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Selection and Pricing of Green and Sustainability-Linked Corporate Bonds

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Abstract

We examine when firms choose to issue green or sustainability-linked bonds (SLBs), and how these bonds are priced relative to regular bonds. We hypothesize that firms are more likely to issue green bonds when credit spreads are high ("reaching for features"). Using recent data on corporate bond issues in US dollars, yen, and euros, we estimate a trivariate probit model and find evidence consistent with this hypothesis. Further, higher emission firms are more likely to issue SLB securities, while companies that do not disclose emissions are less likely to issue environmental securities. We consider matching, OLS, and using a heteroskedasticity-based instrument to see how green and SLB securities are priced. During the 2019 to 2022 period, regression methods suggest sustainability-linked bond spreads were issued at 29 to 43 basis points tighter than regular bonds. Green bonds were also priced tighter than regular bonds, although this difference is not always statistically significant.

Keywords: Greenium; Green Bonds; Sustainability-linked Bonds; Selection Model

JEL Classification: G12; G15; Q30; M48

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I. Introduction

The first green bond was issued by the World Bank in 2008, while the first sustainability-linked bond (SLB) was issued by the energy company Enel in September of 2019.[1] Since then, the market for both types of securities has expanded greatly, with municipalities, agencies, and corporations issuing both types of securities. In this study, we address two issues. First, we analyze what market and firm characteristics lead companies to issue green or SLB securities. Second, we expand on the unresolved question of whether these types of securities carry a price premium (or greenium as the additional value of a green bond is sometimes called).

We hypothesize that issuers may be more willing to add potentially restrictive environmental features when markets for regular corporate bonds are less favorable. That is, Becker and Ivashina (2015) describe how insurance companies which invest in corporate bonds "reach for yield" within a given rating. Similarly, we expect issuers to consider adding bond features which reduce spreads if market conditions are less advantageous, and we term this process "reaching for features." Specifically, we use a trivariate multinomial probit to model firms' decisions on whether to issue a regular, green, or SLB security. We gather all large public corporate bond issues in US dollars, Yen, or euros by firms from the 10 countries with the most observations from September 2019 through 2022. We consider country-level, industry-level, currency-level, and firm-level determinants of the type of bond issue.

The results from our first-stage specification show that firms are more likely to choose green bond –and to some degree SLB issues –when spreads are high. Based on our selection model estimates, a one standard deviation increase in the quality spread (approximately 46 basis points)

[1] Green bonds are issued with the understanding that their proceeds will go towards pre-determined environmentally related projects, whereas SLBs include covenants which make the cost of debt contingent on the achievement of sustainability performance targets.

implies a 1.33% increase in the probability of issuing a green bond. Given that 5.65% of our sample is made up of green bonds, a one standard deviation increase in the quality spread translates to a 23.6% increase in the probability of green bond issuance. Thus, firms reach for these additional features when market conditions are worse. This self-selection makes correcting for market conditions important when examining pricing. Otherwise, even within the same firm, spreads on green bonds are likely to be high due to the market conditions when these bonds are issued rather than due to the green feature.

The increase in green bond and SLB issuance when firms face higher yields is consistent with either firms switching to greener projects when financing is more expensive or with firms misclassifying projects as green to take advantage of lower spreads. While detailed data on project type (and alternatives) is not available, Flammer (2021) finds that green bond issuers improve their environmental impact, which is consistent with at least some firms switching to greener projects.[2]

Additionally, firms that do not report CO_2 emissions are much less likely to issue either green bonds or SLBs. After all, SLBs typically include contractual obligations to reduce emissions, and therefore firms that do not report are unlikely to credibly issue these securities. SLB issuers are also more frequently firms with low growth opportunities, high tangible assets, and low credit ratings. The average Moody's credit rating for an SLB issuer is only Ba1, whereas the average green bond issuer is rated A3, and the average regular bond issuer is rated Baa2.

To provide some sense of how demand for these securities has increased, we note that in the U.S. the number of sustainability-focused bond funds grew from 39 in 2018 to 112 in 2021, with 99 out of these 112 funds focusing on taxable bonds while the rest invest in municipal bonds. At the same time, fund inflows to sustainability-focused bond funds grew from approximately $1.7

[2] Moreover, we find no evidence that markets value third-party opinions certifying the environmental quality for our sample. This suggests that markets believe firms are actually undertaking green projects when they issue green bonds.

billion in 2018 to $11.1 billion in 2021 (Morningstar, 2018 and 2021). Given this growth in the demand for ESG (environmental, social, and governance) bonds, as well the recent increase in the greenium for German sovereign bonds documented by Pastor, Stambaugh, and Taylor (2022), we expect to find a larger greenium than in Flammer (2021), who only considers bonds issued up to 2018. Given the stricter nature of SLB securities, which commit the firm to reaching a sustainability goal otherwise they provide additional coupon payments, we expect a larger greenium on SLB issues.

After examining the issuance decision, we consider whether green and SLB securities are priced differently from regular bonds. The prior research on this topic has been mixed, with Larcker and Watts (2020) finding that yields on green and regular municipal bonds issued by the same entity on the same day are equal, and Flammer (2021) finding no difference between the spreads of green corporate bonds and a matched sample of regular bonds. In contrast, Deng, Tang, and Zhang (2020) find a greenium of 79 basis points for securities issued for a fully green purpose in their sample of Chinese corporate bonds, and Kolbel and Lambillon (2022) find a spread of 9 basis points on their sample of SLBs. We consider a more recent and larger sample than prior studies using corporate bond issues in US dollars, euros, or yen from 10 different countries.

Corporations do not issue both green and regular bonds on the same day, thus we require a different method to determine the pricing of green and SLB issuances than that used by Larcker and Watts (2020). Following Flammer (2021), we first consider several matched sample techniques, where we separately match green and SLB securities to regular securities based on firm and market characteristics. However, nearest neighbor matching (as used by Flammer, 2021), produces estimated spreads which vary depending on the choice of matching characteristics.

We therefore consider regression methods with controls for industry and market conditions, as well as an instrumental variable procedure where the first stage models the firms' trivariate selection decision. Specifically, we use the heteroskedasticity in our selection model as one possible set of instruments (see Lewbel 2012, 2018).

These regression methods provide a range of greeniums, from 14 to 19 basis points for green bonds and from 29 to 43 basis points for SLBs. The estimates for green bonds are only significantly different from zero in the instrumental variable specification, whereas the estimates for SLB securities are significant in all specifications. The magnitudes are consistent with the notion that the market currently provides a lower cost of capital to issuers who provide green or SLB securities.

We contribute to the literature by estimating an empirical model for when firms are more likely to issue green or SLB securities. We show that when companies face higher market spreads, they are more likely to issue green securities. Rather than "reaching for yield," issuers "reach for features" to keep costs down. Second, we show that firms with greater emissions are more likely to issue SLB securities, while firms that do not report emissions are much less likely to do so. Third, we demonstrate how different methods affect the estimation of the premium for green and SLB securities. We compare the estimates from using different matched sample, OLS, and instrumental variable models to estimate the premiums for green and SLB securities.

II. Literature Review

II.A. Prior Empirical Findings on Spreads

The growth in green bond issuance has been accompanied by a growth in the literature, with Cheong and Choi (2020) providing an early review of the literature. Many of the findings have focused on municipal bonds, with Larcker and Watts (2020) showing that green and non-green bonds issued simultaneously by a municipality have similar spreads. However, Baker, Bergstresser, Serafeim, and Wurgler (2022) show that municipal green bonds trade at a slight premium (about 5 to 9 basis lower spreads) except when issued at the same time as a non-green bond, and in that case, the premium emerges over time. Pastor, Stambaugh, and Taylor (2022) also find that the greenium increased after 2020 for green German government bonds relative to regular German government bonds.

Flammer (2021) considers corporate green bonds issued in the 2013 to 2018 period and finds a positive stock price response to green bond issuance. Similar to Tang and Zhang (2020), Flammer also documents an improvement in corporate environmental performance after a green bond issuance, and that there is no significant pricing difference between green bonds and a matched sample of regular bonds. That said, Flammer's findings on pricing are based on a relatively small sample of 152 green bonds and an equally sized matched sample of regular bonds, and her sample ends in 2018, whereas our sample begins in 2019 (when the first SLB was issued) and ends in 2022.

In contrast to Flammer (2021), Deng, Tang, and Zhang (2020) and Ehlers and Packer (2017) find a significant difference between the pricing of green and nongreen bonds. Using a sample of Chinese bonds issued from 2016 to 2018, Deng et al. find that bonds whose purpose is fully green trade at spreads which are 79 bp lower than similar nongreen bonds. Deng et al. also find that firms which employ third-party verification for the green projects have lower bond spreads, and this difference is as high as 126 basis points for all green projects which use international third-party verification. Ehlers and Packer find a smaller 18 bp difference in their sample of US dollar and euro denominated green bonds relative to similar regular bonds. More recently, Kolbel and Lambillon (2022) examine the pricing of SLBs and find that they had an average 9 basis point lower spread than regular corporate bonds.

We also find tighter spreads on green bonds at issuance, although not as large as those found by Deng et al. Our results for SLB securities suggest a larger spread difference than in Kolbel and Lambillon (2022).

II.B. Theory

The theoretical literature on the issuance of these securities is still at an early stage. Barbalau and Zeni (2022) provide a theoretical model where firms choose between issuing green and SLB securities. They show that both types of securities may be issued depending on signaling and how much firms are able to manipulate green outcomes. Additionally, firms with higher historic emission intensity are more likely to issue SLB securities. Our choices of variables to explain firms' issuance choices are partly motivated by this theory, as we also consider firm-level or industry-level pollution and ESG reporting as determinants of issuance type.

Ramadorai and Zeni (2021) show that current and future abatement of environmental emissions can be explained by a two-firm model with cross-firm information asymmetry and reputational externalities. Additionally, Hsu, Li, and Tsou (2022) provide a general equilibrium model of how uncertainty about future environmental regulation impacts the pricing of equity securities. Empirically, they show that equity returns from high pollution emissions firms generate a 4.42% annual premium over the returns from low pollution emissions firms. Prior papers also show that carbon risk and hazardous chemical emissions are priced in financial markets; see, for example, Chava (2014), Bolton and Kacperczyk (2021), and Sautner, van Lent, Vilkov, and Zhang (2023).

II.C. Prior Empirical Findings on Issuance Choice

In contrast to the relatively large literature on green bond spreads, the literature on whether a firm chooses to issue green bonds is much smaller. Recently, Cicchiello, Cotugno, Monferra, and Perdichizzi (2022) examine the choice between issuing regular and green bonds for a sample of European issuers. They find that firms with more long-term debt and with a higher current ratio are more likely to issue green bonds. Garcia, Herrero, Miralles-Quiros, and Miralles-Quiros (2023) show that firms with higher environmental scores and with sustainability committees are more likely to issue green bonds. Using a sample of European and Chinese bond issues, Dutordoir, Li, and Neto (2024) find that firms are more likely to issue green bonds if they get more reputational gains from being seen as environmentally friendly. We are not aware of any prior works that examine the choice of issuing green, SLB, or regular bonds simultaneously.

III. Methods

We provide two types of analysis in this study: a choice model for whether a firm decides to issue regular, green, or SLB fixed income securities, and a pricing model which measures differences in how the market prices these different types of bonds. We also combine these models by using the choice model to instrument for self-selection in the pricing equation.

III.A. Selection Model

We model the firm's issuance decision using a multinomial probit, where the outcome variable is whether the firm issues a regular, green, or SLB security.[3] The advantage of using a trivariate multinomial probit is that it does not suffer from the independence of irrelevant alternatives (IIA) problem. As McFadden (1974) shows, multinomial logit models require the IIA property to be valid, and we do not expect this condition to hold among the bond choices we consider.[4] The disadvantage of using the multinomial probit is that maximizing the likelihood can be slow, although with only three alternatives this issue is still manageable.

Let Y_i denote the choice of which type of security firm *i* issues. And denote the latent variables associated with firm *i*'s profit from issuing regular, green, and SLB securities as $Y_i^{regular*}$, Y_i^{green*}, and Y_i^{SLB*}. The multinomial probit can be specified as corresponding to the following equations:

$$Y_i = \begin{Bmatrix} 1 \; if \; Y_i^{regular*} > Y_i^{green*} \; and \; Y_i^{regular*} > Y_i^{SLB*} \\ 2 \; if \; Y_i^{green*} > Y_i^{regular*} \; and \; Y_i^{green*} > Y_i^{SLB*} \\ 3 \; if \; Y_i^{SLB*} > Y_i^{green*} \; and \; Y_i^{SLB*} > Y_i^{regular*} \end{Bmatrix}$$

The firms' managers do not need to be pure profit maximizers; they may instead have some other utility function based on their own or the firms' stakeholders' preferences. In that case, the latent variables would correspond to the unobserved utilities rather than profits.

[3] An alternative method would use a bivariate choice model to compare environmental (green and SLB) vs. non-environmental issues. However, such an approach would overlook the differences between the motivations of green and SLB issuers that are highlighted in the trivariate model.

[4] The IIA property requires that the odds ratio between any two alternatives is independent of whether a third alternative is present. McFadden (1974) provides the red bus/blue bus example, where a commuter has a choice between taking a red bus or driving to work. If a second type of bus, the blue bus, also becomes available, the IIA property requires that this not affect the odds ratio between the red bus and driving. If the buses are otherwise identical, the commuter would be indifferent between taking a red or blue bus, and the IIA property would not hold. In general, we do not expect the IIA property to hold in the bond issuance space we consider.

We then assume a linear specification for the latent variables, and we normalize against one of the alternatives; thus, the estimated coefficients correspond to how much a particular variable impacts the choice for green relative to regular or SLB relative to regular. We estimate:

$$\begin{cases} Y_i^{green*} = X_i\beta^{green} + \varepsilon_i^{green} \\ Y_i^{SLB*} = X_i\beta^{SLB} + \varepsilon_i^{SLB} \end{cases} \qquad (1)$$

Note that our estimated parameters for the green choice capture the difference between the impact of a particular variable on the choice of green relative to the choice of a regular bond. Our X variables include Tobin's Q (market value of equity plus book value of debt divided by total assets), the firm size (log of total assets), leverage (debt as a fraction of total assets), tangibility (property, plant, and equipment divided by total assets), and ROA. We also include the rating of the firm, from 1 for C-rated firms to 21 for AAA rated firms, as well as a dummy variable if the firm is unrated. To test our hypothesis about market conditions and issuance choice, the independent variables include the treasury rate and the quality spread — equal to the average BAA rate minus the treasury rate for a given currency and maturity.[5]

Given the theoretical setup in Barbalau and Zeni (2021), we include the firm's CO_2 emissions and the firm's ESG score from the prior year. Barbalau and Zeni's model predicts that, in the presence of asymmetric information, firms with higher historical CO_2 emission levels find it optimal to issue contingent green debt, such as SLBs. Firms with greater discrepancy between their sustainable image—measured by the firm's ESG score—and a credible signal of environmental commitment also find it optimal to issue SLBs. Thus, these variables are expected to capture the key factors that determine optimality in a sustainable debt contract. We also include

[5] We use the quality spread from 10 business days prior to the issuance date, as this would more likely capture the firm's timing of what type of security to issue, although our findings are not sensitive to this lag. We use the German treasury rate as the benchmark for the euro market.

the country-industry-year average of CO_2 and ESG, as these variables may determine the market demand for green or SLB issues. While firm-level CO_2 and ESG variables may be endogenous with the later bond pricing, we expect the country-industry-year average of CO_2 and ESG to be related to ease of issuance for these securities but not to the pricing of individual bonds. We also include indicator variables for whether CO2 or ESG are missing. The choice regression also incorporates industry (based on 2-digit GICS codes), country, and currency fixed effects. As the time period we use is relatively short, we include a time trend; and including non-linear time trend variables does not meaningfully change the results.

Given the short time period and our inclusion of country fixed effects, we are unable to consider institutional differences between countries. That said, we add an indicator variable for whether the issuer's country added a new environmental law. For instance, Germany added a new climate protection law on December 12, 2019, and thus we set our *new_law* indicator equal to zero for German issuers prior to that date and equal to one after that date.

III.B. Pricing Models

We consider several methods to estimate the difference in issuance spreads between green and regular, or SLB and regular, bonds. Our first method matches green bonds to similar regular bonds and SLBs to similar regular bonds. As in Flammer (2021), we use the nearest-neighbor technique which requires an exact match for country and industry, then minimizes the Mahalanobis distance based on five characteristics: Tobin's Q, issue size, ROA, leverage and ESG environmental scores.[6] The characteristics are from the year prior to the issuance date.[7]

We then extend this method to include an exact match on currency and rating. We add other distance-matching variables including quality spreads, treasury rates, CO_2 emissions, and tangibility ratios as these variables are significant in the selection model. We also consider a weighted matching using the MD Kernel procedure—where green bonds and SLBs are separately matched against regular bonds using an Epanechnikov weighting function—rather than a one-to-one nearest neighbor match.

Next, we provide a simple OLS regression to show the partial correlations between the variables of interest. Our pricing equation is a linear specification with indicator variables for the issuance type. We estimate:

$$Spread_i = \alpha + \gamma_1 Green_i + \gamma_2 SLB_i + \Sigma_{k=3}^{n} \gamma_k X_i^k + \mu_i \qquad (2)$$

The additional control variables in the pricing equation include firm characteristics (Tobin's Q, size, leverage, tangibility, and ROA), as well as bond characteristics including maturity and whether the security is callable. To control for other credit risk features, we include a numeric value for the firm's Moody's rating category and a separate indicator for if the firm is unrated. We also include dummy variables for industry (2-digit GICS code), country, and currency. Deng et al. (2020) find that green bonds with third-party opinions (TPO), that is those where the issuer commits to having a third-party verify the nature of the green investment, have

[6] Flammer also matches by coupon and maturity in some specifications. However, we find this problematic; as most bonds are priced at par, the coupon equals approximately the treasury rate plus the spread. Thus, matching on coupon would also match on spread if treasury rates do not change. Matching on coupon therefore biases the results towards finding no difference between green and regular bonds.
[7] Flammer (2021) matches based on these variables from both one and two years before the issuance.

lower spreads than green bonds without such opinions. We therefore run additional regressions with interactions between TPO and green and TPO and SLB indicators as robustness checks.[8]

A potential issue with an OLS estimation of equation (2) is that the choice of green or SLB is endogenous. We therefore consider an instrumental variable (IV) estimation procedure. Lewbel (2012) suggests that heteroskedasticity in the first stage estimation can be used as an instrument, and Lewbel (2018) extends this method to considering binary endogenous regressions. We apply his method, using the multinomial probit to estimate both binary endogenous regressors (green and SLB) simultaneously.

While our instruments show varying levels of statistical significance in the selection model, the Kleibergen-Paap underidentification tests suggest they meet the instrumental variable (IV) relevance criteria. We also believe these variables meet the exclusion criteria as, after controlling for company characteristics, they are unlikely to impact spreads – see Lewbel (2012 and 2018) for additional assumptions. Wooldridge (2002) discusses how using a parametric estimation in the first stage improves estimation efficiency, and we therefore use the fitted values from the multinomial probit as instruments. While Wooldridge discusses the application for a single endogenous indicator variable, the extension to multiple indicator variables (green and SLB in our case) using multinomial probit is straightforward.

The first SLB was issued in September of 2019, but the number of SLB issues is very sparse until the third quarter of 2020.[9] Given this issuance pattern, we also test how OLS and IV estimates fare using a sub-sample that starts in the third quarter of 2020.

In all estimation procedures, the continuous variables are winsorized at the upper and lower 1%. Standard errors in all pricing regressions are clustered by country.

[8] Regular bonds do not have third-party opinions, therefore TPO by itself would be collinear to the other variables.
[9] SLBs account for less than 0.1% of corporate bond issues from the 3rd quarter of 2019 until the 3rd quarter of 2020.

IV. Data and Summary Statistics

Our selection analysis incorporates data for 8,306 bonds and 825 issuers covering the period from September of 2019—the issuance date of the first sustainability-linked bond—through December of 2022. As spreads are not available for all issues, the pricing analysis includes only 6,408 bonds and 745 issuers. To create the sample, we begin with Securities Data Company's (SDC) New Issues database and screen for all corporate bonds issued in U.S. Dollars, Euros, or Japanese Yen with proceeds greater than $100 million USD during the period of interest. We further exclude issues that are equity-related, credit sensitive, payable-in-kind, collateralized debt obligations, floating rate notes, or hybrid securities. We use Bloomberg's database of self-labeled environmental bonds in the corporate market to identify the green and sustainability-linked bonds from our original sample. Our initial screen yields a sample of 26,677 regular bonds, 373 sustainability-linked bonds and 949 green bonds. SDC's database provides us with bond issuance data, including issuance and maturity dates, proceeds, callability, and the bond's spread to benchmark. From issuance and maturity dates, we compute each issue's time horizon in years. Our pricing measure and dependent variable, the spread to benchmark, is computed as the difference between the bond's yield at issue and the comparable maturity treasury yield based on currency.

We further limit our sample to only issuers from countries with at least 25 bonds and at least some green and SLB securities. Without this restriction, the sample would include issues from countries with only a small number of securities, and these are likely to either be dropped in the multinomial probit or to add noise to the estimation. That said, our results are similar if we do not use this additional filter.

We gather financial statement variables—such as total assets, Tobin's Q, tangibility ratios, return on assets, and debt to assets— from Capital IQ and environmental data—such as ESG scores and CO2 emissions per sales— from Bloomberg. The firm-level independent variables are from the year preceding issuance. Our final sample of observations used in the spread analysis consists of 5,757 regular bonds, 362 green bonds, and 289 sustainability-linked bonds. Appendix A displays a full list of the variables included in our analysis along with their respective descriptions and sources.

To control for macroeconomic conditions, we include quality spreads and treasury yields from 10 days prior to the issuance date.[10] These spreads and yields are matched to the maturity and currency of similar treasury bonds. For instance, a 5-year bond issued by a Mexican company is US dollars would be compared against the quality spread for 5-year US BAA corporate bonds and against 5-year US government bonds.[11] We compute quality spreads as the differential yield between currency-matched Baa rated corporate bonds and similar maturity treasury rates. Yields for Baa bonds and treasuries for each currency and each issuance day are obtained from Bloomberg, with the exception that Baa yields for Japanese bonds are obtained from the Japan Security Dealers Association web page. We also construct an indicator variable for whether the country passed a new environmental law during the sample period by searching the Carrots and Sticks database for mandatory laws and regulations for the countries in our sample.

Panel A of Table 1 provides a breakdown of the sample by country. The sample includes companies from 10 countries, although US bonds make up approximately 85% of the observations. However, only 49% of the green bonds come from US issuers, and only 42% of the SLBs are from

[10] We use a 10-day lag to roughly capture when the issuer would decide on bond features, although our results hold without a lag as well.
[11] We match euro bond issues against German government treasury bonds.

US issuers. Panel B of Table 1 provides a breakdown of the sample by issuing currency. Just over 80% of the sample is in US dollars.

Panel A of Table 2 shows descriptive statistics for all our variables, and Panel B of Table 2 provides descriptive statistics grouped by bond type. Both green and sustainability-linked bonds have lower average spreads, by 73 bp and 23 bp, respectively, than regular bonds. A t-test shows that these means are significantly different than the mean spreads for traditional bonds at the 1% level. Moreover, green and sustainability-linked bond issuers emit significantly more CO_2/sales and show lower environmental scores than the regular bond issuers.

Table 3 provides the correlations between the primary variables of interest. Spreads are negatively correlated with both green and SLB issuance types.

V. Estimation Results

V.A. Issuance Choice

Table 4 presents the estimates from our multinomial probit regression. Our full-sample selection model is displayed in columns 1 and 2, while our later-sample estimates – after SLB issues became more widely used– are displayed in columns 3 and 4.

Consistent with our hypothesis regarding “reaching for features,” the Quality Spread is significantly positively associated with green bond issuance for both the full sample (column 1) and the latter period sample (column 3). A one standard deviation increase in the quality spread (approximately 46 basis points) implies a 1.33% increase in the probability of issuing a green bond given the estimate in column 1—or a 23.6% increase in issuance over the unconditional probability. Higher quality spreads are also significantly related to SLB issuance in the later time period (column 4). Treasury yields are also positively significantly associated with green bond issuance for the full sample, with a one standard deviation increase in treasury yields (approximately 71 basis points) implying a 0.9% increase in the probability of green bond issuance. Thus, firms which face less favorable market conditions are more likely to reach for additional features to lower the yield. This effect helps create a bias toward similar spreads on regular and green securities in studies which match only on firm characteristics.

Consistent with Garcia et al. (2023), Column 1 of Table 4 also shows that better firm ESG scores are associated with a higher probability of issuing green bonds for the full sample. A one standard deviation increase in company ESG score is associated with a 0.6% increase in the probability of issuing a green bond, which corresponds to a 10.6% change in issuance. Higher firm-level emissions are also associated with a greater likelihood of issuing SLBs in the full sample, and issuing either green or SLB securities in the later sample**.** The estimate in column 2 implies that a one standard deviation increase in company CO2/sales is associated with a 0.9% increase in the probability of issuing an SLB. This is consistent with the findings of Barbalau and Zeni (2022), who conclude that firms with greater emission intensity are more likely to issue contingent environmental debt contracts. Moreover, for the full sample, companies which do not report CO2 emissions are 38% less likely to issue SLBs.[12] There are several potential explanations for these results. Barbalau and Zeni (2022) argue that, in the presence of low information asymmetry, firms which are better able to manipulate environmental impact information and less able to achieve green outcomes are more inclined towards regular debt.[13] This is because investors are able to distinguish whether firms have an incentive to implement the green project. However,

[12] All SLB issuers in our sample reported CO2 emissions, thus this coefficient is estimated based on the impact of reporting on regular and green issuance. The maximization is not able to estimate a significance level for this coefficient in column 4.

[13] Barbalau and Zeni (2022) define manipulation as the selective disclosure of information about a company's environmental performance so as to create a positive corporate image.

disclosure is often not optional for firms; 84.5% of our sampled bonds are issued by US firms, which are subject to the mandatory reporting rule established by the EPA in January of 2010. Disclosure thresholds vary by source category, the most common being 25,000 tons of $CO2_e$ (Tomar, 2023). This implies that, at least in some countries, firms that do not disclose CO_2 emissions are often low polluters. Low-emission firms may simply not have an opportunity to issue green or SLB securities.

Several of the firm-level control variables are also significantly related to the type of issuance. Companies with higher Tobin's Q are significantly less likely to issue both green bonds and SLBs, and larger firms are less likely to issue SLBs. Higher leverage is associated with an increased probability of issuing green bonds and a lower probability of issuing SLB securities for the full sample, and greater tangibility is positively associated with SLB issuance. ROA is also negatively associated with green issuance, while firm rating is positively associated with green bond issuance and negatively associated with SLB issuance. Overall, the evidence shows that green and SLB securities are chosen by different types of firms and that this choice is sensitive to market conditions.

V.B. Spreads on Green and SLB Securities Using Matching

We next examine several estimation methods for how much green and SLB securities differ in pricing terms from regular bonds. Our first analysis of spreads uses a matched sample analysis. Table 5 reports the match using the same variables as Flammer (2021) in columns 1 and 2 for green and SLB securities. Columns 3 and 4 additionally force an exact match for currency and rating. Columns 5 and 6 add quality spreads, treasury rates, CO_2 emissions, and tangibility ratios as distance matching variables. Columns 7 and 8 use a kernel match rather than a nearest neighbor match, allowing the treated (green or SLB issues) to be matched against a weighted average of non-treated issues. We report the average treatment effect (ATE), and, in all cases, the average treatment on the treated and the average treatment on the untreated are similar to the ATE.

When using the matching method in Flammer (2021), we find a large and statistically significant premium of 40 basis points for green bonds in column 1, and a large but not significant premium of 17 basis points for SLB securities in column 2. Adding an exact match for currency and rating, we find a smaller but still significant premium of 27 basis points for green bonds, and a larger 35 basis point premium on SLBs.

As firms are more likely to issue green bonds when market spreads are high, we anticipate that not matching on the quality spread will lead to lower estimates for the greenium. That is, a particular issuer is more likely to choose green bonds when overall market spreads are high, and therefore a comparison of spreads (even for the same issuer) are likely to be biased towards higher spreads if not adjusting for market conditions. Consistent with this self-selection, spreads for green bonds in column 5 are significantly more negative (at 53 basis points) than without correcting for market conditions in column 3.

Columns 7 and 8 of Table 5 use a kernel rather than a nearest neighbor match, and this method produces economically and statistically significant estimates of 18 and 55 basis point premiums for green and SLB securities, respectively. However, these different matching procedures produce relatively large differences in estimated premiums, and these are largely due to choosing different subsamples of green and SLB observations for comparison. Interestingly, the kernel matching procedure produces estimates close to those from OLS, and we next turn to our regression greenium estimates. In additional untabulated analyses, we consider matching within the same issuers. However, the sample size from this procedure is small, and the results are highly dependent on the choice of matching characteristics.

V.B. Regression Estimates of Green and SLB Spreads

In Table 6, we provide OLS and IV estimations of the spread equation. Columns 1 shows an OLS estimate of spread, controlling for market conditions using quality spread and treasury yield; security characteristics including issue size, maturity, and callability; and firm characteristics including size, ROA, leverage, tangibility, an indicator if the issuer is unrated, and the numerical value for the Moody's rating. [14] All specifications include industry, country, and currency fixed effects.

In column 1, green securities are issued at 19 basis point tighter spreads, while SLB securities are issued at 43 basis point tighter spreads. The difference for SLBs is significantly different from zero, while the difference for green bonds is not.

In column 2, we consider an instrumental variable specification using heteroscedasticity generated instruments. The underidentification test rejects the null hypothesis, and therefore the instruments meet the relevance criterion. Moreover, the tests for weak identification are much larger than the Stock-Yogo statistics, suggesting that weak identification is not an issue. Both the green and SLB coefficients are negative and significant (at the 5% and 1% levels, respectively) at 14 and 29 basis points. Overall, the analysis provides strong evidence that over this time period, SLB securities were priced significantly tighter than regular bonds. The evidence for green bonds

[14] One possible alternative would be to use dummy variables for each rating. However, our tests show that such a specification suffers from considerable multicollinearity, as most of the rating dummies have VIF statistics greater than 100 (where a value of 10 suggests an unacceptable level of multicollinearity).

is more mixed in terms of statistical significance, although economically the impacts are meaningful in all the analyses.

In additional untabulated tests we consider how third party opinions affect green and SLB pricing. Unlike the findings in Deng et al. (2019), we find no significant impact on how tightly green or SLB bonds trade at issuance from third party opinions in either OLS, fitted IV, or heteroskedastic IV regressions. This suggests that third party opinions are less important for the largely developed country sample we consider. We also consider estimations with additional non-linear time trend variables. The magnitude and significance of our estimates remain similar to our original specification with these additional controls.

The other control variables in the spread regressions mostly have the expected signs. Firms with better credit ratings issue lower-spread securities. Securities issued when quality spreads are high show higher spreads. Longer maturity issues and callable bonds have higher spreads as well.

VI. Conclusion

We analyze which firms are more likely to issue green or SLB securities relative to regular bonds using a trivariate multinomial probit. Our estimates show that firms facing higher yields, as reflected by a higher quality spread, are significantly more likely to issue green bonds. This result is consistent with firms "reaching for features" when market conditions are more challenging. This finding suggests that controlling for market conditions is crucial when examining pricing, otherwise green bond issues appear to have higher spreads because they are issued when market spreads are generally high.

We also find that firms with greater emissions are much more likely to issue SLB securities. Moreover, firms that do not report emissions are less likely to issue either green or SLB securities. Credit ratings also differentiate green bond issuers from SLB issuers. Better rated firms are more likely to issue green bonds, while lower rated firms are more likely to issue SLBs. Results from the selection model suggest that green and SLB securities cater to different types of firms' financing needs.

We then consider several different techniques for estimating how spreads on green and SLB issues differ from spreads on regular bonds. These methods include matching, OLS, and using instruments either based on industry characteristics and country policies or heteroskedasticity generated instruments. Matching methods provide a wide dispersion of estimated values, depending on which securities are included in the sample, while regression methods provide more consistent estimates of spreads. The estimates for SLB securities suggest that spreads at issuance are 29 to 43 basis point tighter than spreads for comparable regular bonds. Economically, green bonds are also associated with tighter spreads, although the significance of this finding is not consistent across estimation methods. Overall, the estimates suggest larger greeniums in the recent 2019 to 2022 period, and they provide new evidence on how different estimation methods impact greenium estimates.

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VII. Table 1

Panel A: Number of issues and bond spreads by country and type

Country	Total Issues	Percent	Green Bonds	SLBs	Regular Bonds	Spread (%)
Canada	44	0.69	9	1	34	2.484
France	132	2.06	34	26	72	1.042
Germany	106	1.65	37	11	58	1.333
Ireland	36	0.56	6	8	22	1.040
Italy	34	0.53	18	10	6	1.302
Japan	446	6.96	60	36	350	0.348
Mexico	41	0.64	5	21	15	2.404
Netherlands	92	1.44	8	39	45	2.838
United Kingdom	61	0.95	7	16	38	3.089
United States	5,416	84.52	178	121	5,117	1.802
Total	6,408	100.00	362	289	5,757	

Panel B: Number of issues and bond spreads by currency and type

Country	Total Issues	Percent	Green Bonds	SLBs	Regular Bonds	Spread (%)
USD	5,168	80.65	181	162	4,825	1.901
EUR	790	12.33	117	87	586	1.186
JPY	450	19.35	64	40	346	0.347
Total	6,408	100.00	362	289	5,757	

Table 2

Panel A: Full-Sample Descriptive Statistics

Variable	Count	Mean	Median	Standard Deviation	Minimum	Maximum
Spread (%)	6,408	1.704	1.150	1.426	0.116	7.961
Green	6,408	0.056	0.000	0.230	0.000	1.000
SLB	6,408	0.042	0.000	0.199	0.000	1.000
Tobin's Q	6,408	1.276	1.000	0.956	0.306	3.859
Firm Size	6,408	10.270	10.114	1.386	6.421	13.804
Leverage	6,408	0.391	0.308	0.419	0.001	2.973
Tangibility	6,408	0.281	0.143	0.451	0.001	3.833
ROA	6,408	6.579	4.980	6.342	0.100	33.920
Quality Spread	6,408	1.088	1.064	0.463	0.343	2.864
Treasury Rate	6,408	0.844	0.860	0.710	-0.675	2.390
Rating	6,408	12.308 (Baa3)	13.000 (Baa2)	4.253	1.000 (C)	21.000 (Aaa)
Unrated	6,408	0.059	0.000	0.235	0.000	1.000
CO2/Sales	6,408	0.599	0.315	2.745	0.000	10.806
CO2 Missing	6,408	0.619	1.000	0.486	0.000	1.000
Environmental Score	6,408	50.644	52.270	20.811	0.000	96.220
Environmental Score Missing	6,408	0.158	0.000	0.364	0.000	1.000
Industry CO2	6,408	0.503	0.488	0.705	0.000	10.806
Industry ESG	6,408	50.875	56.199	12.922	0.000	72.985
New Law	6,408	0.022	0.000	0.147	0.000	1.000
Issuance Amount	6,408	20.128	20.207	0.909	12.213	22.468
Maturity	6,408	2.495	2.083	1.575	.032	9.603
Callable	6,408	0.429	0.000	0.495	0.000	1.000
Time	6,408	434.471	458.000	263.904	1.000	1,206.000

Panel B: Descriptive statistics by bond type

Variable	**Full Sample**	**Green**	**SLBs**	**Regular**
Observations	6,408	362	289	5,757
Spread to Benchmark				
Mean	1.704	1.024^{c}	1.520^{c}	1.754
Std. deviation	1.426	0.775	1.131	1.458
Tobin's Q				
Mean	1.276	1.073^{c}	0.853^{c}	1.309
Std. deviation	0.956	0.935	0.727	0.961
Firm Size				
Mean	10.270	11.171	9.997	10.227
Std. deviation	1.386	1.872	1.451	1.326
Leverage				
Mean	0.391	0.835^{c}	0.608^{c}	0.353
Std. deviation	0.419	1.001	0.669	0.309
Tangibility				
Mean	0.281	0.472^{c}	0.612^{c}	0.254
Std. deviation	0.451	0.942	1.090	0.328
ROA				
Mean	6.579	2.449^{c}	4.431^{c}	6.936
Std. deviation	6.342	2.562	3.158	6.505
Quality Spread				
Mean	1.088	1.014^{c}	0.854	1.104
Std. deviation	0.463	0.500	0.212	0.470
Treasury Rate				
Mean	0.844	0.626^{c}	0.693^{c}	0.864
Std. deviation	0.710	0.794	0.729	0.700
Rating	12.308	14.802^{c}	11.247^{c}	12.202
Mean	(Baa3)	(A3)	(Ba1)	(Baa2)
Std. deviation	4.253	3.016	3.719	4.289
Unrated				
Mean	0.059	0.014^{c}	0.052^{c}	0.062
Std. deviation	0.235	0.117	0.223	0.242
CO2/Sales				
Mean	0.599	1.481^{c}	3.332^{c}	0.418
Std. deviation	2.745	3.174	4.485	1.567
CO2 Missing				
Mean	0.319	0.192^{c}	0.000^{c}	0.675
Std. deviation	0.486	0.394	0.000	0.469
Environmental Score				
Mean	50.644	32.948^{c}	28.637^{c}	52.762
Std. deviation	14.141	27.885	30.633	18.499
Environmental Score Missing				
Mean	0.158	0.536^{c}	0.566^{c}	0.115
Std. deviation	0.364	0.499	0.497	0.319
Industry CO2				
Mean	0.503	0.801^{c}	1.019^{c}	0.461
Std. deviation	0.705	1.556	1.293	0.552
Industry ESG				
Mean	50.875	36.759^{c}	31.476^{c}	52.650
Std. deviation	12.922	22.958	25.863	9.414
Issuance Amount (in millions USD)				
Mean	726	494^{c}	704	742
Std. deviation	542	372	354	555

See Appendix A for variable definitions. ^{c} and ^{b} indicate statistical difference from traditional bond means at 0.01 and 0.05, respectively.

Table 3

Correlation between select variables.

	Spread	Green	SLB	Tobin's Q	Firm Size	Tangibility	Leverage	ROA	Quality Spread	Treasury Rate	CO2/Sales	Environmental Score
Spread	1											
Green	-0.1163	1										
SLB	-0.0268	-0.0509	1									
Tobin's Q	-0.0602	-0.052	-0.0924	1								
Firm Size	-0.3595	0.1586	-0.0411	0.0345	1							
Tangibility	0.0602	0.1042	0.153	0.0091	-0.1312	1						
Leverage	-0.0655	0.2592	0.1083	-0.0101	0.0544	0.1532	1					
ROA	-0.0429	-0.1589	-0.0706	0.0522	-0.224	-0.0192	-0.0938	1				
Quality Spread	0.3339	-0.0387	-0.1052	0.0088	-0.0194	-0.0188	-0.1586	0.0009	1			
Treasury Rate	-0.0068	-0.0748	-0.0442	-0.0345	-0.1344	0.0541	-0.1493	0.2291	0.2789	1		
CO2/Sales	0.0383	0.1076	0.2849	-0.0819	-0.0561	0.21	0.0146	-0.0736	-0.0679	-0.0049	1	
Environmental Score	-0.1616	-0.2075	-0.2205	0.034	0.1421	-0.1817	-0.1251	0.2152	0.0627	0.1477	-0.1244	1

Table 4

Multinomial probit regression on whether a firm issues regular, green, or SLB bonds

VARIABLES	(1) Green	(2) SLB	(3) Green	(4) SLB
Tobin's Q	-0.386^{c}	-0.592^{c}	-0.309^{c}	-0.603^{c}
	(-7.190)	(-5.200)	(-4.478)	(-4.825)
	[-0.017]	[-0.009]	[-0.013]	[-0.013]
Firm Size	-0.061	-0.194^{c}	0.105^{b}	-0.176^{b}
	(-1.510)	(-2.690)	(1.970)	(-2.120)
	[-0.002]	[-0.003]	[0.005]	[-0.004]
Leverage	0.354^{c}	-0.747^{a}	0.325^{c}	-1.283^{c}
	(4.330)	(-1.810)	(3.112)	(-2.774)
	[0.018]	[-0.013]	[0.019]	[-0.031]
Tangibility	0.101	0.780^{c}	0.114	0.679^{c}
	(1.220)	(4.860)	(1.139)	(3.801)
	[0.003]	[0.013]	[0.003]	[0.016]
ROA	-0.106^{c}	0.034	-0.072^{c}	0.037
	(-5.820)	(1.610)	(-3.083)	(1.446)
	[-0.005]	[0.001]	[-0.003]	[0.001]
Quality Spread	0.626^{c}	0.042	0.949^{c}	0.938^{b}
	(5.410)	(0.130)	(3.172)	(1.968)
	[0.029]	[-0.001]	[0.042]	[0.019]
Treasury Rate	0.287^{c}	0.166	0.235	-0.048
	(3.170)	(0.830)	(1.355)	(-0.172)
	[0.013]	[0.002]	[0.011]	[-0.002]
Rating	0.125^{c}	-0.219^{c}	0.084^{c}	-0.347^{c}
	(6.040)	(-5.640)	(3.049)	(-6.822)
	[0.006]	[-0.004]	[0.015]	[-0.008]
Unrated	-0.482	-1.241	-0.596	-3.316^{c}
	(-1.080)	(-1.240)	(-1.047)	(-3.037)
	[-0.020]	[-0.020]	[-0.018]	[-0.077]
CO2/Sales	0.037	0.175^{c}	0.032	0.198^{c}
	(1.590)	(7.890)	(1.166)	(8.150)
	[0.001]	[0.003]	[0.001]	[0.005]
CO2 Missing	-0.796^{c}	-22.581	-1.336^{c}	-22.067
	(-6.810)	(-0.000)	(-8.028)	(-0.000)
	[-0.017]	[-0.378]	[0.001]	[-0.521]
Environmental Score	0.012^{c}	0.011	-0.003	0.019^{b}
	(2.690)	(1.550)	(-0.593)	(2.381)
	[0.001]	[0.000]	[-0.000]	[0.000]
Environmental Score Missing	2.096^{c}	2.216^{c}	1.562^{c}	3.387^{c}
	(8.540)	(3.790)	(4.898)	(4.800)
	[0.093]	[0.032]	[0.063]	[0.076]
Industry CO2	0.000	-0.003^{c}	0.001	-0.003^{c}
	(0.000)	(-3.480)	(0.927)	(-3.047)

	[0.000]	[0.000]	[0.004]	[-0.008]
Industry ESG	-0.005	-0.044[c]	0.008	-0.040[c]
	(-0.570)	(-3.150)	(0.729)	(-2.609)
	[0.000]	[-0.001]	[0.051]	[-0.097]
New Law	-0.069	-1.048	-0.062	-1.033
	(-0.280)	(-1.560)	(-0.206)	(-1.360)
	[0.001]	[-0.018]	[0.000]	[-0.024]
Time	0.001[c]	0.005[c]	0.002[c]	0.005[c]
	(6.080)	(9.620)	(3.869)	(6.049)
	[0.000]	[0.000]	[0.000]	[0.000]
Industry Fixed Effects	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Currency Fixed Effects	Yes		Yes	
Observations	24,918		16,044	
Number of issues	8,306		5,348	
Log-Likelihood	-1,385.054		-951.263	

This table displays coefficients, z-statistics (in parentheses), and marginal effects (in brackets) for the self-selection model. The dependent variable is an indicator variable for whether the firm chooses to issue regular, green or SLB securities. See Appendix A for variable definitions. The analysis includes currency, nation, and industry fixed effects. [c], [b], and [a] indicate statistical significance at 0.01, 0.05 and 0.10 level, respectively.

Table 5

Panel A: Matched sample treatment effects

	Similar to Flammer (2021)		Currency and Rating		Additional Controls		Multivariate Distance Match	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ATE	-0.400[c]	-0.173	-0.265[c]	-0.353[b]	-0.529[c]	-0.303[b]	-0.182[b]	-0.554[c]
	(-5.460)	(-1.260)	(-3.260)	(-2.340)	(-5.560)	(-1.990)	(-2.480)	(-5.960)
Treatment Group	Green	SLB	Green	SLB	Green	SLB	Green	SLB
Additional Variables	No	No	No	No	Yes	Yes	Yes	Yes
Country and Industry Exact Match	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Currency and Rating Match	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Method	Nearest Neighbor	Nearest Neighbor	Nearest Neighbor	Nearest Neighbor	Nearest Neighbor	Nearest Neighbor	MD Kernel	MD Kernel
Treated Observations	334	186	249	138	249	138	264	144
Untreated Observations	334	186	249	138	249	138	3482	2082
Total Observations	668	372	498	276	498	276	3746	2226

Column 1 and 2 display treatment effects for SLB and Green bonds resulting from sample matching using following the matching methodology of Flammer (2021). Columns 3 and 4 display treatment effects adding country, currency, and quality spread as matching variables. Columns 5 and 6 further add exact country matching into the methodology. Average Treatment Effect (ATE) refers to the aggregated causal effects over all individuals. Standard errors clustered by country are presented in parentheses. [c], [b], and [a] indicate statistical significance at 0.01, 0.05 and 0.10 level, respectively.

Table 6

OLS and instrumental variable regressions

	(1)	(2)
	OLS	**Heteroskedastic IV**
Green	-0.190	-0.139[b]
	(-1.247)	(-2.056)
SLB	-0.433[b]	-0.286[c]
	(-2.011)	(-3.040)
Tobin's Q	0.016	-0.012
	(0.312)	(-0.348)
Firm Size	0.103[a]	0.049[a]
	(1.829)	(1.662)
Leverage	0.198[b]	0.196[c]
	(2.161)	(3.550)
Tangbility	0.031	-0.027
	(0.246)	(-0.452)
ROA	-0.003	0.001
	(-0.338)	(0.100)
Quality Spread	0.783[c]	0.792[c]
	(6.349)	(8.519)
Treasury Rate	-0.610[c]	-0.470[c]
	(-4.472)	(-5.542)
Rating	-0.304[c]	-0.285[c]
	(-10.258)	(-18.759)
Unrated	-4.100[c]	-4.113[c]
	(-7.938)	(-16.258)
CO2/Sales	0.000	0.000
	(-0.210)	(0.981)
CO2 Missing	0.048	0.072
	(0.371)	(0.846)
Environmental Score	-0.001	-0.002
	(-0.206)	(-0.871)
Env. Score Missing	0.403[a]	0.397[b]
	(1.792)	(2.566)
Issuance Amount	-0.081	-0.034
	(-1.484)	(-1.040)
Maturity	0.247[b]	0.158[b]
	(2.181)	(2.478)
Callable	0.203[a]	0.184[c]
	(0.110)	(0.063)
Time	-0.001[c]	-0.001[c]
	(-3.790)	(-5.363)
Industry Fixed Effects	Yes	Yes

Country Fixed Effects	Yes	Yes
Currency Fixed Effects	Yes	Yes
Observations	6,408	6,408
Adjusted R-squared	0.619	0.535
Underidentification K.P. lm		199.704
(p-value)		(0.000)
Weak Ident. K.P. Wald		436.149
[Stock-Yogo 10% level]		[10.88]
Hansen's J p-value		(0.201)

See Appendix A for variable definitions. The dependent variable is the bond's spread to benchmark at issuance. SLB and Green refer to sustainability-linked bond and green bond indicators. The estimates in column 1 are from an OLS regression. The estimates in column 2 are from an instrumental variable regression using heteroskedasticity-based instruments. All regressions include country, industry, and currency dummies. Standard errors are clustered by country. t-statistics are presented in parentheses. [c], [b], and [a] indicate statistical significance at 0.01, 0.05 and 0.10 level, respectively.

Appendix A

Variable definitions

Variable	Definition	Source
Spread	A bond's spread, relative to its benchmark. Our benchmark measure is the treasury yield that matches the bond's currency and maturity	SDC
CO2 Emissions/Sales	Total emissions (measured in hundreds of metric tons of CO2), standardized by total sales	Bloomberg/Investor Relations Sites
ESG Environmental	Sustainability component of a company's ESG score	Bloomberg
Industry CO2	Country-industry-year average levels of CO2 emission intensity	Bloomberg/Investor Relations Sites
Industry ESG	Country-industry-year average ESG ratings	Bloomberg
CO2 Missing	Indicator set to 1 for firms that do not report CO2 emissions	Bloomberg/Investor Relations Sites
Environmental Missing	Indicator set to 1 for firms that are not ESG rated	Bloomberg
Size	The natural logarithm of total assets. Total assets are measured in millions of USD	Capital IQ
Tobin's Q	Market value of equity + book value of debt, standardized by total assets	Capital IQ
Leverage	Firm-level debt-to-asset ratio. Total debt standardized by total assets	Capital IQ
ROA	Return on total assets, computed as net income standardized by total assets	Capital IQ
Tangibility	Property, plant, and equipment standardized by total assets	Capital IQ
Rating	A numerical value corresponding to the firm's Moody's ratings, with AAA equal to 21 and C equal to 1. Unrated issuances have this variable set to 0	Bloomberg
Rating Missing	Indicator variable set to 1 for firms that are not rated by Moody's	Bloomberg
Issuance Amount	Total proceeds resulting from the bond issuance, in millions of USD	SDC
Quality spread	Currency-average Baa rate minus the similar maturity Treasury rate (lagged by 10 business days)	Bloomberg and Japan Security Dealers Association
Benchmark Yield	Treasury yield used as a benchmark to calculate the spread. Our treasury benchmarks must the bond's maturity and currency	Bloomberg
New Law	Indicator variable for whether the issuer's country added a new environmental law	Carrots & Sticks
Time	A time trend measuring the days between September 1st, 2019—the first day in our sample—and the issuance date of the bond	SDC