The Reversal of the Green Bond Premium *

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Abstract

Anecdotal evidence suggests that the greenium—the yield difference between green and conventional bonds—may have disappeared, raising questions about investor preferences for green investments. This paper examines whether this is the case using a global sample of corporate green bonds from 2020 to 2024. We match each green bond to a similar conventional bond issued by the same firm and estimate the green bond premium as the fixed effect from regressions of yield differences on differences in liquidity and volatility. Our results show that the greenium has not only disappeared but reversed after 2022, indicating a declining preference for green bonds among investors. We further investigate whether broader sentiments on the market such as the ESG backlash or doubts about the effectiveness of ESG investing can explain this reversal. Using ESG scores interacted with a post-2022 dummy, bond, and macro-level controls, we find that high ESG scores lose importance after 2022, showing the most pronounced greenium reversal, consistent with increasingly negative sentiment towards ESG investing. Prior to 2023, green bond investors do not seem to exhibit counterproductive behavior because in this period the greenium is lower for dirtier firms in terms of emission intensity. After 2022, premia reverse across both clean and dirty issuers, which suggest an overall decreased demand for green bonds. So despite regulatory efforts such as the European green bond standard, convincing investors to pay a premium for green bonds remains challenging, complicating efforts to finance decarbonization.

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1 Introduction

Over the past decade, financial markets have increasingly embraced sustainable investments.[1] Within fixed income markets, green bonds have experienced particularly rapid growth, reaching a cumulative issuance volume of $3.65 trillion by 2025. This expansion has made green bonds the largest sustainable debt instrument, surpassing social bonds and sustainability-linked loans (Climate Bonds Initiative, 2025). Alongside this growth, academics and practitioners have debated the existence of a so-called greenium, a yield discount for green bonds relative to conventional bonds. While the empirical evidence remains mixed, several studies document a small but statistically significant greenium in secondary markets (e.g., MacAskill et al., 2021), suggesting that investors have been willing to pay a premium for environmentally labeled debt. Such pricing differences are often attributed to investor green preferences or non-pecuniary utility derived from holding sustainable assets (Pástor et al., 2021; Zerbib, 2019).

However, both recent academic research and anecdotal evidence indicate that these preferences may be weakening or even reversing. Financial news outlets report declining investor enthusiasm for ESG investing and suggest that the greenium has largely disappeared.[2] Consistent with this anecdotal evidence, Baker et al. (2024) show that investors' willingness to pay for ESG index funds was initially positive but turned negative after 2022, reflecting the emergence of what has been termed an ESG backlash. At the same time, the effectiveness of ESG investing itself has come under scrutiny. For example, Hartzmark and Shue (2022) argue that investors may allocate capital counterproductively by favoring firms that are already environmentally clean, thereby limiting real-world impact. Similarly, Lam and Wurgler (2024) find that green bonds do not meaningfully increase financing for newly developed green projects.

These developments raise two research questions addressed in this paper. First, we examine whether the greenium exhibits significant time variation. Building on the empirical framework of Zerbib (2019), we estimate the green bond premium as a fixed effect in regressions that control for differences in liquidity and volatility between matched green and conventional bonds on a year-by-year basis. In addition to matching on a large set of bond characteristics, we impose limits on amount issued, issue date and maturity at issuance and we construct a synthetic bond from two matched conventional bonds to exactly correspond to the maturity of the green bond. Using

[1] Bloomberg Intelligence (2024, February 22). ESG AUM set to top 40 trillion by 2030, anchor capital markets. See www.bloomberg.com.

[2] Bloomberg (2023, January 13). Goldman says goodbye greenium as ESG is now priced like all debt. See www.bloomberg.com. Financial Times (2023, December 4). The real impact of the ESG backlash. See www.ft.com.

this approach, we successfully match 1,349 corporate green bonds with comparable conventional bonds by the same issuer. Our results show that the green bond premium has disappeared during our sample period from 2020 to 2024. Toward the end of the sample, we even observe a positive premium, indicating a reversal in green bond pricing. To our knowledge, we are the first to document such a reversal. Theoretically, this finding suggests that as the supply of green bonds has become more abundant (Lehkonen et al., 2024) and demand has decreased, the structural costs and constraints inherent to green bonds, *e.g.* restricted use of proceeds, the higher costs associated with third-party validation and the risk of loosing a green label, have begun to outweigh their non-pecuniary benefits. Consequently, on average investors now appear to demand a yield premium for the reduced flexibility and potential costs associated with green bonds, reversing the greenium. This finding is consistent with recent evidence pointing to a broader ESG backlash and associated reversal of green premia (Baker et al., 2024).

Our findings naturally lead to a second research question: Do investors differentiate between issuers' ESG characteristics and greenness, and has this differentiation changed over time? Green bonds are defined as fixed income instruments whose proceeds are exclusively allocated to environmentally friendly projects (ICMA, 2021), yet they are issued by firms with widely varying environmental footprints. From an impact perspective, investors concerned with real-world outcomes should prioritize issuers with the greatest potential for improvement—namely, firms with higher emission intensity (Hartzmark and Shue, 2022). We hypothesize, however, that investor behavior deviates from this ideal. Specifically, we expect green bonds issued by cleaner firms to face stronger demand from sustainable investors and, consequently, to command a higher greenium. However, this preference is expected to weaken as ESG sentiment declines. Accordingly, we predict that any greenium associated with cleaner issuers diminishes over time. To test this hypothesis, we incorporate issuer-level ESG scores and emission intensity measures from LSEG Eikon, interacted with a post-2022 indicator, alongside a comprehensive set of bond-level and macroeconomic controls.

We find evidence for our hypothesis in the period prior to 2022: higher ESG scores are associated with a more negative yield differential, i.e., a larger greenium, which suggests a clear preference for high-ESG firms by sustainable investors. A different pattern emerges when issuer greenness is measured using emission intensity, including upstream and downstream emissions. Before 2023, issuers in the highest quintile of emission intensity—the dirtiest firms—exhibit a significantly larger greenium. These findings imply that investors initially targeted issuers

with the largest scope for environmental improvement, as emphasized by Hartzmark and Shue (2022). After 2022, green bond premia become positive for both clean and dirty firms. However, relative to the previously negative premia, the green bond premium becomes most positive for clean firms and firms with high ESG-scores.

Together, these findings document a reversal in the corporate green bond premium and changing investor preferences, motivating the following contributions to the literature. First, we contribute to the literature on green bonds, and in particular to studies examining the existence and determinants of the greenium. A large body of empirical work investigates whether green bonds trade at a premium relative to conventional bonds (Aswani and Rajgopal, 2025; Baker et al., 2022; Caramichael and Rapp, 2024; Cortellini and Panetta, 2021; Flammer, 2021; Gianfrate and Peri, 2019; Ghitti et al., 2025; Karpf and Mandel, 2018; Lam and Wurgler, 2024; Lehkonen et al., 2024; MacAskill et al., 2021; Pietsch and Salakhova, 2022; Renjie and Xia, 2023; Zerbib, 2019). Much of this literature documents a negative green bond premium in secondary markets, often interpreted as reflecting investors' non-pecuniary preferences for environmentally labeled assets. For example, Zerbib (2019) attributes the greenium observed between 2013 and 2017 to such preferences. Other studies show that the greenium varies over time and is driven by shifts in investor demand (Boermans, 2023; Caramichael and Rapp, 2024; Karpf and Mandel, 2018; Pietsch and Salakhova, 2022; Sangiorgi and Schopohl, 2023). We extend this literature by providing evidence that the average corporate green bond premium has not merely declined but has reversed sign in recent years. This finding is consistent with a weakening of ESG-related preferences among investors (Baker et al., 2024) and links our results to the broader literature on non-pecuniary investor preferences and their implications for asset pricing (e.g., Starks, 2023).

Second, we contribute to the literature on the cross-sectional determinants of the greenium. Green bonds were designed to mobilize capital toward decarbonization and close financing gaps for climate-related investments (OECD, 2017). Under an impact-oriented framework (Hartzmark and Shue, 2022; Oehmke and Opp, 2025), one would expect a greenium to be concentrated in bonds—or issuers—that finance projects with meaningful transition potential. Prior work operationalizes greenness using information on the use of proceeds. For instance, Benincasa et al. (2022) show that bonds financing greener projects command lower yields in the primary market, while projects associated with substantial and lasting CO_2 reductions—often proxied by a darker "shade of green" assigned by second-party opinion providers—exhibit larger green premia (Dorfleitner et al., 2022; Ghitti et al., 2025; Huynh et al., 2022).

However, detailed project-level information is often difficult for investors to obtain or interpret (Dinh et al., 2023; Kapraun et al., 2021; Tuhkanen and Vulturius, 2022). Consistent with this, several studies find that investors do not appear to price project additionality, as green bond premia do not differ between bonds financing additional versus non-additional projects (Caramichael and Rapp, 2024; Lam and Wurgler, 2024). An alternative approach is therefore to assess greenness at the issuer level. Prior research shows that green bonds issued by financial institutions exhibit significantly larger premia, suggesting that already clean firms may be disproportionately rewarded (Aswani and Rajgopal, 2025; Caramichael and Rapp, 2024; Lehkonen et al., 2024; Pietsch and Salakhova, 2022; Zerbib, 2019). Evidence based on ESG scores is mixed, with some studies finding that only very low ESG scores are associated with lower premia, while others document a more monotonic relationship (Immel et al., 2022; Huynh et al., 2022; Kapraun et al., 2021).

We add to this literature by examining whether investor assessments of issuer greenness have changed over time. We show that prior to 2023, higher ESG scores are associated with larger green premia, indicating an initial preference for green bonds issued by cleaner firms. This relationship disappears after 2022, consistent with a broader ESG backlash (Baker et al., 2022). While most studies using emissions data focus on whether issuers reduce emissions following green bond issuance (Aswani and Rajgopal, 2025; ElBannan and Löffler, 2024; Ehlers et al., 2020; Fatica and Panzica, 2021; Flammer, 2021), we use issuer emission intensity as a cross-sectional measure of greenness. We find that although bonds issued by the highest-emission firms also exhibit positive premia after 2023, these premia are considerably smaller than those of the lowest-emission firms.

The remainder of the paper is structured as follows. Section 2 describes the sample construction and the matching process in detail. Next, the fixed effect regression to recover the green bond premium and the regression to analyzes the distribution of the green bond premium across issuers are explained in the methodology (Section 3). Results are reported and discussed in Section 4. Section 5 concludes.

2 Data

In this data section, we first describe our matching procedure for pairing green bonds with comparable conventional bonds in subsection 2.1. Next, we provide additional details on our

green bond sample in subsection 2.2. Finally, in subsection 2.3, we introduce our measures of issuer greenness and explain how we combine the greenness data with the bond data.

2.1 Matching

In the literature, the green bond premium is defined as the yield difference between a green bond and a similar conventional bond. When the green bond has a lower yield (higher price), the difference is negative and we refer to it as a greenium. In order to estimate it, we match a sample of non-convertible, non-putable, plain vanilla fixed coupon, corporate green bonds from LSEG Eikon to conventional bonds by the same issuer. We start with 5,147 green bonds by 1,785 issuers that have non-missing identifiers (RIC) and maturity dates, and positive issue amounts. Next, we download daily ask yields[3], ask and bid prices in USD for both green and conventional bonds by the same issuers.[4] We winsorize ask yields, ask prices and bid prices at the 1^{st} and the 99^{th} percentile for all bonds. Following the procedure in Zerbib (2019), we match green and conventional bonds based on callability, currency, collateral, coupon frequency, instrument type, issuer, rating and seniority. Table 1 provides an overview of the matching criteria used to match green to conventional bonds by the same issuer. In addition, we require that the available data of potential matches need to overlap by at least 100 days.

[Insert Table 1 about here]

We select the two nearest neighbors based on amount issued, coupon, issue date and maturity. Having two matches allows us to control for potential maturity biases by constructing a synthetic bond. As in Zerbib (2019), we extra-/interpolate the maturity at issuance to calculate a maturity matched yield of the (synthetic) conventional bond. This also implies that the two conventional bonds need to have different maturities from each other, otherwise the match is redundant in the inter/extrapolation. If only one conventional bond is found but the maturity is within a seven-day window to the green bond, we treat the one matched conventional bond as a synthetic bond. This is the case for 268 of 1,349 bonds in the final sample.

The advantage of our conservative matching process over a cross-sectional regression is that it controls for potential confounders at the bond-pair level. Successfully matched bonds only differ by the variable of interest: the green bond label. As observed by e.g. Kapraun et al. (2021),

[3]Zerbib (2019) argues that since we are looking at the demand side the ask yield is the relevant metric. Moreover, ask yields are much more available then yield to maturity on LSEG Eikon.

[4]We consider conventional (non green), non-convertible, non-putable plain vanilla fixed coupon bonds by the same issuer as the green bonds

Lehkonen et al. (2024) and Zerbib (2019), some differences between groups remain. Appendix Table B.1 illustrates that also after matching green bonds on average tend to have smaller issue amounts. This may point to remaining differences in liquidity, fo which we will control in the next stage. Moreover, coupons are slightly higher for green bonds while maturity at issuance shows a very similar distribution for both. Overall we are confident that the matching procedure yields acceptable results.

[Insert Figure 1 about here]

2.2 Green Bonds Sample

The sample to estimate the greenium covers 689,597 unbalanced daily observations of 1,349 matched green bonds by 536 issuers from January 1, 2020, to December 31, 2024. Figure 1 shows that issuance exhibits an upward trend, peaking in 2022 and gradually declining thereafter. Table 2 provides descriptive statistics. Panel A shows that the European Union (EU) remains the dominant player in the green bond market, accounting for 42.6% of the total amount issued and 42.8% of the bond count. While China accounts for the largest share of unique issuers (34.7%), it represents a lower proportion of total capital raised (20.9%). The United States is considerably smaller in this specific sample, contributing 17.2% of the total volume.[5] In terms of credit quality (Panel B), the market is skewed toward high-quality issuers. Investment-grade bonds (AAA–A) constitute 54.2% of the total amount issued. When combined with Lower Investment Grade (BBB) bonds, the total investment-grade universe accounts for nearly 83% of the market value. This concentration suggests that green bond financing is primarily a tool utilized by highly rated, institutional-grade entities, with high-yield and unrated issuers representing a minority (17.2% by amount). Panel C highlights the role of third-party standards. External reviews in the form of a certification from the Climate Bonds Initiative (CBI) and/or a Second Party Opinion (SPO) provide additional credibility to a green bond label. The vast majority of the sample (77.1% by amount) is classified as CBI Aligned, indicating adherence to the Climate Bonds Initiative's rigorous taxonomies. In contrast, CBI Certified bonds, those undergoing formal verification, represent a niche segment at 4.5%, while Self-Labeled bonds account for 18.4% of the total volume. Not shown in the table, 65% of the green bonds issued have a second-party opinion.

[5]Not shown in the table, but note that Germany stands out with a high number of bonds issued. Two of the three largest issuers are German, namely *Deutsche Bank* ($12,597.3 million) and *E ON* ($10,637.2 million). Meanwhile, the five largest single issues are from 2022 and 2023, which are all AAA-rated issues by Chinese banks ($3,725.37 million to $4,193.4 million).

[Insert Table 2 about here]

Panel D shows the distribution across sectors and reveals a significant concentration in the Financial sector, which accounts for 52.0% of both the number of bonds and the total amount issued. This may appear counterintuitive at first, given banks' low direct emissions and energy use (i.e., low Scope 1 and 2 emissions). Nonetheless, banks use these bonds to issue loans targeted to (re)financing green projects (Caramichael and Rapp, 2024). The utilities sector follows as the second-largest segment, representing 21.0% of the total amount issued, likely driven by capital-intensive transitions toward renewable energy. Finally, Panel E details the primary use of bond issuance based on the top 5 by number of bonds issued. For all green bonds, the type of projects that are financed are recorded as use of proceeds. Use of proceeds can be unspecific such as "eligible green projects" and bonds can fall into more than one category, which is why we not report total *Amount Issued*, which may be affected by potential double-counting. Energy Efficiency and Renewable Energy Projects are the most prevalent categories, appearing in 69.5% and 56.2% of bond issuance, respectively. Green Construction and Clean Transport also represent significant allocations (48.0% and 35.6%), underscoring the market's focus on decarbonizing the built environment and infrastructure.

[Insert Table 3 about here]

Table 3 shows the simple yield difference for the greenium sample, $\Delta Yield$, tabulated by year. Our data show a interesting evolution in the green bond premium over the years. Notably, the average yield spread switches from negative to positive in 2023, indicating a reversal of the green bond premium. This preliminary evidence will be further examined using the methodolgy described in Section 3.

2.3 Greenness Subsamples

We hypothesize that investors value green bonds differently according to the bond issuers' "greenness" and that this assessment has changed over time. To test this, we regress annual green bond premia on issuer-level greenness metrics, following the methodology detailed in Section 3. By focusing on corporate bonds in the secondary market, we can explore whether investors value green bonds by issuers of different environmental track records differently. Moreover, it is in the secondary market where newly issued information such as the ESG score or emissions data are taken into account. We proxy issuer greenness by ESG scores and emission intensity

covered by two distinct subsamples. ESG scores are the most readily available and used source of information for investors on sustainability performance (Berg et al., 2024). The ESG subsample, is an unbalanced annual sample of 619 bonds by 289 issuers with ESG data from LSEG Eikon. Emissions on the other hand, are often used to assess the real effect of green bonds (e.g. Flammer, 2021). This subsample is an unbalanced sample of 613 bonds of 203 issuers for Scope 1 to 3 emissions from S&P Trucost.

[Insert Figure 2 about here]

Environmental (E), Social (S) and Governance (G) Pillar scores make up the aggregate ESG Score. The scores range from zero to one where the one is the highest. They are converted to letter grades from D- to A+ according to their percentile position (LSEG, 2024). In our sample, the annual ESG refers to the data available to investors by March 31st of the respective year. Figure 2 shows the distribution of ESG scores over our sample period. The majority of bonds remains non-rated. Among the group of ESG rated issuers, green bonds are issued across almost the entire range from A+ to D and issuers in the same sector are heterogeneous. For example, we have A-rated as well as D-rated electric utility companies in our sample. Both, average ESG and E scores decline slightly over time in our sample from ESG (E) scores of 0.75 (0.78) in 2020 to 0.66 (0.69) in 2024.

In absence of a common identifier, we match the bond issuers with S&P Trucost emission data by name.[6] We can not always match on the issuer directly because bonds are often issued via special purpose vehicles. Thus, we match on the parent level[7] as well.

In the final sample, we have 450 unique issuer matches, 52 in the immediate parent and five on ultimate parent level. GHG emissions, hereafter emissions, can be broken down as direct (Scope 1), indirect via purchased energy (Scope 2)[8] and indirect in upstream and downstream activities (Scope 3). Scope 3 downstream data which measures the emissions of the products' use and disposal is less available than Scope 3 downstream activities which measures emissions

[6]Specifically, we standardize issuer names by removing abbreviations and special characters. We then match issuers based on exact string matches in name and domicile or country of incorporation, followed by matches on ticker and domicile. We further apply fuzzy string matching to account for minor discrepancies such as word order or typographical errors. Remaining unmatched cases are manually reviewed and, where appropriate, linked to the issuer's immediate or ultimate parent. All matches are double-checked using additional information from Eikon, including issuer websites. To eliminate duplicates, we prioritize firms with operating status over operating subsidiary or acquired status, and we consolidate mergers and acquisitions once they have been part of the group for a full financial year (S&P Global, 2020).

[7]LSEG defines immediate parents as a parent, owner or owning more than 50% of voting stock and ultimate parent as the last immediate parent (variable definition by the Data Item Browser (DIB).

[8]For Scope 2 we use the location-based emissions where emissions factor comes from the overall grid rather than specific suppliers because the data is mostly missing.

along the supply chain (WRI and WBCSD, 2015). An advantage of S&P Trucost data is that it records Scope 3 emissions. Scope 3 emissions offer the most complete picture of the carbon emissions for which firms are responsible, but they are less available than Scope 2 emissions, which decreases our sample to 203 issuers. Greenhouse Gas (GHG) emissions are measured as carbon dioxide (CO_2) equivalents. We scale them by economic activity to get emission intensity (tons of CO_2/sales). These are heavily skewed and therefore log transformed.

3 Methodology

In this methodology section we first explain how we estimate the green bond premium. We adopt the methodology of Zerbib (2019) and recover the greenium as the bond-specific fixed effect in the matched sample. Second, we present the regression setup to analyze the impact of issuer greenness on the distribution of green bond premia in the subsamples of bonds with ESG or emissions data.

3.1 Estimating the Greenium

To isolate the greenium, we follow the two-step matching and regression procedure established by Zerbib (2019). A common challenge in bond matching is that even the closest conventional bonds (CB) rarely share the exact maturity of the green bond (GB). To prevent maturity mismatches from biasing our yield spread estimates, we construct a synthetic conventional bond (SB). The yield of the synthetic bond, $y_{i,d}^{SB}$, is determined by linearly interpolating the yields of two matched conventional bonds ($CB1$ and $CB2$) whose remaining maturities bracket that of the green bond. On any given day d, the synthetic yield is calculated as:

$$y_{i,d}^{SB} = y_{i,d}^{CB1} + b_{i,d} \times (\text{Maturity}_i^{GB} - \text{Maturity}_i^{CB1})$$

where $y_{i,d}$ is the yield of bond i at day d and the slope is given by

$$b_{i,d} = \frac{y_{i,d}^{CB2} - y_{i,d}^{CB1}}{\text{Maturity}_i^{CB2} - \text{Maturity}_i^{CB1}}$$

Next, we address the potential remaining differences in liquidity. Green and conventional bonds may differ significantly in liquidity. Pástor et al. (2022) suggest that green bonds have lower liquidity due to their usually lower issue sizes. This is also the case in our sample even after

matching on liquidity and within a limit on the liquidity difference. Therefore, like in Zerbib (2019), we also control for the liquidity difference measured as the difference in daily bid-ask spreads computed as percent quoted spread.[9]

$$\Delta Liquidity_{i,d} = Liquidity_{i,d}^{GB} - Liquidity_{i,d}^{SB}$$

where

$$\text{Liquidity}_{i,d}^{SB} = w1 \times \text{Liquidity}_{i,d}^{CB1} + w2 \times \text{Liquidity}_{i,d}^{CB2}$$

and the weights w1 and w2 are equal to

$$w1 = \frac{|\text{GB maturity} - \text{CB 2 maturity}|}{|\text{GB maturity} - \text{CB 1 maturity}| + |\text{GB maturity} - \text{CB 2 maturity}|}$$

and

$$w2 = \frac{|\text{GB maturity} - \text{CB 1 maturity}|}{|\text{GB maturity} - \text{CB 1 maturity}| + |\text{GB maturity} - \text{CB 2 maturity}|}$$

Another concern is a potential risk difference given by the differences in volatility[10] Volatility is computed as the standard deviation of a 30-day rolling window of the daily returns of ask yields. The difference in volatility, $\Delta Volatility$, is calculated analogously to the difference in liquidity described above.

Finally, following Zerbib (2019), we employ a within-regression to estimate the fixed effects p_i to isolates the bond-specific, time-invariant unobserved effect without imposing distributional assumptions or requiring information from other bonds in the sample. The within-estimator ensures unbiasedness and consistency under the assumption of strict exogeneity and it does not require the control variables, like the liquidity proxy, to be uncorrelated with the unobserved bond-specific effects. This allows for a more flexible range of control parameters while ensuring the recovered purely reflects the greenium. Specifically, the green bond premium p_i found in a fixed effect regression and reflects the difference in yield driven solely by the label as green bond.

$$\Delta y_{i,d} = p_i + \beta_1 \Delta Liquidity_{i,d} + \beta_2 \Delta Volatility_{i,d} + \epsilon_{i,d} \tag{1}$$

[9]

$$\text{Bid-Ask Spread} = \frac{\text{Ask Price - Bid Price}}{(\text{Ask Price + Bid Price})/2}$$

[10]For instance, a report by the Dutch bank ABN Amro suggest that the lower volatility of green bonds may be driving the greenium. ABN AMRO (2025, 27 March). ESG-green bonds exhibit lower volatility and higher liquidity than non-green bonds. See www.abnamro.com.

where $\Delta y_{i,d} = y_{i,d}^{GB} - y_{i,d}^{SB}$ and $\hat{p}_i$ is the estimated green bond premium.[11] A negative premium corresponds to a greenium, reflecting a lower yield for the green bond relative to the synthetic conventional bond. Because we are particularly interested in its time-variation, we perform this regression on yearly subsamples, which provides us with a green bond premium for each bond i and each year t ($\hat{p}_{i,t}$).

3.2 Distribution of the Greenium

A greenium reveals investors' non-pecuniary preferences (Zerbib, 2019), suggesting that its distribution across issuers can be informative regarding investors' priorities. This is particularly relevant as green bonds are issued by firms across the entire 'greenness' spectrum. While investors may derive utility from rewarding already 'clean' issuers (Pástor et al., 2021), Hartzmark and Shue (2022) argue that the marginal impact of capital is highest at 'brown' firms, where emissions can be reduced by substantially larger absolute amounts. If investors prioritize such impact elasticity, we would expect a stronger preference, and thus a larger (more negative) greenium, for green bonds issued by historically brown firms. To analyze whether investors value already environmentally friendly green bonds less and whether this changes over time, we run the following regression.

$$\begin{aligned}\hat{p}_{it} = \alpha_{it} &+ \beta_1 Greenness_{ft} + \beta_2 Post\ 2022_t + \beta_3 Post\ 2022_t \times Greenness_{ft} \\ &+ \beta_4 Bond\ Controls_{i(,t)} + \beta_5 Macro\ controls_t + \eta_{it}\end{aligned} \tag{2}$$

where $\hat{p}_{it}$ is the estimated annual green bond premium from Equation 1. $Greenness_{ft}$ refers to the firm f's ESG score or emissions. Post 2022_t is an indicator equal to one after 2022 and equal to zero otherwise. Standard errors are clustered at the issuer level. The coefficient β_3 of the interaction will be significant if investors re-evaluate the bonds' greenness after 2022. The reversal of the premium equity investors attach to ESG and the associated ESG backlash can be dated approximately to 2022 (Baker et al., 2024). Furthermore, Lehkonen et al. (2024) ascribe the disappearing greenium to the increase in supply. In our sample of global, corporate green bonds, the peak of green bonds issued is reached in 2022 (See Figure 1). As discussed in detail below, this timing aligns precisely with the observed reversal of the greenium (see Figure 3).

In alternative specifications, we further control for bond characteristics and macroeconomic

[11] We run this regression without a constant using the Stata package `reghdfe`. That is, $\hat{p}_i$ reflects the absolute level of yield differences for each bond i.

developments. The bond and issuer characteristics we control for are rating, sector, country (group), remaining maturity (at the end of the respective year) and log amount issued. Contrary to Zerbib (2019), we prefer country over currency because we expect that the greenium may be driven by the difference in local investors' green preferences and regulations at country-level. Concerning macroeconomic developments, the literature proposes that attention to climate change could drive investors' interest in green bonds (Pástor et al., 2021, 2022). Hacıömeroğlu et al. (2022) report higher returns for corporate green bonds in the secondary market during the COVID-19 pandemic which they attribute to increased demand for green assets in crisis times. Instead of climate news driving the greenium, Shi and Zhang (2024) show oil price shocks can explain variation in the greenium. The MCCC is a normalized aggregate of climate sentiments in eight US newspapers where a higher score represents higher concerns (Ardia et al., 2023). The oil price is the Brent Crude Oil Price discounted by the US Consumer Price Index both obtained from the Federal reserve Bank St. Louis. As expected, with a correlation coefficient of 0.89, climate news and real oil prices are highly correlated.

4 Results

The first part of this section reports the results of the fixed-effect regressions used to estimate green bond premia. In the second part, we regress these estimated premia on issuer greenness indicators to test whether the market rewards already-green firms or favors the transition potential of brown firms, and how this relationship has evolved with the reversal of the green bond premium.

4.1 The Reversal of the Green Bond Premium

Table 4 reports the results of estimating the fixed effect regression in Equation 1 for all years combined. We cluster standard errors at the issuer level due to the existence of heteroskedasticity and serial correlation and test the appropriateness of the fixed effect regression with a Mundlak test. Across all specifications, we find that higher liquidity differences are associated with lower yield differences. In line with Caramichael and Rapp (2024) ignoring the liquidity difference would lead to an underestimation of the greenium. The magnitude of the effect is substantial: a one basis point increase in the liquidity difference is associated with a 16.78 basis point decrease in the yield difference. This sensitivity is higher than the 9.88 basis point decrease reported by

Zerbib (2019) for an earlier sample period. In line with Zerbib (2019), Column 2 shows that volatility differences are not significant considering the entire period from 2020 to 2024.

[Insert Table 4 about here]

The green bond premia for every bond i is given by the bond-fixed effect $\hat{p}_i$. We find a small, positive and significant green bond premium of 3.84 basis points averaged over the period from 2020 to 2024 (See Appendix Table C.1).[12] This is in contrast with earlier papers which have mostly found a small, negative green bond premium in the secondary market (MacAskill et al., 2021). For example, Zerbib (2019) reports a greenium of -1.8 bps over the period from 2013 to 2017. Similarly, Pietsch and Salakhova (2022) report an average greenium of -4.3 bps averaged over 2016 to 2021. We argue that our findings fit into the literature because taking a time average masks an important development in our sample. That is, taking a simple average covers up a switch from negative to positive green bond premium. In Column 3 of Table 4, we add year fixed effects, which shows a statistically significant and positive coefficient for the year 2024. Together with the evidence of a previous greenium (Aswani and Rajgopal, 2025; Baker et al., 2022; Cortellini and Panetta, 2021; Gianfrate and Peri, 2019; Lehkonen et al., 2024; MacAskill et al., 2021; Pietsch and Salakhova, 2022; Zerbib, 2019), this points further towards time variation and namely to a diminishing greenium. Indeed, we find evidence for both.

[Insert Table 5 about here]

Table 5 reports the results for estimating Equation 1 for each year separately. Similar to Table 4, lower liquidity of green bonds compared to the synthetic is associated with a positive yield difference. Moreover, the coefficient increases over time. In contrast to the regression on the entire sample in Table 4, the difference in volatility is significant in 2023. That is, in 2023 (small) differences in volatility are correlated with the greenium. Specifically, an increase of one basis point in $\Delta Volatility$ is associated with a decrease in $\Delta Yield$ of 3.1 basis points. Figure 3 shows the average green bond premium by year together with a 95% confidence interval calculated using a wild bootstrap. Initially, we observe a negative yield difference, a greenium. However, the green bond premium disappears and even turns positive in 2023. Average green bond premia range from -6.42 bps in 2020 to 6.4 bps in 2024 controlling for both the difference in liquidity and

[12] We use a simple T-test as well as a bootstrapped test for the mean. While the sample size is sufficiently large, we have one premia for each 1,349 bond pairs, the bootstrapped test for the mean with re-sampling by cluster should alleviate concerns of non-normality and clustering issues. Both tests confirm the hypothesis of a significant positive green bond premium.

in volatility (see Appendix Table C.2). Inspecting the confidence intervals, we find statistically significant green bond premia in 2022 and 2024. We conclude that the previously observed greenium, significant in our sample in 2022, has disappeared. In contrast to earlier findings, we show that the green bond premium has recently become significantly positive. This result extends the analysis of previous studies (e.g. Caramichael and Rapp, 2024; Ghitti et al., 2025; Pietsch and Salakhova, 2022; Zerbib, 2019) and aligns with Lehkonen et al. (2024), who find that the corporate greenium disappears after 2021. However, while Lehkonen et al. (2024) show the greenium has disappeared, our findings identifying a full reversal, where green bonds now trade at a yield disadvantage relative to their conventional counterparts.

[Insert Figure 3 about here]

Our findings confirm that the green bond premium is time varying as predicted by Pástor et al. (2021). It also strengthens the mostly anecdotal evidence of a vanishing greenium. Previous papers attribute the time-varying nature of the greenium to excess demand by investors (Boermans, 2023; Caramichael and Rapp, 2024; Pietsch and Salakhova, 2022). Our results suggests that in more recent years investors no longer prefer green bonds over similar conventional bonds which coincides with the increasingly negative market perception of ESG (Baker et al., 2024). An alternative explanation for the premium's reversal is the growing skepticism regarding the environmental impact of green bonds. For instance, Aswani and Rajgopal (2025) find no evidence of a reduction in carbon emissions following issuance, while Ehlers et al. (2020) fail to identify any significant association between green bond issuance and lower emission intensity across the supply chain (Scopes 1–3). Furthermore, Lam and Wurgler (2024) demonstrate that most US corporate and municipal green bonds simply refinance existing projects or fund initiatives identical to those already in place. This raises the question whether a sustainable investment strategy focused on green bonds achieves the intended outcome of greening the economy and how investors use additional information related to the environmental performance of the bond.

To ensure that the documented reversal of the greenium is not a byproduct of specific methodological choices, we address potential sample selection concerns through several robustness checks. Appendix Figure C.1) shows that we still observe a reversal when we (i) exclude bonds with only one conventional bond match (red), restrict the sample to the 122 bonds for which have data for all years (green), exclude bonds without credit rating (yellow) and exclude

bonds with amount issued smaller than $300 million (purple). Notably, the reversal in these subsamples appears even more pronounced than in the aggregate sample, suggesting that our baseline results provide a conservative estimate of the trend.

4.2 Do investors prefer green issuers?

Green bond funding is explicitly earmarked for environmentally friendly projects, but green bonds are issued by both green and brown firms. Empirically, we observe substantial heterogeneity in the estimated green bond premia. This variation motivates our second-stage analysis, in which we test whether issuer-level greenness can explain the cross-sectional distribution of these premia and whether this relationship contributes to the observed reversal of the greenium.

4.2.1 ESG scores

Figure 4 plots the greenium for 2023-2024 and 2020-2022 for different ESG scores binned according to the letter ratings A, B and non-rated (NR). It illustrates that the average annual green bond premium varies not only over time but also with the issuer's ESG score. Moreover, consistent with the overall effect, the average green bond premia increases noticeably for A, B and non-rated (NR) bonds after 2022.

[Insert Figure 4 about here]

We confirm the preliminary evidence of ESG scores explaining part of the greenium's cross-sectional distribution and reversal over time. Table 6 reports the results of estimating Equation 2 with *ESG scores* as the greenness indicator. Standard errors are clustered at the issuer level. Columns 1 and 2 show that the *Post 2022* indicator by itself is positive and statistically significant without and with bond fixed effects, respectively. In column 3, we add continuous *ESG scores* as an explanatory variable. The coefficient on the *Post 2022* indicator remains statistically significant, while the issuer *ESG score* does not seem to explain green bond premia. However, when we interact the *ESG score* with the *Post 2022* indicator in Column 4, both the *ESG score* and its interaction with the *Post 2022* indicator are significant at the 10% level. Higher (better) ESG scores correspond to a lower green bond premium, i.e. a higher greenium, before 2023. Column 4 suggests that the opposite is the case after 2022. That is, higher ESG scores are associated with a higher green bond premium. When we add further bond-level and macroeconomic control variables in Columns 5 to 7 the main effect of the *ESG*

scores becomes significant at the 5% level, while the interaction of *ESG scores* with *Post 2022* remains significant at the 10% level. In terms of economic magnitude, a one standard deviation increase in the ESG score (0.15) after 2022 is associated with an increase in the greenium of about 0.03 to 0.04 basis points. While these magnitudes are relatively modest, they illustrate an interesting shift in market dynamics: Investors appear to no longer be willing to pay a premium for green bonds issued by high-ESG firms. This finding is consistent with the ESG backlash recently documented in the mutual fund industry (Baker et al., 2024) and suggests that the non-pecuniary utility previously derived from holdings bonds from issuers with high ESG ratings has decreased over time.

[Insert Table 6 about here]

In terms of the control variables, in column 5 we add bond level controls.[13] The reference category is "non-rated" for the bond ratings, and "other" for all remaining categories. Neither bond rating nor sector seem to play an additional role in explaining green bond premia, even though previous authors have found that the sector, specifically the financial sector, is relevant for explaining variation in the greenium (Aswani and Rajgopal, 2025; Caramichael and Rapp, 2024; Lehkonen et al., 2024; Pietsch and Salakhova, 2022; Zerbib, 2019). Surprisingly, the green bond premium is around 0.14 basis points higher for bonds domiciled in the EU, which contradicts the assumption that stricter regulation (Ghitti et al., 2025; Pástor et al., 2021; Pietsch and Salakhova, 2022), in particularthe introduction of the green bond standard in 2023 in the EU, would be associated with a greenium. Moreover, European investors are believed to be more willing to pay for ESG (Baker et al., 2024). Column 5 shows that longer remaining maturities are associated with higher green bond premia, although the effect size is small. In line with Zerbib (2019), liquidity measured as log amount issued has no effect. In Column 6 we inlude climate news. Consistent with Ardia et al. (2023) more climate news is associated with prices of green assets increasing and therefore a lower greenium. Similar results are reported by Lehkonen et al. (2024) and Renjie and Xia (2023) for municipal bonds. The effect of the real oil price is qualitatively similar to that of climate news but smaller in magnitude. Higher real oil prices are associated with higher greenium. In additional analyses, we find no evidence that the ESG effect is driven by the E score of the ESG rating (see Appendix Table C.3) even if the correlation of ESG and E score is high (0.81). The *E score* as well as its interaction with the

[13]Note that we refrain from adding bond-level fixed effects because it would lead to the already limited variation in ESG scores by issuer to be further restricted.

Post 2022 indicator are statistically insignificant for all specifications.

4.2.2 Emission Intensity

As argued by Hartzmark and Shue (2022), the primary driver of decarbonization is the ability of firms to significantly reduce their absolute emission intensity. In our sample, however, neither ESG nor E-scores are significantly correlated with emission intensity (see Appendix Figure C.3). This divergence may be partly due to the limited overlap between the ESG and emission-level subsamples. It may also reflect the construction of these metrics: ESG scores aggregate social and governance factors with environmental ones, and even Environmental (E) scores conflate emissions data with other environmental metrics. Furthermore, E-scores are benchmarked against industry peers (LSEG, 2024), potentially masking the absolute level of environmental impact. Therefore, we now explicitly consider emission intensity as greenness measure.

[Insert Figure 5 about here]

Figure 5 shows the average green bond premium for quintiles of issuers emission intensity for 2020 to 2022 and 2023 and 2024. Similarly to above, green bond premia across all quintiles on average are positive after 2022. Moreover, the issuers with the highest emission intensity (dirtiest issuers) seem to have the lowest green bond premium before 2023. That is for the dirtiest issuers, their green bond yields are substantially below their matched conventional bond yields. Conversely, the issuers with the lowest emission intensity (cleanest issuers) seem to have the highest green bond premium after 2022, with yields of their green bonds being substantially higher than those of their conventional bonds.

[Insert Table 7 about here]

We capture this nonlinearity in a regression by using quintiles of issuers' annual emission intensity. Table 7 shows the results. As observed in Figure 5, across specifications issuers in the dirtiest quintile are associated with a lower green bond premium (Column 3). Nonetheless, this reverses after 2022 (Column 4). Compared to the middle quintile, issuers in the first, second and fifth quintile have statistically significant higher green bond premia after 2022. Again, the results stay robust when adding bond and macroeconomic controls (Columns 5 to 7). When controlling for emission intensity, only more climate news (Column 6) but not higher real oil prices (Column 7) have a significantly negative effect. In sum, we find evidence that investors in

the green bond market invest "productively" preferring bonds by dirtier issuers. However, the reversal is present for all types of issuers suggesting that this effect dominates and investors no longer are willing to pay a premium for green bonds irrelevant of its impact potential.

5 Conclusion

In this paper, we provide evidence that the corporate green bond premium has reversed. While the early literature largely documented a greenium, a yield discount for green bonds driven by non-pecuniary utility, our results show that after 2022 green bonds started trading at a significantly positive premium. This finding suggests that whereas green bond issuance, once enabled firms to lower financing costs, now carries a yield penalty in the secondary market. We interpret this reversal as consistent with a broader shift in market sentiment, i.e. an ESG backlash, marking the transition towards an era of reduced interest in sustainable investments.

Our analysis links the reversal of the green bond premium to bond investors' reduced preferences for issuers' environmental performance. We show that the historically positive relationship of firms performing better in terms of ESG having higher greeniums reversed after 2022. That is, investors are no longer willing to pay a premium for the debt of firms with high sustainability ratings and may even demand a discount. This evidence aligns with the trends observed in the mutual fund industry and suggests that the non-pecuniary utility previously derived from ESG-labeled assets has significantly diminished.

Furthermore, our cross-sectional results offer a nuanced perspective on the "impact elasticity" debate initiated by Hartzmark and Shue (2022). Contrary to the concern that sustainable investing disproportionately favors already-clean issuers, we find that prior to 2023, the largest greeniums were actually concentrated among emission-intensive firms. This suggests that the market initially rewarded issuers with the greatest potential for decarbonization. However, this issuer-specific preference has since been overshadowed by a market-wide pricing reversal, with a green bond premium that has reversed for both green and brown firms .

The disappearance of the greenium has important implications for the role of green bonds in the transition to a low-carbon economy. The lack of a cost-of-capital advantage for green bonds, reduces the financial incentive for firms to undergo the rigorous reporting and project-tracking required for green issuance. Our findings suggest that for green bonds to remain an effective tool for capital allocation in the absence of a global carbon tax, tighter regulatory frameworks, such as

the EU Green Bond Standard, may be necessary to restore investor confidence in the effectiveness of green bonds. In a more skeptical financial climate, the challenge for both policymakers and issuers is to re-establish a credible economic link between sustainable debt and real-world environmental outcomes.

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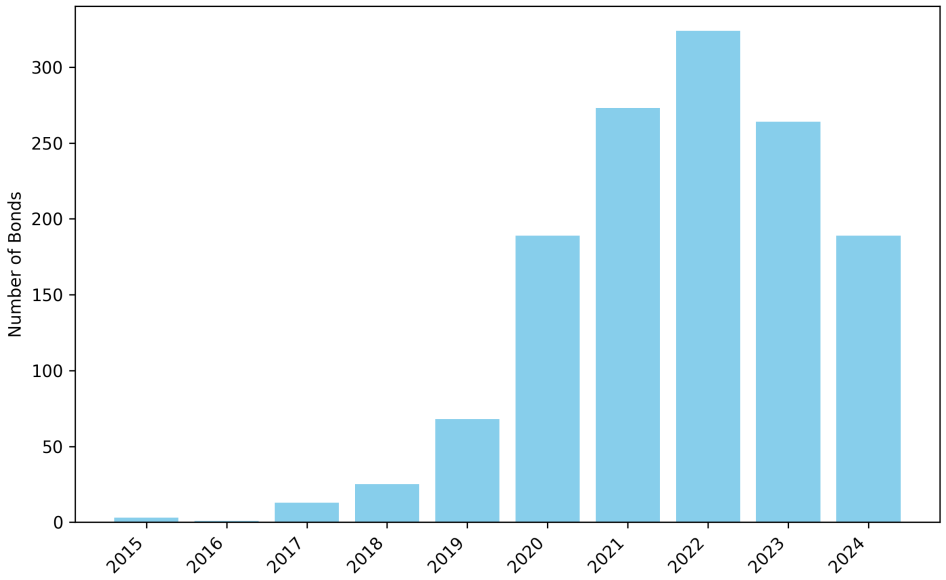
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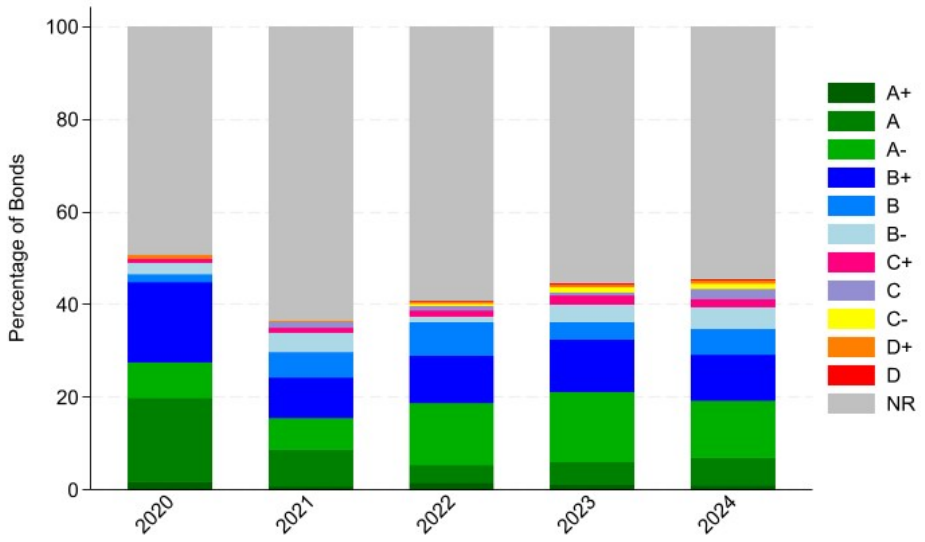
Figures

Figure 1: Number of Green Bonds by Issue Year



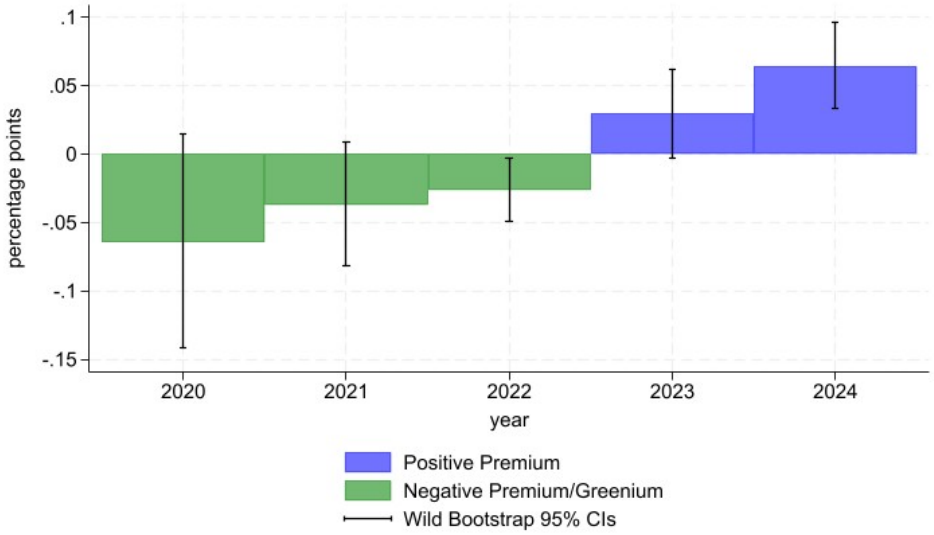
This figure shows the total number of green bonds issued per issue year.

Figure 2: Distribution of ESG scores



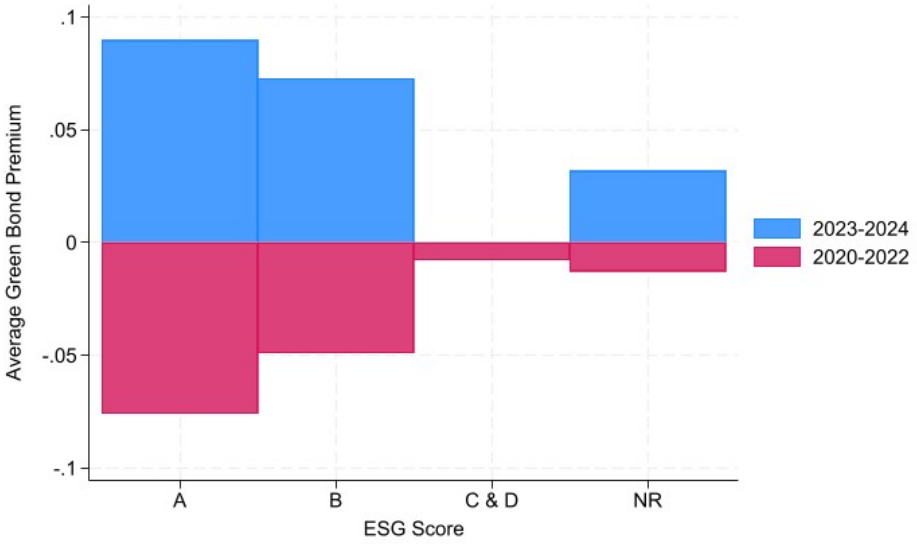
This figure shows the distribution of ESG scores across the sample of green bonds.

Figure 3: Average Green Bond Premium by Year



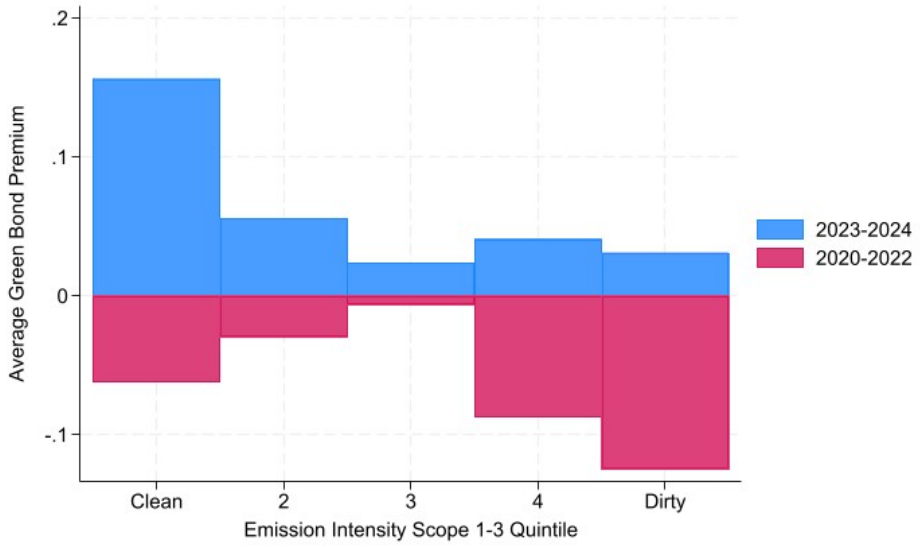
This figure shows the average annual green bond premia and confidence intervals (CIs) calculated via cluster-robust wild bootstrap. It suggests that the greenium, significant in 2022, has disappeared and that we now observe a positive green bond premium.

Figure 4: Average Green Bond Premium by ESG Score



This figure shows the green bond premium averaged for 2020–2022 and for 2023–2024 by ESG score groups A, B, C & D, and Non-Rated (NR). ESG rating categories C and D are combined due to the small number of bonds in these groups.

Figure 5: Average Green Bond Premium by Scope 1–3 Emission Intensity



This figure shows the green bond premium averaged for 2020–2022 and for 2023–2024 by the quintile of issuers' emission intensity, where the 1st quintile represents issuers with the lowest emission intensity.

Tables

Table 1: Matching Criteria

Criteria	Limit	Matching Method
Amount Issued	1/4 to 4x	Nearest Neighbor
Issue Date	+/- 6 Years	Nearest Neighbor
Maturity at Issuance	+/- 2 Years	Nearest Neighbor
Coupon	-	Nearest Neighbor
Callable	-	Exact Matching
Collateral	-	Exact Matching
Coupon Frequency	-	Exact Matching
Currency	-	Exact Matching
Instrument	-	Exact Matching
Rating	-	Exact Matching
Seniority	-	Exact Matching

This table lists the criteria by which we match green to conventional bonds by the same issuer. We only consider conventional bonds whose price data overlaps with the green bond for at least 100 days. There are three limits placed on the conventional bonds. First, the amount issued must be within a range of one fourth to four times the amount issued of the green bond. Second, the issue date must be six years before or after the issue date of the green bond. Third, the maturity at issuance must be within two years shorter or longer than the maturity at issuance. Moreover, green and conventional bond must match on every criteria of the exact matching criteria and lastly, we select the two closest neighbors in terms of amount issued, coupon, issue date and maturity at issuance. For detailed variable descriptions refer to Table A in the Appendix.

Table 2: Descriptive Statistics Green Bonds

	Bonds N	Bonds %	Issuers N	Issuers %	Amount Issued $ mln	Amount Issued %
Panel A: Issuer Geography						
China	323	23.9%	186	34.7%	107,845	20.9%
EU	577	42.8%	139	25.9%	219,605	42.6%
Other	315	23.4%	140	26.1%	99,589	19.3%
United States	134	9.9%	71	13.2%	88,716	17.2%
Panel B: Credit Quality						
Investment Grade (AAA-A)	526	39.0%	280	52.2%	279,755	54.2%
Lower IG (BBB)	221	16.4%	101	18.8%	147,543	28.6%
Unrated/ High Yield	602	44.6%	171	31.9%	88,456	17.2%
Panel C: Certification						
CBI Aligned Green bond	1,007	74.6%	381	71.1%	397,494	77.1%
CBI Certified Green Bond	44	3.3%	31	5.8%	23,179	4.5%
Self-Labeled Green Bond	298	22.1%	189	35.3%	95,080	18.4%
Panel D: Sector						
Financials	701	52.0%	225	42.0%	267,960	52.0%
Industrials	107	7.9%	64	11.9%	23,195	4.5%
Other	152	11.3%	79	14.7%	75,996	14.7%
Real Estate	155	11.5%	72	13.4%	40,443	7.8%
Utilities	234	17.3%	96	17.9%	108,160	21.0%
Panel E: Use of Proceeds						
Energy Efficiency	937	69.5%	361	67.4%		
Renewable Energy Projects	758	56.2%	339	63.2%		
Green Construction/Buildings	648	48.0%	276	51.5%		
Clean Transport	480	35.6%	246	45.9%		
Pollution Prevention & Control	274	20.3%	160	29.9%		
Total Sample	1,349	100.0%	536	100.0%	515,754	100.0%

This table presents the distribution and characteristics of the green bond sample, where *Bonds N* indicates the number of bonds, *Bonds %* indicates the percentage of bonds, *Issuers N* indicates the distinct number of issuers, *Issuers %* indicates the percentage of issuers based on the distinct number of issuers, *Amount Issued* indicates the total amount issued in millions of US dollars and *Amount Issued %* indicates the percentage of the amount issued. Panel A reports the distribution by issuer geography. Panel B reports credit quality based on LSEG composite ratings, where *Investment Grade* includes ratings from AAA to A-, *Lower IG* includes the BBB category and *Unrated/High Yield* includes all bonds rated below BBB and those without a rating. Panel C shows the distribution of bond certifications. Panel D provides the distribution of bonds across sectors. Panel E provides the distribution across use of proceeds for the top 5 issuers based on number of bonds issued (*Bonds N*). Here the *Amount Issued* is omitted to avoid double-counting because potentially bond proceeds could be used for multiple purposes.

Table 3: Yield Differences by Year

	count	mean	sd	min	p50	max
2020	19,405	-0.0317	0.3178	-1.7952	-0.0003	2.2389
2021	68,102	-0.0412	0.2662	-1.8053	-0.0026	2.4123
2022	125,169	-0.0367	0.3477	-1.8054	-0.0094	2.4140
2023	189,076	0.0150	0.3441	-1.8035	-0.0011	2.4163
2024	287,845	0.0470	0.3735	-1.8045	-0.0002	2.4169
Total	689,597	0.0121	0.3518	-1.8054	-0.0011	2.4169

This table shows the average yield difference $\Delta y_{i,t} = y_{i,t}^{GB} - y_{i,t}^{SB}$ in percentage points (pp) by year. It suggests that the average yield difference has flipped from negative to positive, pointing to a vanishing greenium.

Table 4: Regression of Liquidity and Volatility Differences on Yield Differences

	(1) Δ Yield	(2) Δ Yield	(3) Δ Yield
Δ Liquidity	-16.7844***	-17.3447***	-17.0484***
	(2.7371)	(2.8377)	(2.6996)
Δ Volatility		-1.2183	
		(1.4795)	
year=2021			-0.0083
			(0.0176)
year=2022			-0.0100
			(0.0203)
year=2023			0.0357
			(0.0252)
year=2024			0.0678***
			(0.0247)
Observations	689,597	672,080	689,597

This table shows the results of the fixed effects regression $\Delta y_{i,d} = p_i + \beta_1 \Delta Liquidity_{i,d} + \beta_2 \Delta Volatility_{i,d} + \epsilon_{i,d}$ (Equation 1). The reference category for year is 2020. Standard errors are clustered at the issuer level.

Table 5: Yearly Regressions of Liquidity and Volatility Differences on Yield Differences

	2020 Δ Yield	2021 Δ Yield	2022 Δ Yield	2023 Δ Yield	2024 Δ Yield
Δ Liquidity	-6.3310**	-11.5782***	-12.2184***	-18.0441***	-23.8248***
	(2.7702)	(2.8306)	(2.0557)	(3.5203)	(4.5877)
Δ Volatility	5.2993	3.4379	-1.1649	-3.1488**	-3.0880
	(3.9288)	(3.0860)	(3.2654)	(1.5308)	(1.8806)
Observations	17,930	62,806	121,324	185,696	284,319

This table shows the results of the fixed effects regression $\Delta y_{i,d} = p_i + \beta_1 \Delta Liquidity_{i,d} + \beta_2 \Delta Volatility_{i,d} + \epsilon_{i,d}$ (Equation 1) run separately for every year. Standard errors are clustered at the issuer level.

Table 6: Regression of ESG Scores on Estimated Green Bond Premia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post 2022	0.1076***	0.0990***	0.1076***	-0.0803	-0.0466	-0.0641	-0.0660
	(0.0286)	(0.0278)	(0.0287)	(0.0859)	(0.0801)	(0.0792)	(0.0829)
ESG Score			0.0380	-0.1643*	-0.2447**	-0.2581**	-0.2572**
			(0.1003)	(0.0972)	(0.1137)	(0.1129)	(0.1141)
Post 2022 × ESG				0.2630*	0.2337*	0.2519*	0.2435*
				(0.1392)	(0.1318)	(0.1289)	(0.1317)
Investment Grade					-0.0849	-0.0866	-0.0839
					(0.0579)	(0.0577)	(0.0584)
Not Investment Grade					-0.1745	-0.1763	-0.1743
					(0.1465)	(0.1460)	(0.1466)
Financials					0.0499	0.0499	0.0487
					(0.0426)	(0.0429)	(0.0428)
Industrials					-0.0180	-0.0180	-0.0190
					(0.0760)	(0.0763)	(0.0761)
Real Estate					0.0443	0.0456	0.0420
					(0.0445)	(0.0443)	(0.0448)
Utilities					-0.0017	-0.0022	-0.0019
					(0.0370)	(0.0371)	(0.0371)
China					0.0151	0.0129	0.0121
					(0.0373)	(0.0377)	(0.0374)
EU					0.1403***	0.1397***	0.1402***
					(0.0388)	(0.0392)	(0.0390)
United States					-0.0129	-0.0131	-0.0098
					(0.0380)	(0.0382)	(0.0385)
Maturity					0.0051**	0.0051**	0.0046*
					(0.0023)	(0.0023)	(0.0024)
Log Amount Issued					0.0040	0.0051	0.0041
					(0.0107)	(0.0105)	(0.0107)
Climate News						-0.0908*	
						(0.0468)	
Real Oil Price							-0.0012*
							(0.0007)
Constant	-0.0295*	-0.0372*	-0.0557	0.0901	0.0034	0.1818	0.1038
	(0.0174)	(0.0190)	(0.0709)	(0.0711)	(0.2209)	(0.2687)	(0.2346)
Adjusted R^2	0.0325	0.0414	0.0330	0.0376	0.0741	0.0756	0.0738
Bond Fixed Effects	No	Yes	No	No	No	No	No
N	1478	1478	1478	1478	1478	1478	1478

This table shows the results of the regression $\hat{p}_{it} = \alpha_{it} + \beta_1 \text{ESG Score}_{ft} + \beta_2 \text{Post 2022}_t + \beta_3 \text{Post 2022}_t \times \text{ESG Score}_{ft} + \beta_4 \text{Bond Controls}_{i(,t)} + \beta_5 \text{Climate News}_t + \eta_{it}$ (Equation 2) in the ESG subsample. $ESGScore_{ft}$ refers to the continuous ESG score of firm f in year t. The reference categories for country and sector is "Other" and for the rating is is non-rated (NR). Standard errors are clustered at the issuer level.

Table 7: Regression of Emission Intensity Quintiles on Estimated Green Bond Premia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post 2022	0.0885***	0.0788***	0.0946***	0.0145	0.0317	0.0189	0.0137
	(0.0292)	(0.0267)	(0.0206)	(0.0306)	(0.0327)	(0.0352)	(0.0393)
EQ=1			0.0766	0.0095	0.0352	0.0244	0.0256
			(0.0699)	(0.0481)	(0.0577)	(0.0625)	(0.0609)
EQ=2			0.0135	-0.0128	-0.0156	-0.0248	-0.0294
			(0.0217)	(0.0127)	(0.0138)	(0.0157)	(0.0220)
EQ=4			-0.0327	-0.0160	0.0023	-0.0021	-0.0043
			(0.0223)	(0.0535)	(0.0560)	(0.0557)	(0.0564)
EQ=5			-0.0743**	-0.1418***	-0.1157***	-0.1266***	-0.1246***
			(0.0344)	(0.0405)	(0.0383)	(0.0370)	(0.0381)
Post 2022×EQ=1				0.1289**	0.1229**	0.1324**	0.1316**
				(0.0649)	(0.0567)	(0.0565)	(0.0569)
Post 2022×EQ=2				0.0891**	0.1053**	0.1166**	0.1209**
				(0.0423)	(0.0448)	(0.0460)	(0.0493)
Post 2022×EQ=4				0.0363	0.0057	0.0118	0.0135
				(0.0661)	(0.0724)	(0.0729)	(0.0735)
Post 2022×EQ=5				0.1537***	0.1560***	0.1673***	0.1652***
				(0.0550)	(0.0568)	(0.0562)	(0.0573)
Investment Grade					-0.0054	-0.0071	-0.0043
					(0.0314)	(0.0312)	(0.0319)
Not Investment Grade					-0.0701	-0.0708	-0.0693
					(0.1451)	(0.1447)	(0.1450)
Financials					0.0599	0.0616	0.0586
					(0.0465)	(0.0462)	(0.0471)
Industrials					-0.0537	-0.0562	-0.0557
					(0.0855)	(0.0863)	(0.0859)
Real Estate					0.0289	0.0285	0.0259
					(0.0526)	(0.0521)	(0.0531)
Utilities					0.0218	0.0198	0.0200
					(0.0427)	(0.0432)	(0.0430)
China					0.0279	0.0261	0.0236
					(0.0418)	(0.0423)	(0.0434)
EU					0.0818**	0.0820**	0.0810**
					(0.0322)	(0.0323)	(0.0325)
United States					-0.0144	-0.0159	-0.0145
					(0.0469)	(0.0476)	(0.0468)
Maturity					0.0046	0.0052*	0.0041
					(0.0032)	(0.0029)	(0.0034)
Climate News						-0.0994*	
						(0.0584)	
Real Oil Price							-0.0009
							(0.0008)
Constant	-0.0164	-0.0249	-0.0196	0.0057	-0.1278**	0.0826	-0.0498
	(0.0188)	(0.0172)	(0.0241)	(0.0164)	(0.0568)	(0.1663)	(0.1083)
Adjusted R^2	0.0294	0.0310	0.0418	0.0469	0.0658	0.0673	0.0651
Bond Fixed Effects	No	Yes	No	No	No	No	No
N	1637	1637	1637	1637	1637	1637	1637

This table shows the results of the regression $\hat{p}_{it} = \alpha_{it} + \beta_1 \text{EQ}_{ft} + \beta_2 \text{Post 2022}_t + \beta_3 \text{Post 2022}_t \times \text{EQ}_{ft} + \beta_4 \text{Bond Controls}_{i(,t)} + \beta_5 \text{Climate News}_t + \eta_{it}$ (Equation 2) in the Emissions subsample. EQ_{ft} refers to the quintile of issuer f's Scope 1-3 emission intensity in year t. The reference categories for country and sector is "Other" and for the rating it is non-rated (NR). Standard errors are clustered at the issuer level.

A Appendix: Variable definitions

Table A.1: Variable definitions

Variable	Definition
Panel A: Bond characteristics and matching variables	
Amount Issued	Measured in millions of USD. All bonds in the sample have a positive amount issued.
Callable	An indicator variable equal to one if the bond is callable and zero otherwise.
Certification	Categorical variable identifying green bonds as Climate Bonds Initiative (CBI) certified, aligned, or self-labeled. Missing values are assigned as "self-labeled." Source: Eikon variable "ESG Bond Type."
Currency	Categorical variable indicating the currency of denomination.
Collateral	An indicator variable equal to one if the bond has collateral and zero otherwise. Collateral types are not differentiated.
Coupon	The interest rate of the bond, measured as a percentage.
Coupon Frequency	Categorical variable identifying the payment schedule: annually, quarterly, or semi-annually.
Country	Categorical variable for issuer domicile, grouped into: China, European Union (EU), United States, or Other.
Instrument	Classification of bond types. Covered bonds (e.g., Belgian Mortgage Pandbrieven, Cedula de Internacionalizacion) are aggregated into a single category.
Issue Date	The specific date on which the bond was issued.
Liquidity	Measured as the Bid-Ask Spread, calculated as the percent quoted spread.
Maturity	The date on which the principal amount of the bond becomes due.
Maturity at Issuance	The time to maturity at the date of issue, measured in years.
Rating	Categorical variable with 22 categories based on S&P Equivalent Ratings. Non-rated and missing values are combined into the "NR" category.
Second Party Opinion	An indicator variable equal to one if the bond has a Second Party Opinion (SPO) and zero otherwise. Source: Eikon variable "Second Party Opinion Provider."
Sector	TRBC Sector classification aggregated into five categories: Financials, Industrials, Real Estate, Utilities, or Other.
Use of Proceeds	Qualitative record of how the issued amount is allocated for green projects.
Volatility	Calculated as the 30-day standard deviation of the daily return of ask prices, measured as a percentage.
Yield	The ask yield of the bond, measured as a percentage.
Panel B: Issuer and Macro Variables	
$\hat{p}_{it}$	The estimated annual green bond premium derived from the bond-specific fixed effect.
ESG Score	Aggregate sustainability score ranging from 0 to 1, provided by LSEG Eikon.
Emission Intensity	Ratio of GHG emissions (tons of CO_2) to millions of USD in sales, log-transformed.
Post 2022	Indicator variable equal to one from 2023 onwards, and zero otherwise.
Climate News (MCCC)	Normalized aggregate of climate sentiment across eight US newspapers (Ardia et al., 2023).
Real Oil Price	Brent Crude Oil Price discounted by the US Consumer Price Index.
Seniority	Categorical variable identifying the bond's priority in the issuer's capital structure (e.g., Senior Unsecured).

This table provides definitions and unit measurements for the bond-specific variables used in the empirical analysis.

B Appendix: Descriptives Greenium

Table B.1: Green and Conventional Bond Characteristics

	Amount Issued		Coupon		Issue Date		Maturity at Issuance	
	GB	CB	GB	CB	GB	CB	GB	CB
count	1349	2430	1349	2430	1349	2430	1349	2430
mean	382.32	424.59	2.54	2.26	2022-03-17	2021-02-07	7.78	7.87
std	462.63	601.47	1.70	1.67	NaN	NaN	5.58	5.56
min	1.10	2.90	0	0	2015-04-15	2013-09-19	2	2
25%	68.99	66.34	0.88	0.74	2021-03-10	2019-12-06	4.98	5
50%	206.97	221.43	2.65	2.25	2022-04-14	2021-01-15	7	7
75%	523.30	518.75	3.70	3.38	2023-06-06	2022-11-06	10	10
max	4139.30	5492.39	7.88	9.62	2024-10-17	2024-10-03	31.01	31

This table shows the summary statistics of amount issued (in USD), coupon (in percent), issue date (date) and maturity at issuance (in years) of green bonds (GB) and Conventional Bonds (CB) in the final (matched) sample.

Table B.2: Summary Statistics Ask Yields

	GB	CB 1	CB 2	SB	Δ Yield
count	689597	689597	564863	689597	689597
mean	2.82	2.79	2.90	2.80	0.01
std	1.98	1.98	1.93	1.99	0.35
min	-0.30	-0.30	-0.30	-1.95	-1.81
1%	0.02	0.02	0.03	0.02	-1.05
5%	0.11	0.09	0.14	0.10	-0.44
50%	3.29	3.26	3.40	3.20	-0
95%	5.63	5.62	5.60	5.69	0.55
99%	6.65	6.38	6.49	6.75	1.44
max	16.42	16.58	15.38	16.53	2.42

This table shows summary statistics of ask yields (in %) for green bonds (GB) and matched conventional bonds (CB1, CB2), as well as of the synthetic bond (SB), and the dependent variable: $\Delta Yield = Yield^{GB} - Yield^{SB}$ (in percentage points). Any extreme variation in differences can stem from the fact that we work with three sets of daily yields (GB, CB1, CB2) which are prone to error rather than the matching process. Thus, we winsorized the yield difference at $1^{st}$and 99^{th} percentile.

Table B.3: Summary Statistics Bid Ask Spread

	GB	CB 1	CB 2	SB	Δ Liquidity
count	689597	689597	564863	689597	689597
mean	0.01	0	0	0	0
std	0	0	0	0	0
min	-0.02	-0.01	-0.01	-0.01	-0.03
1%	0	0	0	-0	-0.01
5%	0	0	0	0	-0
50%	0	0	0	0	0
95%	0.01	0.01	0.01	0.01	0.01
99%	0.01	0.01	0.01	0.02	0.01
max	0.08	0.07	0.06	0.07	0.01

This table shows summary statistics of bid ask spreads (in %) for green bonds (GB) and matched conventional bonds (CB1, CB2), as well as of the synthetic bond (SB) and the independent variable: $\Delta Liquidity = Liquidity^{GB} - Liquidity^{SB}$ (in percentage points). Bid-Ask Spreads are computed as percentage quoted spread. Any extreme variation in differences can stem from the fact that we work with six sets of bid and ask prices and their combinations (synthetic bond variables and yield differences) which are prone to error rather than the matching process. Thus, we winsorized the difference in bid ask spreads at $1^{st}$and 99^{th} percentile.

Table B.4: Summary Statistics Volatility

	GB	CB 1	CB 2	SB	Δ Volatility
count	683835	689597	564863	689597	672082
mean	0.01	0.01	0.01	0	0
std	0.02	0.01	0.01	0.23	0
min	0	0	0	-17.32	-0.01
1%	0	0	0	0	-0.01
5%	0	0	0	0	-0
50%	0	0	0	0	0
95%	0.01	0.01	0.01	0.01	0
99%	0.03	0.01	0.02	0.02	0.01
max	2.13	1.98	1.26	43.89	0.02

This table shows summary statistics of volatility (in %) for green bonds (GB) and matched conventional bonds (CB1, CB2), as well as of the synthetic bond (SB) and the independent variable: $\Delta Volatility = Volatility^{GB} - Volatility^{SB}$ (in percentage points). Volatility is computed as the standard deviation of a 30-day rolling window of the daily returns of ask yields. Any extreme variation in differences can stem from the fact that we work with three sets of ask prices (GB, CB1, CB2) and their associated volatility and their combinations (synthetic bond variables and yield differences) which are prone to error rather than the matching process. Thus, we winsorized the difference in volatility at $1^{st}$and 99^{th} percentile.

C Appendix: Additional Results and Robustness Checks

Table C.1: Summary Statistics Green Bond Premia $\hat{p}_i$

	mean	sd	min	p50	max
$\hat{p}_i$	0.0384	0.2461	-1.1868	0.0018	2.0913
Observations	1349				

This table shows the summary statistics of the green bond premia $\hat{p}_i$ (in percentage points) extracted as the fixed effect from a regression of Δ Yield on Δ Liquidity (see Equation 1).

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Table C.2: Summary Statistics Green Bond Premia $\hat{p}_{i,t}$ by Year

	count	mean	sd	min	p50	max
2020						
$\hat{p}_it$ controlling for $\Delta Liquidity$	134	-0.0430	0.2928	-1.1152	-0.0077	1.3228
$\hat{p}_it$ controlling for $\Delta Liquidity$ and $\Delta Volatility$	68	-0.0642	0.2461	-0.8428	0.0020	0.3791
2021						
$\hat{p}_it$ controlling for $\Delta Liquidity$	405	-0.0392	0.2093	-1.6087	-0.0147	0.6430
$\hat{p}_it$ controlling for $\Delta Liquidity$ and $\Delta Volatility$	168	-0.0373	0.2358	-1.0795	-0.0045	0.5871
2022						
$\hat{p}_it$ controlling for $\Delta Liquidity$	643	-0.0300	0.2904	-1.1701	-0.0060	1.8360
$\hat{p}_it$ controlling for $\Delta Liquidity$ and $\Delta Volatility$	523	-0.0264	0.3067	-1.3018	-0.0050	1.8395
2023						
$\hat{p}_it$ controlling for $\Delta Liquidity$	926	0.0312	0.2584	-1.3682	0.0033	1.5933
$\hat{p}_it$ controlling for $\Delta Liquidity$ and $\Delta Volatility$	809	0.0295	0.2615	-1.3669	0.0021	1.6211
2024						
$\hat{p}_it$ controlling for $\Delta Liquidity$	1332	0.0605	0.3048	-1.2054	0.0058	2.2637
$\hat{p}_it$ controlling for $\Delta Liquidity$ and $\Delta Volatility$	1230	0.0640	0.3077	-1.0728	0.0058	2.2655

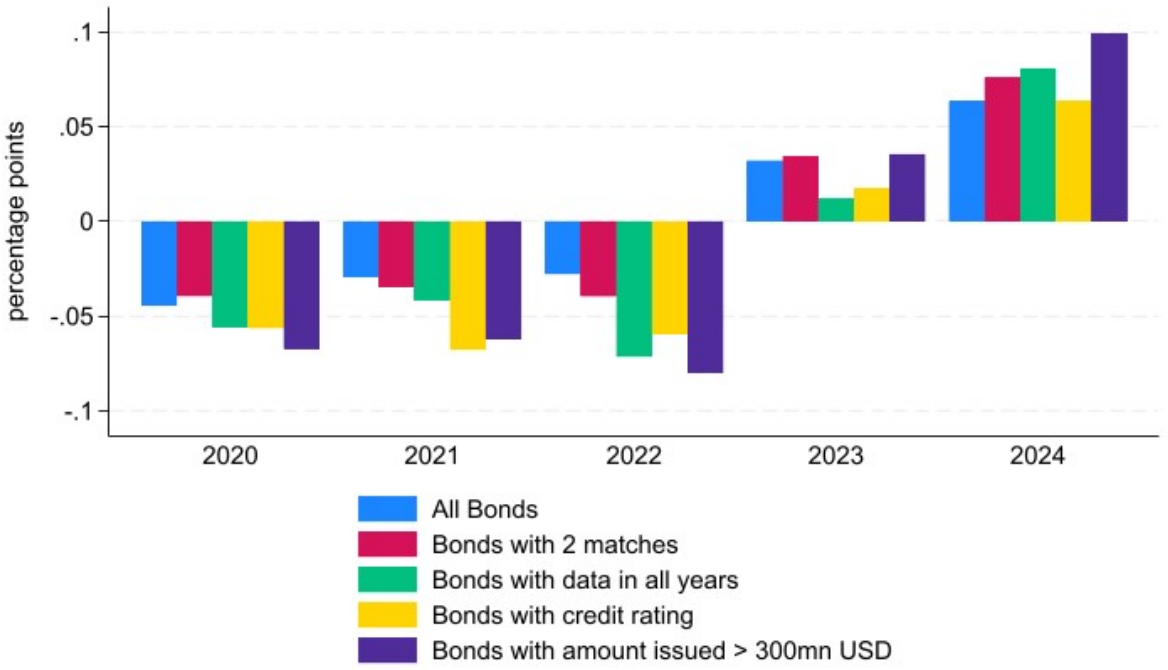
This table shows the summary statistics of the green bond premia $\hat{p}_{i,t}$ (in percentage points) extracted as the fixed effect from an annual regression of Δ Yield on Δ Liquidity and Δ Volatility (see Equation 1).

Table C.3: Regression of E Scores on Estimated Green Bond Premia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post 2022	0.1076***	0.0990***	0.1074***	-0.0465	-0.0228	-0.0351	-0.0379
	(0.0286)	(0.0278)	(0.0285)	(0.0910)	(0.0868)	(0.0836)	(0.0870)
E Score			0.0757	-0.0764	-0.1640	-0.1720	-0.1701
			(0.0899)	(0.0856)	(0.1107)	(0.1083)	(0.1096)
Post 2022 × E Score				0.2064	0.1928	0.2034	0.1972
				(0.1432)	(0.1399)	(0.1353)	(0.1377)
Investment Grade					-0.0886	-0.0905	-0.0878
					(0.0579)	(0.0576)	(0.0583)
Not Investment Grade					-0.1713	-0.1733	-0.1708
					(0.1472)	(0.1466)	(0.1472)
Financials					0.0559	0.0558	0.0552
					(0.0383)	(0.0387)	(0.0386)
Industrials					-0.0131	-0.0131	-0.0138
					(0.0759)	(0.0761)	(0.0760)
Real Estate					0.0512	0.0526	0.0495
					(0.0424)	(0.0422)	(0.0426)
Utilities					0.0045	0.0040	0.0046
					(0.0381)	(0.0382)	(0.0382)
China					0.0231	0.0207	0.0204
					(0.0356)	(0.0361)	(0.0358)
EU					0.1366***	0.1360***	0.1364***
					(0.0391)	(0.0396)	(0.0393)
United States					-0.0169	-0.0172	-0.0141
					(0.0383)	(0.0385)	(0.0387)
Maturity					0.0054**	0.0054**	0.0049**
					(0.0023)	(0.0023)	(0.0023)
Log Amount Issued					0.0047	0.0058	0.0048
					(0.0108)	(0.0105)	(0.0108)
Climate News						-0.0897*	
						(0.0466)	
Real Oil Price							-0.0012*
							(0.0007)
Constant	-0.0295*	-0.0372*	-0.0842	0.0303	-0.0659	0.1059	0.0253
	(0.0174)	(0.0190)	(0.0652)	(0.0630)	(0.2087)	(0.2517)	(0.2218)
Adjusted R^2	0.0325	0.0414	0.0358	0.0403	0.0742	0.0757	0.0739
Bond Fixed Effects	No	Yes	No	No	No	No	No
N	1478	1478	1478	1478	1478	1478	1478

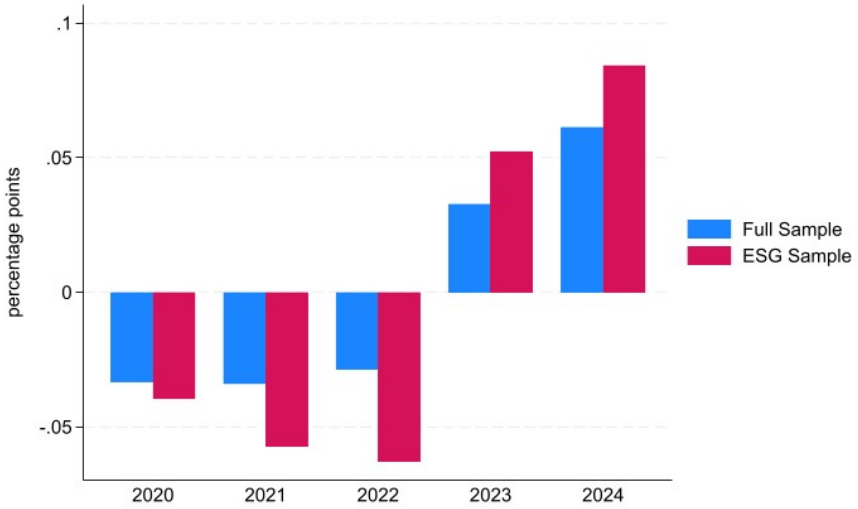
This table shows the results of the regression $\hat{p}_{it} = \alpha_{it} + \beta_1 \text{E Score}_{ft} + \beta_2 \text{Post 2022}_t + \beta_3 \text{Post 2022}_t \times \text{E Score}_{ft} + \beta_4 \text{Bond Controls}_{i,t} + \beta_5 \text{Climate News}_t + \eta_{it}$ (Equation 2) in the ESG subsample. E Score_{ft} refers to the continuous E score of firm f in year t. The reference categories for country and sector is "Other" and for the rating is non-rated (NR). Standard errors are clustered at the issuer level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure C.1: Average Green Bond Premium by Year: Subsamples



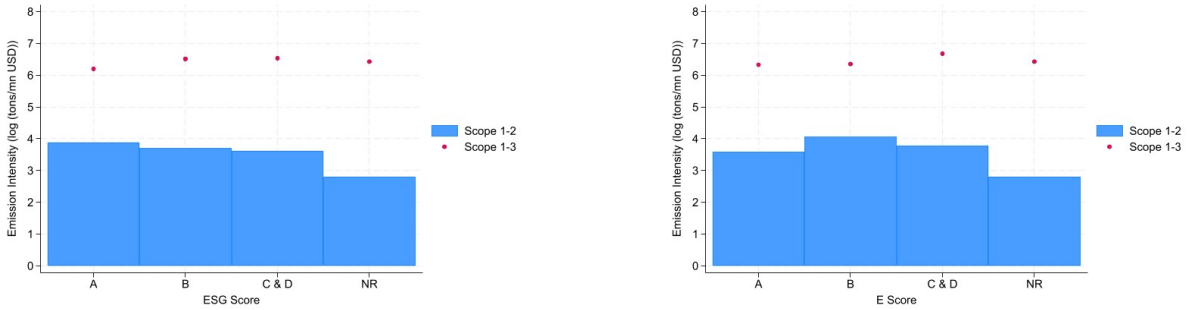
This figure shows the average annual green bond premia for the full sample (blue), excluding bonds with only one conventional bond match (red), excluding bonds without data for all years (green), excluding bonds without credit rating (yellow), and excluding bonds with amount issued < 300 mn USD (purple). It demonstrates that the reversal is observable in all subsamples.

Figure C.2: Average Green Bond Premium by Year: ESG Subsample



This figure shows the average annual green bond premia for the full sample (blue) and the subsample of bonds with ESG scores (red). It demonstrates that the reversal is observable in both subsamples.

Figure C.3: Emission Intensity by ESG and E Scores

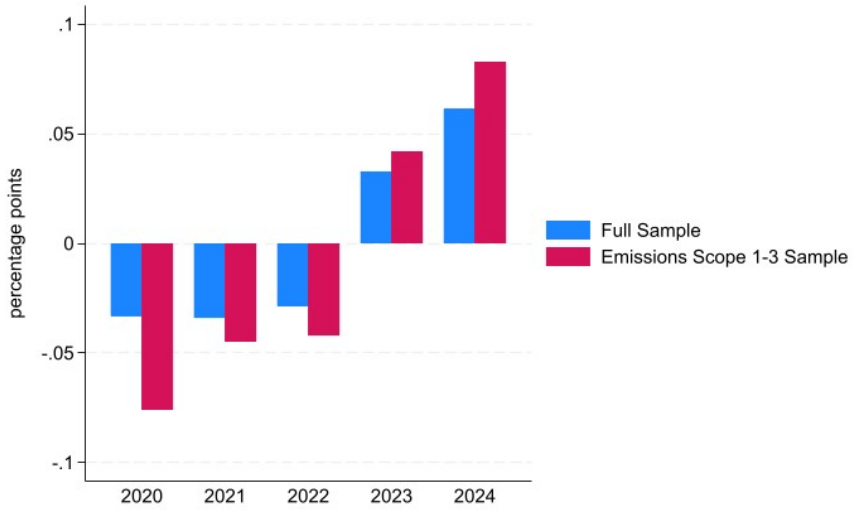


(a) by ESG Score

(b) by E Score

These figures show the average Scope 1–2 (blue bars) and Scope 1–3 (red dots) emission intensity by ESG and E score categories.

Figure C.4: Average Green Bond Premium by Year: Emissions Subsample



This figure shows the average annual green bond premia for the full sample (blue) and the subsample of bonds with Scope 1–3 emission intensity (red). It demonstrates that the reversal is observable in both subsamples.