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**Working Paper**

## It better be good, it better be green

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No. 723

Fabio Fornari, Daniele Pianeselli,  
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## It better be good, it better be green

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# It better be good, it better be green

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## Abstract

We provide empirical evidence that the pricing of green bonds tends to be highly sophisticated and based on a two-tiered approach. When buying a green bond, investors do not look only at the green label of the bond but also consider additional characteristics that involve the soundness of the underlying project and the environmental score of the issuer. By comparing the yields at issuance of green bonds to those of a matched control sample of conventional bonds, we identify a premium of 16 basis points for the green label alone. However, when the environmental score of the issuer is in the top tercile of the cross-sectional distribution, the greenium increases up to doubling. Green certification and periods of heightened climate uncertainty also significantly influence the size of the greenium. Additionally, we find that this pricing mechanism fully emerged only after the Paris Agreement came into force in late 2016.

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# 1 Introduction

Given the growing awareness about climate change and the role of financial markets in supporting the transition to a low-carbon economy, it is not surprising that the pricing of green assets has received significant attention. In particular, one of the most recurrent goals of the literature is to verify whether green bonds are placed (and traded) at a lower return than traditional bonds. The existence of this spread, also known as greenium, would suggest by definition an advantage for the funding of green projects. Indeed, the main difference between a green bond and a traditional bond is that the proceeds of the issuance are committed to be employed for selected green projects, i.e. projects with an environmental return. It is worth mentioning that the use-of-proceeds approach allows any company to issue green bonds, regardless of their main business activity.

This earmarking of the funds raised on the market cannot however represent a complete shift from traditional bond investing, where investors typically focus on all available information including broad company balance sheet characteristics and creditworthiness indicators, rather than the specific use of funds. While the bulk of the literature has focused on the yield spread between bonds with the green label and traditional bonds, we argue that investors do not price all green bonds in the same way. We show that, in addition to the green label, there are other characteristics about the issuer's sustainability that matter. When the latter are taken into account, premia attached to green bonds turn out to be very different, not only across bonds but also across issuers.

There are (at least) two sources of additional information regarding a company's environmental performance that must be considered: the *ESG – score(s)* and the readiness of a third-party certification. The *ESG – score* evaluates not only the environmental performance of a company (*E – score*), but also the social performance (*S – score*) and the soundness of the governance framework (*G – score*). The third-party certifications introduce an additional guarantee that the green bond to be placed is consistent with the *Green bond principles* published by the International Capital Market Association (ICMA (2021)). Since both are part of the information set of the investors, they will likely have

a bearing on the price of the bond.

To preview our results, we find that a greenium of approximately 16 basis points is attached to the green label of a bond. However, when the issuers' environmental performance is in the top tercile of the cross-sectional distribution of the  $E - score$ , the greenium increases up to doubling. A similar increase, around 15 basis points, is found also for certified green bonds, a category for which the greenium typically stands at 25 basis points. In addition, we find that this two-tiered pricing mechanism fully emerged only after the Paris Agreement came into force in late 2016 and it is stronger during periods of high climate change uncertainty.

One interesting policy implication stemming from our analysis is that even brown firms might obtain a price advantage when issuing a green bond, provided of course that the underlying green project is convincing. Even firms in the middle or lower tercile of the  $E - score$  distribution can still reap a positive greenium, indicating that companies without top environmental performance can still achieve a portion of the greenium: that uniquely associated with the bond's green label. This is even more important since, as highlighted by Angelini (2024), imposing higher financing costs on high-emission firms might provide them with an incentive to maintain polluting technologies rather than to transition to cleaner alternatives. Thus, significantly shifting the portfolio composition away from high emitters and towards low emitters may not lead to a fully-fledged decarbonization or an effective transition risk mitigation. The findings of the paper suggest instead that green bonds are a financial instrument able to support virtuous high-emitters committed to genuine and ambitious carbon footprint reduction efforts.

The paper is organized as follows: Section 2 places our contribution in the extant literature; Section 3 provides information about the data employed and the matching algorithm used to create comparable sets of green and non-green bonds; Section 4 presents the regression setup and reports the empirical findings; Section 5 provides robustness checks and Section 6 draws the conclusions.

## 2 Related literature

As already mentioned, one of the most popular investigation concerning green bonds is whether they provide a direct incentive to corporations and institutions that wish to invest in climate friendly projects. Among the potential direct incentives, the most important is the borrowing cost advantage for green bonds versus non-green bonds, in the form of a (negative) yield spread at issuance (greenium). For a company deciding whether to issue a green bond is not a trivial task given that issuing a green bond may lead to additional costs relative to a conventional bond. Firstly, committing the bond proceeds to green projects restricts companies' investment policies. Moreover, to endorse the bond as green, issuers might want to look for a third-party assessment to establish that the proceeds are funding projects in line with the *Green Bond Principles* (ICMA (2021)). The procedure gives rise to additional administrative and compliance costs (Flammer (2021)).

While extensive and growing, the literature is almost unanimous in confirming the existence of the greenium, but it remains inconclusive about the characteristics that determine its size and fluctuations over time (Zerbib (2019), Tang and Zhang (2020), Flammer (2021), Baker et al. (2022), Bolton et al. (2021), Moro and Zaghini (2024)). Concerning corporate issuance, Zerbib (2019) focuses on a set of 110 green bonds issued globally between 2013 and 2017, finding a statistically significant but small greenium of around 2 basis points. Similarly, Baker et al. (2022) estimated the greenium to be between 5-9 basis points. Fatica et al. (2021) report a larger negative premium of 22 basis points for non-financial corporations, while financial corporations do not experience a significant negative yield differential. The greenium of supranational institutions, however, is significantly larger than for corporations, standing at 80 basis points.

Tang and Zhang (2020) find that stock markets respond positively to green bond issuance announcements, whereas Flammer (2021) documents a significant increase in firms' environmental performance after the issuance, indicating that green bonds effectively enhance corporate environmental footprints. However, both contributions do not find strong empirical evidence supporting the existence of a significant spread between green bonds

and conventional bonds issued by the same firm. More recently, Caramichael and Rapp (2024) identify a greenium of 3-8 basis points linked to demand pressure at issuance. Their findings indicate that the greenium emerged only after 2019, coinciding with the growth of the sustainable asset management industry following the EU Sustainable Finance Disclosure Regulation (SFDR). The greenium is observed predominantly among large, investment-grade issuers, particularly within the banking sector and in developed economies.

Kapraun et al. (2019) analyze over 1,500 green bonds and 20,000 conventional bonds, finding similar yields on average in the secondary market. However, they also note that investors accept 5-18 basis points lower yields on: i) bonds issued by governments, local governments or supranational entities; ii) on bonds denominated in euro. In addition, external certification of the bond's greenness proves to be a key driver of the size of the greenium. Closer to what we do in this paper, Loeffler et al. (2021) analyze a large cross section of green and conventional bonds between 2007 and late 2019 and use a matching method to align some of the relevant characteristics of the two sets. Overall, they find a greenium as of 18 basis points, a size that is consistent with findings by Ehlers and Packer (2017) over a shorter period.

Moro and Zaghini (2024) first develop a partial-equilibrium model featuring foreign investors with mean-variance preferences and a convex disutility associated to brown asset holdings. According to the model, the greenium should be smaller in countries with more closed financial systems and highly volatile exchange rates. Behind this is that foreign investors tend to allocate smaller portions of their wealth in such economies, consequently placing less emphasis on the ethical considerations associated with investing in brown assets. Therefore, their empirical analysis shows that the greenium is negatively influenced by the volatility of the currency of denomination of the bond and positively by the financial openness of the market where the bond is placed.

Few studies have analyzed the impact of a company's environmental performance on green bond pricing. Focusing on a limited sample of 466 green bonds issued globally up to 2019, Immel et al. (2021) find a greenium of 13 basis points. At the same time, also



the availability of an *ESG – score* leads to a premium of 22 basis points. Along this line, Eskildsen et al. (2024), relying on 23 company greenness measures and forward-looking expected returns, compare bonds issued by green versus brown firms. In the preferred estimation, they end up with a spread of 13 basis points. However, for both contributions the negative correlation between returns and environmental performance holds for both green and non-green bonds since it is linked to the issuer. Restricting the sample to green bonds only and relying on a sample of 561 Chinese issues, Tang et al. (2023) find that there exists a negative correlation between the bond yield and an environmental information disclosure index ad hoc devised.

As concerns the research methodology, the contributions on the greenium can be classified into two large strands. The one employing a regression approach (Ehlers and Packer (2017), Kapraun et al. (2019), Tang and Zhang (2020), Fatica et al. (2021), Baker et al. (2022), Zaghini (2023)) and that relying on a matching approach (Gianfrate and Peri (2019), Zerbib (2019), Larcker and Watts (2020), Loeffler et al. (2021), Flammer (2021)). As for the first method, bond yields are regressed on a green dummy, controlling for other variables that capture the issuer’s and bond’s characteristics. The coefficient attached to the green dummy represents the estimate of the greenium. The matching approach matches each green bond to one or more non-green counterparts based on selected characteristics, followed by a regression analysis on the matched samples to estimate the greenium, ideally with additional controls for other unmatched issuance characteristics.

In our paper, we rely on the matching approach by using the Coarsened Exact Matching (CEM) method proposed by Iacus et al. (2012) to align green and non-green bonds based on key characteristics. Following this, we apply a regression analysis, enhancing the model with ESG data, balance sheet information, and other relevant variables to provide a more comprehensive analysis of the greenium. More details on our methodology are provided in the next section.

## 3 Data

### 3.1 Green bond issuance

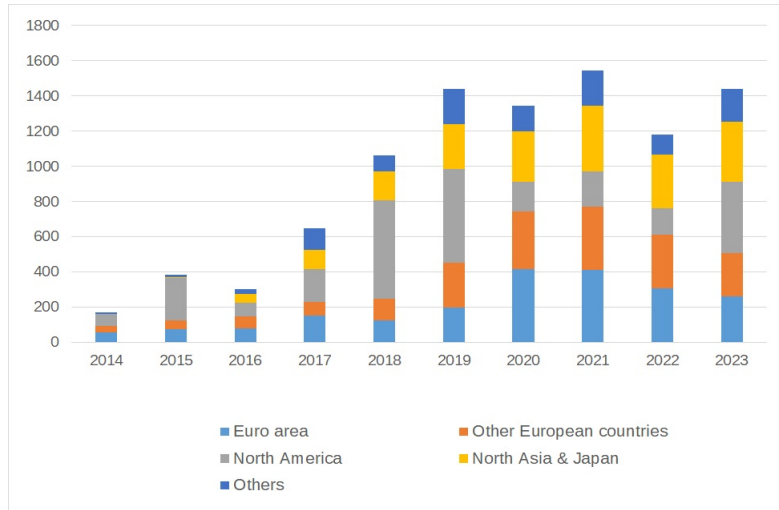
The issuance of green bonds has surged over time, reflecting growing investor interest in sustainable finance and environmentally responsible projects. Sourced from Dealogic DCM Analytics and LSEG Data Analytics, between January 2014 and October 2023, we tracked a total of 9,507 green bonds issued across 73 countries. Over the same period, the total number of bonds issued amounted to 258,421 bonds, spanning 145 nationalities. Among green bond issuers, the financial sector is the most represented at around 27%, followed by government entities and energy and utilities companies (both at 16%), development and multilateral agencies (11%), and transportation (5%). The LSEG database is also utilized as a source of information on the green footprint of issuers. Specifically, we downloaded the ESG scores and their three sub-components—Environmental (E), Social (S), and Governance (G)—for all available firms/issuers. These scores, computed at the firm level by LSEG based on a predefined set of indicators, range from zero (poor score) to 100.

Figures 1 and 2 illustrate the geographical distribution and total value of green bond issues between 2014 and 2023. The issuance of green bonds has significantly increased over this period, rising from 170 in 2014 to 1,441 in the first 10 months of 2023. In 2014-19, North American issuers led the market. However, after 2020, European and Asian issuers, particularly from China, have increased their activity, offsetting a reduction in North American issuance. In other regions, activity has remained subdued (Figure 1). Figure 2 displays the total value of green bond issues by region and year. Between 2014 and 2018 the value of green bond proceeds ranged from 14 to 30 billion euros. Afterward, the value surged, peaking at almost 500 billions euros in 2021 and stabilizing at around 400 billion euros in subsequent years. Europe has significantly contributed to the development of the green bond market, with nearly 50% of the global value of green bonds issued in the first 10 months of 2023 originating from the euro area alone.

Globally, there has been a progressive diversification of issuers over time, as illustrated

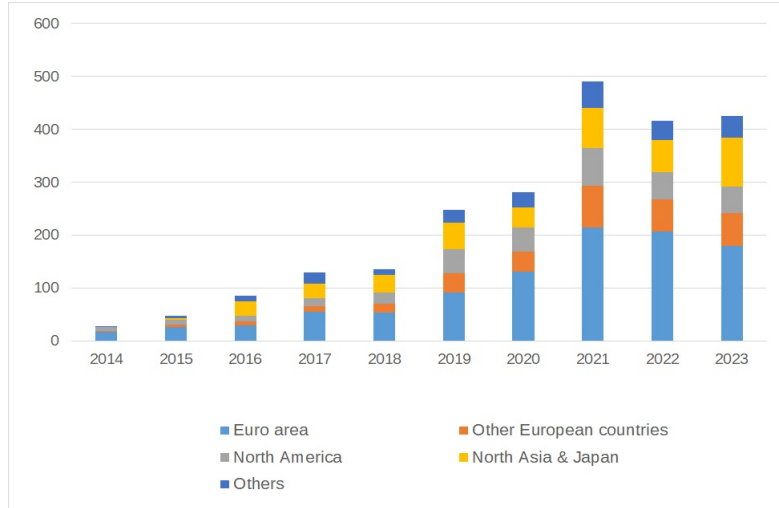
**Figure 1:** Number of green bond issued by geographical area and year

Note: Data for the year 2023 are limited to the January-October period due to data availability. Sources: Dealogic and LSEG.



**Figure 2:** Value of green bond by geographical area and year. Billion of euros.

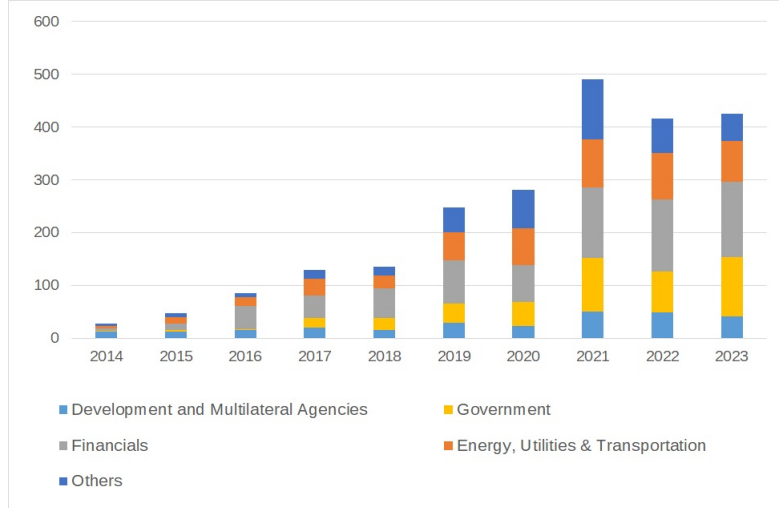
Note: Data for the year 2023 are limited to the January-October period due to data availability. Sources: Dealogic and LSEG.



in Figure 3. While the financial sector, primarily represented by banks, has maintained a key role, there has been a notable increase in issuance activity by governments and companies in carbon-intensive sectors such as energy, utilities, and transportation. Additionally, after 2020, other non-financial corporations have significantly increased their issuance of green bonds.

**Figure 3:** Value of green bond by issuer sector and year. Billion of euros.

Note: Data for the year 2023 are limited to the January-October period due to data availability. Sources: Dealogic and LSEG.

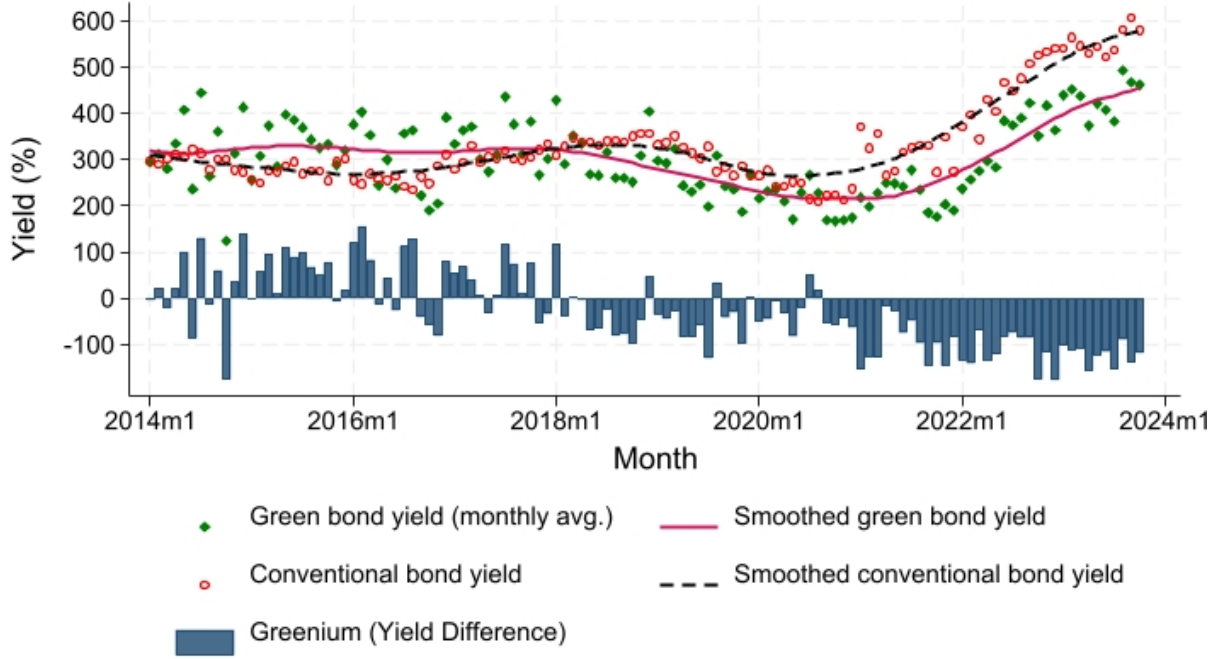


The bond return across our sample has varied over time, reflecting factors such as global monetary policy and global risk-taking attitudes. Figure 4 shows the monthly averages of the redemption yield at issuance for green and conventional bonds. Between 2014 and 2017, conventional bonds exhibited a lower yield compared to their green counterparts. However, since around 2018, a notable reversal occurred as green bonds began to exhibit a negative premium, implying a lower yield than conventional bonds. This premium deepened further after 2020. While the overall realized difference in yields between the two bond types averaged 28 basis points over the entire sample, the yield gap has widened significantly post-2020, exceeding 100 basis points.

It is crucial to note that the observed difference in yields between the two sets of bonds is a purely descriptive and naïve measure of the greenium. This is due to the significant heterogeneity in bond characteristics and issuer profiles across different times and geographical areas. To accurately determine the size of the greenium from an econometric perspective, it is essential to create comparable samples of green and conventional bonds. This issue will be addressed in the next subsection.

**Figure 4:** Yields at issuance for green and conventional bonds.

Note: This figure shows monthly averages of yields at issuance across our sample (Jan 2014 - Oct 2023) for green (diamonds) and conventional - brown - bonds (circles). The straight lines are locally weighted scatterplot smoothing (Lowess) fitted to the original observations. The barchart in the lower panel is the spread between the two bond categories, i.e. a naïve measure of the *greenium*. Values on the y-axis are in basis points. Sources: Dealogic and LSEG.



### 3.2 The matching procedure

To ensure that the spread in the returns genuinely reflects the differential green footprint of the firms or the green label of the bonds, it is crucial to achieve comparability between green and conventional bonds. Traditional regression analysis based on a sample of green and convention bonds is exposed to a bias when the two bond samples differ systematically on characteristics likely to influence the yield that are not properly controlled for. For instance, if green bonds are predominantly issued by high-credit quality firms and have shorter maturities relative to non-green bonds, then a simple regression of green and conventional bond yields on a constant and a dummy for the green bonds might capture the combined effect of both the green label and the these confounding factors.

To address the selection bias and ensure comparability between green and conventional bond groups, we employ the Coarsened Exact Matching (CEM) technique developed by Iacus et al. (2012). Unlike other commonly used matching procedures, like the propensity score matching (PSM), that estimate a continuous score to predict the probability of being green, Coarsened Exact Matching (CEM) is a non-parametric method that avoids assumptions about the functional form of the relationship between control variables and treatment assignment. With CEM, observable characteristics between the green and non-green groups are directly balanced, ensuring robustness against model misspecification. CEM ensures balance across multiple covariates by matching groups on predefined coarsened bins for each covariate, rather than relying on a single dimension like a propensity score, thereby mimicking exact matching. Additionally, CEM provides greater flexibility in handling both categorical and continuous variables, enhancing the accuracy of the matching across various bond and issuer characteristics.

Our matching procedure involved several steps. First, we categorized bonds into groups based on a selected set of control variables. The latter includes bonds characteristics as year of issuance, issued amount, maturity period, currency of denomination, coupon frequency, interest rate type, credit rating and other embedded options (subordination, callability and collateralization). Bonds are also matched according to the country of origin and sector of the issuers. Next, we coarsened the control variables. Coarsening involves transforming continuous variables into categorical variables by creating intervals or bins or recoding discrete variables into broader categories. This simplifies the matching process by reducing the number of unique values each variable can take without losing significant information, as the uncoarsened matching variables are included later in the regression. Certain variables, such as year of issuance, currency denomination, embedded options and the country and sector of the issuer, were matched exactly without any coarsening. The coupon rate was recoded into five categories, while the interest rate type remained as either fixed or floating. The bonds credit rating was reduced from 20 to eight categories, and continuous variable like the amount issued and the bond maturity were categorized in 12 and 11 items, respectively. After coarsening the variables, CEM

performs exact matching within these coarsened groups. Each green bond is matched with  $k$  non-green bonds (1-to- $k$  matching) that fall into the exact same categories for all coarsened control variables, with the non-green bonds' influence adjusted by the matching weights produced by CEM. All unmatched bonds are excluded from further analysis, ensuring a high degree of comparability within the matched sample.

**Table 1:** Sample composition.

	<b>Regression Sample</b>		<b>Restricted Sample</b>	
	Conventional	Green	Conventional	Green
<b>Num. Of obs.</b>	12,103	2,589	8,919	2,152
<b>Region:</b>				
North America	5,846	503	4,246	432
Europe	1,851	1,149	1,407	971
North Asia & Japan	4,047	766	3,031	618
Others	359	171	235	131
<b>Sector:</b>				
Multilateral Institutions	632	327	461	266
Government	4,587	235	3,309	202
Financials	3,733	753	2,954	641
Energy, Util. & Transport	1,203	468	909	378
Others	1,948	806	1,286	665

Sources: Dealogic and LSEG.

The resulting sample consists of 2,589 green bonds and 12,103 comparable conventional bonds, which are used in the regression analysis as weighted matched controls. This analysis incorporates additional controls, including both uncoarsened matching variables and metrics related to ESG factors, balance sheet data, and financial and macroeconomic indicators. The ratio of treatment (green bonds) to control (conventional bonds) observations in our sample is 1:4.7, which supports a robust comparison and provides sufficient statistical power. For comparison, related literature reports various ratios of common support, ranging from 1:1 in Flammer (2021) and Zerbib (2019), to 1:4 in Loeffler et al. (2021), and up to 1:8 and 1:10 in Gianfrate and Peri (2019) and Kapraun et al. (2019), respectively. Table 1 summarizes the composition of the regression sample, alongside that of a restricted sample used for robustness checks in Section 5. The latter is obtained by applying a finer coarsening to the issued amount and bond maturity variables, resulting in a closer match between green and conventional bonds. However, this increased precision

comes at the expense of a smaller sample size.

## 4 Modelling the greenium

To assess the size and determinants of the yield spread between green and non-green bonds, we rely on the following baseline model:

$$yield_{b,c,i,t} = \alpha + \beta * green_b + \delta * X_{b,i} + \gamma * \Theta_t + \lambda_{c,t} + \varepsilon_{b,c,i,t} \quad (1)$$

where *yield* represents the annualized yield to maturity at issuance for bond *b*, denominated in currency *c*, placed by issuer *i* at time *t*. The variable *green* is a dummy that takes a unit value for green bonds, and zero otherwise. The vector *X* contains the bond and issuer characteristics: maturity (measured in years to maturity), amount issued in EUR millions, the coupon frequency, the interest rate type (fixed, floating, variable), dummies for collateralized, subordinate and callable bonds, the rating of the bond, the rating of the issuer, the nationality of the issuer, the industry sector of the issuer and three indicators from the issuer’s balance sheet (total assets, leverage and ROE). In addition the vector *X* contains also a dummy variable which identifies the level of greenness of the firm which, in subsequent econometric analysis, is used to form an interaction term with the variable *green*. The vector  $\Theta$  includes time-varying financial and macroeconomic factors that are likely to affect bond yields. There are three classes of market indices at the daily frequency: (i) the VIX and VSTOXX indexes that are measures of the expected equity market volatility in the US and euro area, respectively; (ii) the CISS (Composite Indicator of Systemic Stress) indexes by Hollo et al. (2012) that measure the systemic stress in the financial markets in China, the euro area, the UK and the US; (iii) the iTraxx index that captures market-wide variation in CDS spreads due to changes in fundamental credit risk, liquidity, and CDS market-specific shock (Acharya et al. (2014)). In addition, also at the daily frequency, we include: (i) the index of macroeconomic surprises for the US and the euro-area provided by Citi; (ii) the index of economic policy uncertainty (EPU) by Baker et al. (2022) for the US, the UK and China (the latter at the monthly frequency). To



account for global factors, we rely on: i) the monthly index of global commodity prices from the IMF Global Commodity Dataset that covers both oil and other commodities; ii) the geopolitical risk index (GPR) by Caldara and Iacoviello (2022). Finally, the term  $\lambda$  indicates bond denomination currency time-varying fixed effects. Equation 1 is estimated by Ordinary Least Squares; standard errors are clustered at the issuer level.

Table 2 shows the regression results based on equation 1. At placement, green bonds benefit from a negative spread (i.e. greenium) of 11 basis points with respect to non-green bonds (column 1). Thus, issuing a green bond seems convenient independently of the company environmental performance. Similarly, when the issuer has an  $E - score$  publicly available (i.e., there is a market disclosure), it also benefits from a yield discount of 20 basis points (column 2). This indicates that disclosing a firm’s environmental involvement provides *per se* a reduction in the cost of bond issuance.<sup>1</sup>

A more precise estimate of the greenium and an assessment about how the two characteristics interact are shown in the third column. For green bonds issued by companies without an  $E - score$ , the greenium amounts to 16 basis points, whereas for green bonds issued by companies with an  $E - score$ , the greenium increases to 27 basis points. At the same time, the effect of disclosing the  $E - score$  provides a benefit of 23 basis points. Thus, while the two sources of discount do not perfectly add up, there is clear evidence of an additional convenience in disclosing the  $E - score$  for green bond issuers or, viceversa, there is an additional convenience for disclosing issuers in placing a green bond instead of a traditional one. From an economic point of view, given that the unconditional mean of the cross sections of yields at issuance stands at 2.44%, the greenium amounts to a non-trivial 11% discount on the company financing costs.

A further investigation concerns the possibility of a non-linear effect of the environmental performance of the issuing company on the bond yield. Disclosing a high score might be more favorably received by investors than disclosing a low score, affecting both

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<sup>1</sup>The variable *disclosure* is a dummy variable equal to one for companies having a publicly available  $E - score$  and 0 otherwise. The coefficient estimate is in line with the results reported by Immel et al. (2021) and Ferriani (2023) for an *ESG* dummy. For a critique on the divergence across rating agencies providing ESG scores see Berg et al. (2022).

**Table 2:** Estimates of the *greenium* in the primary bond market

	Green	Disclosure	G&D	E-score	Certified	ESG-score	G-score	S-Score
<b>Green</b>	-0.1115*** (0.0372)	.. ..	-0.1595*** (0.0579)	-0.1597*** (0.0580)	-0.2532*** (0.0710)	-0.1596*** (0.0579)	-0.1908*** (0.0531)	-0.1917*** (0.0530)
<b>Disclosure</b>	.. ..	-0.2070*** (0.0691)	-0.2262*** (0.0737)	-0.2285*** (0.0732)	-0.2276*** (0.0709)	-0.2278*** (0.0734)	-0.2112*** (0.0696)	-0.2148*** (0.0697)
<b>Green&amp;Disclosure</b>	.. ..	.. ..	-0.2717*** (0.0709)	.. ..	.. ..	.. ..	.. ..	.. ..
<b>Green*Disclosure*TOP</b>	.. ..	. ..	.. ..	-0.1712** (0.0809)	-0.1529* (0.0942)	-0.1427* (0.0814)	-0.0360 (0.0854)	-0.1339 (0.0835)
<b>Green*Disclosure*MED</b>	.. ..	.. ..	.. ..	-0.0793 (0.0923)	0.0111 (0.1163)	-0.1099 (0.0890)	0.0032 (0.0859)	0.0683 (0.0969)
<b>Green*Disclosure*LOW</b>	.. ..	.. ..	.. ..	0.0005 (0.1426)	-0.0465 (0.1935)	0.0138 (0.1865)	-0.2377 (0.1910)	-0.0736 (0.1463)
<b>Bond+Issuer Controls</b>	YES	YES	YES	YES	YES	YES	YES	YES
<b>Market Controls</b>	YES	YES	YES	YES	YES	YES	YES	YES
<b>Macro Controls</b>	YES	YES	YES	YES	YES	YES	YES	YES
<b>Currency*Year Controls</b>	YES	YES	YES	YES	YES	YES	YES	YES
<b>Observations</b>	14,692	14,692	14,692	14,692	14,692	14,692	14,692	14,692
<b>R<sup>2</sup><sup>a</sup></b>	0.8294	0.8299	0.8303	0.8304	0.8308	0.8303	0.8303	0.8308

*p*-values in parentheses\* denotes  $p < 0.10$ , \*\* denotes  $p < 0.05$  and \*\*\* denotes  $p < 0.01$ 

Note: The Table reports the coefficient estimates of separate regressions on the yield at issuance for a set of green and (matched) brown bonds, controlling for a number of market and macroeconomic factors and with selected fixed and time effects. The environmental performance measure used to split companies across terciles in the last three lines of the Table is the cross-sectional E-Score as reported by LSEG. Green is a variable that takes 1 for green bonds, and 0 otherwise. Disclosure is a variable that takes 1 for bonds placed by an issuer for which a E-score is available, and 0 otherwise. TOP, MED, LOW are variables taking 1 when the issuer's E-score is in the first, second and third tercile of the E-score cross-section distribution, respectively.

ordinary and green bonds. In addition, there might be a threshold below which the additional discount is not applied by market participants. The fourth column of the Table 2 shows that is indeed the case. When the  $E - score$  is in the top tercile of its cross-sectional distribution, the interaction of the green bond and the disclosure is rewarded by investors by additional 17 basis points with respect to standard green bonds (i.e. those issued by non-disclosing companies). Overall, the greenium on bonds in the top tercile of the distribution amounts to 33 basis points. No additional premium at issuance is attributed to the green bonds issued by companies in the other two terciles, indicating that disclosing a poor or an average environmental performance is neither rewarded nor penalized by investors. In summary, only a very good environmental performance matters for the greenium.<sup>2</sup>

As a first check of the baseline results, column 5 focuses on the subset of green bonds having a third-party opinion certifying the consistency with the *Green Bond Principles* (ICMA (2021)). We observe an increase in the *greenium* to 25 basis points for non-disclosing companies and a slight reduction in the spread from the top tercile of disclosing companies. This suggests that certification enhances trust in the authenticity of the green credentials of the bond, especially for non-disclosing companies.

As a second step, we examine the disclosure and cross-sectional distribution of the  $ESG - score$  as a whole and the two additional components of social performance ( $S - score$ ) and governance performance ( $G - score$ ) of the companies. When the  $ESG - score$  is employed instead of the  $E - score$ , the estimate and the statistical significance of each

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<sup>2</sup>Since market reports have evidenced that green bonds are typically over-subscribed (see, for example, CBI (2022)) and their over-subscription usually exceeds that for conventional bonds, one may conjecture that the size of the greenium could be related to a small and inelastic supply of the green bonds relative to their brown counterparts (Caramichael and Rapp (2024)). To this aim we have created a dummy equal to one for those green bonds for which the over-subscription rate was above 100%, combining information from Bloomberg and International Financing Review. Data for the over-subscription rate is available for 651 green bonds, i.e., around one third of our sample, and therefore some degree of caution must be acknowledged. Unlike the evidence in Caramichael and Rapp (2024), the over-subscription dummy has a positive coefficient, indicating that the greenium reached a trough (i.e., it was closer to zero), rather than a peak, for the over-subscribed bonds, against the prior that the demand effect was compensated by a lower yield at auction. More importantly, the other coefficients in the regressions (i.e., those on the green label and the  $E - score$ ) remain unchanged after the inclusion of the over-subscription dummy and therefore do not lead to results different than those presented so far.

coefficient are in line with the baseline regression (column 6 vs column 4). This evidence is not surprising given the strong positive correlation between the two scores (0.87). However, when the *S-score* and the *G-score* are used, the statistical significance disappears (column 7 and 8, respectively), indicating that a firm’s environmental performance is the only factor that significantly impacts the pricing of green bonds.

We further investigate two additional factors that might influence the pricing of green bonds: the entry into force of the Paris Agreement and the occurrence of climate shocks. The Paris Agreement is a legally binding international treaty on climate change, negotiated by 196 Parties at the UN Climate Change Conference (COP21) held in 2015 in Paris. Signing countries committed to a long-term goal of keeping the rise in global surface temperature well below 2 degrees Celsius above pre-industrial levels, preferably below 1.5 degrees. The Agreement aims to assist countries in fighting climate change and mobilizing sufficient finance to achieve this goal. Its innovative approach lies in the way each country must contribute to achieving the common goal. Under the Agreement, participating countries must determine their own plans and regularly report on their contributions. The Agreement was ratified on 5 October, 2016 and entered into force on 4 November, 2016.

By setting up two dummies tracking all the bonds issued before and after the start of the Paris Agreement, we test whether the entry into force of this international treaty increased investor awareness and demand for green bonds, potentially affecting their pricing. It turns out that the virtuous effect of disclosing the *E-score* of the company fully materialised only after 4 November, 2016 (Table 3; column 1). Indeed the coefficient on the dummy tracking the period before that date is not statistically different from zero. On the contrary, the coefficient on the dummy for the following period is statistically significant and aligns with the baseline estimation. Also the non-linearity of the market reward is confirmed. By focusing on the post-Paris period, only the firms disclosing their environmental performance and having an *E-score* within the top tercile of distribution benefit of a further discount (17 basis points) with respect to non-disclosing firms when issuing green bonds (column 2). Conversely, the coefficient for the top tercile is negative

**Table 3:** Estimates of the *greenium* before and after the Paris Agreement

	(1)	(2)	(3)
<b>Green</b>	-0.1597*** (0.0560)	-0.1598*** (0.0580)	-0.1600*** (0.0581)
<b>Disclosure</b>	-0.2259*** (0.0737)	-0.2277*** (0.0731)	-0.2268*** (0.0736)
<b>BeforeParis*Green*Disclosure</b>	0.0335 (0.1674)	0.0317 (0.1672)	.. ..
<b>AfterParis*Green*Disclosure</b>	-0.1255* (0.0765)	.. ..	-0.1257* (0.0766)
<b>Green*Disclosure*TOP</b>	.. ..	-0.1695** (0.0799)	-0.0798 (0.2184)
<b>Green*Disclosure*MED</b>	.. ..	-0.0989 (0.0939)	0.2630 (0.2200)
<b>Green*Disclosure*LOW</b>	.. ..	-0.0202 (0.1528)	0.1790 (0.2219)
Bond+Issuer Controls	YES	YES	YES
Market Controls	YES	YES	YES
Macro Controls	YES	YES	YES
Currency*Year Controls	YES	YES	YES
<b>Observations</b>	14,692	14,692	14,692
<b><math>R^2</math><sup>a</sup></b>	0.8303	0.8304	0.8213

*p*-values in parentheses\* denotes  $p < 0.10$ , \*\* denotes  $p < 0.05$  and \*\*\* denotes  $p < 0.01$ 

Note: The Table reports the coefficient estimates of separate regressions on the yield at issuance for a set of green and (matched) brown bonds, controlling for a number of market and macroeconomic factors and with selected fixed and time effects. The environmental performance measure used to split companies across terciles in the last three lines of the Table is the cross-sectional E-Score as reported by LSEG. The variable BeforeParis takes 1 for all the days before 4 November, 2016, and 0 otherwise. The variable AfterParis takes 1 for all the days after 4 November, 2016, and 0 otherwise.

(8 basis points) but not statistically significant in the pre-Paris period (column 3).<sup>3</sup>

Regarding climate awareness, Pastor et al. (2021) propose a theoretical framework to model the impact of changes in sustainability preferences on asset prices. Their model predicts that green shares outperform non-green shares when climate change concerns strengthen. For bonds, in particular, they show that the greenium between two matched bonds issued by the German Government was almost negligible at issuance (2 basis points), but it spiked around the occurrence of catastrophic climate-related events as the July 2021 floods in Central Europe. Such events may influence investor behavior, increasing the perceived value of investments in sustainable projects and, consequently, the pricing of green bonds (Pastor et al. (2022)).

In order to test this prediction with our dataset, we rely on the Climate Policy Uncertainty Index (CPU) proposed by Gavrilidis (2021). This monthly index gauges climate change uncertainty based on news from major US newspapers and newswires. Accordingly, we introduce two dummy variables tracking periods of high and low climate change uncertainty based on days above and below the median value of the CPU Index over the full period of investigation.<sup>4</sup>

Estimation results in Table 4 show that in periods of heightened uncertainty about climate change, the greenium is larger (column 1), confirming the findings of Ardia et al. (2023) about the better performance of green stocks versus the brown ones in the US market. Two findings are worth noting. First, the market discount granted to the green issuance made by companies in the top tercile of the cross-sectional disclosure distribution is the largest across all regressions (30 basis points) and leads the overall greenium to reach 44 basis points (column 2). Secondly, the discount in the yield at issuance extends

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<sup>3</sup>Further analyses of the period after the entry into force of the Paris Agreement do not show any other change in the relationship between the green label of the bonds and the environmental disclosure of the issuing companies. For instance, the two-tiered price mechanism was already at work before the burst of the Covid pandemic (29 February, 2020) or even the EU regulation proposal (SFDR) dated 8 March, 2018.

<sup>4</sup>As concerns stock market pricing, Ardia et al. (2023) empirically confirm the prediction of the model by Pastor et al. (2021) using data for S&P 500 companies over the period January 2010 - June 2018. For the scope, they propose a daily index, also based on news published by major US newspapers, named *Media and Climate Change Concerns* (MCCC) Index. Notwithstanding a rather limited availability, the MCCC index will be used as a robustness check in Section 6.

**Table 4:** Estimates of the *greenium* with respect to climate uncertainty

	(1)	(2)	(3)
<b>Green</b>	-0.1593*** (0.0580)	-0.1397*** (0.0576)	-0.1592*** (0.0575)
<b>Disclosure</b>	-0.2267** (0.0736)	-0.2187** (0.0732)	-0.2249** (0.0735)
<b>LowUncertainty*Green*Disclosure</b>	-0.0751 (0.0816)	-0.0528 (0.0805)	.. ..
<b>HighUncertainty*Green*Disclosure</b>	-0.2218** (0.0914)	.. ..	-0.1657** (0.0960)
<b>Green*Disclosure*TOP</b>	.. ..	-0.3009*** (0.0966)	-0.1576** (0.0810)
<b>Green*Disclosure*MED</b>	.. ..	-0.2958** (0.1417)	-0.0578 (0.1002)
<b>Green*Disclosure*LOW</b>	.. ..	-0.2089 (0.1502)	0.0736 (0.1711)
Bond+Issuer Controls	YES	YES	YES
Market Controls	YES	YES	YES
Macro Controls	YES	YES	YES
Currency*Year Controls	YES	YES	YES
N	14,692	14,692	14,692
$R^2$ <sup>a</sup>	0.8304	0.8350	0.8298

*p*-values in parentheses\* denotes  $p < 0.10$ , \*\* denotes  $p < 0.05$  and \*\*\* denotes  $p < 0.01$ 

Note: The Table reports the coefficient estimates of separate regressions on the yield at issuance for a set of green and (matched) brown bonds, controlling for a number of market and macroeconomic factors and with selected fixed and time effects. The environmental performance measure used to split companies across terciles in the last three lines of the Table is the cross-sectional E-Score as reported by LSEG. The variable LowUncertainty takes 1 for all the days when the CPU index by Gavriliadis (2021) is below average, and 0 otherwise. The variable HighUncertainty takes 1 for all the days when the CPU index is above average, and 0 otherwise.

also to the firms in the middle tercile of the  $E - score$ . In this case, not only is the coefficient statistically significant, but it also stands at the same magnitude of the top tercile. Thus, in periods of climate stress, investors not only seem prone to finance green projects at a higher cost, but also to extend the additional reward to companies with a lower environmental performance. Overall, this evidence suggests a sort of “dash for green” in challenging environmental times. Conversely, in periods of reduced climate concerns, the usual ranking across the disclosure terciles applies (column 3). Specifically, when the CPU index falls below its median value, only the coefficient for the top tercile remains statistically significant, but smaller in magnitude (16 basis points) compared to periods when the index stands above its median value.

## 5 Robustness

In this section we provide some robustness checks to the results, first by employing an alternative index of climate stress and subsequently by constraining the bonds in the regression in order to match selected characteristics of the issuers.

Table 5 shows the estimation results when we use the MCCC index by Ardia et al. (2023) instead of the index proposed by Gavrilidis (2021) and used in Section 5. Even though the availability of the MCCC index is more limited over time (its availability ends in May 2022), it has the advantage of being constructed at the daily frequency. In addition, it focuses on the “negative” variations in the attention about climate change. In other words, it takes into account changes in the concern about climate change.

The estimated coefficients show that in periods of climate stress, investors tend to award larger premia to green bonds than in tranquil periods (column 1). In addition, while the estimation based on the MCCC confirms that the additional premium reaches a peak in the case of the top performing firms (33 basis points), it also suggests that the premium extends to the issuers in the second tercile of the  $E - score$  distribution, i.e., those with a medium environmental performance (column 2). The third column reports instead that the usual price tiering applies in normal times.



**Table 5:** Estimates of the *greenium* with respect to climate concern

	(1)	(2)	(3)
<b>Green</b>	-0.1621** (0.0731)	-0.1626** (0.0732)	-0.1622** (0.0732)
<b>Disclosure</b>	-0.2302** (0.1001)	-0.2318** (0.0999)	-0.2325** (0.0992)
<b>LowConcern*Green*Disclosure</b>	-0.0985 (0.1097)	-0.0998 (0.1098)	.. ..
<b>HighConcern*Green*Disclosure</b>	-0.2336** (0.109)	.. ..	-0.3259** (0.1090)
<b>Green*Disclosure*TOP</b>	.. ..	-0.3272*** (0.1216)	-0.1804* (0.1084)
<b>Green*Disclosure*MED</b>	.. ..	-0.2328** (0.1426)	-0.0687 (0.1385)
<b>Green*Disclosure*LOW</b>	.. ..	-0.0258 (0.1614)	0.0384 (0.2101)
Bond+Issuer Controls	YES	YES	YES
Market Controls	YES	YES	YES
Macro Controls	YES	YES	YES
Currency*Year Controls	YES	YES	YES
N	10,104	10,104	10,104
$R^2$ <sup>a</sup>	0.8272	0.8277	0.8277

*p*-values in parentheses\* denotes  $p < 0.10$ , \*\* denotes  $p < 0.05$  and \*\*\* denotes  $p < 0.01$ 

Note: The Table reports the coefficient estimates of separate regressions on the yield at issuance for a set of green and (matched) brown bonds, controlling for a number of market and macroeconomic factors and with selected fixed and time effects. The environmental performance measure used to split companies across terciles in the last three lines of the Table is the cross-sectional E-Score as reported by LSEG. The variable LowConcern takes 1 for all the days when the MCCC index by Ardia et al. (2023) is below average, and 0 otherwise. The variable HighConcern takes 1 for all the days when the MCCC index is above average, and 0 otherwise.

As a further set of robustness checks we change the regression sample. We initially rely on the smaller matched sample made of 11,071 bonds (see section 3), for which the matching constraints are set with stricter conditions. We then reduce the baseline sample in two additional ways. First, by excluding the bonds issued by government institutions, thereby restricting our analysis to private sector corporations and multilateral development banks (ending up with 9,870 observations). Secondly, by excluding also the issuance by the banking system. In order to have a proxy of the issuance of the non-financial sector, we maintain in the sample the financial vehicles of non-financial corporations (NFCs) and the insurance companies.

**Table 6:** Robustness on a stricter matched sample

	E-score	Certified	ESG	G-score	S-score	Paris	Uncertainty
<b>Green</b>	-0.1700*** (0.0555)	-0.2679*** (0.0694)	-0.1699*** (0.0556)	-0.1947*** (0.0529)	-0.2029*** (0.0534)	-0.1699*** (0.0556)	-0.1453*** (0.0551)
<b>Disclosure</b>	-0.2284*** (0.0796)	-0.2113*** (0.0760)	-0.2280*** (0.0799)	-0.2101*** (0.0752)	-0.2156*** (0.0742)	-0.2275*** (0.0796)	-0.2124*** (0.0797)
<b>BeforeParis*Green*Disclosure</b>	.. ..	.. ..	.. ..	.. ..	.. ..	-0.0522 (0.1903)	.. ..
<b>LowUncertainty*Green*Disclosure</b>	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	-0.0477 (0.0828)
<b>Green*Disclosure*TOP</b>	-0.1720** (0.0816)	-0.2049** (0.0862)	-0.1538* (0.0858)	-0.0301 (0.0925)	-0.1288 (0.0813)	-0.1621** (0.0790)	-0.2723*** (0.1045)
<b>Green*Disclosure*MED</b>	-0.0603 (0.0920)	-0.1065 (0.1113)	-0.0744 (0.0883)	-0.0065 (0.0893)	0.0386 (0.0972)	-0.0775 (0.0920)	-0.3463** (0.1522)
<b>Green*Disclosure*LOW</b>	0.0269 (0.1601)	-0.1490 (0.2149)	-0.0005 (0.2111)	-0.2562 (0.1833)	-0.0216 (0.1685)	0.0167 (0.1734)	-0.1579 (0.1728)
<b>Bond+Issuer Controls</b>	YES	YES	YES	YES	YES	YES	YES
<b>Market Controls</b>	YES	YES	YES	YES	YES	YES	YES
<b>Macro Controls</b>	YES	YES	YES	YES	YES	YES	YES
<b>Currency*Year Controls</b>	YES	YES	YES	YES	YES	YES	YES
<b>Observations</b>	11,071	11,071	11,071	11,071	11,071	11,071	11,071
<b>R2<sup>a</sup></b>	0.8401	0.8403	0.8400	0.8400	0.8421	0.8401	0.8437

*p*-values in parentheses

\* denotes  $p < 0.10$ , \*\* denotes  $p < 0.05$  and \*\*\* denotes  $p < 0.01$

Note: The Table reports the coefficient estimates of separate regressions on the yield at issuance for a set of green and (matched) brown bonds, controlling for a number of market and macroeconomic factors and with selected fixed and time effects. The environmental performance measure used to split companies across terciles in the last three lines of the Table is the cross-sectional E-Score as reported by LSEG. The sample used is the matched one for which the matching constraints were set with stricter conditions than baseline.

Table 6 reports the results from the regressions run on the stricter matched sample. Even with this smaller and more homogeneous set of bonds, the regression results confirm the evidence shown in the previous sections. In particular, estimates in column 1 still

supports the main finding that disclosing the environmental performance of the company provides an additional benefit when placing a green bond, provided that the  $E - score$  is in its top tercile. The greenium for non-disclosing companies amounts to 17 basis points, while that for disclosing companies adds another 17 basis points to reach a total premium of 34 basis points. This market pricing effect is valid also when considering only certified green bonds (column 2) and when using the  $ESG - score$  instead of the  $E - score$  (column 3). For certified green bonds, there also appears to be a slightly larger greenium for companies without disclosure, estimated at 27 basis points. At the same time, also the irrelevance of the assessment of the company performance concerning both the social and governance context is confirmed: all the coefficient tracking the cross-sectional distribution of the  $G - score$  and the  $S - score$  are not statistically significant (column 4 and 5, respectively).

Focusing on the UN COP21 meeting, column 6 confirms that the effect of the  $E - score$  disclosure is evident only after the entry into force of the Paris Agreement in late 2016. The pre-event dummy is not statistically significant, while in the post-event period the green bonds issued by companies with an  $E - score$  in the top tercile of the cross-sectional distribution received an additional discount of 16 basis points. As concerns the effect of climate change uncertainty, the last regression (column 7) validate the hypothesis of a “dash for green” in bad times (i.e, when the CPU index is above the median value). Indeed, the additional premium awarded to a good environmental performance extends also to the middle tercile of the  $E - score$  distribution.

The left panel of Table 7 presents the results when the baseline sample is restricted to 9,870 observations, which is obtained by removing the bonds placed by government institutions (local authorities, central authorities and government sponsored entities). The right panel of the table reports instead results when the sample is further reduced to 8,225 bonds by removing issues attributable to the banking system.

While all the results of the previous sections are confirmed, it is worth noting that the estimates for the non-financial sector suggests a somewhat larger premium for the green label (right panel, first line) especially for certified green bonds (31 basis points

**Table 7:** Robustness: Estimation with adjusted samples

	E-score	Certified	Paris	Uncertainty	E-score	Certified	Paris	Uncertainty
<b>Green</b>	-0.1577*** (0.0647)	-0.2084*** (0.0793)	-0.1580*** (0.0648)	-0.1581*** (0.0644)	-0.1901*** (0.0751)	-0.3099*** (0.0943)	-0.1903*** (0.0751)	-0.1886 *** (0.0752)
<b>Disclosure</b>	-0.2438*** (0.0773)	-0.2272*** (0.0734)	-0.2433*** (0.0773)	-0.2406*** (0.0775)	-0.2705*** (0.0965)	-0.2854*** (0.0948)	-0.2700*** (0.0964)	-0.2688*** (0.0965)
<b>BeforeParis*Green*Disclosure</b>	.. ..	.. ..	-0.0440 (0.1840)	.. ..	.. ..	.. ..	-0.0209 (0.2513)	.. ..
<b>LowUncertainty*Green*Disclosure</b>	.. ..	.. ..	.. ..	-0.1037 (0.1903)	.. ..	.. ..	.. ..	..-0.1339 (0.0994)
<b>Green*Disclosure*Top</b>	-0.1964** (0.0848)	-0.2826*** (0.0921)	-0.1960** (0.0829)	-0.2718*** (0.1059)	-0.2402** (0.0974)	-0.1980* (0.1127)	-0.2301** (0.0955)	-0.3388*** (0.1173)
<b>Green*Disclosure*Med</b>	-0.0977 (0.0939)	-0.1342 (0.1089)	-0.1214 (0.0949)	-0.2488* (0.1438)	-0.1410 (0.1063)	-0.0269 (0.1307)	-0.1705 (0.1072)	-0.3077** (0.1498)
<b>Green*Disclosure*Low</b>	0.0685 (0.1458)	-0.1911 (0.1824)	-0.1038 (0.1566)	-0.2512 (0.1732)	-0.0051 (0.1898)	0.0695 (0.2296)	-0.0362 (0.1928)	-0.1486 (0.1944)
<b>Bond+Issuer Controls</b>	YES	YES	YES	YES	YES	YES	YES	YES
<b>Market Controls</b>	YES	YES	YES	YES	YES	YES	YES	YES
<b>Macro Controls</b>	YES	YES	YES	YES	YES	YES	YES	YES
<b>Currency*Year Controls</b>	YES	YES	YES	YES	YES	YES	YES	YES
<b>Observations</b>	9,870	9,870	9,870	9,870	8,225	8,225	8,225	8,225
<b>R<sup>2</sup><sup>a</sup></b>	0.8357	0.8369	0.8368	0.8369	0.8312	0.8317	0.8312	0.8315

*p*-values in parentheses

\* denotes  $p < 0.10$ , \*\* denotes  $p < 0.05$  and \*\*\* denotes  $p < 0.01$

Note: The Table reports the coefficient estimates of separate regressions on the yield at issuance for a set of green and (matched) brown bonds, controlling for a number of market and macroeconomic factors and with selected fixed and time effects. The environmental performance measure used to split companies across terciles in the last three lines of the Table is the cross-sectional E-Score as reported by LSEG. The left panel reports the estimates when the baseline sample is reduced by removing the government issuance. The right panel reports the estimates when the sample is further reduced by removing the banking sector issuance.

with respect to 25 in the baseline regression).

## 6 Conclusions

In this paper we provide evidence that investors price differently green bonds across issuers. Focusing on the bare difference among green and brown bond yields (greenium) may be misleading. We suggest that the interaction of the green label of the bond with the environmental performance of the issuer provides a better assessment of the greenium.

We start from a large sample covering yields at issuance for green and traditional bonds issued between January 2014 and October 2023 by governments, supranational agencies and private sector corporations worldwide, denominated in various currencies. A matching algorithm is employed to align the set of conventional bonds to the green bonds according to a restricted number of selected issuer and issuance characteristics. This results in a smaller and more homogeneous sample, mitigating differences that could

affect our estimates.

Pooled panel regressions run on the matched sample reveal that the premium attached to the green label of a bond has hovered around 16 basis points across the decade we examine. However, this estimate increases notably when the environmental performance of the issuing company is disclosed (indicated by the public availability of an  $E - score$ ). The interaction between the green bond label and the disclosure flag is statistically significant, suggesting that green bonds issued by disclosing companies command a larger premium, potentially doubling the greenium.

Importantly, this interaction is non linear. Market participants seem to be particularly attracted by green bonds issued by firms whose environmental score ranks high in the cross-sectional score distribution. In other words, beyond displaying a general preference for the green assets (see the results for the equity market in Pastor et al. (2022), Ardia et al. (2023), Ciciretti et al. (2023)), investors also seem to scrutinize the climate awareness and performance of the company placing the bond, being willing to give in additional yield to hold in their portfolios the bonds issued by such firms. Indeed, the doubling of the greenium applies to green bonds issued by firms in the top tercile of the distribution only.

Further investigations underscore the importance of bonds' green certification in determining the greenium, and that the information conveyed by the environmental score is not subsumed by either governance or social scores. Lastly, while the greenium tends to become larger in periods of heightened climate uncertainty, the two-tiered pricing mechanism that takes into account both the green label and the environmental disclosure took place only after the entry into force of the Paris Agreement in late 2016, when the green bond market started picking up.

All in all, relative to the average yield at issuance across our sample, the funding advantage for companies tapping the green bond market is significant, ranging between 7 and 14 percent, in normal times, and up to 18 percent in periods of climate change stress.

The existence of a two-tiered greenium as a function of the environmental performance of the issuers has some interesting policy implications. ESG rating agencies seem to play a crucial role in signaling and assessing corporate environmental performance, since market

participants invest according to their scores, awarding a further discount to green projects of highly rated firms. In this respect, divesting from carbon-intensive corporations and investing in low-carbon ones contributes to mitigating transition risks. Furthermore, this strategy should make access to finance more difficult for the brown firms and easier for the green ones, supporting an orderly climate transition.

Yet, completely orienting the portfolio composition away from high emitters and towards low emitters may not lead to an effective transition. As underlined by Angelini (2024), it is fundamental for a fully-fledged decarbonization that high-emission firms are supported in their shift towards less polluting technologies. Our findings suggest that, by financing climate friendly projects via green bonds, this is still possible. Indeed, companies with poor or average environmental performance (i.e., with an *E – score* in the lower and middle tercile) can still secure a positive greenium. Thus, the placing of green bonds by virtuous high-emitters committed to genuine and ambitious carbon footprint reduction efforts, will lead such companies to get at least a part of the overall greenium, namely that part directly associated to the green label.

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