold significant implications for policymakers worldwide seeking pragmatic solutions to bridge the climate finance gap and advance global climate goals.

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Introduction

The urgent need to bridge the climate finance gap is widely recognized by policymakers. If investment continues at the current pace, global climate action will fall short of around EUR 24.6 trillion by 2030.[1] Meeting the goals of the Paris Agreement will require almost EUR 185 trillion in total investment by 2050.[2] Yet, despite more than a decade of growth in climate finance flows, funding still lags dangerously behind. Asia illustrates the severity of the situation: the region needs around USD 1.1 trillion annually for climate-resilient infrastructure, but current investment levels remain at just USD 333 billion.[3] Japan, one of Asia's largest economies, is already feeling the consequences of insufficient action, with projections of a 3.72% decline in GDP by 2050 under current trends—a burden that could be cut in half with stronger climate policies.[4] Without a rapid and coordinated acceleration of global and regional climate finance, the world risks locking in climate damages and economic losses.

Green bonds[5] emerge as a viable financial instrument to address the challenge of insufficient investments, promoting the transformation towards a more sustainable economy[6] by improving the environmental performance of issuers[7]. Compared to conventional bonds, they are associated with lower financing costs[8] and, beyond their financial advantages, have been shown to contribute meaningfully towards carbon neutrality.[9] Furthermore, green bonds enhance the capacity of various stakeholders, including regulators, issuers, and investors, to address climate change through credible regulations, transparent practices, and climate-resilient investments.[10] Structurally similar to conventional bonds, green bonds require a dedicated framework aligned with recognized standards—set by bodies such as the International Capital Market Association and the Climate Bonds Initiative, as well as regional frameworks like the

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[1] Benayad et al. 2023
[2] Albuixech and Lazarova 2024
[3] Basu and Lim 2024
[4] Fondazione CMCC
[5] Di Zhou and Kythreotis 2024, Kartal, Pata, and Alola 2025, Chen, Yang, and Liu 2023, Bai and Wang 2024, Saravade, Weber, and Vitalis 2025
[6] Cui et al. 2020
[7] Flammer 2021, Chen, Yang, and Liu 2023
[8] Zhou and Kythreotis 2024
[9] Kartal, Pata, and Alola 2025
[10] Saravade and Weber 2020

ASEAN and EU Green Bond Standards—adding to their transaction costs. These challenges limit their broader uptake and effectiveness in mobilizing climate finance.[11] Furthermore, current policy frameworks provide insufficient support, indicating governments need to implement more direct financial incentives—such as cash rewards, subsidies, or tax breaks—to enhance corporate engagement in green finance.[12]

In this context, Japan stands out as the only G7 country offering a direct subsidy for green bond issuance. Launched in April 2018 by the Ministry of the Environment, the Financial Support Programme for Green Bond Issuance[13] targets companies, municipalities, and others who intend to fund new or existing environmentally beneficial projects. The program subsidizes external review and consultation costs—such as pre-issuance assessments, post-issuance reviews, and support for establishing a green bond framework[14]—up to a cap of JPY 50 million (approximately USD 330,000) per issuance[15]. By lowering upfront costs and reinforcing adherence to international green bond standards, the subsidy serves as a financial catalyst for market participation and enhanced transparency.

This study empirically investigates whether the subsidy facilitates the development of a stronger green bond market in Japan by reducing the financial barrier to entry. Using green bond data from LSEG and macroeconomic data from the World Bank, we apply the synthetic control method (SCM)[16] to estimate the subsidy's impact on green bond issuance dynamics. Our findings show increased bond count, market volume, and issuer diversity, highlighting the subsidy's role in shaping Japan's green bond market. However, we also observe a decrease in the average issuance size post-subsidy introduction. We expand our analysis to issuer-level outcomes, finding minimal direct impacts on firm value or environmental performance. Nonetheless, our results, robust across multiple tests, suggest a causal relationship between the subsidy and green bond issuance dynamics, emphasizing the importance of government policies and market dynamics acting indispensably to channel capital towards green finance.[17]

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[11] OECD 2017
[12] Liu et al. 2022
[13] Schumacher et al. 2020, Azhgaliyeva and Kapsalyamova 2023, Giorgi CBI 2020, R&I 2018
[14] Ministry of the Environment Government of Japan
[15] Schumacher et al. 2020, Azhgaliyeva and Kapsalyamova 2023, Giorgi CBI 2020, Climate Bonds Initiative
[16] Abadie 2021
[17] Diaz-Rainey et al. 2023

A growing body of research underscores the transformative potential of green finance in driving sustainable development, particularly across industrialized and emerging economies. Empirical evidence from East Asia[18], China[19], and OECD countries[20] highlights its contributions to pollution reduction[21], green innovation[22], resource efficiency[23], and the mobilization of ESG capital[24]. However, the literature also highlights the need for targeted public interventions—such as subsidies and tax incentives—to accelerate the expansion of green finance.[25] Market-based mechanisms alone are unlikely to mobilize the scale of investment required for the low-carbon transition, making government support an essential complement.[26] In this context, the Japanese green bond subsidy offers an important and adaptable solution. By directly lowering the cost differential between green and conventional bonds, the subsidy shifts issuers' cost-benefit analysis and encourages green bond issuance without requiring structural market reforms. Its institutional simplicity and compatibility with existing frameworks make it a pragmatic, scalable, and transferable model for expanding green finance in economies around the world.

Results. Japan's green bond subsidy significantly accelerates market development by driving substantial increases in bond issuance, fostering market growth, and broadening issuer participation, while simultaneously reducing the average issuance size.

To derive these findings and examine the impact of Japan's subsidy program on green bond issuance dynamics, we apply the SCM[27], a robust tool for evaluating policy effects, such as California's tobacco control program.[28] The SCM constructs a synthetic Japan by combining data from countries with active green bond markets (the donor pool), selecting those most similar to Japan. This synthetic market represents Japan's green bond market in the absence of the subsidy. By comparing Japan's actual market

[18] Shi and Yang 2025
[19] Xu et al. 2023, Li, Ma, and Ma 2024, Sun, Bao, and Taghizadeh-Hesary 2023, Lou 2025
[20] Han and Gao 2024
[21] Sun, Bao, and Taghizadeh-Hesary 2023
[22] Li, Ma, and Ma 2024
[23] Han and Gao 2024
[24] Bai and Wang 2024, Han and Gao 2024
[25] Bai and Wang 2024, Shi and Yang 2025
[26] Campiglio et al. 2018
[27] For details on the SCM, see Data and Methodology section
[28] Abadie et al. 2010

development to this synthetic counterfactual, we isolate and interpret the causal effect of the subsidy.

We use data on green bonds and other economic indicators for all countries for the period 2007-2024. Based on prior literature[29], we use 14 economic indicators—such as GDP, foreign direct investment, and inflation[30]—as predictors[31] for the development of the synthetic green bond market. The year 2007 is chosen as a starting point because it marks the inaugural issuance of a green bond by the European Investment Bank. We denote the introduction of the subsidy in April 2018 as t, with prior years labeled as $t - n$ and subsequent years as $t + n$. We use four outcome variables—green bond count (*BondCount*), market volume (*MarketVolume*), unique issuers (*UniqueIssuers*), and issuance amount (*IssuanceAmount*)—to assess the effects of Japan's green bond subsidy on its green bond market.

We start by analyzing the subsidy's effect on the number of green bonds issued (*BondCount*). Prior to the subsidy, Japan issued 14 green bonds in total. Right after the subsidy is introduced the actual (solid line) and synthetic (dotted line) paths of green bond counts diverge significantly (see Figure 1). In the first year post-subsidy, the green bond market grows by 257%. This subsidy-driven surge expands Japan's green bond market, measured by bond count, to 44 times its original size by the end of $t + 5$, compared to 19 times in Japan's synthetic green bond market. On average, the market grows at a monthly rate of about 6% post-subsidy, while synthetic Japan grows by 4%. As a result, the subsidy not only accelerates growth but also elevates Japan to the sixth-largest global issuer in terms of green bond count[32], well above the anticipated thirteenth-place ranking without the intervention.

With respect to market volume (*MarketVolume*), actual and synthetic Japan exhibit a comparable divergence (see Figure 1). At the time of subsidy introduction, the market volume amounts to USD 4.21 billion. Since then, the market expands over 21 times, reaching USD 96.26 billion compared to synthetic Japan with only USD 32.32 billion. The average yearly growth rate for Japan post-subsidy is 70%, compared to 51%

[29] Abadie and Gardeazabal 2003, Abadie et al. 2015, Lee et al. 2023, Tolliver et al. 2020
[30] Full outline, see Data and Methodology section
[31] For details on the predictor variables, see Data and Methodology section
[32] 1. China, 2. Sweden, 3. United States, 4. Germany, 5. France, 6. Japan

in the synthetic scenario, with market volume nearly doubling in the first year post-subsidy.

[Insert Figure 1 here]

Next, we focus on the number of unique issuers (*UniqueIssuers*) to examine whether the subsidy attracts more participants to the green bond market. Unique issuers see a distinct post-subsidy divergence (see Figure 2). The year before the subsidy, there are only seven unique issuers per event-year, which increases to 124 five years after the policy intervention. In comparison, synthetic Japan reaches only 34 unique issuers by the same time. Immediately following the subsidy introduction, the number of unique issuers increases by 371%, maintaining a steady growth trajectory with an average annual growth rate of 89%. Between April 2022 ($t + 4$) and April 2023 ($t + 5$) growth slows to 7%, while synthetic Japan fails to sustain this rate, experiencing a 33% decline during the same period.

Finally, we examine whether the average issuance amount (*IssuanceAmount*) is affected by the subsidy. Indeed, issuance amounts decrease, with the average issue amount per event-year dropping over 62%, from USD 255.97 million to USD 95.42 million post-subsidy (see Figure 2). In contrast, synthetic Japan sees a modest increase of 3%, rising from USD 321.63 million to USD 331.73 million in the same period. Following the initial decline, Japan's issue size rebounds, reaching USD 208.74 million five years after the intervention but staying below the USD 304.84 million observed for the synthetic counterfactual. Furthermore, eight of the nine unique issuers before the subsidy continue issuing bonds post-subsidy, with corporate issuers reducing the size of their average bond issuance by 15% (USD 435 million to USD 371 million) and government issuers increasing theirs (USD 180 million to USD 381 million). Notably, the number of issuers issuing multiple bonds within a month rises significantly from one pre-subsidy to 62 post-subsidy, averaging 2.36 issuances per month.

[Insert Figure 2 here]

As the number of unique issuers increases substantially post-subsidy, we examine industry-sector dynamics and variation in the bonds use of proceeds. For the former analysis, we split the sample into pre- and post-subsidy periods and examine each sector's share of the total green bond count. Before the subsidy, firms in the financial industry dominate Japan's green bond market with a 57% share. Post-subsidy,

this share drops to 27%, reflecting increased participation from other industries. Notably, the real estate sector grows from 0% pre-subsidy to 25% post-subsidy (see Figure 3). Examining the use of proceeds reveals a significant increase in categories like Energy Efficiency, Clean Transport, Climate Change Adaptation, and Green Construction. Post-subsidy, Energy Efficiency projects account for 40%, with Green Construction jointly comprising nearly half the allocation. The findings align with Japan's Strategic Energy Plan (2018)[33] and revisions to the Energy Efficiency Act[34], emphasizing energy-efficient designs and climate adaptation, prompting real estate companies to leverage green finance. The rise in Clean Transport reflects Japan's Green Growth Strategy[35], aiming to reduce transport emissions below 2013 levels[36].

[Insert Figure 3 here]

In sum, the introduction of Japan's green bond subsidy significantly strengthens the country's green bond market, driving sustained growth in bond count, market volume, and issuer participation. This development not only supports sustainable project funding and aligns with Japan's environmental goals, but a more developed green bond market and broadened issuer participation enables the economy to better withstand financial shocks and distributes risks across sectors.[37] Furthermore, by elevating Japan to the sixth-largest global issuer in green bonds, the subsidy strengthens its global standing in sustainable finance.

Robustness of results. To ensure that the observed treatment effect is not a result of confounding factors or selection bias in control countries, we implement a series of robustness tests. These additional analyses are consistent with our main findings and indicate that the observed changes in Japan's green bond market are related to the introduction of the subsidy. Among these, placebo tests are central in validating the reliability of the SCM analysis, since these tests verify whether the significant treatment effects observed in Japan also appear in countries without the subsidy. To perform this, we iteratively assign the treatment to each country in the donor pool while shifting Japan back to it, generating multiple plots that illustrate the placebo effects in untreated

[33] International Energy Agency 2019
[34] International Energy Agency 2017
[35] Ministry of Economy, Trade and Industry (METI) 2022
[36] United Nations Framework Convention on Climate Change (UNFCC) 2021
[37] OECD 2024, BlackRock 2022

countries. Among the countries tested, only Germany shows a larger outcome difference (see Figure 4) for the green bond count (*BondCount*), making it the only country exceeding Japan in this regard. The probability of observing a gap of this size under a random permutation of the intervention is less than 5%, indicating statistical significance.[38] The lack of similar effects in placebo countries indicates limited confounding factors.

[Insert Figure 4 here]

We perform additional robustness tests, including sensitivity analyses with iterative deletion of predictors (see OA Figure 2) and exclusions of sectors or use of proceeds linked to concurrent policies. These tests consistently support the robustness of the subsidy's estimated effects on Japan's green bond market, indicating that the observed trends are unlikely to be driven by specific predictors, alternative donor pool selections, government-issued bonds, or concurrent policies, thereby reinforcing the validity of our findings.

Discussion. This study investigates the effect of Japan's Financial Support Programme for Green Bond Issuance on key issuance dynamics within the country's green bond market. Based on our results, we conclude that the subsidy program in Japan effectively stimulates the growth of green bond issuance, increases overall market volume, and diversifies the range of issuers. Furthermore, the subsidy also leads to a reduction in the average size of green bond issuances. This trend may indicate that firms are optimizing subsidies by issuing smaller bonds more frequently, as reflected in the notable rise in issuers releasing multiple bonds within the same month. At the same time, the influx of smaller issuers post-subsidy—reflected in the decline of the average market capitalization of listed issuers from USD 4.72 billion pre-subsidy to USD 1.06 billion post-subsidy[39]—suggests that this fragmentation is partly driven by increased participation from smaller firms, rather than solely strategic behavior by larger issuers. Supporting this, corporate issuers average bond-to-assets ratio[40] rises from 3.87% pre-subsidy to 5.66% post-subsidy, showing smaller issuers contribute relatively larger issuances.

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[38] Abadie et al. 2010

[39] Specifically, we use the following variable from LSEG: Market Capitalization (WC08001)

[40] The bond-to-assets ratio is calculated by dividing the value of each green bond issuance by the issuing firm's total assets in the respective year. This ratio provides a standardized measure of the relative size of each issuance compared to the firm's size.

However, one way to address potential issuance fragmentation is to impose a cap on subsidy claims per issuer, as previously implemented in Hong Kong. This prevents firms from splitting larger issuances into smaller ones to maximize subsidies, which raises administrative costs without adding market value. However, Hong Kong ultimately removed the cap in its latest subsidy scheme update[41], acknowledging its trade-offs: while it discourages subsidy exploitation, it risks undermining the goal of increasing green bond issuance. The additional costs of structuring green bonds—such as verification, reporting, and compliance—can make smaller issuances less viable, potentially discouraging participation from smaller issuers and new entrants, thereby limiting market growth and diversity.

To complement these findings, we examine how financial markets respond to green bond announcements using an event study. While conventional bond issuance typically causes no significant market reaction[42], green bonds may generate mixed responses: their higher costs could prompt a negative reaction, but their sustainability signal, generally viewed favorably[43], might lead to a positive response. We hypothesize that as Japan's subsidy offsets the additional costs, the positive sustainability signal dominates. Analyzing 138 first-time green bond announcements from Japanese companies using the Fama-French Five-Factor Model, we find that cumulative abnormal returns ($CARs$) in the event window [-5, 10] are small and statistically insignificant (see Table 1). These results hold across other event windows, subsamples split in pre- and post-subsidy introduction and under alternative models, including the Fama-French Three-Factor Model and the market model (see OA Table 2). The statistically insignificant $CARs$ suggest that green bond announcements are not perceived as enhancing firm value, indicating the subsidy does not drive a shift from public to private capital. This aligns with mixed evidence showing that green bond announcements may generate positive market responses when seen as credible signals of environmental commitment—particularly from first-time or certified issuers[44]—but can also lead to negative or muted reactions due to concerns over greenwashing, firm fundamentals, or

[41] Hong Kong Monetary Authority 2024
[42] Eckbo et al. 2007
[43] Flammer 2013, Klassen and McLaughlin 1996, Krueger 2015
[44] Flammer 2021, Chen, Yang, and Liu 2023

issuance costs[45]. These outcomes often vary by issuer characteristics, geography, and broader macroeconomic conditions.[46] Furthermore, the muted market response may reflect the maturation of Japan's green bond market, where growth and diversification have likely diluted the signaling power of individual announcements, making them appear routine rather than impactful to investors. Taken together, green bond subsidies can lower barriers to entry and expand issuer participation, their impact on market perception and stock price reactions remains ambiguous.

[Insert Table 1 here]

Green bonds are intended to finance sustainable projects, which raises the question of whether they improve the environmental performance of issuing firms. To address this, we use a matching-based difference-in-differences (DiD) approach to investigate the impact of green bond issuance on firm-level environment rating, CO_2 emissions, and emission intensity. Treated firms, defined as the 177 Japanese-listed green bond issuing companies, are matched to Japanese control firms from the same sector based on firm characteristics such as size, leverage, and environment rating (see OA Table 1).[47] Using data from LSEG covering 2010 to 2024, our findings reveal no significant changes in environment rating, CO_2 emissions, or emission intensity (see Table 2), suggesting that green bond issuance has limited immediate impact on these metrics. While green bonds aim to support corporate sustainability, our results challenge the assumption that issuance alone translates into short-term environmental improvements. This aligns with recent evidence showing no clear link between green bond issuance and CO_2 reductions post-net-zero pledges[48], while other studies point to more sector-specific effects, suggesting that the impact of green bonds may depend on contextual and sectoral factors.[49] Overall, policymakers should consider these findings as a prompt to reevaluate the accountability and effectiveness of green bonds, potentially through stricter reporting requirements or clearer impact metrics.

[Insert Table 2 here]

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[45] Wu 2022
[46] Khiari et al. (2024)
[47] Full outline, see Data and Methodology section
[48] Zhou and Kythreotis, 2024
[49] Kartal, Pata, and Alola, 2025

Overall, our findings reveal critical implications for governmental policy design and effectiveness in climate finance. The development of green debt capital markets plays a pivotal role in scaling sustainable finance. By fostering liquidity, transparency, and accountability, robust green bond markets drive capital allocation towards impactful sustainability initiatives, narrowing the global financing gap for climate change mitigation.[50] Japan's green bond subsidy, despite constituting just 0.01%[51] of the country's total yearly government expenditure[52], demonstrates a strategic and globally relevant policy tool to stimulating green finance. Its strength lies in institutional simplicity: operating within existing market frameworks, the subsidy avoids the complexity of taxonomies or regulatory overhauls. This plug-and-play design enhances transferability, particularly to advanced economies that control most global capital and emissions yet often face political or institutional limits to regulatory reform. The Japanese model thus offers a fiscally pragmatic and scalable approach to mobilizing private capital for climate action.

[50] Saltane 2022
[51] Average based on every green bond claiming the subsidy
[52] Ministry of Finance Japan

Data and Methodology

Database. We source green bond data from LSEG (formerly Refinitiv), which integrates data from the Climate Bonds Initiative, combining two key databases in green bond analysis. LSEG uses a document-based classification approach, relying on issuer labels, frameworks, independent opinions, and the alignment of proceeds with ESG goals, making its labeling a strong signal regarding the greenness of a bond. We aggregate issuer-level data from the LSEG Green Bond Guide to create a monthly country-level panel dataset. To ensure consistency and comparability, we standardize the issuer and bond type variables by consolidating certain categories. More precisely, issuer types related to government entities are grouped under a single classification: government. This leads to a dichotomous issuer type variable: government and corporate. For bond types, only specific classifications are considered as green bonds, namely CBI Aligned Green Bond, Self-Labeled Green Bond, and CBI Certified Green Bond. To align with World Bank data, which is used for the SCM, Taiwan is consolidated with China, and Jersey is grouped under Great Britain.

The green bond dataset comprises 15,619 bonds issued across 101 countries between July 2007 and March 2024, of which 10,007 are explicitly classified as green bonds, representing a total issuance volume of USD 3,085.24 billion (see OA Figure 3). Japan accounts for 6% of these bonds but only for 3% of the total issuance volume (USD 96.26 billion). Compared to the global market, Japan's green bond market exhibits unique characteristics, particularly in its sectoral composition. While globally, financials dominate with 43% of bonds issued, Japan's financial sector accounts for only 27%, significantly lower than the average for the other G7, where financials represent 73%. Conversely, Japan features higher shares of government activity (13% vs. 4% in the G7 without Japan) and industrials (17% vs. 7% in the G7 without Japan). Real estate, representing 25% of Japan's issuances, is also far more prominent than in the other G7 (4%) and the global sample (12%). Meanwhile, utilities account for only 8% of Japan’s green bonds, compared to 18% globally and 9% within the other G7. Country-level analysis identifies China as the largest green bond issuer, with 1,556 bonds totaling USD 369.14 billion, followed by Sweden, the US, Germany, France, and Japan. Japan's average bond size (USD 154.26 million) is about half the global average (USD 308.31 million), reflecting smaller issuances and potentially broader market participation. However,

Japanese green bonds have a longer average maturity of 8.96 years compared to the global average of 7.93 years, while offering a significantly lower average coupon rate of 0.82% compared to 3.34% globally. These differences underline Japan's stability-focused and domestically oriented market[53] and form the basis for understanding how Japan's green bond market responds to subsidy policies.

Outcome variables. For the SCM we use four outcome variables—*BondCount*, *MarketVolume*, *UniqueIssuers*, and *IssuanceAmount*—constructed from the green bond dataset to analyze the subsidy effects on country-level.

We use cumulative green bond issuance (*BondCount*), which is the total of all green bonds issued in a country from 2007 to 2024, as our primary measure to evaluate the efficacy of the green bond subsidy. Each bond in the LSEG database is assigned a distinct ISIN, which serves as a unique identifier. To calculate *BondCount*, we count the number of bonds issued in each country on a monthly basis. We use a cumulative measure for several reasons: Cumulative issuance reflects the total financial commitment towards sustainable financing, providing a clear and consistent view of the market's size and growth over time. This approach helps smooth out short-term volatility, capturing long-term trends and shifts, similar to the $CARs$ in event studies. Additionally, it enables a better assessment of how the green bond market responds to policy changes, investor interest, and economic conditions.

The market volume (*MarketVolume*) is represented by the cumulative issuance amount of green bonds. To calculate *MarketVolume*, we sum up the nominal issuance values, provided by LSEG in USD, for all green bonds within each country on a monthly basis, using the same aggregation logic as for *BondCount*. This provides a straightforward measure of the total financial commitment towards sustainable financing over our time-period, from 2007 to 2024.

The unique issuers (*UniqueIssuers*) metric tracks the number of distinct companies or entities issuing green bonds each event-year, offering insight into market participation and diversity. For *UniqueIssuers*, we determine the number of distinct issuer names within each event-year for each country.

[53] East Asia Forum 2024

The issuance amount (*IssuanceAmount*) reflects the relative issuance size of green bonds on an event-yearly basis. The *IssuanceAmount* metric is calculated at the event-year level by using the aggregate values of *BondCount* and *MarketVolume*. Specifically, we divide the total market volume by the total number of bonds issued in a given event-year for each country. Using yearly data minimizes fluctuations from seasonal trends and prevents misleading conclusions from short-term variations. Annual metrics offer a clearer perspective on sustained growth, reducing random noise and aligning with policymakers and businesses planning horizons.

For the DiD estimation, we use three outcome variables—CO_2 emissions, emission intensity and the environment rating[54]—to assess the issuer-level effects. The variables are sourced from the LSEG database. CO_2 emissions capture the total greenhouse gas output, while the environment rating reflects a company's overall environmental performance. Emission intensity is calculated as the ratio of CO_2 emissions to total assets, offering a standardized metric to evaluate emissions relative to the scale of an entity's operations, complementing the examination of total CO_2 emissions. These variables are critical as they provide insight into whether green bond issuance translates into measurable environmental improvements and enhanced sustainability practices at the issuer level.

SCM Methodology. The SCM is a policy evaluation technique that constructs a synthetic control using a data-driven approach, enabling comparison against a treated unit to isolate the effect of an intervention.[55] For a comprehensive methodological overview of the SCM, refer to the works of Abadie.[56] In our setting, the analysis includes a total of 101 units, comprising one treated unit, Japan, and 100 potential control units that constitute the donor pool. To accurately construct a counterfactual scenario without an intervention, we restrict the donor pool to countries with at least one green bond issuance, but without subsidy schemes. Hong Kong, Singapore, and Malaysia are excluded due to their subsidy policies. China and the US, despite having subsidy

[54] Specifically, we use the following variables from LSEG: CO2 emissions (ENERDP023), Environment Pillar Score (ENSCORE), and Total Assets (WC02999)
[55] Abadie and Gardeazabal 2003, Abadie et al. 2010
[56] Abadie and Gardeazabal 2003, Abadie et al. 2010, Abadie et al. 2015

programs, are included as their policies significantly differ from those under investigation.[57] This ensures that the various countries share similar economic conditions, but none of the control countries have implemented subsidies similar to Japan. To qualify as a control country, a minimum of one annual data point for each predictor variable within the estimation period is required, which reduces the pool of potential donor countries, primarily excluding small economies.[58] Predictor variables are key observed characteristics used in the SCM for constructing a synthetic counterpart for the treated unit. These variables are selected based on their relevance to the outcome of interest, guiding the creation of a weighted combination of untreated units that closely mirrors the pre-intervention trends and attributes of the treated unit. By matching the predictor variables, the SCM estimates the counterfactual outcome of the treated unit in the absence of the intervention, thereby enabling a clear assessment of treatment effects.

Our sample comprises a balanced panel spanning two time periods: the pre-intervention period (T_0) and the post-intervention period (T_1), with the total period given by $T = T_0 + T_1$. The intervention, marked by the introduction of the green bond subsidy in April 2018 ($t = 0$), affects the treated unit from $t = 0$ onward but has no impact during the pre-intervention period ($t < 0$). The pre-intervention period begins with the inaugural green bond issuance (EIB, July 2007) and ends six months before the subsidy to mitigate anticipation effects.[59] Embedded within this pre-intervention period, the optimization window spans five years leading up to the six-month cutoff point, which is used to

[57] The US previously offered Qualified Energy Conservation Bond and Clean Renewable Energy Bond incentives, which ended in 2017. This program differed from Japan's subsidy model, as it targeted clean energy projects rather than addressing disadvantages and review costs for sustainable bonds. China's green finance policies exhibit substantial heterogeneity due to a pilot zone approach, making it not comparable to Japan. A robustness test including both countries in the donor pool showed consistent results.

[58] **Countries with data:** Australia, Austria, Belgium, Brazil, Chile, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Côte d'Ivoire, Egypt, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Kenya, South Africa, South Korea, Luxembourg, Malaysia, Malta, Mauritius, Mexico, Morocco, Namibia, Netherlands, New Zealand, Norway, Panama, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Serbia, Seychelles, Singapore, Slovakia, Slovenia, Spain, Switzerland, Thailand, Turkey, Ukraine, United Kingdom, United States
Countries without data: Andorra, Argentina, Benin, Bermuda, Bolivia, Burkina Faso, Canada, Cayman Islands, Channel Islands, China, Denmark, Dominican Republic, Ecuador, Estonia, Fiji, Finland, Georgia, Guinea-Bissau, Guatemala, Honduras, Hong Kong, Iceland, Isle of Man, Latvia, Laos, Liechtenstein, Lithuania, Macau, Mali, Marshall Islands, Niger, Nigeria, Pakistan, Paraguay, Senegal, Sudan, Sweden, Togo, United Arab Emirates, Uruguay, Uzbekistan, Venezuela, Vietnam, Virgin Islands

[59] Abadie 2021

calibrate the weights of the control units. This window ensures that the synthetic control closely mimics the pre-treatment trends of the treated unit.

The SCM approximates the pre-intervention characteristics of the treated unit using a weighted average of units from the donor pool. The weights W are chosen to minimize the difference between the characteristics X_1 of the treated unit and the synthetic control X_0W. This minimization is done across a set of variables, with each variable m weighted by v_m, reflecting its relative importance. The objective is to find the optimal weights W^* that minimize the difference between X_1 and X_0W. This can be formalized as follows:

$$W^* = \sum_{m=1}^{k} v_m \left(X_{1m} - X_{0m}W\right)^2$$

where k is the number of predictor variables, X_{1m} represents the treated unit's value for predictor variable m, and X_{0m} is the vector of values for the donor pool units.

The outcome, denoted as Y_{jt} , represents the value of the variable of interest for unit j at time t. This study defines four outcomes of interest (i.e., *BondCount*, *MarketVolume*, *UniqueIssuers*, and *IssuanceAmount*). Y_1 represents a vector of post-intervention values of the outcome for the treated unit, and Y_0 is a matrix collecting these values for the control units not exposed to the intervention. The synthetic control estimator compares these post-intervention outcomes: $Y_1 - Y_0W^*$, where $W^*$are the weights derived from pre-intervention periods.

In the post-intervention period ($t \geq 0$), the synthetic control method estimates the treatment effect by comparing the treated unit's outcome to that of the synthetic control:

$$Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}$$

where Y_{1t} represents the outcome of the treated unit at time t, and Y_{jt} are the outcomes of the control units in the synthetic control. The weights $W = (w_2^*,\ w_3^*, \ldots, w_{J+1}^*)$ form a vector of optimal weights, with each w_j^* reflecting the contribution of a control unit to the synthetic control. The predictor variables, X_0 and X_1, used to derive these weights, are selected based on pre-intervention characteristics to predict post-intervention outcomes and are assumed to be unaffected by the intervention. This methodology provides a robust framework for isolating the causal impact of the green bond subsidy on

the defined outcomes, leveraging a data-driven approach to construct a credible counterfactual and assess the intervention's effectiveness.

To ensure the validity and reliability of our findings, we perform a series of robustness checks designed to evaluate the consistency of the treatment effect and the stability of the synthetic control model. To assess the significance of the treatment effect, we conduct placebo tests.[60] Using the SCM, we construct counterfactual scenarios where control group units are hypothetically exposed to the intervention, while the treated unit is shifted back to the donor pool. If the resulting placebo effects are comparable to the observed effect, this indicates that the treatment has no significant impact. Conversely, consistently smaller placebo effects provide evidence of a significant treatment effect. The reliability of placebo tests depends on the accuracy of the synthetic control unit. To ensure this, we exclude control units with a pre-treatment Mean Squared Prediction Error (pre-MSPE) exceeding a country-specific factor of the treated unit's pre-MSPE, as they violate the parallel trends assumption.[61] The MSPE measures the average squared differences between actual and synthetic outcomes, serving as a metric for model accuracy. By filtering out units with a high pre-MSPE, we enhance the robustness of our comparisons between treatment and placebo effects. To further evaluate the accuracy of the synthetic control, we compute the Root Mean Squared Prediction Error (RMSPE), which is the square root of the MSPE. A low RMSPE indicates a reliable synthetic control and is calculated as follows:

$$RMSPE = \left(\frac{1}{T_0} \sum_{t=1}^{T_0} \left(Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt} \right)^2 \right)^{\frac{1}{2}}$$

To compare the treatment and control groups, we compute the RMSPE ratio, which is influenced by two key factors: the alignment of pre-treatment characteristics and the post-treatment gap between the treated unit and its synthetic counterpart. The RSMPE ratio is defined as the post-treatment RMSPE divided by the pre-treatment RMSPE:

$$RMSPE\text{-}Ratio = \frac{post\text{-}RMSPE}{pre\text{-}RMSPE}$$

[60] Abadie et al. 2010
[61] Abadie et al. 2010

A higher RMSPE ratio for the treated unit compared to the control group suggests a significant treatment effect (see OA Figure 1).[62]

Furthermore, we conduct sensitivity tests to assess the resilience of our primary findings to variations in the predictor weights, denoted as V^*. These weights are derived from the optimization process used in the SCM to approximate the treated unit's characteristics. To address concerns about overfitting and robustness, we iteratively delete each predictor variable to observe its influence on the results. In this process, we repeatedly re-estimate the baseline model to generate a synthetic unit, systematically excluding one of the predictor variables in each iteration. While this approach may entail a reduction in goodness of fit, it serves as a crucial sensitivity analysis, enabling us to evaluate the influence of individual predictors on our results.[63]

To strengthen the robustness of our findings, we conduct additional tests addressing potential confounding factors. To address concerns about the choice of countries serving as potential controls, we limit the donor pool to OECD countries, ensuring comparability and avoiding over-reliance on small economies. To rule out that the subsidy's effects are driven by government-issued bonds, we exclude them from our analysis. Finally, we address potential spillover effects from concurrent policies (i.e., Japan's Strategic Energy Plan, Energy Efficiency Act revisions, and Green Growth Strategy). Thus, we exclude the real estate sector and bonds tied to use of proceeds closely associated with the aforementioned policies (i.e., Energy Efficiency, Clean Transport, and Green Construction) from our analysis. These measures collectively enhance the robustness of our analysis, isolating the specific effects of the green bond subsidy.

Our predictor variables. We select predictor variables related to the determinants of the green bond market based on empirical research on its drivers[64] and the effects of green bond policies[65]. Furthermore, our approach is supplemented and validated by two significant studies on synthetic controls and country-level outcomes.[66] This results in the

[62] Abadie et al. 2010, Abadie et al. 2015
[63] Abadie et al. 2015
[64] Tolliver et al. 2020
[65] Lee et al. 2023
[66] Abadie and Gardeazabal 2003, Abadie et al. 2015

selection of 14 country-level economic indicators from the World Bank's open database, capturing key factors that influence green bond markets.

Gross domestic product based on purchasing power parity (PPP) is used as a predictor variable due to its significance in reflecting economic size. PPP provides the value of gross domestic product in international dollars adjusted by a purchasing power parity conversion factor, which standardizes price levels across countries.[67] Smaller economies with lower PPP may struggle to develop robust bond markets, limiting appeal to foreign issuers and increasing price volatility.[68] In contrast, larger economies with higher PPP typically offer more stable investment environments and better governance, crucial for the development and attractiveness of green bond markets.[69]

The Trade-to-GDP ratio (TRD), which is the sum of exports and imports of goods and services measured as a share of the gross domestic product[70], serves as an indicator of a country's degree of openness to international trade and its exposure to global competitive forces. An increased TRD suggests a greater integration into global markets, potentially influencing the behavior of entrenched interest groups, such as banks.[71] Countries with higher TRDs are often more prepared to adopt global standards and attract international capital leading to more developed bond markets.[72]

Stocks traded, total value (STV), is defined as the aggregate value of shares traded, encompassing both domestic and foreign shares, multiplied by their corresponding market prices.[73] This measure provides insight into the overall activity and liquidity within a country's stock market. Well-developed domestic financial systems, as measured by bank deposits and stock market size, lead to larger domestic bond markets.[74] This suggests that a robust financial infrastructure promotes the growth of local bond markets.[75]

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[67] World Bank
[68] Eichengreen and Luengnaruemitchai 2004
[69] Tolliver et al. 2020, Abadie et al. 2015
[70] World Bank
[71] Rajan and Zingales 2004
[72] Tolliver et al. 2020, Abadie et al. 2015
[73] World Bank
[74] Claessens et al. 2007
[75] Tolliver et al. 2020

Rule of Law (ROL) expresses societal adherence to legal norms, property rights enforcement, and judicial effectiveness[76]. Strong ROL fosters bond market development by enhancing investor confidence, while corruption diminishes this trust.[77] Additionally legal traditions, especially common law systems, protect investor rights and stimulate financial market growth.[78] One can argue that countries with reliable law enforcement attract more investment and exhibit larger bond markets.[79]

Regulatory Quality (RQE) refers to perceptions of the government's ability to formulate and implement effective policies and regulations that facilitate private sector development.[80] This impacts economic factors such as investments in human and physical capital, economic incentives availability, and efficient resource allocation. Regulatory quality significantly influences economic growth by affecting investment levels.[81] By creating a stable and predictable framework for investments, high regulatory quality can encourage issuances, attract investors, and foster innovation in sustainable finance.[82]

Two variables mentioned in the study of green bond market drivers[83] are excluded from this study for the following reasons. First, Trade Freedom (TF) by the Heritage Foundation is excluded because it overlaps with other included variables, potentially leading to redundancy and confounding effects. Additionally, TF is an index calculated by a third party, introducing external biases and inconsistencies. Second, the Paris Agreement NDCs are excluded as it is a proprietary calculation by the author, lacking public availability and verifiability, which could undermine the reproducibility and transparency of the study.

Population density (POP), population divided by land area[84], may serve as a measure for the economic activity and market size of a region. Higher population density

[76] World Bank
[77] Eichengreen and Luengnarumitchai 2004
[78] LaPorta et al. 1998
[79] Tolliver et al. 2020
[80] World Bank
[81] Mauro 1995
[82] Tolliver et al. 2020
[83] Tolliver et al. 2020
[84] World Bank

often correlates with increased economic activity[85] and can impact the demand for financial instruments, including bonds.[86]

Higher education levels are associated with better financial literacy and innovation, which can influence the development of financial markets. Tertiary education enrollment rates (SET), measured by the gross enrollment ratio[87] indicates the availability of skilled labor and the potential for economic growth, both of which can affect the bond market.[88]

Services, Value Added (SVA), measures the net output of service sectors as a percentage of GDP.[89] The services sector's contribution to GDP indicates the structure of an economy. Economies with a significant service sector possess more developed financial markets[90], which in turn foster the development of more specialized and efficient technologies and thus greater potential for the issuance and trading of bonds, including green bonds.[91]

Government Expenditure (GOV), denotes government expenditure on fiscal policy and public investments, including wages, subsidies, grants, and other costs.[92] A higher proportion of public expenditure allocated to current expenses contributes positively to economic growth.[93] Therefore, government spending can lead to greater economic stability and development, which can create a favorable environment for bond markets.[94]

Foreign Direct Investment (FDI), the net inflow of foreign capital into a country[95], signals investor confidence in the economy. Beyond its direct contribution to growth, FDI indirectly boosts economic development through synergies with human capital, infrastructure, and technology.[96] This overall economic enhancement can positively impact the attractiveness of the bond market.[97]

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[85] Becker et al. 1999
[86] Lee et al. 2023, Abadie and Gardeazabal 2003
[87] World Bank
[88] Lee et al. 2023, Abadie and Gardeazabal 2003
[89] World Bank
[90] Saint-Paul 1992
[91] Lee et al. 2023, Abadie et al. 2015, Abadie and Gardeazabal 2003
[92] World Bank
[93] Devarajan et al. 1996
[94] Lee et al. 2023
[95] World Bank
[96] Mello 1997, Zhang 2001, Li and Liu 2005
[97] Lee et al. 2023

GDP per Capita Growth (GDP), reflects the annual percentage change in average economic output per person, adjusted for inflation and population changes.[98] Higher economic growth is positively correlated with expected future investment opportunities[99], potentially leading to greater demand for bonds, and also enhancing the ability to service debt.[100]

Domestic Credit to Private Sector (DCP), represents the proportion of a country's GDP that is allocated as financial resources to the private sector through various means such as loans and securities purchases[101], impacting the bond market by potentially influencing interest rates and liquidity conditions, thereby shaping investment opportunities and market dynamics. It is referred to as a standard economic growth predictor.[102]

Inflation rates (INF) affect the real return on investments and the stability of the financial environment, as the expected real return on interest rates is negatively related to the expected inflation component.[103] Lower and stable inflation is generally favorable for bond markets as it preserves the value of returns.[104]

Gross Capital Formation (GCF) is the total investment in fixed assets and inventory changes within an economy.[105] Higher capital formation indicates robust economic activity and the potential for growth, which can positively impact the bond market, including the issuance and investment in green bonds. It is referred to as a standard economic growth predictor.[106]

For each outcome variable, we use the first green bond issuance in Japan—October 2014—as a special predictor, marking the inception of Japan's green bond market and its synthetic counterpart. This variable captures the timing of market maturity, an important factor in understanding the effectiveness of subsidy interventions, as the stage of market development at which the subsidy is introduced can significantly influence outcomes.

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[98] World Bank
[99] Chen 1991
[100] Lee et al. 2023, Abadie and Gardeazabal 2003
[101] World Bank
[102] Abadie et al. 2015
[103] Fama and Gibbons 1982
[104] Abadie et al. 2015
[105] World Bank
[106] Abadie and Gardeazabal 2003

Event Study Methodology. We employ an event study methodology to examine the impact of green bond issuance on stock prices, using the Fama-French five-factor model calibrated for the Japanese market. The methodological framework follows the approach used in a prominent study on corporate green bonds.[107] Daily stock price data is sourced from Refinitiv, while the five-factor data is obtained from the Fama-French database for Japan. Event dates are identified based on the announcement date disclosed by LSEG. Stock returns are calculated using the total return index, and excess returns are determined by subtracting the risk-free rate from the individual stock returns. Initially, we identify 404 announcement dates across 177 companies. We retain only the first issuance per company, which carries the most information[108]. This reduces the sample to 177 announcement dates, which further narrows to 138 after accounting for stock data availability. Using a 200-trading day estimation window ending 20 trading days before each event date, the abnormal returns are calculated based on the Fama-French five-factor model:

$$AR_{i,t} = R_{i,t} - [R_{f,t} + \widehat{\alpha_i} + \widehat{\beta_{1,i}}(R_{m,t} - R_{f,t}) + \widehat{\beta_{2,i}}SMB_t + \widehat{\beta_{3,i}}HML_t + \widehat{\beta_{4,i}}RMW_t + \widehat{\beta_{5,i}}CMA_{i,t}]$$

where $(R_{m,t} - R_{f,t})$ is the excess market return at time t, $R_{f,t}$ is the risk-free rate, and the terms SMB_t, HML_t, RMW_t, and $CMA_{i,t}$ represent the size, value, profitability, and investment factors, respectively. Abnormal returns are aggregated into cumulative abnormal returns over specified event windows, as follows:

$$CAR_{i,t} = \sum_{t=-\tau}^{t=\tau} AR_i$$

The primary event window spans [–5, 10], with additional intervals—[–20, –11], [–10, –6], [11, 20], [21, 60]—analyzed to capture pre- and post-event effects. To ensure robustness, we also examine alternative event windows, testing whether our findings remain consistent across varying time frames. The $CARs$ are statistically evaluated using t-tests to assess whether their mean significantly deviates from zero. For further robustness, we additionally estimate expected returns using the Fama-French three-factor model and

[107] Flammer 2021
[108] Flammer 2021

the market model. This ensures that our results are not sensitive to the choice of return estimation model, providing a comprehensive assessment of the stock price response to the issuance of green bonds.

Difference-in-Differences Methodology. We follow the methodological approach of a prominent study on green bonds[109] and employ a matching-based difference-in-differences (DiD) approach to investigate the impact of green bond issuance on issuer-level outcomes. Treated firms, defined as the 177 Japanese-listed companies issuing green bonds, are matched to control firms based on several criteria to ensure comparability. These include being from the same country and two-digit TRBC economic sector, as well as proximity in firm-level characteristics: size, return on assets, market to book value, leverage, and the environment rating.[110] Matching is performed using the Mahalanobis distance, considering both the levels of these variables in the year preceding the green bond issuance ($t-1$) and their pre-trends ($t-2$ to $t-1$). The matching process reduces the sample size due to limitations in data availability for the required variables.

The DiD is specified as follows:

$$Y_{i,t} = \alpha_i + \alpha_s \times \alpha_t + \beta_1 \times Green\ bond_{i,t} + \beta_2 \times Controls_{i,t} + \varepsilon_{i,t}$$

In this model, i represents firms, t represents years, and s represents sectors. The variable Y denotes the outcome of interest—CO_2 emissions, emission intensity, and environment rating. α_i captures firm fixed effects, and $\alpha_s \times \alpha_t$ represents industry-by-year fixed effects to control for unobserved heterogeneity. The variable $Green\ bond$ is a binary indicator set to one if firm i issued a green bond, and zero otherwise. $Controls$ is a vector of control variables—total assets, return on assets, market to book value, and leverage. The error term is represented by ε. Standard errors are clustered at the industry level. The coefficient of interest, β_1, reflects the difference-in-differences in the outcome variable Y between treated firms—those issuing green bonds—and matched control firms. Specifically, β_1 quantifies the change in Y associated with a green bond issuance,

[109] Flammer 2021

[110] Specifically, we use the following variables from LSEG: Total Assets (WC02999), Return on Assets (WC08326), Market to Book Value (MTBV), Total Debt % Total Capital (WC08221), and Environment Pillar Score (ENSCORE)

while accounting for simultaneous changes in Y observed in comparable firms that did not issue green bonds. Data for the matching and outcome variables is sourced from LSEG, covering the timeline from 2010 to 2024, with the earliest issue year of a green bond from a listed Japanese company being 2019.

Limitation A limitation of our study is the uncertainty surrounding whether the subsidy truly incentivizes the issuance of new green financial instruments or simply results in the reclassification of existing ones. While we observe a significant increase in green bond issuance (*BondCount*), overall market volume (*MarketVolume*), and the number of unique issuers (*UniqueIssuers*) post-subsidy—indicators that suggest a strengthening green finance market—it remains unclear whether the subsidy specifically prompts firms to issue bonds solely because of the program. While comparing the use of proceeds for conventional bonds before and after the subsidy introduction could help identify whether existing green projects were reclassified as green bonds, such an analysis is unreliable and inconclusive, as conventional bonds are typically issued for general purposes and do not disclose detailed use-of-proceeds information[111]. Further, such an analysis might not fully account for other overlapping policies, market conditions, regulatory changes, and company-level dynamics that could influence green bond issuance.

Regarding the methodology, critics of the SCM raise concerns about the potential impact of unmeasured factors and heterogeneous treatment effects on outcome measurement. However, by matching on pre-intervention outcomes, we can effectively control for these unmeasured factors, provided that sufficient pre-intervention data is available. This ensures that any observed post-intervention differences between the treated and synthetic units are attributable to the intervention itself rather than to pre-existing conditions.[112]

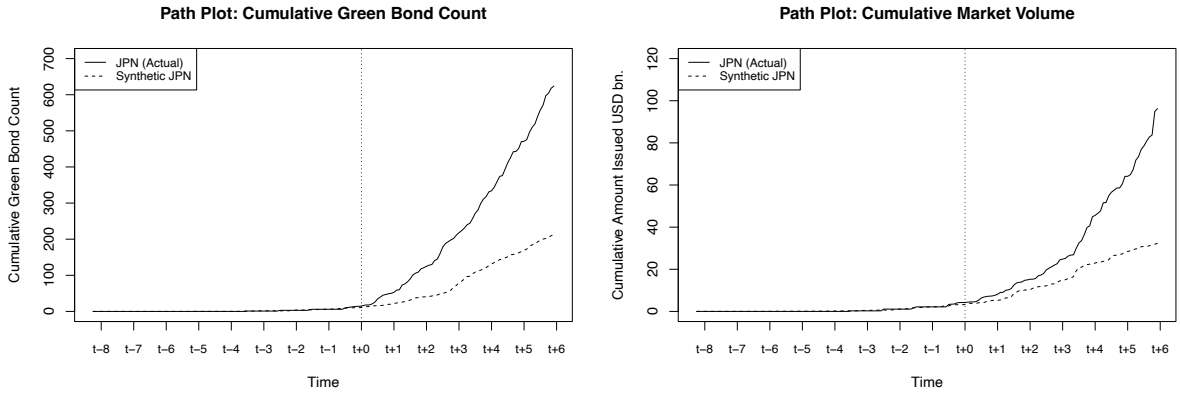
A key challenge in studying the impact of green bond issuance on issuer-level outcomes is the difficulty of establishing causality. Issuing companies may differ from non-issuers in unobservable ways, such as their underlying commitment to sustainability, which could influence both their decision to issue green bonds and their

[111] LSEG only labels 0.48% as use of proceeds bonds from 07.2007 onwards
[112] Abadie et al. 2010

subsequent environmental performance. This raises the question of whether observed changes are directly attributable to green bonds or driven by other factors. To address this issue, we employ a matching-based DiD approach. This method pairs green bond issuers with similar non-issuers based on observable characteristics such as environmental performance, profitability, size, and industry. By comparing these matched groups, we aim to reduce selection bias and isolate the impact of green bond issuance.

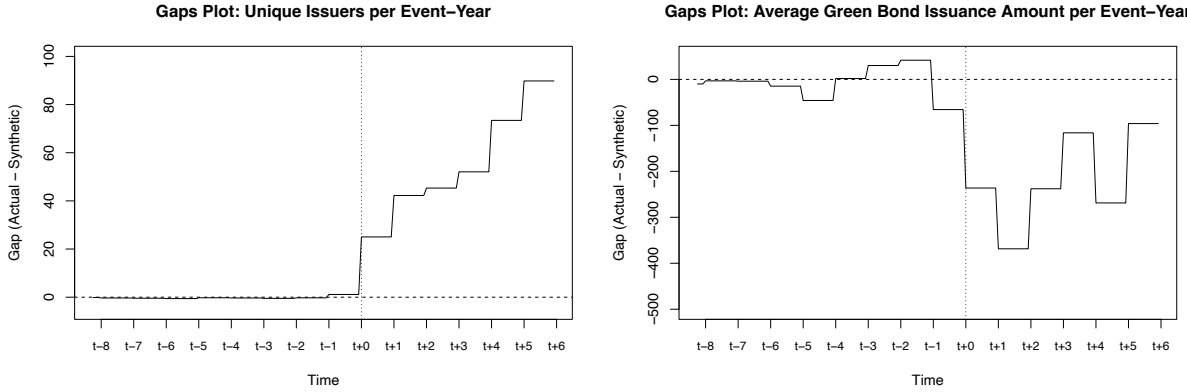
R package. The necessary computations for our analysis are conducted using the statistical software R, with the Synth package specifically employed for implementing the SCM.

Figure 1: Trends in green bond issuance: Japan vs. synthetic Japan path plots



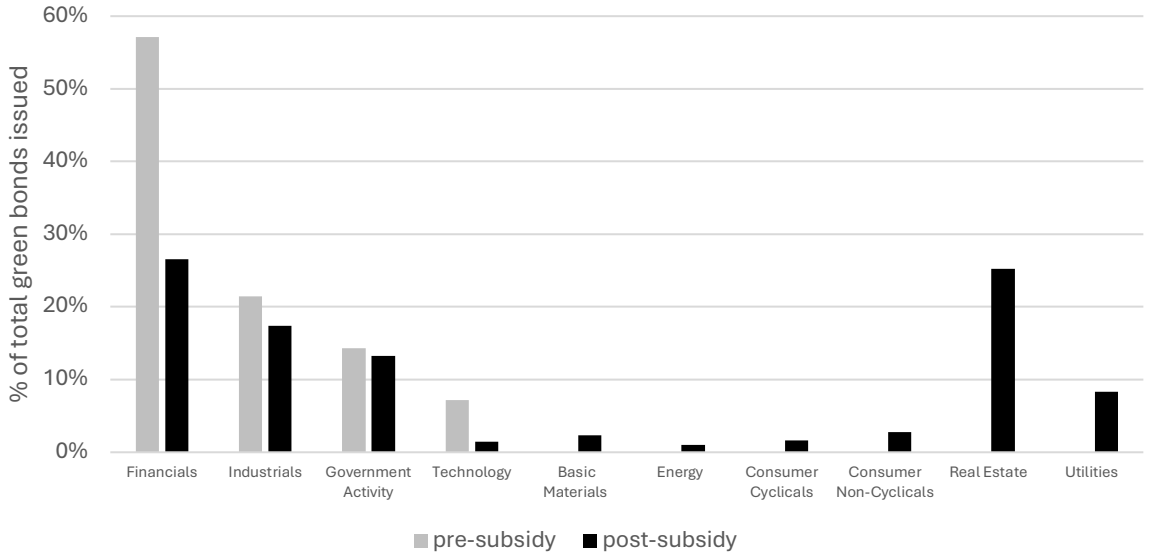
Path plot of the cumulative green bond count (*BondCount)* and the green bond market volume *(MarketVolume)* for Japan (solid line) and its synthetic counterpart (dashed line). The dashed vertical line marks the introduction of the subsidy in 04.2018.

Figure 2: Trends in green bond issuance: Japan vs. synthetic Japan gaps plots



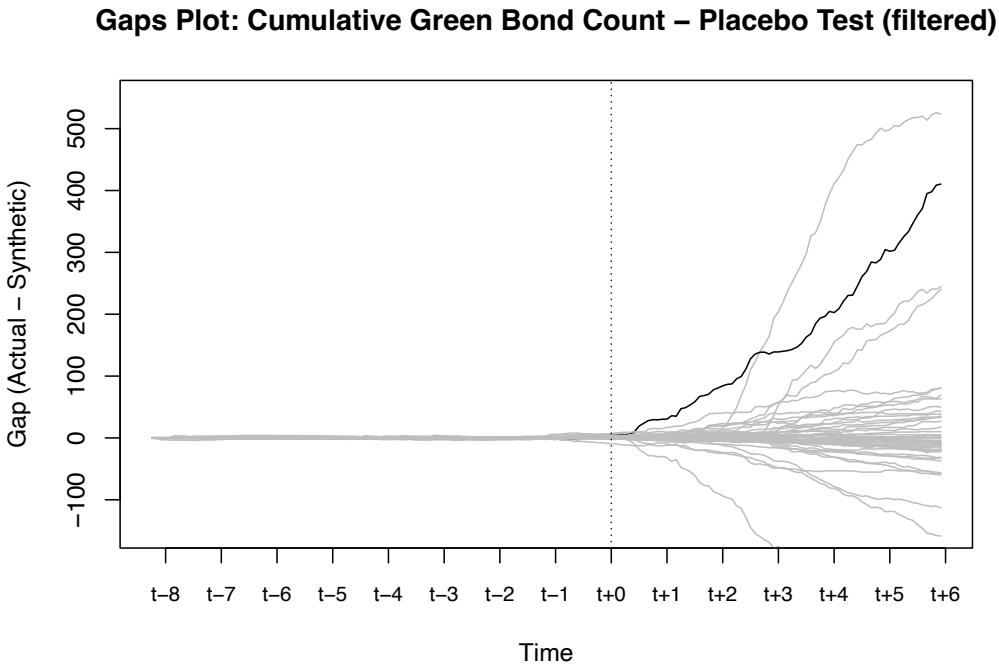
Gaps plot of the difference in unique issuers (*UniqueIssuers*) and average green bond issuance amount in USD million (*IssuanceAmount*) per event-year between Japan and its synthetic counterpart, with the synthetic control serving as the baseline. The dashed vertical line marks the introduction of the subsidy in 04.2018.

Figure 3: Sector distribution before and after subsidy introduction



The figure reports the percentage share of total green bonds issued across the TRBC 2-digit sectors during the pre- and post-subsidy period.

Figure 4: Trends in green bond count (*BondCount*): Placebo test



Gaps plots for the placebo test of the cumulative green bond count (*BondCount*). Treatment is falsely assigned to control units from the donor pool. Grey lines show gaps plots for placebo-treated units, the black line shows Japan's gaps plot. Countries with a pre-subsidy MSPE 20 times higher than Japan are discarded. The dashed vertical line marks the introduction of the subsidy in 04.2018.

Table 1: Event study results to the green bond announcement

	FF5M			
Event time	CAR	Std. err.	T-statistic	P-value
[-20:-11]	0.0026	0.0408	0.7393	0.46
[-10:-6]	0.0034	0.0340	1.1661	0.25
[-5:10]	0.0011	0.0446	0.2948	0.77
[11:20]	0.0011	0.0148	0.8625	0.39
[21:60]	0.0041	0.0269	1.7782	0.08 *

This table reports the stock market reaction to the announcement of a green bond issuance. We report the average cumulative abnormal return (CAR) for different event windows with the announcement of the green bond issuance designated as the event. The sample consists of $N = 138$ Japanese first-time green bond issuances. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Table 2: Environmental performance following green bond issuance

	Environmental performance					
	Environment rating		CO_2 emissions		Emission intensity	
Green bond	-0.663	-0.865	1,753.156	1,645.438	79.917	62.345
	-2.127	-2.122	-1,836.021	-1,749.965	-82.561	-67.107
Total assets (log)		2.572		2,761.522		222.962
		-3.038		-2,493.641		-262.366
Return on assets		-0.162		-30.257		-55.005
		-0.107		-58.185		-35.855
Market to book value		-0.189**		5.487		-7.353
		-0.061		-28.599		-10.391
Leverage		0.045		74.924		1.080
		-0.083		-94.191		-10.187
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,732	1,725	1,460	1,456	1,460	1,456
R-squared	0.838	0.838	0.901	0.904	0.933	0.938

The table reports the estimates of the difference-in-differences regression. Green bond is a dummy variable equal to one if the issuer issued a green bond. Environment rating, CO_2 emissions, and control variables are obtained from LSEG. CO_2 emissions is reported in tons. Emission intensity is calculated as the ratio of CO_2 emissions to total assets and expressed in tons of CO_2 per billion JPY. The sample includes all firm-year observations of the treated and matched control firms from 2010-2024. Standard errors (reported in parentheses) are clustered at the two-digit TRBC economic sector level. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

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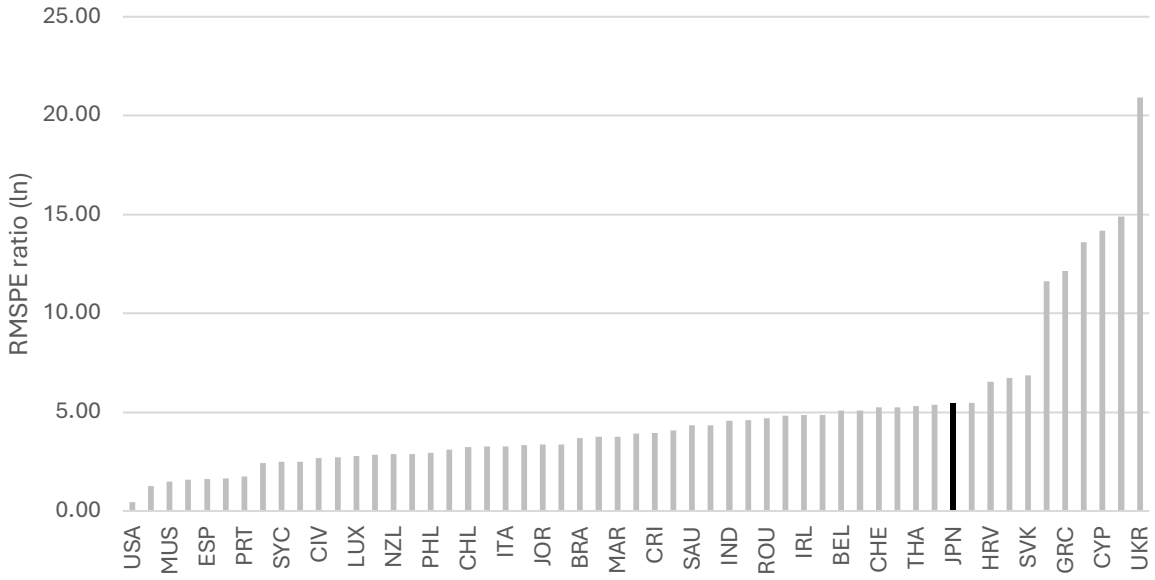
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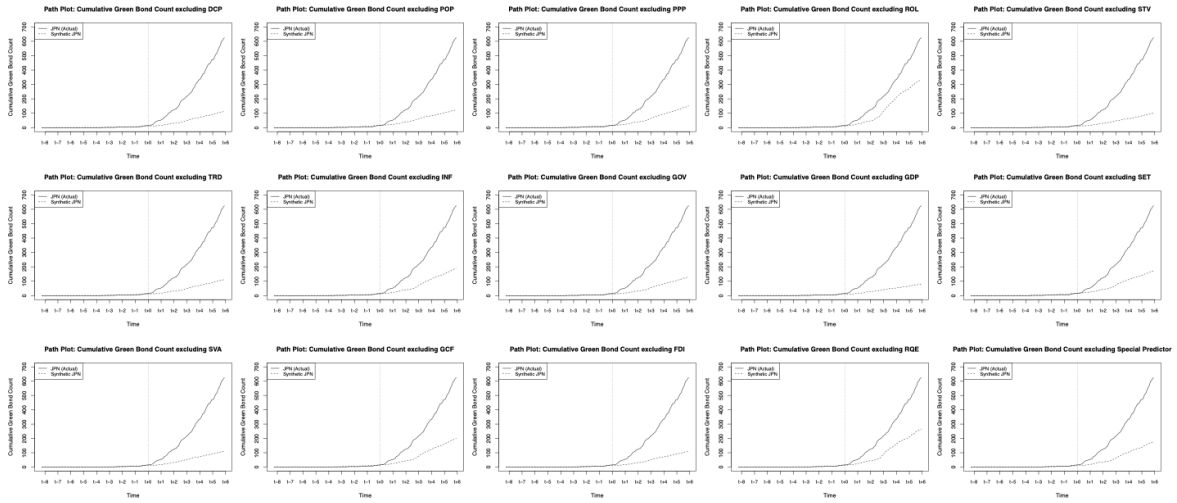
Online Appendix (OA)

OA Figure 1: RMSPE ratio (ln) of the green bond count *(BondCount)*



This figure reports the natural logarithm (ln) of the RMSPE ratio of the cumulative green bond count (*BondCount*), which is the ratio of post-intervention RMSPE to pre-intervention RMSPE. Placebo tests form the basis for the calculation of the pre- and post-RMSPE. Japan, represented by the black bar, demonstrates a high post-intervention RMSPE, along with a notably low pre-treatment value. However, some countries achieve even closer pre-treatment fits, which lowers Japan's RMSPE ratio in comparison, resulting in higher overall ratios for those countries.

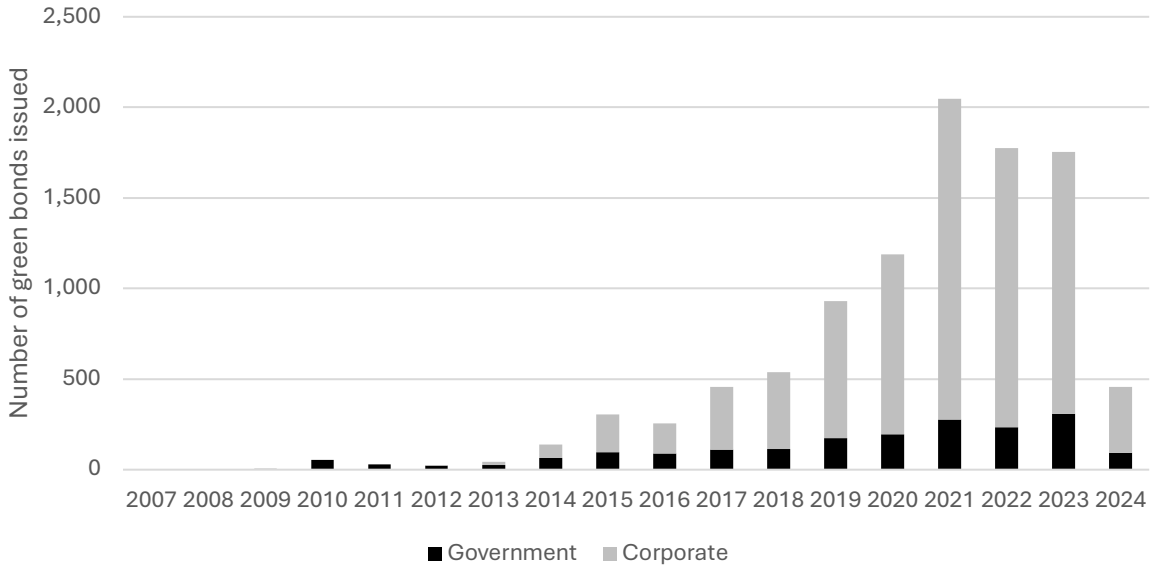
OA Figure 2: Trends in green bond count (*BondCount*): Sensitivity analysis



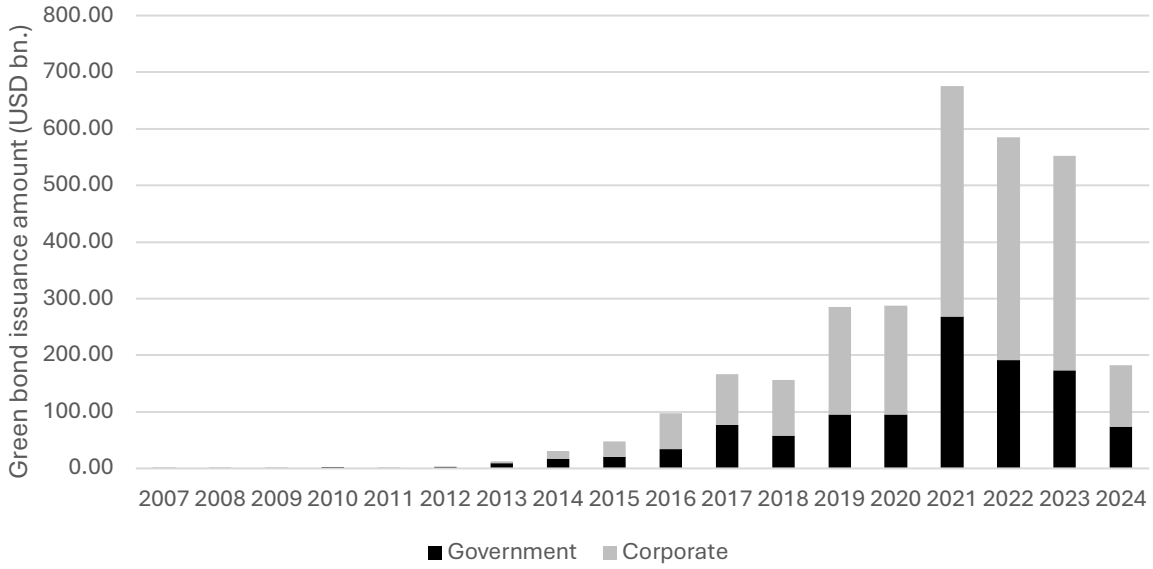
Path plots for the sensitivity analysis of the predictor variables of the green bond count (*BondCount*). Baseline model is repeatedly re-estimated to generate a synthetic unit, systematically excluding one of the predictor variables in each iteration. Solid line represents Japan, dashed line synthetic Japan. The dashed vertical line marks the introduction of the subsidy in 04.2018.

OA Figure 3: Green bond issuance over time

Panel A: Number of green bonds issued



Panel B: Issuance of green bonds in USD billion



The figure reports the annual count of green bonds issued and their total issuance volume in USD billion, covering all green bonds issued from July 2007 to March 2024.

OA Table 1: Issuer characteristics before and after matching

		Mean	Std. dev.	P-value	
Panel A. Unmatched characteristics					
Total assets	Green bond	17,581,352,059.69	56,736,643,980.78	0.03	**
	Unmatched control	3,333,078,511.50	12,488,574,864.60		
Return on assets	Green bond	3.10	4.60	0.01	**
	Unmatched control	4.42	5.38		
Market to book value	Green bond	1.14	0.75	0.00	***
	Unmatched control	1.93	4.15		

Leverage	Green bond	46.62	20.32	0.00	***
	Unmatched control	28.22	22.89		
Environment rating	Green bond	67.36	21.75	0.00	***
	Unmatched control	48.77	27.80		
Δ Total assets	Green bond	235,741,941.08	1,786,973,085.51	0.71	
	Unmatched control	159,771,322.79	1,118,136,404.97		
Δ Return on assets	Green bond	-0.41	3.07	0.12	
	Unmatched control	0.15	4.03		
Δ Market to book value	Green bond	-0.08	0.31	0.47	
	Unmatched control	-0.02	5.04		
Δ Leverage	Green bond	0.60	6.75	0.35	
	Unmatched control	-0.13	5.87		
Δ Environment rating	Green bond	3.47	8.94	0.10	*
	Unmatched control	1.76	8.06		
Panel B. Matched characteristics					
Total assets	Green bond	17,581,352,059.69	56,736,643,980.78	0.55	
	Matched control	12,712,450,942.48	42,385,548,540.26		
Return on assets	Green bond	3.10	4.60	0.84	
	Matched control	3.26	5.23		
Market to book value	Green bond	1.14	0.75	0.32	
	Matched control	1.26	0.68		
Leverage	Green bond	46.62	20.32	0.26	
	Matched control	42.87	20.71		
Environment rating	Green bond	67.36	21.75	0.79	
	Matched control	66.45	21.25		
Δ Total assets	Green bond	235,741,941.08	1,786,973,085.51	0.83	
	Matched control	294,403,836.91	1,560,942,743.93		
Δ Return on assets	Green bond	-0.41	3.07	0.87	
	Matched control	-0.49	2.75		
Δ Market to book value	Green bond	-0.08	0.31	0.47	
	Matched control	-0.04	0.36		
Δ Leverage	Green bond	0.60	6.75	0.66	
	Matched control	0.15	5.99		
Δ Environment rating	Green bond	3.47	8.94	0.57	
	Matched control	2.74	6.77		

The table reports descriptive statistics of the treated and control firms, before and after matching. Treated firms are defined as the ones issuing green bonds. Variable levels are measured in the year preceding the green bond issuance ($t-1$), while the pre-trends, denoted by Δ, are measured as the change between $t-2$ and $t-1$. We report the mean, standard deviation and the p-value of the difference in means test. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

OA Table 2: Event study results to the green bond announcement (extended)

		FF5M		
Event time	CAR	Std. err.	T-statistic	P-value
[-20:-11]	0.0026	0.0408	0.7393	0.46
[-10:-10]	0.0042	0.0577	0.8652	0.39
[-10:-6]	0.0034	0.0340	1.1661	0.25
[-5:5]	0.0001	0.0386	0.0327	0.97
[-5:10]	0.0011	0.0446	0.2948	0.77
[-2:2]	-0.0025	0.0271	-1.0965	0.27
[-1:1]	-0.0013	0.0215	-0.7018	0.48
[-2:0]	-0.0015	0.0243	-0.7362	0.46
[-1:0]	-0.0004	0.0193	-0.2622	0.79
[0:1]	-0.0012	0.0185	-0.7765	0.44
[0:2]	-0.0014	0.0209	-0.7762	0.44

[0:5]	0.0017	0.0294	0.6878	0.49	
[0:10]	0.0027	0.0381	0.8428	0.40	
[11:20]	0.0011	0.0148	0.8625	0.39	
[21:60]	0.0041	0.0269	1.7782	0.08	*

FF3M

Event time	CAR	Std. err.	T-statistic	P-value	
[-20:-11]	0.0023	0.0418	0.6539	0.51	
[-10:-10]	0.0037	0.0573	0.7517	0.45	
[-10:-6]	0.0042	0.0327	1.5235	0.13	
[-5:5]	-0.0001	0.0391	-0.0191	0.98	
[-5:10]	-0.0003	0.0451	-0.0700	0.94	
[-2:2]	-0.0024	0.0271	-1.0623	0.29	
[-1:1]	-0.0016	0.0206	-0.9338	0.35	
[-2:0]	-0.0016	0.0240	-0.7683	0.44	
[-1:0]	-0.0009	0.0182	-0.5944	0.55	
[0:1]	-0.0012	0.0181	-0.7567	0.45	
[0:2]	-0.0013	0.0207	-0.7511	0.45	
[0:5]	0.0012	0.0292	0.4836	0.63	
[0:10]	0.0010	0.0373	0.3138	0.75	
[11:20]	0.0015	0.0143	1.1890	0.24	
[21:60]	0.0039	0.0240	1.8936	0.06	*

MM

Event time	CAR	Std. err.	T-statistic	P-value	
[-20:-11]	0.0025	0.0431	0.6795	0.50	
[-10:-10]	0.0067	0.0622	1.2717	0.21	
[-10:-6]	0.0060	0.0345	2.0446	0.04	**
[-5:5]	0.0011	0.0436	0.2891	0.77	
[-5:10]	0.0010	0.0493	0.2387	0.81	
[-2:2]	-0.0023	0.0307	-0.8822	0.38	
[-1:1]	-0.0024	0.0230	-1.2034	0.23	
[-2:0]	-0.0013	0.0258	-0.6089	0.54	
[-1:0]	-0.0013	0.0195	-0.7544	0.45	
[0:1]	-0.0019	0.0196	-1.1533	0.25	
[0:2]	-0.0018	0.0228	-0.9204	0.36	
[0:5]	0.0011	0.0326	0.3910	0.70	
[0:10]	0.0010	0.0398	0.2994	0.77	
[11:20]	0.0006	0.0144	0.5163	0.61	
[21:60]	0.0036	0.0258	1.6184	0.11	

This table reports the stock market reaction to the announcement of a green bond issuance. We report the average cumulative abnormal return (CAR) for different event windows with the announcement of the green bond issuance designated as the event. The results are presented for three models used to estimate expected returns: the Fama-French five-factor model, the Fama-French three-factor model, and the market model. The sample consists of $N = 138$ Japanese first-time green bond issuances. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.