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**The Sovereign Greenium: Big Promise but Small
Price Effect**

Ugo Panizza

Geneva Graduate Institute and CEPR

Beatrice Weder di Mauro

Geneva Graduate Institute and CEPR

Shuyang Shi

Geneva Graduate Institute

Mitu Gulati

University of Virginia, Law School

Chemin Eugène-Rigot 2
P.O. Box 136
CH - 1211 Geneva 21
Switzerland

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Ugo Panizza
Geneva Graduate Institute and CEPR

Shuyang Shi
Geneva Graduate Institute

Beatrice Weder di Mauro
Geneva Graduate Institute and CEPR

Mitu Gulati
University of Virginia, Law School

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Abstract

This paper investigates the existence, magnitude and drivers of the sovereign greenium: the yield discount on sovereign and quasi-sovereign green bonds relative to conventional bonds. Using a dataset of 332 matched pairs of green and conventional bonds issued between 2014 and 2023 by sovereigns, sovereign-backed agencies, and multilateral development institutions, we analyze secondary-market pricing to capture both cross-sectional and time-varying heterogeneity. We find a small but statistically significant greenium, averaging about 2 basis points for advanced economies and nearly 13 basis points for emerging markets. The greenium is larger for lower-rated issuers and increases when climate transition risks become more salient or when issuers are more vulnerable to climate change. Interaction effects indicate that global awareness of transition risks and domestic climate vulnerability jointly amplify the greenium. While green sovereign bonds trade at lower yields, the resulting fiscal savings are economically modest relative to total interest expenditures. A novel analysis of bond documentation shows that sovereign green bonds contain no binding commitments regarding environmental outcomes, suggesting that the observed greenium reflects symbolic rather than contractual sustainability value.

JEL Codes: Q54; Q56 ; H63 ; G15; G12

Keywords: Green bonds; Sovereign debt; Greenium; Sustainable finance; Climate risk; ESG investing

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1 Introduction

Over the past decade, the rapid expansion of sovereign green bond issuance has reshaped how governments and investors think about financing the transition to a low-carbon economy. Since Poland's pioneering issuance in 2016, more than thirty governments have issued debt instruments whose proceeds are earmarked for environmentally friendly projects. Yet a fundamental question remains unresolved: do investors accept lower yields to support the green transition? In other words, is there a sovereign greenium, a systematic pricing advantage for labeled green bonds relative to otherwise identical conventional bonds?

Understanding whether such a greenium exists, and what drives it, matters for both theory and policy. From a theoretical standpoint, since sovereign green bonds share the same credit risk as conventional bonds, the presence of a greenium implies that non-pecuniary investor preferences or institutional constraints affect equilibrium yields. From a policy perspective, the presence of a greenium could reduce borrowing costs and expand fiscal space for climate investment, especially in emerging markets where financing needs are acute. Conversely, if the premium is negligible, the recent boom in sovereign green issuance may amount to little more than the relabeling of conventional debt.

This paper provides new evidence on the magnitude, high-frequency variation, and institutional foundations of the sovereign greenium. Using a unique dataset with daily data for 332 matched pairs of green and conventional bonds issued between 2014 and 2023 by sovereigns, sovereign-backed agencies, and multilateral development institutions, we analyze secondary-market pricing to identify the drivers of yield differentials. We document a small but statistically significant greenium of about 2 basis points for advanced economies and 13 basis points for emerging markets. The greenium is larger for lower-rated issuers, rises with the global salience of transition risk, and is amplified in countries more vulnerable to climate change. These results suggest that investor demand, rather than differences in credit fundamentals, underlies the observed pricing gap.

To examine the underpinnings of this demand, we complement the quantitative analysis with a close reading of bond documentation. We find that sovereign green bonds contain no legally enforceable commitments regarding the use of proceeds or environmental outcomes. The “green” promise rests entirely on issuer reputation and voluntary reporting. This institutional weakness helps explain why the greenium, though statistically significant, remains economically small: even if investors were willing to accept lower returns for green investment, there is no credible mechanism ensuring that sovereign issuers use proceeds as promised.

Our findings contribute to three strands of literature. First, we extend research on green bond pricing by providing the first comprehensive evidence on the time-varying and cross-country determinants of the sovereign greenium. Second, we link sustainable-finance research to the literature on climate risk and sovereign spreads, showing that the salience of transition risk and country-specific climate vulnerability jointly shape pricing. Third, we connect financial-economic and legal perspectives by documenting that, despite the ESG label, sovereign green bonds remain de facto unsecured by environmental commitments.

The first sovereign green bond was issued by Poland in December 2016. This five-year euro-denominated bond, with a face value of €750 million, was priced at a yield of 63 basis points and carried an estimated “green penalty” of roughly 8 basis points relative to comparable non-green bonds (Ministry of Finance of the Republic of Poland, 2019 and Societe Generale 2019). While Poland’s initial issuance suggested a cost disadvantage, subsequent sovereign green bonds have tended to be issued at parity or with a small greenium. For example, Spain’s inaugural green bond in September 2021 exhibited no significant yield differential, whereas the European Union’s Next Generation issuance of 2021, amounting to €12 billion, displayed a greenium of about 2.5 basis points. Similarly, Germany’s twin green bond issued in June 2024 carried a greenium of roughly 1 basis point, and Denmark’s twin issuance in September 2025 a greenium of 1.5 basis points.¹ Evidence from emerging markets points to larger premia: Romania’s February 2024 green bond showed a greenium near 10 basis points, Egypt’s September 2020 issuance around 12.5 basis points, and India’s rupee-denominated green bond in January 2023 approximately 5.5 basis points (for a discussion of these three cases, see World Bank, 2022, 2023, and 2025).

Whether issuing green bonds is “worth it” remains an open question. On the one hand, evidence suggests no systematic difference in underwriting fees between green and conventional sovereign bonds. Additional costs stem mainly from sustainability structuring fees and second-party opinions, which Lindner and Chung (2023) estimate at roughly 3 basis points for a \$1 billion bond. These costs can be offset even by a small greenium. On the other hand, green bonds require more complex reporting, monitoring, and verification procedures that may strain the administrative capacity of debt management offices (Doranzo et al. 2021). In June 2022, Egypt’s finance minister noted that the country’s green

¹ A “twin bond” structure enhances transparency and controls for liquidity differences. Under this approach, the government issues a green bond that is identical in all financial characteristics (maturity, coupon, currency, and payment schedule) to an existing conventional bond. The two bonds are mutually exchangeable, which guarantees the same liquidity and market access. The only distinction lies in the earmarking of proceeds for environmentally beneficial expenditures, allowing any yield differential to be interpreted as a pure measure of the sovereign greenium. The first twin bonds were issued by Germany in 2020.

bond had “cost more than a traditional Eurobond,” attributing the difference to additional reporting and review requirements rather than higher bank fees.²

Measuring the greenium in the primary market presents two challenges. The first is sample selection, since sovereigns may issue green bonds only when they expect favorable pricing. The second is the absence of a “twin” conventional bond, which often forces researchers to construct synthetic yield curves, introducing bias. Our approach—analyzing the evolution of the greenium in secondary markets using bond-pair-time fixed effects—controls for time-variant differences between green and conventional bonds and allows us to study how global and domestic, time-varying factors shape the greenium.

We begin by corroborating the existence of a small but statistically significant greenium that is larger for lower-rated issuers. Our estimates indicate a greenium of roughly 2 basis points for advanced economies and 13 basis points for emerging markets. This difference is not simply a reflection of higher yields in emerging markets. When expressed relative to average yield levels, the greenium for a typical emerging-market issuer is about three times larger than that of a typical advanced economy, a pattern that also holds across credit-rating categories.

Next, we show that the greenium varies over time, increases with the salience of transition risk, and is higher in countries more vulnerable to climate change. A one-standard-deviation increase in country-specific vulnerability raises the greenium by about 4 basis points, while a similar increase in transition-risk salience raises it by 0.8 basis points. The interaction between global salience and domestic vulnerability further amplifies the effect by roughly 0.8 basis points. To our knowledge, we are the first to show that the sovereign greenium, and green premia more generally, are jointly shaped by global transition-risk awareness and local climate vulnerability.

Our finding that green sovereign bonds trade at lower yields than conventional bonds demonstrates that investors are willing to pay a premium for green assets. Yet the small magnitude of this premium suggests limited willingness to sacrifice returns. Even when translated into monetary savings, the effect remains modest. For example, Germany, one of the largest sovereign green issuers, issued nearly USD 80 billion in green sovereign bonds between 2020 and 2024. With a greenium of 2 basis points, this translates into annual interest savings of about USD 16 million, negligible relative to Germany’s USD 40 billion annual interest bill. The same holds for Egypt, which exhibits one of the largest greenia.³

² See <https://www.reuters.com/world/middle-east/egypts-green-bonds-cost-it-more-than-conventional-bonds-would-have-minister-says-2022-06-21/>

³ Even under extreme assumptions, the fiscal impact of the sovereign greenium remains limited. Suppose that all German government debt were converted into green bonds (a theoretical impossibility, since not all public spending can be classified as green) and that the current greenium applied uniformly to total outstanding debt of

There is a caveat to our interpretation that sovereign green bonds are not particularly useful instruments for reducing borrowing costs. While our analysis focuses on price effects, the decision to issue green bonds may also affect market access, especially for emerging market issuers with discontinuous access to international capital markets. These governments may choose to issue green bonds during periods of tighter financing conditions, using the “green” label as a sweetener to attract investors when conventional issuance would be more difficult. Hence, even though we find a small price effect, there could exist a more significant quantity effect that our data do not allow us to examine.⁴

An important question concerns the sources of the small greenium observed in the data. Kling et al. (2025) show that higher climate vulnerability is associated with significantly higher sovereign spreads, particularly among developing countries. Consistent with this evidence, we find that the greenium is larger for countries that are more exposed to climate risk. However, this relationship cannot be interpreted as evidence that green bond issuance reduces overall climate risk, since any such effect should apply equally to green and conventional bonds. As emphasized by the IMF (2022b), “from an issuer perspective, the greenium should not exist given that the default probability is the same.” The existence of a yield differential must therefore reflect investor-side factors, such as preferences or constraints that extend beyond conventional risk-return tradeoffs. Previous work provides theoretical and empirical support for this interpretation. Zerbib (2019) was among the first to document a measurable yield discount for green bonds, attributing it to pro-environmental investor preferences and segmented demand. Pastor et al. (2021) formalize this mechanism, showing that when investors derive utility from holding green assets, equilibrium prices incorporate a “green preference premium.”

Cross-sectional studies that focus on yield at issuance, however, cannot easily disentangle demand-driven from supply-driven effects. Sovereigns may issue green bonds under favorable market conditions or after major climate shocks (Andreasen and Margaretic, 2025), which complicates causal interpretation. Our empirical approach mitigates these concerns by exploiting high-frequency variation in investor sentiment. Specifically, we identify demand effects by interacting the green bond indicator

roughly USD 3 trillion. Even in this highly optimistic scenario, annual interest savings would amount to about around 1.5 percent of Germany’s total interest bill. If Egypt could convert its entire debt stock into green instruments and maintain the full 30-basis-point premium, total annual savings would be less than 2 percent of its overall interest payments.

⁴ Green bond issuances have typically been met with strong demand, often exceeding the amount offered. For instance, the U.K.’s inaugural green gilt in 2021 was around 10 times oversubscribed, and the first German green Bund in 2020 saw investor orders totaling about 5 times the issuance amount (nearly 200 distinct investors participated). Similarly, Chile’s 2019 sovereign green bond was 13× oversubscribed, and more recent issues from other European sovereigns (e.g. Austria’s 2022 green bond, Hungary’s 2021 green bond) have seen bid-to-cover ratios between 5× and 7×. These subscription levels are above typical oversubscription of conventional government bonds. Karpf and Mandel (2018) shows that higher bid-to-cover ratios for U.S. municipal green bonds relative to comparable non-green issues. Bakshi et al. (2022) find that green bond yield spreads are directly linked to proxies of demand pressure such as oversubscription rates and index inclusion..

with daily measures of transition-risk salience in the secondary market, which are unaffected by country-specific issuance decisions and therefore exogenous to supply factors.

The small magnitude of the observed greenium can be interpreted in several ways. First, investors may not value green investments highly enough to forgo a meaningful share of yield. Second, they may perceive green bond issuance as having little causal impact on project implementation, believing that most financed activities would occur even in the absence of labeling. Third, investors may question the credibility of use-of-proceeds commitments, doubting whether the funds are genuinely directed toward additional environmental projects. The first explanation aligns with the view that green investment is largely fashionable window dressing: acceptable as long as it does not entail significant financial sacrifice. The second explanation is particularly plausible in advanced democracies, where political and institutional commitment mechanisms already ensure a baseline level of environmental spending. The third is likely more relevant in countries with limited transparency and state capacity, where weak monitoring and enforcement reduce confidence in the link between financing and environmental outcomes.

From a policy perspective, distinguishing among these mechanisms is essential. If investors are indifferent to environmental outcomes or perceive sovereign green bonds as a form of “greenwashing,” their contribution to climate action will remain limited. If, instead, the main constraint is credibility, strengthening contractual frameworks, verification standards, and disclosure requirements could enhance investor trust and expand the greenium. The positive correlation we document between the greenium and climate vulnerability suggests that investors may value green investments more in climate-exposed countries, possibly for altruistic or reputational reasons. Yet even in these cases, the small magnitude of the premium underscores that sovereign green bonds are, at present, more important as signals of intent than as instruments of cheap finance.

Literature

Early studies of the broader green bond market—dominated by corporate and municipal issuers—consistently identify modest but statistically significant premia. Zerbib (2019) documents an average premium of about 2 basis points in secondary markets after controlling for credit risk and other bond characteristics. Karpf and Mandel (2018) find that U.S. municipal green bonds carry yields 7–8 basis points lower than comparable conventional issues. Kapraun et al. (2021) highlight the importance of credibility and investor perception: significant premia arise mainly for sovereign and supranational bonds, euro-denominated issues, or very large corporate deals, whereas smaller corporate green bonds show no significant greenium. Hinsche (2021) similarly reports larger premia for supranational issuers with AAA ratings, while Pietsch and Salakhova (2022) find that the credibility of the green label and

the issuer's reputation are positively associated with the magnitude of the premium. Fatica et al. (2021) likewise show that bonds with external reviews command higher premia than self-labeled ones.⁵ In contrast, and in line with our own findings for sovereign issuances, Ehlers and Packer (2017) observe that the greenium tends to be higher for riskier borrowers and find no systematic relationship between premia and the degree of "greenness" of the bond.

The emerging literature on sovereign green bonds finds small but statistically significant premia. Kapraun and Scheins (2022), focusing on euro-area sovereign issuers, report a greenium of 3–6 basis points, robust to controls for maturity and liquidity. Dorfleitner et al. (2021) estimate premia of similar magnitude, noting larger discounts (up to 5 bps) for bonds with external certification and near-zero premia for "light green" bonds. Grzegorzcyk and Wolff (2022) document premia between 3 and 16 basis points for six EU sovereign issuers. Ando et al. (2024) find an average greenium of roughly 4 basis points in advanced economies, and, like us, find that the greenium is larger in emerging markets. They also show that the greenium has increased over time. Chesini (2024) also reports a small but persistent premium, especially for euro-denominated issues. By contrast, Doronzo et al. (2021) detect no robust greenium: across 14 sovereign issuers, they find a green penalty of 3.8 basis points in the primary market and only a 0.5-basis-point greenium in secondary markets. More recently, Descombes and Szczerbowski (2024) examine euro-area sovereign green bonds between 2021 and 2023 and estimate an average greenium of 2.8 basis points. Notably, they find that while corporate green premia largely disappeared in this period, sovereign green bonds continued to trade at a small but persistent premium.

Taken together, these studies suggest that demand-side factors, rather than credit risk, explain the greenium. In standard asset-pricing theory, two bonds with identical cash flows should trade at the same yield; a greenium therefore implies that some investors derive non-pecuniary utility from holding green assets or face institutional incentives that lead them to accept lower returns. Fama and French (2007) formalize such "taste-based" preferences in asset pricing, while Pastor et al. (2021) model them as a "green factor," showing that investors willing to sacrifice yield for environmental impact drive down returns on green assets (Mosionek-Schweda and Szmelter, 2019 provide some evidence on the structure of holder of 5 sovereign green bonds).

⁵ The term "greenwashing" refers to cases where the environmental benefits are overstated or dubious, for example, labelling routine infrastructure spending as "green" without additional climate impact. In a study of corporate green bonds, Flammer (2021) finds that companies issuing green bonds do not experience a drop in share price which suggests investors generally view the issuance as a credible signal rather than a gimmick. Moreover, Flammer documents that firms issuing green bonds tend to improve their environmental performance post-issuance, indicating that, at least in the corporate space, green bond financing is associated with genuine green investments rather than mere relabelling. Bachelet et al. (2019) shows that external green audits are associated with a higher greenium for corporate bonds.

Empirical evidence supports this preference-driven interpretation. Riedl and Smeets (2017) find that retail investors trade off financial returns for social or environmental goals. Hartzmark and Sussman (2019) show that mutual funds receiving favorable sustainability ratings attract large inflows despite unchanged performance, consistent with non-financial motives driving capital reallocation (see also Baker et al., 2018). In bond markets, Dorfleitner et al. (2021) interpret the greenium as reflecting a “non-financial utility component.” Auction data reinforce this interpretation: German green Bunds, issued alongside conventional “twin” Bunds with identical financial characteristics, have been consistently oversubscribed (IMF, 2022; 2023), while Karpf and Mandel (2018) report higher bid-to-cover ratios for U.S. municipal green bonds. These patterns indicate excess demand created by dedicated ESG funds, asset managers with sustainability mandates, and regulated institutions with portfolio constraints favoring green assets. Regulatory and institutional factors—such as the ECB’s tilt toward green securities and the inclusion of green bonds in benchmark indices—further amplify this inelastic demand.

Theoretical models predict weaker premia for emerging-market issuers, given weaker institutions and narrower investor bases, yet empirical evidence often shows the opposite. Like us, Ando et al. (2024) find that emerging-market sovereign green bonds exhibit larger premia than those of advanced economies. Bolton et al. (2022) show that climate risk and vulnerability are positively correlated with premia: a one-standard-deviation increase in climate exposure is associated with an 8-basis-point higher greenium, and a one-standard-deviation increase in climate vulnerability with an 11-basis-point higher greenium. Chan and Liao (2025) refine this picture by studying adaptation bonds in emerging markets, finding that bonds financing climate adaptation command higher premia than other green bonds, especially in countries with greater physical risk exposure or stronger governance capacity.

Beyond pricing effects, several studies emphasize the signaling and market-development roles of green bonds. Flammer (2021) shows that corporate green bond announcements are followed by positive stock market reactions, suggesting reputational gains even in the absence of yield advantages. Similarly, IMF (2022) argues that sovereign green bond issuance signals climate commitment, potentially improving reputation and investor sentiment. Dell’Atti et al. (2022) document that EU sovereign green bonds are perceived as value-enhancing and risk-reducing, with issuance associated with lower CDS spreads, particularly in periods of high market stress. Cheng et al. (2024) further show that debut sovereign green bond issuance stimulates domestic sustainable finance: corporate green issuance increases, market liquidity improves, and more firms seek external reviews. In this sense, sovereign green bonds play a catalytic role for sustainable finance, much as conventional sovereign bonds serve as benchmarks for corporate debt markets. However, the question of additionality remains open. Many sovereign green bonds refinance projects that were already planned, raising concerns that issuance may amount to relabeling rather than mobilizing new investment. The German Debt Management Agency, for instance,

notes that all expenditures must be approved by parliament, meaning that green bond proceeds finance pre-existing commitments (CBI, 2021). Like us Bolton et al. (2022), show that most sovereign frameworks contain no binding requirement to allocate proceeds exclusively to new projects. Nevertheless, it is possible that green labeling can accelerate project implementation, expand scope, or enhance transparency. Even if strict additionality is limited, the signaling and catalytic effects of sovereign green bonds suggest broader benefits that may extend beyond immediate fiscal savings.

2 Data

Our dataset covers all green bonds issued between 2014 and 2023 for which a matching conventional bond could be identified. It includes 332 such bonds comprising 43 issued by sovereigns, 143 by agencies with sovereign guarantees, and 130 by multilateral financial institutions. According to IMF data, the face value of green bonds issued by sovereigns, public agencies with sovereign guarantees, and multilateral financial institutions spiked in 2021 when it went from less than US 100 billion to nearly 280 billion (top left panel of Figure 1). It then dropped to just below US 200 billion over 2022-24. The pattern in our sample follows that of overall issuance (top right panel of Figure 1). Over 2018-2022, our sample covers more than 50% (in dollar value) of total issuances (bottom left panel of Figure 1). Coverage is more limited in 2014, 2016-17 and 2023. We do not have data for 2024.

Strength of the Promises to Finance Green Projects

A key premise of our analysis is that investors may value the credibility of issuers' commitments to finance green projects. Indeed, as described above, there is some evidence that bonds that are more credible in terms of their green promises have higher greenia (Dorfleitner et al., 2021, Kapraun et al. 2021). Building on this insight, we examine all sovereign and quasi-sovereign bonds in our dataset to assess the legal strength of their green promises: that is, the extent to which issuers were willing to expose themselves to legal liability for failing to fulfill their stated environmental commitments.

We looked for evidence of two types of promises. The first concerns direct legal liability: if investors are willing to lend at lower rates in exchange for a commitment to finance green projects, one would expect them to seek the ability to claim monetary damages if those promises are not fulfilled. The second involves contractual mechanisms short of litigation. Recognizing that investors may have little appetite for costly disputes with sovereigns, they could instead design instruments that include a schedule of green targets. Failure to meet these targets could then constitute an "Event of Default," allowing investors to withdraw their funds and reallocate them to more credible green issuers.

As in Bolton et al. (2022), where we examined a smaller sample of bonds, we find that across our entire dataset, issuers are explicit that they are not making any legally binding commitments to fulfill their green promises. The bond documentation likewise makes clear that there are no contractual mechanisms allowing investors to declare an Event of Default in the event of insufficient progress toward the stated environmental objectives.

In sum, the green promises in the bonds in our dataset are backed solely by the issuer's reputation—that is, by its credibility to do what it has pledged to do. One might therefore expect issuers with stronger reputations for honoring their commitments to exhibit a higher greenium. Yet we find the opposite: greenia are larger in emerging economies, which are generally perceived to have weaker reputations in international capital markets than advanced economies. These findings are consistent with Lupo-Pasini (2022), who shows that the absence of strong financial incentives for investors, combined with constitutional and political constraints on sovereigns, makes it difficult to design and enforce effective ESG-related contractual arrangements. Nonetheless, both issuers and investors share an interest in gaining access to the rapidly expanding ESG market. The result is that sovereign green bonds often only nominally fulfill the sustainability objectives presented to investors.

Matching

We match each green bond to a single conventional bond using a strict, rule-based procedure. For each green bond, the candidate pool includes only conventional bonds issued by the same issuer and denominated in the same currency, with identical seniority, credit rating, and coupon type. To ensure comparability in term structure and market timing, we restrict matches to pairs with a contractual maturity difference of no more than 730 days (approximately two years) and an issuance date difference of no more than 730 days. If multiple candidates satisfy these criteria, we select the bond with the smallest absolute maturity gap, breaking ties by the closest issuance date. Green bonds without a qualifying match are excluded to preserve sample integrity.

After pairing, we merge bond-day secondary market data at the pair-date level, retaining only one-to-one matches. In the empirical analysis, we further restrict the sample by excluding observations in which the difference in remaining tenor between the green and conventional bond exceeds 20 percent (in absolute value) of the green bond's remaining tenor (see details below).

Summary Statistics and Trends

The average face value of the green bonds in our dataset is USD 1.5 billion. Sovereign green bonds stand out as significantly larger, averaging USD 7 billion, compared with approximately USD 900

million for agency and multilateral green bonds (Table 1). Sovereign green bonds also tend to have longer tenors at issuance—12 years on average, compared with 7 years for green agency bonds and 9 years for green multilateral bonds. At the same time, sovereign green bonds carry lower yields to maturity (around 2% versus 2.4% and 2.7% for agency and multilateral bonds, respectively), consistent with their larger size, and the higher credit quality typically associated with sovereign issuers.

Within the sample, we also observe marked heterogeneity across countries. Bonds issued by advanced economies (150 bonds) are typically larger, have longer maturities, and carry lower yields than those issued by emerging and developing economies (42 bonds). This pattern highlights how issuer creditworthiness and market depth in advanced economies contribute to more favorable financing conditions. A similar pattern emerges when looking at currency denomination: euro-denominated bonds tend to be larger in size and priced at lower yields than those denominated in U.S. dollars or renminbi. The differences are particularly pronounced for bonds denominated in currencies issued by emerging economies other than the renminbi, which are generally smaller in size and carry higher yields, reflecting both shallower investor bases and greater perceived risk.

Although green sovereign bonds represent a relatively small share of total issuances by number, they play a disproportionately important role in shaping green bond issuance by sovereign guaranteed agencies and multilateral. Since 2018, sovereigns have consistently accounted for more than half of total issuance volume in our sample (Figure 1). Turning to currency composition, the euro dominates in terms of issued amounts, underscoring Europe’s leadership in this segment of the bond market. By contrast, the U.S. dollar (together with other advanced-economy currencies) plays a larger role in terms of the number of bonds issued, reflecting the smaller average deal size of dollar-denominated bonds (Figure 2). These currency patterns are closely tied to issuer origin: emerging economies account for only a small fraction of global sovereign and quasi sovereign green bond issuance, both by number and volume, while advanced economies issue the bulk of sovereign and agency bonds in terms of face value. Multilateral financial institutions issue a comparable number of bonds to sovereigns (Figure 3) albeit with a smaller average size, providing an important supply of green assets across currencies and maturities. In terms of tenor, while roughly half of all green bond issuances in our sample carry an original maturity of less than ten years, the vast majority of issued amounts are concentrated in bonds with maturities of ten years or longer (Figure 4), underscoring the role of green bonds in financing long-horizon investments.

In addition to primary market data (issuance date, coupon, maturity, rating, etc.), we also collected high-frequency secondary market data, including yields to maturity and bid-ask spreads, to analyze liquidity and pricing dynamics. The original dataset contains 408,000 observations, each corresponding to a bond-day (204,000 bond-pair days). To mitigate the influence of outliers, we drop observations with

yields below -1% or above 20% , bid-ask spreads above 100 basis points, and cases where the difference between the remaining tenor of the green and conventional bond exceeds 20% (in absolute value) of the remaining tenor of the green bond.⁶ After these filters, the dataset contains 322,000 observations (161,000 bond-pair days), with the largest reduction in sample size—about 42,000 bond-pair days—stemming from the tenor-difference filter.

In the full sample, green bonds have an average yield to maturity which is one basis point lower than that of matched conventional bonds, the same average bid-ask spread, and less than half the average face value (USD 1.4 billion versus USD 3.1 billion; top panel of Table 2). In the sovereign subsample, green bonds exhibit a more pronounced pattern, with an average yield to maturity six basis points lower than conventional bonds, a slightly larger bid-ask spread (8 versus 6 basis points), and again less than half the average face value (USD 6 billion versus USD 13 billion; second panel of Table 2). For agency bonds, we find no systematic difference in yields to maturity or bid-ask spreads between green and conventional bonds, but green bonds are smaller on average (USD 950 million versus USD 2.2 billion; third panel of Table 2). Finally, among multilateral issuers, green bonds have an average yield to maturity one basis point lower than that of conventional bonds and a face value somewhat more than half that of conventional bonds (bottom panel of Table 2).

Taken together, these patterns suggest that while pricing differences between green and conventional bonds are modest, green bonds tend to be smaller in size across all issuer categories, with sovereign green bonds standing out as both larger and longer dated than other segments of the market.

3 Cross Sectional Evidence

We start with a set of models in which we regress yield-to-maturity (we use the mid yield) on a green bond dummy, bond characteristics and pair-date fixed effects. Formally:

$$y_{i(p),d(t)} = \alpha G_{i(p)} + \gamma_1 s_{i(p),d(t)} + \gamma_2 b_{i(p)} + \gamma_3 m_{i(p),d(t)} + \theta_{p,d(t)} + \varepsilon_{i(p),d(t)} \quad (1)$$

Where $y_{i(p),d(t)}$ is the secondary market yield-to-maturity of bond i , belonging to pair p on day d of year t ; $G_{i(p)}$ is a dummy that takes value one if bond i belonging to pair p is a green bond; $s_{i(p),d(t)}$ is the secondary market bid-ask spread of bond i , belonging to pair p on day d of year t ; $b_{i(p)}$ is the log of the face value (in USD) of bond i belonging to pair p ; $m_{i(p),d(t)}$ is the residual maturity (in days) of

⁶ This can occur even though our matching strategy only retains bonds with a difference in remaining tenor smaller than 730 days at the time of matching, since differences become proportionally larger as bonds approach maturity. For example, if the difference in original tenor is 30 days, when the green bond reaches a residual maturity of 150 days, the relative difference exceeds 20% .

bond i , belonging to pair p on day d of year t ; and $\theta_{p,d(t)}$ are bond-pair day fixed effects. These fixed effects absorb all shocks that may affect the prices of a given bond pair (and therefore all issuer-specific shocks) on each day. The coefficient α is our measure of the greenium: a negative value indicates that green bonds have lower yields than otherwise comparable conventional bonds (so a negative α is evidence of a *positive* greenium, and the other way around). Standard errors are clustered at the bond level, which is the relevant source of variation for our parameter of interest.

We start by estimating Equation (1) without controlling for bond characteristics and find that, on average, green bonds have a lower yield than conventional bonds. However, the difference is small (1.3 basis points, like the simple mean comparison in the top panel of Table 2) and not statistically significant (column 1, Table 3). When we control for bond characteristics, the estimated greenium becomes roughly three times larger (3.8 basis points) and statistically significant (column 2, Table 3). As expected, we find that bond size is negatively associated with yield-to-maturity, while residual maturity is positively associated with yield. Surprisingly, the bid-ask ratio—which should increase with illiquidity—is negatively associated with yield-to-maturity. The fact that we do not find a greenium without controls, but do so once controls are included, is mostly due to the role of bond size, which is negatively correlated with both yield-to-maturity and the green bond dummy. Overall, our findings corroborate the existing evidence of a small but statistically significant sovereign greenium (Kapraun and Scheins, 2022; Ando et al., 2024).

Next, we explore heterogeneity. We first estimate separate models for bonds issued by sovereigns, agencies with a sovereign guarantee, and multilaterals. We find a statistically significant greenium in all three subsamples (columns 3–5, Table 3), but the estimate is much larger for sovereign issuers (almost 18 bps) than for agencies and multilaterals (2 and 3 bps, respectively). We also examine the role of currency denomination and find statistically significant greenia for euro- and USD-denominated bonds (4.2 and 5.8 bps, respectively), but no significant effects for bonds issued in other advanced-economy currencies (where coefficients are positive but insignificant) or in EM currencies (columns 8–9, Table 3). Splitting the sample by country of origin, we compare sovereign and agency bonds issued by advanced and emerging economies. Consistent with Ando et al. (2024), we find that the greenium is much larger for emerging-economy issuers (see columns 1–2, Table 4, noting that column 3 of Table 3 corresponds to column 5 of Table 2). The point estimates of the greenium in our data and in Ando et al. (2024) data are also similar. We find a greenium of 2 bps for advanced economies and 12.7 bps for emerging economies and they find greenia of 4 and 11.6 bps respectively.

We also analyze heterogeneity by credit rating, creating four groups: prime (AAA), high (A– to AA+), medium (BBB– to BBB+), all investment-grade (BBB– to AAA), and sub-investment-grade (below

BBB–). The greenium tends to be higher for medium-rated and sub-investment-grade bonds. For instance, the greenium is about 3 bps for investment-grade bonds, while it reaches 55 bps for sub-investment-grade bonds (columns 7–8, Table 4). For highly rated bonds (A– to AA+), the greenium is positive but not statistically significant.

One concern is that sovereign issuers are overrepresented among emerging economies and tend to have lower ratings than issuers from advanced economies. Thus, the higher greenium observed for sovereigns and emerging economies could be driven by issuer type or by credit rating. Horse-race regressions are inconclusive due to multicollinearity: there are no sub-investment-grade issuers among advanced economies, and few agency issuers among emerging economies. Nonetheless, the available evidence suggests that credit rating, rather than issuer type, drives the differences: low-rated issuers display larger greenia compared to highly rated issuers.

The differences in greenia between EM and AE issuers, or between sub-investment- and investment-grade issuers, holds when we scale them by average yields. For instance, the greenium for advanced-economy issuers amounts to about 1% of their average yield-to-maturity (2.2 bps versus 200 bps), while for emerging economies it represents about 3.5% of their average yield (13 bps versus 370 bps). Similarly, the greenium for investment-grade bonds equals about 1.4% of the average yield (3.2 bps versus 231 bps), whereas for sub-investment-grade bonds it is about 6% (55.5 bps versus 895 bps).

4 Global and Local Drivers of the Greenium

While existing work has used cross-sectional data to document the presence of a small greenium—typically larger for low-rated issuers or issuers from emerging market economies—to the best of our knowledge, no study has examined the drivers of the greenium over time or the country characteristics associated with its evolution.

This question is important because estimates of the greenium display substantial variation over time. The top-left panel of Figure 5 shows the results from estimating Equation (1) using a 120-day rolling window (each black dot represents the point estimate for the previous 120 days, with the grey area indicating the 95% confidence interval). The figure suggests that there was no greenium—and even a small, though statistically insignificant, green penalty—in the early years of the sample, while stronger evidence of a greenium emerges toward the end of 2019. Separate estimates for advanced economies, emerging economies, and multilaterals display even greater volatility (top-right and bottom panels of Figure 5).

Given that existing work has emphasized the role of demand factors, we begin by examining whether climate change uncertainty affects the evolution of the greenium, possibly through a salience effect. Specifically, we test whether the greenium responds to news related to transition risk by estimating the following model:

$$y_{i(p),d(t)} = G_{i(p)}(\alpha + \beta r_{d(t)}) + X_{i(p),d(t)}\Gamma + \theta_{p,d(t)} + \varepsilon_{i(p),d(t)} \quad (2)$$

where $\mathbf{X}$ is a matrix with the bond level controls of Equation (1), $r_{d(t)}$ is a daily measure of transition risk, and all other variables are as in Equation (1). Within the framework of Equation (2), a negative value of β indicates that the greenium tends to increase on days when discussion of transition risk is more intense. Note that equation (2) does not include the main effect of transition risk because this variable is fully captured by the pair-day fixed effects.

We measure transition risk using the global transition risk index developed by Bua et al. (2024). This index captures news related to costly adjustments toward a climate-neutral economy, typically driven by climate policies, technological advances, and shifts in public preferences.⁷ We use three different measures of r : a trailing 5-day moving average (so the value at time t is the average between t and $t - 4$), the contemporaneous value, and the one-day lagged value. In all three cases, we standardize the transition risk index so that α can be interpreted as the greenium when $r = 0$, and β as the effect on the greenium of a one-standard deviation increase in r . In the baseline model, we exclude bonds issued by multilateral financial institutions, since in the next step of the analysis we study how transition risk interacts with country-specific climate change vulnerability.

We find that transition risk is significantly associated with the greenium. The point estimates indicate that a one-standard deviation increase in transition risk is associated with a 0.6 basis point increase in the greenium (about one-sixth of the average greenium in the sample) when using the trailing 5-day moving average, and with a 0.2 basis point increase when using either the daily or the lagged value (columns 1–3, Table 5). The results are robust to controlling bond-level fixed effects. This specification does not allow us to estimate time-invariant bond-specific characteristics such as the green bond dummy or the bond face value. However, the interaction between the green bond dummy and the time-varying

⁷ To construct the index, Bua et al. (2024) follow the methodology of Engle et al. (2020). They begin by selecting a large set of scientific and authoritative texts on climate change, from which they build two vocabularies: one for physical risk and one for transition risk. These vocabularies are based on scientific sources, represent global measures of physical and transition climate risk, and can be applied to any text to assess the extent of discussion on these topics. Using these vocabularies, Bua et al. (2024) construct a Physical Risk Index (PRI) and a Transition Risk Index (TRI) by matching the vocabularies against a corpus of Reuters News articles. They find that the TRI is significantly associated with returns on green stocks, while the PRI is not.

transition risk remains negative and statistically significant, and, if anything, is larger than in the estimations without bond fixed effects (column 4, Table 5). The findings are also robust to excluding country-years without information on country-specific climate vulnerability (column 5, Table 5). By contrast, when issuances by multilateral development banks are included, the interaction between the green bond dummy and the transition risk index remains negative but loses statistical significance (column 6, Table 5). This result is driven by the European Investment Bank (EIB), which accounts for nearly 20% of the observations in our sample and whose estimated greenium moves in the opposite direction compared to the rest of the sample, with a positive and statistically significant coefficient (β). Once EIB bonds are excluded, however, we again find that β is negative and statistically significant (column 7, Table 5).

Taken together, the results in Table 5 corroborate our previous finding of a greenium and further show that the greenium tends to increase when transition risk is salient, although the effects are small. We now probe further and explore how transition risk interacts with time varying (but at a lower frequency) country specific vulnerability or exposure to climate change. We estimate the following model:

$$y_{i(p),d(t)} = G_{i(p)}(\alpha + \beta r_{d(t)} + \delta v_{c,t} + \lambda r_{d(t)} \times v_{c,t}) + X_{i(p),d(t)}\Gamma + \theta_{p,d(t)} + \varepsilon_{i(p),d(t)} \quad (3)$$

where $v_{c,t}$ is a standardized time-varying indicator of climate change vulnerability for country c in year t . Given the standardization of both the transition risk indicator and the vulnerability indicator, the parameter α measures the greenium when transition risk and vulnerability are at their mean value, the parameter δ measures how the greenium responds to a one-standard deviation increase in climate vulnerability when transition risk is at its mean value. The parameter β measures how the greenium responds to a one-standard deviation increase in transition risk when vulnerability is at its mean value. Finally, λ captures the interaction between transition risk and vulnerability in affecting the greenium. A negative value of δ indicates that the greenium is higher in country-years that are more vulnerable to climate change. Similarly, a negative value of β indicates that the greenium is higher when transition risk is more salient globally. A negative value of λ indicates that the global salience of transition risk is particularly important in countries with high vulnerability to climate change. The main effect of vulnerability, transition risk, and the interaction between transition risk and vulnerability is fully absorbed by the pair-time fixed effects.

In our baseline estimates we measure climate change vulnerability with the IMF adapted version of the INFORM vulnerability indicator. This is a composite measure of countries' structural vulnerability to climate change and natural disasters, based on the INFORM Risk Index developed by the European Commission. It focuses on three dimensions: exposure to climate-related hazards (such as floods, storms, and droughts), susceptibility due to structural conditions (e.g., reliance on agriculture,

population in hazard-prone areas, weak infrastructure), and limited coping or adaptive capacity. The IMF adapts the original index by emphasizing factors relevant for macro-financial analysis, making it a standardized cross-country tool to assess how climate vulnerability affects debt sustainability, financing conditions, and broader economic resilience.

We start by setting $\beta = \lambda = 0$ and estimate how vulnerability affects the greenium. We find that the coefficient on climate change vulnerability is negative, statistically significant, and similar in magnitude to the main effect of the greenium (column 1, Table 6). In country-years where climate vulnerability is one standard deviation above the sample mean, the greenium is nearly twice as large (9.7 bps versus 5.3 bps). Adding transition risk without the interaction term (column 2, Table 6) leaves the results from column 1 unchanged, with the coefficient on transition risk like that reported in Table 5 (about half a basis point). Finally, we include the triple interaction and find that it is negative and statistically significant. Its inclusion slightly increases the estimated effect of transition risk (column 3 of Table 6). The point estimates indicate that in country-years where vulnerability is one standard deviation above the mean and on days when transition risk is particularly salient (also one standard deviation above its mean), the greenium is more than twice as large as when both interaction variables are at their mean values (11.4 bps versus 5.4 bps).

We also run a battery of robustness test and show that the results are robust to different climate change vulnerability and exposure indicators. We experiment with the IMF adjusted versions of INFORM lack of copying capacity, INFORM climate driven hazard and Exposure, INFORM climate driven risk, and ND-Gain climate change driven vulnerability (Appendix Tables A1-A4).

As noted above, the greenium tends to be larger in emerging economies or in countries with lower credit ratings, which are also typically associated with higher sovereign risk (Kling et al. 2025). We now explore whether our results on climate risk are simply capturing an emerging market or low-rating effect. To address this, we augment our model with an additional set of interactions and estimate the following specification:

$$y_{i(p),d(t)} = G_{i(p)}(\alpha + \beta r_{d(t)} + \delta_1 v_{c,t} + \lambda_1 r_{d(t)} \times C_{c,t} + \delta_2 H_{c,t} + \lambda_2 r_{d(t)} \times H_{c,t}) + X_{i(p),d(t)}\Gamma + \theta_{p,d(t)} + \varepsilon_{i(p),d(t)} \quad (3)$$

Where $H_{c,t}$ is a country-year variable that measures either the log of GDP per capita, rule of law, regulatory quality, voice and accountability, or credit rating (with higher values indicating higher ratings). Note that these variables are not standardized, so the main effect of the green bond dummy and the other interactions cannot be directly interpreted, as they are evaluated at $H=0$.

Table 7 shows that, as expected, the greenium is lower ($\alpha > 0$) for richer countries (column 1), for countries with stronger institutions (columns 2–4), and for countries with higher credit ratings (column 5). More importantly, controlling for these variables does not affect our baseline results.

5 Conclusions

This paper provides new evidence on the pricing of sovereign and quasi sovereign green bonds using a unique dataset with daily data for 332 matched green and conventional bonds issued between 2014 and 2023. By exploiting high-frequency secondary market data and bond-pair time fixed effects, we provide robust evidence that green sovereign bonds trade at slightly lower yields than comparable conventional instruments. We also show that both global and local factors matter for the greenium.

The estimated greenium is statistically significant but very small. It averages about 2 basis points for advanced economies and nearly 13 basis points for emerging markets. The greenium is larger for lower-rated issuers and increases with both the global salience of transition risk and domestic vulnerability to climate change. These results indicate investor demand and preference heterogeneity rather than differences in credit fundamentals, explain the observed yield differentials. The presence of a greenium suggests that some investors derive non-pecuniary utility from holding labelled green assets or operate under sustainability mandates that constrain portfolio composition. The fact that the greenium increases with the global perception of transition risk indicates that salience matters. At the same time, modest magnitude of the greenium implies limited fiscal gains for sovereign borrowers. Even if the entire stock of public debt were issued as green, the resulting savings would represent only a small fraction of total interest expenditures.

Our analysis of bond documentation highlights a fundamental asymmetry between promises and legal commitments. Sovereign green bonds in our sample lack binding contractual obligations to finance or deliver environmental outcomes, nor do they establish mechanisms for investors to declare default in the event of non-compliance. The “greenness” of these instruments thus relies entirely on issuer reputation and voluntary reporting rather than enforceable legal commitments.

From a financial-economics perspective, the sovereign greenium demonstrates that non-pecuniary preferences and institutional frictions can generate small, persistent deviations from risk-based pricing even in the most liquid segment of global bond markets. Yet the magnitude of the premium also highlights the limits of preference-driven equilibria: investors appear willing to pay for virtue only as long as it is cheap. The result is a market that rewards the appearance of sustainability without materially reallocating capital toward the climate transition. In this sense, sovereign green bonds illustrate a broader paradox in sustainable finance. They embody a big promise—to mobilize capital for the climate

transition—but deliver a small result. The sovereign greenium exists, but it appears to price symbolic rather than transformational value.

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Table 1: Summary statistics on green bond issuances

	N.	Mean	St. Dev.	Min.	Max
All Bonds					
Amount (billion USD)	322	1.535	3.487	0.001	30.867
Tenor (years)	322	8.537	7.687	2.000	100.000
YTM (%)	322	2.510	2.401	-0.814	18.715
Sovereign					
Amount (billion USD)	34	6.971	7.560	0.074	30.867
Tenor (years)	34	12.059	7.479	4.000	32.000
YTM (%)	34	1.957	1.741	-0.814	5.032
Agency Bonds					
Amount (billion USD)	158	0.872	0.906	0.014	6.563
Tenor (years)	158	7.430	8.614	2.000	100.000
YTM (%)	158	2.430	1.886	-0.446	12.143
Multilateral Bonds					
Amount (billion USD)	130	0.918	2.435	0.001	20.180
Tenor (years)	130	8.962	6.119	2.000	30.000
YTM (%)	130	2.753	3.015	-0.105	18.715
Advanced Economies					
Amount (billion USD)	150	2.195	4.485	0.016	30.867
Tenor (years)	150	8.707	9.157	2.000	100.000
YTM (%)	150	2.104	1.857	-0.814	12.143
Emerging Market Economies					
Amount (billion USD)	42	1.084	0.670	0.014	3.343
Tenor (years)	42	6.619	5.967	2.000	30.000
YTM (%)	42	3.210	1.643	1.039	9.956
Dollar Denominated Bonds					
Amount (billion USD)	74	0.805	0.557	0.001	3.000
Tenor (years)	74	7.554	4.949	2.000	30.000
YTM (%)	74	3.070	1.550	0.095	5.845
Euro denominated Bonds					
Amount (billion USD)	102	3.001	4.606	0.016	24.405
Tenor (years)	102	12.598	11.329	3.000	100.000
YTM (%)	102	1.127	1.294	-0.814	5.032
Bonds denominated in currencies issued by Advanced Economies (excl USD and euro)					
Amount (billion USD)	94	1.079	3.845	0.010	30.867
Tenor (years)	94	6.947	3.711	2.000	32.000
YTM (%)	94	2.059	1.479	0.002	5.045
Bonds denominated in RMB					
Amount (billion USD)	21	1.113	0.947	0.014	3.343
Tenor (years)	21	3.286	0.956	2.000	5.000
YTM (%)	21	2.555	0.222	1.901	2.894
Bonds denominated in currencies issued by Emerging Economies (excl RMB)					
Amount (billion USD)	31	0.118	0.194	0.001	0.754
Tenor (years)	31	5.903	2.087	2.000	10.000
YTM (%)	31	7.066	3.744	1.143	18.715

Table 2: Summary Statistics, daily data

	Green					Conventional				
	N. Obs	Mean	St. Dev	Min	Max	N. Obs	Mean	St. Dev	Min	Max
All										
Mid yield (bps)	161,184	237	220	-96	2000	161,184	238	221	-98	1990
Bid-to-Ask (bps)	161,184	5	7	0	100	161,184	5	7	0	100
Amount (million USD)	161,184	1,430	2918	3	30,867	161,184	3,120	7,030	18	65,634
Residual tenor (days)	161,184	2903	2226	20	35197	161,184	2875	2193	19	35249
Sovereign										
Mid yield (bps)	14,247	267	321	-86	2000	14,247	273	331	-83	1990
Bid-to-Ask (bps)	14,247	8	13	0	100	14,247	6	8	0	70
Amount (million USD)	14,247	6,117	6,727	74	30,867	14,247	13,500	14,613	750	43,209
Residual tenor (days)	14,247	3657	2385	685	11152	14,247	3545	2330	686	11235
Agency										
Mid yield (bps)	71,786	224	189	-78	1343	71,786	224	189	-98	1542
Bid-to-Ask (bps)	71,786	5	5	0	90	71,786	5	7	0	100
Amount (million USD)	71,786	951	966	14	6,563	71,786	2,227	3,480	22	29,971
Residual tenor (days)	71,786	2455	1872	122	35197	71,786	2436	1835	122	35249
Multilateral										
Mid yield (bps)	75,151	243	225	-96	1467	75,151	245	223	-98	1459
Bid-to-Ask (bps)	75,151	5	6	0	100	75,151	5	6	0	99
Amount (million USD)	75,151	1,000	2,055	3	20,180	75,151	1,956	5,382	18	65,634
Residual tenor (days)	75,151	3188	2413	20	11096	75,151	3167	2390	19	11033

Table 3: Greenium, Baseline Regressions

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days). Columns 1 and 2 include all bonds in our sample, column 3 only includes sovereign bonds, column 4 only agency bonds, and column 5 only bonds issued by multilateral institutions. Column 6 only includes bonds denominated in euro, column 7 only bonds denominated in US dollars, column 8 only bonds issued in denominated of advanced economies which are not euro or USD, and column 9 only bonds denominated in currencies of EM economies.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Green	-1.276 (0.926)	-3.773*** (1.021)	-17.82** (7.177)	-2.135* (1.127)	-3.286** (1.562)	-4.178*** (1.392)	-5.830** (2.513)	0.641 (1.382)	-5.081 (5.536)
Bid to Ask		-0.181* (0.0968)	-0.367*** (0.128)	-0.0606 (0.180)	-0.290* (0.163)	-0.0454 (0.181)	0.584* (0.300)	-0.290* (0.151)	-0.581*** (0.120)
Ln(amount)		-2.700*** (0.932)	-11.97*** (3.634)	-2.832*** (1.023)	-1.320 (1.438)	-2.880 (2.166)	-3.746* (1.915)	-1.578* (0.934)	-1.394 (1.717)
Time to matur.		0.0198*** (0.00282)	0.0328*** (0.0113)	0.0221*** (0.00411)	0.0161*** (0.00386)	0.0170*** (0.00327)	0.0215** (0.00892)	0.0280*** (0.00524)	-0.0354 (0.0404)
Constant	238.3*** (0.677)	238.4*** (18.62)	427.7*** (56.03)	229.8*** (23.66)	222.5*** (26.15)	127.2*** (44.93)	349.1*** (31.02)	200.8*** (24.65)	623.6*** (76.45)
Observations	322,368	322,368	28,494	143,572	150,302	131,300	87,430	80,628	23,010
R-squared	0.998	0.998	0.999	0.998	0.998	0.997	0.997	0.998	0.997
Sample	All	All	Sovereign	Agency	Multi	euro	USD	AE	EM
Fixed effects	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date

Standard errors clustered at the bond-level

Table 4: Greenium, By country groups and ratings

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days). Column 1 includes sovereign bonds issued by advanced economies, column 2 include bonds issued by emerging economies, column 3 bonds issued by multilaterals (same as column 5 of Table 1), Column 4 bonds with a prime credit rating (AAA), column 5 bonds with a high-grade rating (AA+ to A-), column 6 bonds with medium grade rating (BBB+ to BBB-), column 7 investment grade bonds, and column 8 sub-investment grade bonds.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Green	-2.230** (1.047)	-12.71*** (4.724)	-3.270** (1.562)	-3.366*** (1.184)	-1.528 (1.475)	-8.190*** (1.868)	-3.165*** (0.889)	-55.51*** (1.993)
Bid to Ask	-0.146 (0.169)	-0.0843 (0.166)	-0.279* (0.166)	-0.285** (0.125)	-0.0464 (0.184)	0.373 (0.346)	-0.188* (0.099)	-0.438 (0.497)
Ln(amount)	-3.954*** (0.856)	-3.265** (1.606)	-1.305 (1.438)	-2.522** (1.216)	-1.708 (1.287)	-4.839** (2.007)	-2.475*** (0.927)	-90.23*** (1.835)
Time to matur.	0.0159*** (0.00356)	0.0384*** (0.0108)	0.0161*** (0.00386)	0.0152*** (0.00345)	0.0227*** (0.00332)	0.0212** (0.00920)	0.0183*** (0.003)	
Constant	245.3*** (19.86)	338.1*** (29.68)	222.2*** (26.14)	234.4*** (23.77)	191.2*** (26.78)	485.5*** (75.54)	231.599*** (18.850)	2,781*** (48.81)
Observations	142,074	29,992	150,302	222,766	84,440	12,252	319,458	2,910
R-squared	0.998	0.998	0.998	0.997	0.999	0.998	0.995	0.998
Sample	AE	EM	Multilateral	Prime rating	High Rating	Mid rating	Inv Grade	Sub Inv Grade
Fixed effects	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date

Standard errors clustered at the bond-level

Table 5: Greenium and Transition Risk

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days) and the interaction between the green dummy and a measure of transition risk perception that varies at daily frequency. Columns 1-3 exclude bonds issued by multilaterals, Column 4 only includes observations for which we have country-specific risk variables, Column 5 includes all observations, Column 6 excludes bonds issued by EIB, column only includes bonds issued by EIB.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Green	-3.854*** (0.0779)	-3.858*** (0.0779)	-3.857*** (0.0779)		-3.553*** (0.0950)	-3.774*** (0.0620)	-4.138*** (0.0708)	-1.859*** (0.133)
Green x trans risk	-0.622*** (0.0734)	-0.191*** (0.0630)	-0.223*** (0.0626)	-0.162*** (0.0600)	-0.560*** (0.0857)	-0.312*** (0.0611)	-0.512*** (0.0698)	0.683*** (0.121)
Bid to Ask	-0.127*** (0.0174)	-0.126*** (0.0174)	-0.126*** (0.0174)	-0.323*** (0.0188)	0.318*** (0.0287)	-0.175*** (0.0147)	-0.138*** (0.0169)	-0.369*** (0.0293)
Ln(amount)	-3.497*** (0.0539)	-3.505*** (0.0540)	-3.504*** (0.0540)		-3.171*** (0.0646)	-2.691*** (0.0561)	-2.785*** (0.0591)	-1.480*** (0.145)
Time to maturity	0.0215*** (0.0002)	0.0215*** (0.0002)	0.0215*** (0.0002)		0.0276*** (0.0003)	0.0198*** (0.0002)	0.0215*** (0.0002)	0.0129*** (0.0005)
Constant	250.4*** (1.229)	250.6*** (1.231)	250.6*** (1.231)	233.7*** (0.102)	148.1*** (1.577)	238.2*** (1.367)	251.0*** (1.461)	170.6*** (2.856)
Observations	172,066	172,066	172,066	172,066	116,160	322,368	259,474	62,894
R-squared	0.998	0.998	0.998	0.999	0.998	0.998	0.998	0.997
Transition risk is	5-day MA	Time t	Time t-1	5-day MA	5-day MA	5-day MA	5-day MA	5-day MA
Sample	Excluding Multilaterals	Excluding Multilaterals	Excluding Multilaterals	Excluding Multilaterals	Excluding Multil. & obs without country-year vars	All	Excluding EIB	EIB
Fixed effects	Pair-date	Pair-date	Pair-date	Pair-date Bond	Pair-date	Pair-date	Pair-date	Pair-date

Standard errors clustered at the pair-date level

Table 6: Greenium, Transition Risk, and Vulnerability

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days) and the interaction between the green dummy and a measure of transition risk perception that varies at daily frequency (we use the 5-day MA), the interaction between the green dummy and a variable (from INFORM) that measures climate change vulnerability, and the triple interaction.

	(1)	(2)	(3)
Green	-5.342** (2.198)	-5.405** (2.207)	-5.438** (2.209)
Green x trans risk x Vulnerability			-0.781*** (0.293)
Green x trans risk		-0.458** (0.178)	-0.777*** (0.237)
Green x Vulnerability	-4.358* (2.597)	-4.320* (2.597)	-4.445* (2.602)
Bid to Ask	0.308 (0.220)	0.308 (0.221)	0.309 (0.221)
Ln(amount)	-3.331*** (1.019)	-3.323*** (1.014)	-3.317*** (1.013)
Time to maturity	0.0253*** (0.00373)	0.0253*** (0.00373)	0.0253*** (0.00373)
Constant	157.8*** (22.74)	157.5*** (22.65)	157.4*** (22.64)
Observations	116,160	116,160	116,160
R-squared	0.998	0.998	0.998
Fixed effects	Pair-date	Pair-date	Pair-date

Standard errors clustered at the bond-level

Table 7: Greenium, Transition Risk, and Vulnerability, Horserace

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days) and the interaction between the green dummy and a measure of transition risk perception that varies at daily frequency (we use the 5-day MA), the interaction between the green dummy and a variable (from INFORM) that measures climate change vulnerability, and the triple interaction. The model is augmented with further interactions. Column 1 uses the log of GDP per capita, column 2 rule of law, column 3 bureaucratic quality, column 4 voice and accountability, and column 5 credit ratings (higher values correspond to higher rating)

	(1)	(2)	(3)	(4)	(5)
Green	-64.32*** (24.61)	-16.58*** (4.880)	-16.85*** (4.844)	-14.76*** (3.794)	-0.356 (2.657)
Green x TrRi x Vuln	-0.623* (0.350)	-0.745** (0.316)	-0.645** (0.326)	-0.731** (0.295)	-0.884*** (0.326)
Green x trans risk	-4.942*** (1.893)	-1.228*** (0.328)	-1.224*** (0.255)	-0.904*** (0.214)	-0.490 (0.332)
Green x Vulnerability	-0.633 (2.530)	-1.097 (2.176)	-1.195 (2.152)	-2.813 (2.106)	-3.142 (2.653)
Green x trans risk x INT	0.409** (0.192)	0.429* (0.256)	0.442** (0.223)	0.251* (0.128)	-0.508** (0.237)
Green x INT	5.838** (2.316)	9.483*** (3.094)	9.749*** (3.091)	8.704*** (2.537)	6.242* (3.511)
Bid to Ask	0.256 (0.213)	0.237 (0.193)	0.226 (0.193)	0.200 (0.185)	0.508** (0.237)
Ln(amount)	-2.777*** (0.939)	-2.962*** (0.852)	-2.974*** (0.795)	-3.648*** (0.778)	-6.242* (3.511)
Time to maturity	0.0249*** (0.00381)	0.0259*** (0.00419)	0.0243*** (0.00369)	0.0246*** (0.00364)	0.0251*** (0.00381)
Constant	147.4*** (22.04)	148.6*** (21.22)	153.2*** (19.90)	166.7*** (19.39)	138.8*** (26.31)
Observations	116,160	116,160	116,160	116,160	116,160
R-squared	0.998	0.998	0.998	0.998	0.998
INT is	Ln(GDP PC)	Rule of Law	Regulatory Quality	Voice and Accountability	Credit Rating (higher value lower rating)
Fixed effects	Pair-date	Pair-date	Pair-date	Pair-date	Pair-date

Standard errors clustered at the bond-level

Figure 1: Bond Issuance by year and issuer type

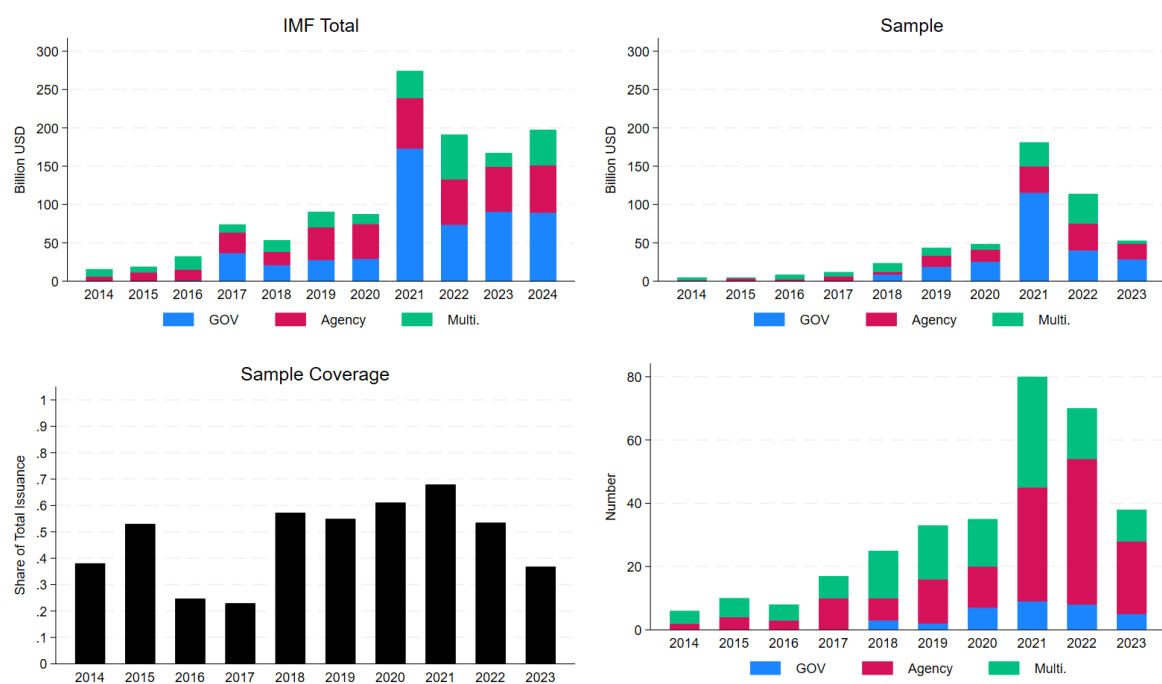


Figure 2: Bond Issuance by year and currency

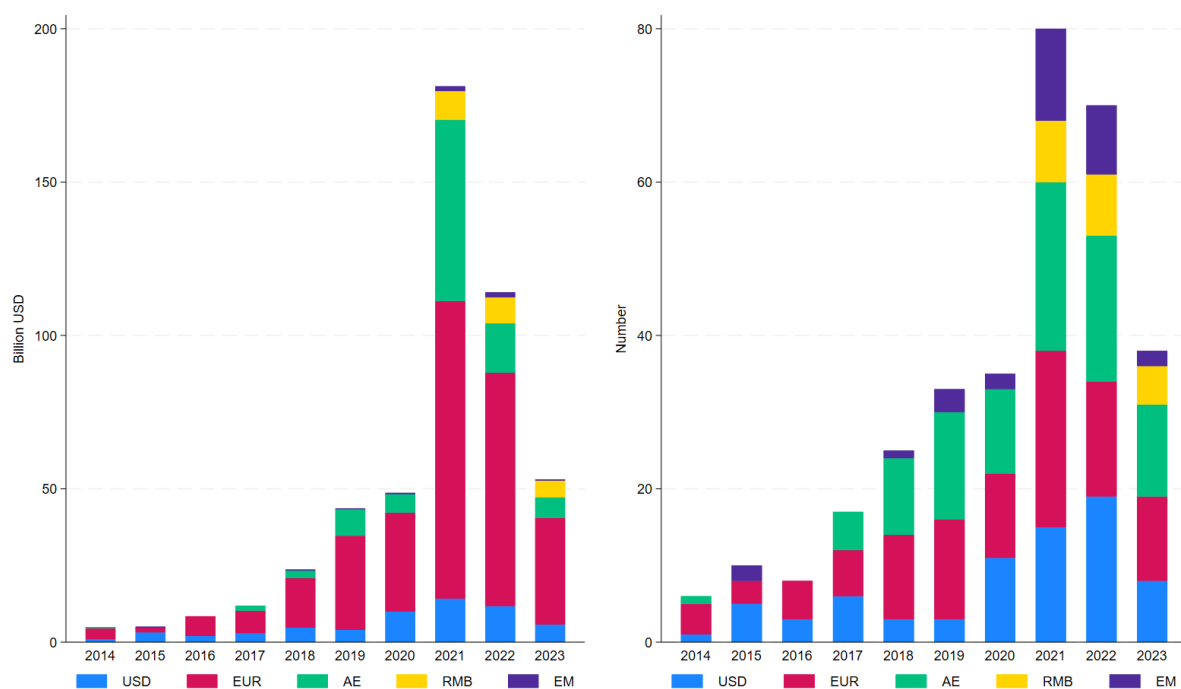


Figure 3: Bond Issuance by year and country

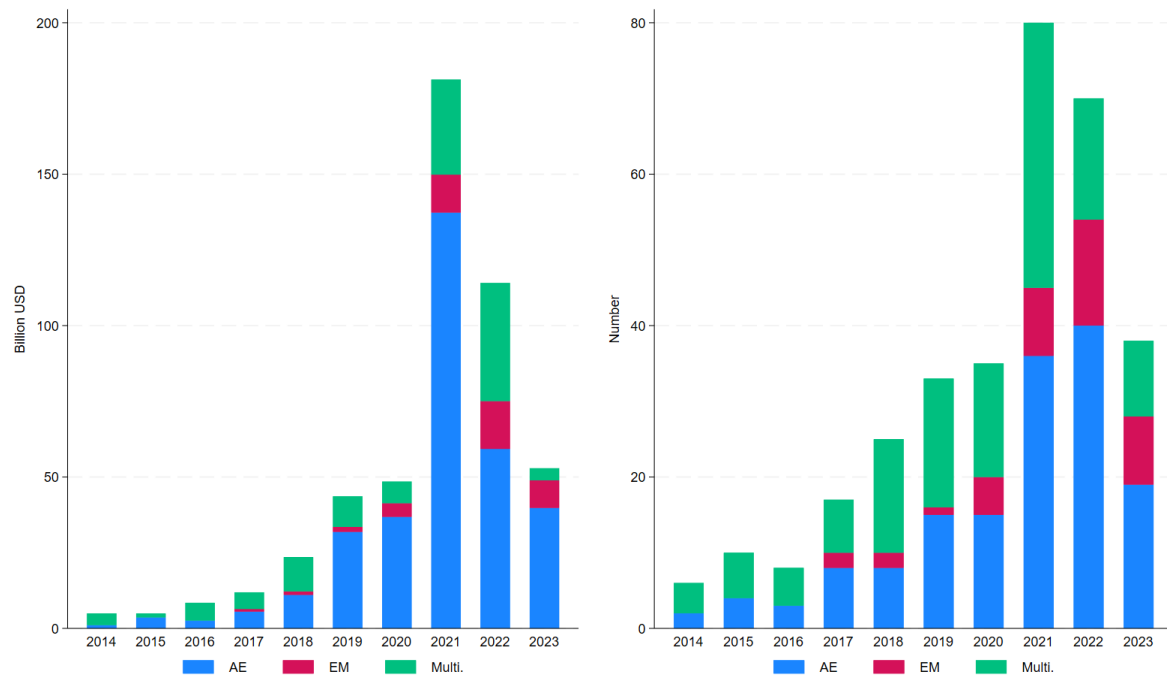


Figure 4: Bond Issuance by year and tenor

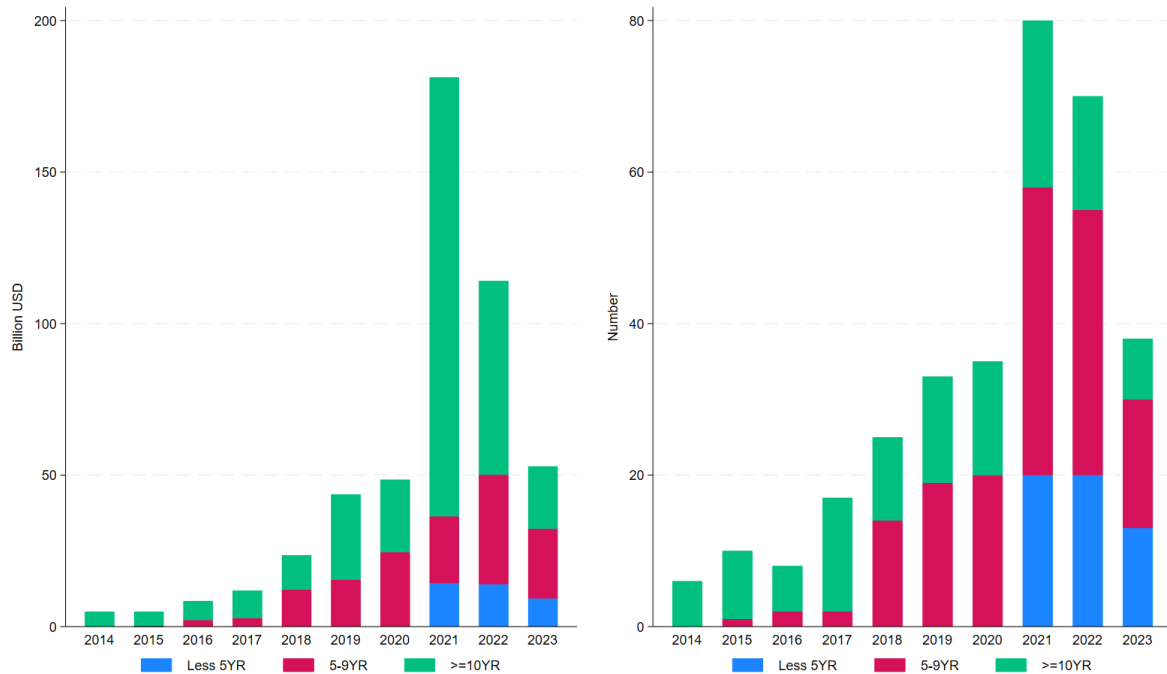
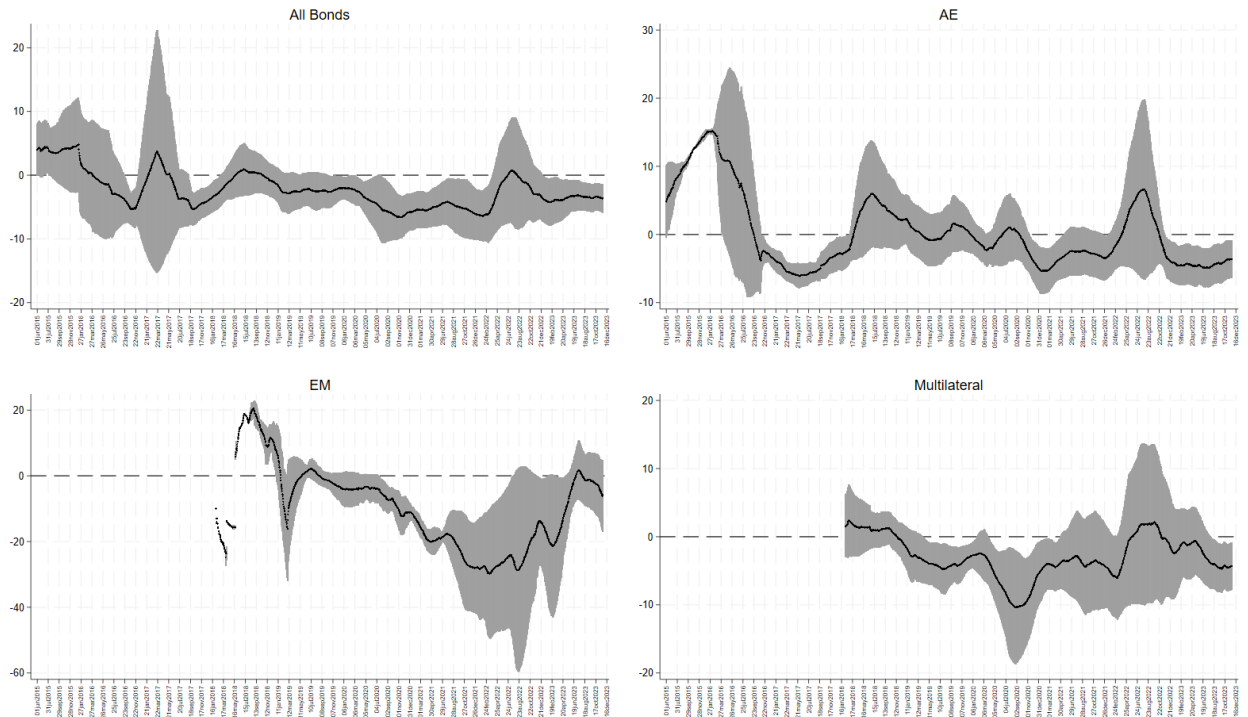


Figure 5: Greenium Over Time

These figures show the evolution of the greenium each point shows the estimated greenium (with 95% confidence interval) for the previous 120 days obtained from a model that controls the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days), pair-date fixed effects. Standard errors are clustered at the bond level. The top left panel uses all bonds, the top right only advanced economies, the bottom left only EM, and the bottom right only multilaterals.



Appendix

Table A1: Greenium, Transition Risk, and Lack of Copying Capacity

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days) and the interaction between the green dummy and a measure of transition risk perception that varies at daily frequency (we use the 5-day MA), the interaction between the green dummy and a variable (from INFORM) that measure lack of climate change copying capacity, and the triple interaction.

	(1)	(2)	(3)
Green	-21.23*** (6.969)	-21.29*** (6.959)	-21.40*** (6.936)
Green x trans risk x Cop Cap			-0.712** (0.336)
Green x trans risk		-0.449*** (0.159)	-1.416*** (0.473)
Green x Cop Cap	-13.35*** (4.718)	-13.34*** (4.711)	-13.42*** (4.697)
Bid to Ask	0.208 (0.202)	0.208 (0.202)	0.208 (0.202)
Ln(amount)	-2.638*** (0.885)	-2.631*** (0.881)	-2.633*** (0.882)
Time to maturity	0.0258*** (0.00419)	0.0258*** (0.00418)	0.0258*** (0.00418)
Constant	142.3*** (21.85)	142.1*** (21.77)	142.1*** (21.79)
Observations	116,160	116,160	116,160
R-squared	0.998	0.998	0.998
Fixed effects	Pair-date	Pair-date	Pair-date

Standard errors clustered at the bond-level

Table A2: Greenium, Transition Risk, and Climate-driven Hazard & Exposure

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days) and the interaction between the green dummy and a measure of transition risk perception that varies at daily frequency (we use the 5-day MA), the interaction between the green dummy and a variable (from INFORM) that measures Climate-driven Hazard & Exposure and the triple interaction.

	(1)	(2)	(3)
Green	-4.191*** (1.559)	-4.267*** (1.576)	-4.267*** (1.576)
Green x trans risk x H&E			-0.183 (0.152)
Green x trans risk		-0.455** (0.184)	-0.489** (0.188)
Green x H&E	-3.458*** (1.210)	-3.447*** (1.210)	-3.480*** (1.218)
Bid to Ask	0.259 (0.215)	0.259 (0.215)	0.259 (0.215)
Ln(amount)	-3.254*** (0.870)	-3.247*** (0.867)	-3.244*** (0.867)
Time to maturity	0.0262*** (0.00419)	0.0262*** (0.00419)	0.0262*** (0.00419)
Constant	153.9*** (19.87)	153.7*** (19.80)	153.7*** (19.81)
Observations	116,160	116,160	116,160
R-squared	0.998	0.998	0.998
Fixed effects	Pair-date	Pair-date	Pair-date

Standard errors clustered at the bond-level

Table A3: Greenium, Transition Risk, and Climate-driven Risk

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days) and the interaction between the green dummy and a measure of transition risk perception that varies at daily frequency (we use the 5-day MA), the interaction between the green dummy and a variable (from INFORM) that measures Climate-driven Risk and the triple interaction.

	(1)	(2)	(3)
Green	-9.620*** (3.042)	-9.672*** (3.041)	-9.758*** (3.047)
Green x trans risk x CD Risk			-0.802*** (0.260)
Green x trans risk		-0.387** (0.173)	-0.997*** (0.264)
Green x CD Risk	-8.015*** (2.940)	-7.996*** (2.939)	-8.132*** (2.950)
Bid to Ask	0.241 (0.199)	0.241 (0.199)	0.242 (0.199)
Ln(amount)	-3.227*** (0.936)	-3.220*** (0.932)	-3.214*** (0.932)
Time to maturity	0.0246*** (0.00387)	0.0246*** (0.00387)	0.0246*** (0.00387)
Constant	157.9*** (21.05)	157.8*** (20.97)	157.6*** (21.00)
Observations	116,160	116,160	116,160
R-squared	0.998	0.998	0.998
Fixed effects	Pair-date	Pair-date	Pair-date

Standard errors clustered at the bond-level

Table A4: Greenium, Transition Risk, and ND Gain climate change vulnerability

This table reports the results of a set of regressions in which yield to maturity is regressed over a green bond dummy, the bid-to-ask spread, the log of the bond face value, remaining time to maturity (in days) and the interaction between the green dummy and a measure of transition risk perception that varies at daily frequency (we use the 5-day MA), the interaction between the green dummy and a variable (from ND Gain) that measures Climate-driven vulnerability.

	(1)	(2)	(3)
Green	-14.66*** (4.845)	-14.69*** (4.838)	-14.83*** (4.857)
Green x trans risk x Vuln			-0.771** (0.365)
Green x trans risk		-0.366** (0.174)	-1.319*** (0.476)
Green x Vuln	-9.181*** (3.310)	-9.153*** (3.306)	-9.280*** (3.326)
Bid to Ask	0.292 (0.225)	0.292 (0.225)	0.292 (0.225)
Ln(amount)	-2.894*** (0.826)	-2.889*** (0.824)	-2.887*** (0.826)
Time to maturity	0.0272*** (0.00429)	0.0272*** (0.00429)	0.0272*** (0.00428)
Constant	143.6*** (19.75)	143.5*** (19.72)	143.5*** (19.74)
Observations	116,000	116,000	116,000
R-squared	0.998	0.998	0.998
Fixed effects	Pair-date	Pair-date	Pair-date

Standard errors clustered at the bond-level