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**In Search of the True Greenium:
Evidence from European Corporate Bond Markets**

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INTRODUCTION

A relatively recent development in corporate finance has been the emergence of corporate green bonds. Green bonds are long-term fixed income debt instruments that generally share the same seniority, recourse, and rating as an issuer's conventional bonds, with the only difference being that their proceeds are directed towards climate- and environment-friendly (green) projects.

For instance, in November 2015 one of the most well-known firms worldwide, Apple Inc. issued \$1.5 B in green bonds - as a response to the 2015 Paris Agreement - dedicated to financing clean energy projects across its global business operations. This operation still today represents the largest green bond transaction to be issued by a U.S. corporation. The issuance was commented on by Lisa Jackson, at that time Apple's Vice President of ESG initiatives, as: "This will allow investors to show they will put their money where their hearts and concerns are".¹

Green corporate bonds have grown in importance in recent years and nowadays account for about 6.25% of European corporate bonds outstanding, still a relevant number if considered that in 2016 the percentage was less than 1%, when annual green corporate bond issuance was substantially lower (**Fig. 1**). Although there are several potential benefits of issuing green bonds, it is unclear whether and how green bonds benefit issuers on the margin. This is relevant especially in the light of the fact that companies, to qualify a green bond as certified, must undergo third-party verification aimed at ensuring that the projects financed by the bond generate genuine environmental benefits and are fully compliant with the ICMA Green Bond Principles, which give rise to administrative and compliance costs. Knowing this, it becomes relevant to consider the main motivations behind the issuance of corporate green bonds and what are their potential implications.

First, green bonds may represent a credible signal of the company's commitment towards the environment. Such signal can be valuable, catering to investors' changing attitudes toward sustainable investing, seeking companies that are indeed committed

¹As reported by Reuters.com, [Volcovici \(2016, February 17\)](#).

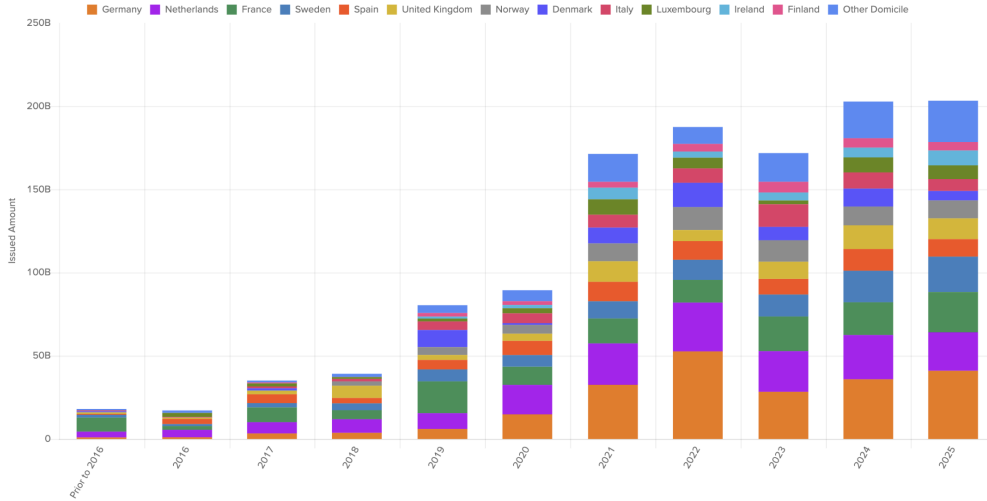


Fig. 1. Annual Issuance of European Green Corporate Bonds. The figure reports the yearly volume of green corporate bond issuance across European countries, highlighting the relative contribution of the main issuing nations. *Source: LSEG Sustainability Data.*

to undertaking investments in green projects and improving their environmental footprints. Second, companies may want to issue green bonds to portray themselves as environmentally committed without taking tangible actions towards this purpose, also referred to in the literature as greenwashing. Third, somehow green bond investors may be willing to trade off financial returns for social benefits and if this is true, it may translate in a cheaper cost of financing for firms known as green issuers. This paper focuses on the third rationale and examines to what extent European corporations directly benefit from issuing green bonds by testing, in principle, whether these bonds exhibit lower yields at issuance — that is, by investigating if and to which extent a *greenium* may exist.

The paper focuses on yield at issuance, as “the primary market determines the actual interest rate paid by issuers to borrow funds. A lower borrowing cost relative to conventional bonds, or greenium, could offer a direct incentive to firms that seek to invest in green projects” as stated by Carmichael and Rapp (2024). Of course, this type of incentive depends on whether the greenium is economically meaningful, on the potential drivers of the greenium and how the greenium is distributed across different countries, industries and firms. Building on this bond-level analysis, the paper subsequently examines whether the transition to becoming a green issuer

translates into a measurable reduction in a firm's overall cost of debt.²

To address and empirically examine these questions, we build a comprehensive dataset made up of corporate bonds, issued in the main European primary bond markets. The sample contains both green and conventional corporate bonds issued in Europe between 2016 and 2025. All these bonds are only EUR denominated and were issued by different European corporations, classified as High Yield, Emerging Market or Investment Grade corporate bonds.

The first step of the empirical analysis is a preliminary assessment designed to understand whether a difference in the YTM at issuance between green and conventional bonds is observable, and to what extent. This is primarily done through a fixed-effects regression approach comparable to those used by [Baker et al. \(2022\)](#). Subsequently, to better understand the drivers of the variation in bond YTM across green and conventional bonds, a heterogeneity analysis is performed. Lastly, once the results at the bond level are established, the analysis is extended to the firm level. In line with the intuition of [Flammer \(2021\)](#), a difference-in-differences (DiD) approach is employed to determine whether becoming a green issuer leads to a measurable reduction in a firm's overall cost of debt.

Our empirical analysis yields three central findings:

First, on average, corporate green bonds offer a small direct borrowing cost advantage - so a greenium - of between 14 bps and 19 bps, depending on the regression specification. This greenium is economically meaningful, robust to the inclusion of non-linear variables and different forms of fixed effects.

Second, based on the heterogeneity analyses, we conclude that the greenium is not uniform across the sample. The greenium varies across major European regions: in Northern and Western Europe the estimates confirm the existence of a strong and consistent greenium, while in Eastern and Southern Europe the coefficients are weaker and less precisely estimated. Then, with respect to emission intensity, the greenium weakens in the most polluting industries, where investors may discount

²It is important to underline that this structure represents the natural continuation of the analysis for the paper's purpose, which begins at bond-level and culminates at firm-level.

the credibility or impact of green labels. Lastly, regarding issue type, the greenium is stronger in mature markets but weakens for emerging market issuers, possibly because investors are more likely to prioritize other risk dimensions — such as credit risk — over environmental considerations. Afterwards, greenium magnitude and significance vary systematically with specific bond- and issuer-level characteristics. Third, while a greenium does emerge at the bond level, it does not translate into a measurable reduction in the overall cost of debt at the firm level. In other words, entering the green bond market does not appear to generate a systematic decrease in an issuer’s cost of debt.

From a financial market perspective, the most important finding is that the greenium emerges as a strictly instrument-specific phenomenon. The pricing advantage applies only to individual green bonds and does not extend to the firm’s other debt instruments. This suggests that the greenium reflects a premium attached to the sustainability label of the bond itself, rather than a broader reassessment of issuers’ underlying credit risk, helping to explain why firms’ overall cost of debt remains unchanged.

LITERATURE REVIEW

In recent years green bonds have become one of the most recognized instruments for the financing of green projects. As mentioned earlier, corporate green bonds are instruments similar to conventional bonds, while they contain provisions that direct the funding raised toward climate- and environment-friendly projects.

Between 2018 and 2019, the green bond market skyrocketed. During this period, in fact, regulators began to introduce broad sustainable finance policies (i.e., the EU Sustainable Finance Plan³, the SFDR⁴ and the EU Taxonomy Regulation⁵).

³2018. EU strategic framework designed to integrate sustainability into financial markets by steering capital towards sustainable activities and improving the management of ESG-related risks.

⁴2019. Sustainable Finance Disclosure Regulation imposes standardized ESG disclosure requirements on financial market participants and products.

⁵2020. EU regulatory framework defining environmentally sustainable economic activities.

As a consequence, this regulatory momentum led to significant growth in assets under management (AUM) by green bond funds, a trend that has been mainly driven by funds domiciled in Europe. In fact, although green bonds have been issued in many countries, European issuers have raised the largest share of green bond proceeds, followed immediately by U.S. and Chinese issuers (**Fig. 2**).

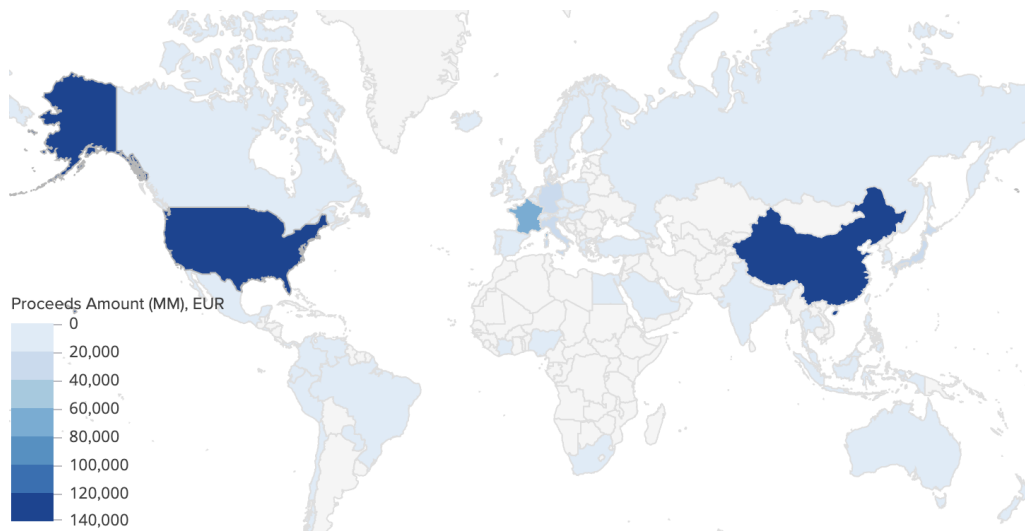


Fig. 2. Global Distribution of Green Bond Issuance Proceeds. The figure shows the geographic distribution of green bond issuance proceeds across countries worldwide. When European countries are considered jointly, the EU emerges - together with the United States and China — as one of the largest green bond markets in terms of issuance proceeds. *Source: LSEG Sustainability Data.*

Naturally, the rapid evolution of sustainable finance and the increasing attention from regulators have stimulated the academic debate, with a growing body of research examining how environmental attributes (ESG) are incorporated into financial asset pricing. Within this context, green bonds and the potential existence of a greenium have become a central focus of empirical investigation.

The purpose of this paper is to add new insights to the green bond literature, particularly in relation to studies examining the greenium in the corporate environment. The existing literature on the greenium is, in fact, highly fragmented both in terms of topics and countries of analysis. Only a small portion of academic research focuses on the bond market (especially when compared to the extensive literature on the stock and loan markets) and an even smaller share specifically investigates corporate

bonds, as many studies analyze other types of bonds such as municipal bonds. With regard to geographical focus, the majority of contributions comes from U.S. scholars (and, by consequence, the US corporate bond market), although a relevant number of European studies has also been conducted on the topic.

In the following section, we review all these papers, regardless of the typology of bonds examined or the country of focus, provided that the results obtained are interesting and meaningful for understanding the dynamics behind the greenium.

Among the first studies to investigate the pricing behavior of green bonds is [Zerbib \(2019\)](#), which provides one of the earliest and most influential empirical estimates of the greenium. The main finding of the paper is the existence of a "small, albeit statistically significant, greenium of approximately 2 basis points" on a heterogeneous sample of bonds.

The empirical approach adopted by the author is the matching method, which consists of matching pairs of securities that share the same characteristics except for the specific attribute whose effect is under investigation — in this case, the bond's greenness. To this end, the study constructs matched pairs composed of a green bond and a conventional bond with identical features, except for their greenness, in such a way that the difference between the green bond yield and the equivalent synthetic conventional bond yield is therefore precisely the cumulative effect of the green bond premium. The empirical results — namely, an average greenium of about 2 basis points — are obtained from a large and heterogeneous dataset covering multiple types of bonds, including supranational, sub-sovereign and agency bonds, municipal bonds, as well as corporate, financial, and covered bonds.

Another relevant contribution to the greenium literature is provided by [Baker et al. \(2018\)](#) who instead focus their analysis exclusively on the U.S. municipal bond market. In this case the main finding is that "green municipal bonds are issued at a premium to otherwise similar conventional bonds". In addition, the authors show that green bonds tend to be held by a more concentrated group of investors than conventional bonds. The empirical method adopted by the authors is a regression-based approach focusing on bond yields at issuance. In particular they estimate a series of ordinary

least squares (OLS)⁶ in which the dependent variable is the bond's after-tax yield at issuance while the main explanatory variable is a dummy indicating whether a bond is green or not. The regressions control for a rich set of bond-related characteristics such as maturity and issue size. Baker et al. find that, at issuance, green bonds offer after-tax yields that are about 6 basis points lower than those of otherwise comparable conventional bonds. This premium doubles, or even triples, for bonds that are not only self-labeled as green but externally certified by a third party according to industry guidelines. Similar evidence in a European context is provided by [Pietsch and Salakhova \(2022\)](#), who extend the analysis beyond the municipal bond market and consider a set of bond types issued by EU entities between 2016 and 2021. Relying on a matching-based methodology, the authors document a greenium of approximately 4 basis points, statistically significant only at the 10% level.⁷ Consistent with the findings of Baker et al. (2018), they show that issuer and bond credibility play a crucial role in shaping the magnitude of the greenium: for green bonds that are externally reviewed, the yield differential increases substantially, reaching up to 22 basis points and becoming more statistically significant.

Similar evidence, consistent with previous findings, is provided by [Carmichael and Rapp \(2024\)](#), who, relative to the existing literature, shift the focus of the analysis to the greenium from the firm's perspective. Specifically, their contribution concentrates exclusively on a global sample of corporate green bonds. They find that, on average green corporate bonds have a yield spread that is between 3 and 8 basis points lower relative to conventional bonds, depending on the regression specification. In addition, they state that a truly statistically significant greenium emerges only after 2019, coinciding with the growth of the sustainable asset management industry following EU regulation, with a peak of 15 basis points in 2019, and then tightens to about 10 basis points and 8 basis points in 2020 and 2021. Building on the findings of Baker et al. (2018), the authors show that external review and issuer credibility

⁶Is a regression method that estimates the relationship between a dependent variable and a set of explanatory variables by minimizing the sum of the squared residuals, that is, the squared differences between observed and fitted values.

⁷Reflects a standard significance threshold in applied econometric analyses and is typically interpreted alongside results obtained at the 5% and 1% levels.

play a central role in determining the magnitude of the greenium. By contrast, the credibility of the underlying green projects appears to have only a limited impact on yield differentials. Once again, Carmichael et al. use a regression-based approach in which they estimate a fixed-effects regression across an unbalanced panel of corporate bonds, with a given bond's yield spread at issuance as the dependent variable.

Another relevant contribution is provided by [Gianfrate and Peri \(2019\)](#). Relative to the studies discussed above, this paper differs in its empirical strategy. While the authors address the question of whether issuing green bonds is financially more attractive compared to conventional bonds, they adopt a propensity score matching (PSM) approach. This methodology is particularly suited to empirical settings characterized by a treatment–control framework, where a group of treated observations is compared to a group of untreated ones. In their analysis, “obtaining the green label” represents the treatment, green bonds constitute the treated group and conventional bonds serve as the control group. The resulting difference in yields at issuance between the two groups captures the treatment effect, interpreted as the greenium. Applying this technique to a sample of 121 European green bonds issued between 2013 and 2017, the authors find that green bonds are more financially convenient than their non-green counterparts, with estimated greenium values ranging between 14 and 19 basis points. The effect is stronger for corporate issuers and persists also in the secondary market.

All the reported studies agree that green bonds are priced at a premium relative to comparable conventional bonds. However, the magnitude of the greenium varies across bond types, market conditions, time periods, and empirical methodologies. In a recent article [Larcker and Watts \(2020\)](#) revisit these studies arguing that “the mixed evidence from prior studies is the result of methodological design mis-specifications that produce biased estimates”. For instance they argue that Baker et al.'s (2018) pooled fixed effects regression insufficiently accounts for differences between green and brown bonds, which biases the analysis towards finding a green bond premium. In contrast, Larcker and Watts (2020) re-examine the U.S. municipal bond market

using a very tight matching methodology ⁸, in which they match each green bond to a quasi-identical brown bond of the same issuer. Under this refined identification approach, they find that the green bond premium is essentially zero, answering that in real market settings investors appear entirely unwilling to forgo wealth to invest in environmentally sustainable projects.

Using the same matching-based identification strategy, [Flammer \(2021\)](#) obtains analogous results in the corporate bond market. Flammer builds his dataset matching each corporate green bond to the most comparable brown bond of the same issuer. The matching process is done in two steps: First requirement, credit rating be the same. Second, pick the nearest neighbor based on four characteristics: (i) log issuance amount, (ii) maturity, (iii) coupon, and (iv) the number of days in between the green and brown bond issuance. The final result is that there is no noticeable difference between the yields of green versus brown bonds, meaning a nearly identical pricing for green and brown (corporate) bonds.

Additionally, Flammer does not stop the analysis at the bond-level. In a second step, the author shifts to the firm-level, examining how firm-level outcomes (environmental performance, ownership structure and firm overall cost of debt) evolve following the issuance of corporate green bonds. To this end, the author uses a difference-in-differences (DiD) specification using all firm-year observations of the treated and matched control firms from 2010 to 2018. The provided results of the DiD analysis indicate that firms' environmental performance goes up in the long run, meaning that companies improve their environmental performance following the issuance of green bonds. Ownership structure changes after issuance of green bonds: long-term investors and green investors increase significantly. Lastly, issuance of green bonds does not provide a cheaper source of financing: firms' overall cost of debt remains unchanged.

Consistent evidence, both at the bond and firm level, is provided by [Tang and Zhang \(2020\)](#). Using a regression-based approach, the authors find mixed results regarding

⁸Tight matching procedures impose stringent similarity requirements between green and conventional bonds, improving internal validity at the cost of reduced sample size and external validity.

the existence of a greenium. When regressing the yield spread at the issuance date on a green bond dummy together with controls for bond- and firm-specific characteristics, they identify a 6.9 bps premium. However, when examining yield spread differences between bonds issued by the same issuer within the same year and month, the estimated premium is no longer statistically significant. The second part of the paper once again adopts a difference-in-differences framework.⁹ The objective of this analysis is to assess whether firms' ownership structure and overall financing conditions change following the issuance of green bonds. The results indicate that, after issuance, institutional investor ownership increases substantially, whereas firms' overall cost of debt remains unchanged.¹⁰

Taken together, the existing literature delivers mixed and, at times, conflicting evidence on the existence of the greenium. While several studies document a statistically significant premium, particularly in specific market segments and under certain conditions, other contributions argue that, once the empirical methodology is tightened, the greenium essentially disappears. Moreover, empirical estimations vary widely depending on the bond-type analyzed (municipal, financial or corporate), on the sample period and on the econometric methodology employed.

Despite the extensive literature on the greenium, three important gaps remain. First, the majority of existing studies are based on datasets that end before 2020, thereby excluding the period with the most rapid expansion of the European green bond markets, the introduction of several sustainable finance policies and also structural changes in macro-financial conditions characterizing the post-pandemic environment. Second, as reported only a limited number of contributions focuses exclusively on corporate bond market segment, even if corporate issuers constitute an increasingly large share of the global green bond market (see **Fig. 1**). Third, existing literature provides only partial and fragmented insights regarding heterogeneity in the greenium across countries, sectors and issuer types. Only a few papers in fact offer a systematic analysis of how the greenium differently behaves across European corporate landscape.

⁹DiD aim to capture dynamic changes in firms' outcomes following green bond issuance, comparing treated firms to a control group that doesn't issue green bonds over the same period.

¹⁰Null effects on firms' overall cost of debt suggest that potential pricing advantages at the bond level may not necessarily translate into broader firm-level financing benefits.

This study makes several contributions to the existing literature by addressing these three gaps and first of all providing an updated and comprehensive analysis of the greenium in the European corporate bond market over the period 2016–2025. Using a large dataset of approximately 4,600 corporate bonds — of which 915 are green — the study first evaluates, through a regression-based approach, whether a greenium is observable in the primary market. It then examines how its magnitude and statistical significance vary across European countries, issuer characteristics, and industries with different levels of emission intensity, through a multidimensional heterogeneity analysis. As a final contribution, the paper investigates whether obtaining a green label — following the issuance of a firm’s first green bond — has a meaningful impact on the firm’s overall financing conditions. To this end, a difference-in-differences identification strategy is employed to assess how firm cost of debt evolves after becoming a green bond issuer.

In summary, this paper makes two complementary contributions. At the bond level, it contributes to the existing literature by providing new, updated, and more nuanced evidence on the existence and determinants of the greenium in the European corporate bond market. At the firm level, it investigates whether the more favorable financing conditions associated with green bonds, relative to conventional bonds, translate into broader improvements in firms’ overall cost of debt.

DATA

The empirical analysis of this study relies on a sample of European corporate bonds, constructed by collecting bond-level data from LSEG Workspace, our primary data source. This dataset allows us to compare green and conventional bonds issued in the main EU markets and examine differences in yields at issuance across comparable bonds.

To construct our sample, we begin from the broad universe of European corporate bonds, both green and conventional, available on LSEG Workspace, and apply a sequence of screening steps.

First, the dataset is restricted to bonds issued between 2016 and 2025. This time window is chosen as it captures both the early development and the subsequent maturation of the European green bond market, while also allowing us to account for major regulatory and institutional developments in the European sustainable finance framework.¹¹

Second, only corporate bonds issued by private-sector firms are included in the dataset. State-owned enterprises (SOEs) are retained in the sample, while bonds issued directly by sovereigns, supranational institutions, and municipal entities are excluded.

Third, the sample is restricted to plain-vanilla corporate bonds, excluding floating-rate and structured instruments. The exclusion of floating-rate bonds is motivated by the need to ensure comparability in yields at issuance, as the pricing of floating-rate instruments depends on reference rates and may introduce additional heterogeneity unrelated to bond- or issuer-specific characteristics. Structured bonds are also excluded because their complex payoff structures affect pricing and yield dynamics, making them less directly comparable to plain-vanilla instruments.

Fourth, the sample is limited to EUR-denominated corporate bonds, as euro-denominated issuances constitute the deepest and most liquid segment of the European corporate green bond market. Although this restriction reduces the size of the initial dataset, the retained sample accounts for the vast majority of corporate green bond issuance volume in Europe over the sample period, thereby ensuring both representativeness and data comparability.

Finally, we retain only bonds issued by firms domiciled in European countries. This restriction ensures a more homogeneous institutional, regulatory, and macroeconomic environment, which is particularly relevant when comparing yield differentials between green and conventional bonds.

Following these screening steps, we obtain a comprehensive dataset comprising 4,662 corporate bonds issued in the main European primary bond markets. The final

¹¹In contrast to most of the existing literature, which typically cover shorter time horizons, as discussed in the LITERATURE REVIEW section.

sample includes 915 green bonds and 3,747 conventional bonds, issued by 1,736 distinct European corporations.

VARIABLE CONSTRUCTION

The dependent variable in our dataset is the Yield to Maturity (YTM) at issuance. The YTM reflects the internal rate of return implied by the bond's issue price, coupon structure, maturity, and redemption value, and therefore captures the effective cost of debt faced by the issuing firm at the time of issuance.

To construct our dependent variable, we calculate the exact yield to maturity on the day of issuance using each bond's offer price, coupon rate, time to maturity, and redemption value under the assumption of annual coupon frequency.¹² We focus on the primary market yield (that is, the yield at issuance) instead of the secondary market yield because "the primary market determines the actual interest rate paid by issuers to borrow funds" (Carmichael and Rapp (2024)). It is worth noting that, unlike several studies that employ the yield spread as the dependent variable (e.g., Fandella and Cociancich (2024)) — defined as the difference between a bond's yield to maturity and the linearly interpolated, maturity-matched government bond yield for the bond's currency at the issuance date — we focus instead on the raw yield to maturity (i.e., in levels). This choice is motivated by the restriction of our sample to EUR-denominated bonds, which implies that all securities are exposed to a common interest rate environment and therefore do not require adjustments for cross-currency interest rate differences.

The independent variables in our dataset are based on traditional financial metrics defined at bond-level, such as the offer price, coupon rate, issue type, issue size and maturity of each bond, as well as variables defined at issuer-level, such as issuer location or sectoral classification based on TRBC taxonomy.¹³ This section outlines

¹²To ensure consistency with the plain-vanilla structure of the bonds included in the sample and to standardize the timing of cash flows across securities.

¹³The Thomson Reuters Business Classification taxonomy is a standardized system that classifies firms into business sectors based on their primary activities, widely used in empirical research.

the construction of these variables employed in the dataset.

For bonds included in our sample, detailed and consistent credit ratings are not available due to limitations of the main data provider (LSEG Workspace). To account for issuer credit risk, this paper therefore employs an Issue Type classification as a proxy, categorizing bonds into Investment Grade, High Yield, and Emerging Market instruments. This classification captures meaningful and structural differences in issuers' credit risk profiles, reflecting variations in default risk, and allows for a consistent comparison between green and conventional bonds within the same credit risk category. In doing so, it mitigates potential bias arising from heterogeneous credit quality across issuers.

Bond sector categories are based on the TRBC taxonomy, which classifies firms according to their primary economic activity. Economic sector categories are used to analyze green bonds across industries and to control for systematic differences across them. Our economic sector categories are utilities, basic materials, consumer cyclical and non-cyclical, energy, healthcare, industrials, real estate, technology and others. This classification reflects the main segments of green bond issuance in Europe and allows for a consistent comparison between green and conventional bonds within the same industry category.

Each bond's issue size is measured by the total amount of proceeds raised at issuance, expressed in millions of euros. This measure includes the full value of the transaction at issuance, accounting for all tranches and any additional amount placed in the market in response to excess demand. As such, it reflects the effective scale of the bond issuance rather than its nominal face value alone, and captures differences in liquidity and market depth across different bond issues.

Bond maturity is measured as the time to maturity at issuance and then transformed into logarithmic form. The log-transformation is applied to account for the highly skewed distribution of maturities and to allow for a non-linear relationship between time to maturity and bond yield.¹⁴

¹⁴The marginal effect of an additional year to maturity is expected to decrease as maturity increases, making the logarithmic specification more appropriate for empirical yield regressions.

The main explanatory variable of interest is a dummy that identifies green bonds. The variable equals one if a bond is classified as green according to the LSEG Workspace green bond definition, and zero otherwise. The classification relies on an instrument-type approach, in which bonds are identified as green based on their issuance characteristics and sustainability label, reflecting the use of proceeds for environmentally sustainable projects. Bonds that do not meet these criteria are classified as conventional. Summary statistics for the bonds in our sample are provided in **Table 1**.

Table 1
Bond Sample Summary Statistics

| | Observations | Mean | S.D. | 25th | Median | 75th |
|---------------------------|--------------|--------|--------|-------|--------|--------|
| <i>Green bonds</i> | | | | | | |
| Yield to Maturity | 915 | 0.03 | 0.02 | 0.01 | 0.03 | 0.04 |
| Issue size (EUR mn) | 915 | 274.21 | 251.99 | 49.98 | 155.14 | 496.34 |
| Coupon (%) | 915 | 0.03 | 0.02 | 0.01 | 0.02 | 0.04 |
| Years to maturity | 915 | 7.95 | 5.17 | 5.02 | 7.02 | 10.02 |
| Offer price | 915 | 99.62 | 2.06 | 99.50 | 100.00 | 100.00 |
| <i>Conventional bonds</i> | | | | | | |
| Yield to Maturity | 3,747 | 0.04 | 0.03 | 0.02 | 0.03 | 0.05 |
| Issue size (EUR mn) | 3,747 | 310.86 | 284.28 | 75.00 | 249.16 | 497.00 |
| Coupon (%) | 3,747 | 0.04 | 0.03 | 0.02 | 0.03 | 0.05 |
| Years to maturity | 3,747 | 8.12 | 6.33 | 5.02 | 6.96 | 10.01 |
| Offer price | 3,747 | 99.87 | 2.06 | 99.63 | 100.00 | 100.00 |

Summary statistics for the full bond sample, reported separately for green and conventional bonds. Bond characteristics are compared across the following metrics. *Yield to Maturity* denotes the bond's yield to maturity at issuance. *Issue Size (EUR mn)* measures the total amount raised at issuance and is reported in millions of euros. *Coupon (%)* refers to the bond's coupon rate, expressed as a percentage. *Years to Maturity* represents the time to maturity measured on the issuance date and reported in years. *Offer Price* is the price at which the bond is offered at issuance. A bond is issued *at par* if the offer price equals 100, *below par* if the offer price is below 100, and *above par* if the offer price exceeds 100. Summary statistics are reported only for quantitative bond characteristics, while qualitative variables are excluded. Details on the bond sample and variables are provided in sections DATA and VARIABLE CONSTRUCTION.

EMPIRICAL STRATEGY

The empirical strategy of this paper relies on a sequential two-step approach, in which the second step builds directly on the evidence obtained in the first.

The first step is a bond-level analysis, conducted through a set of bond-level regressions, to investigate whether green corporate bonds are issued at lower yields than comparable conventional bonds, thereby establishing the existence of a greenium. This analysis is complemented by a multidimensional heterogeneity assessment across issuers, industries, and European regions, aimed at understanding how the magnitude of the greenium varies across different segments of the market.

Building on the previous analysis, the second step moves to a firm-level perspective. Using a difference-in-differences approach, the paper examines whether issuing a green bond — and thus entering the green bond market — affects the firm’s overall cost of debt.

Together, these empirical methods provide a coherent framework for assessing both the existence of the greenium and its broader implications for corporate financing conditions.

I. Pooled OLS

The first empirical approach adopted in our paper is a pooled cross-sectional regression, a suitable choice with respect to our data structure and the objectives of our analysis. Unlike panel data models, which enable the combination of cross-sectional and temporal dimensions, allowing the analysis of the same units over time, pooled regression models exploit only the cross-sectional dimension, allowing the analysis of different units observed at a well-defined point in time, without exploiting within-unit temporal variation.

This model is coherent with the purpose of the paper, which aims to assess whether systematic differences in pricing exist across groups of bonds (i.e., green and conventional bonds) at the time of issuance, rather than to investigate the temporal

evolution of individual securities. Accordingly, since each bond enters the sample only once, within-unit time variation cannot be exploited, and the effect of interest (i.e., the greenium) is identified using cross-sectional comparisons across different bonds. In this context, a pooled cross-sectional framework represents the most appropriate empirical strategy to address the research question.

Furthermore, an important advantage of the pooled cross-sectional framework adopted in this analysis lies in the possibility of controlling for unobserved heterogeneity at the dimension level. In particular, countries, sectors, and time periods are characterized by structural and institutional features — such as regulatory environments, market conditions, or macroeconomic regimes — that are difficult to measure precisely but may systematically affect bond yields. Through the inclusion of fixed effects, the empirical specification is able to absorb these unobserved dimension-specific factors,¹⁵ thereby reducing potential bias arising from omitted variables. Analogously, the inclusion of temporal effects allows the analysis to account for common shocks affecting all bonds in a given period, such as macroeconomic developments, regulatory changes or global events, ensuring that the estimated effects are not driven by such shared influences.

From an operational perspective, the baseline model can be presented as follows:

$$YTM_i = \alpha + \beta \cdot Green_i + \varepsilon_i \quad (1)$$

where the dependent variable denotes the yield to maturity of corporate bond i at issuance, expressed in decimal form. The main explanatory variable is the dummy variable $Green_i$, which equals one for green-labeled bonds and zero otherwise. The coefficient β measures the average difference in yield to maturity at issuance between green and conventional bonds, while ε_i represents the idiosyncratic error term.

Furthermore, building on the baseline model, Equation (2) presents the first controlled specification, which aims to provide a clean and coherent estimation of the relationship between the green bond label and yield to maturity.

¹⁵For instance, including country–year specific trends or sector–year specific trends.

$$\begin{aligned}
YTM_i = & \alpha + \beta Green_i + \gamma \log(Maturity_i) \\
& + \delta IssueType_i + \theta EconomicSector_i + \varepsilon_i
\end{aligned} \tag{2}$$

Control variables¹⁶ are included to account for systematic differences across bonds and issuers, thereby mitigating omitted variable bias in the estimation of the greenium. In the baseline specification, β captures the average difference in yield to maturity at issuance between green and conventional bonds, without accounting for other bond characteristics. In this controlled specification, instead, β still measures the average difference in yield to maturity at issuance, but at equal bond maturity, issue type, and economic sector.

From a methodological point of view, the inclusion of categorical controls in the model, such as issue-type and economic-sector dummies, introduces a degree of multicollinearity due to the strong correlation among explanatory variables. To address the perfect multicollinearity problem, one category per set of dummy variables is omitted and used as the reference category.¹⁷ Nevertheless, some degree of residual multicollinearity is expected to persist. This does not bias the coefficient estimates, but may reduce their precision by increasing standard errors.

Then, to further absorb time-varying unobserved heterogeneity at the sectoral and country levels, Equation (3) extends the controlled specification in Equation (2) by introducing fixed effects.

$$\begin{aligned}
YTM_i = & \alpha + \beta Green_i + \gamma \log(Maturity_i) + \delta IssueType_i \\
& + \mu_{s(i),t(i)} + \lambda_{c(i),t(i)} + \varepsilon_i
\end{aligned} \tag{3}$$

The model includes sector-year and country-year fixed effects. Country-Year FE

¹⁶Described in VARIABLE CONSTRUCTION section.

¹⁷This implies that the estimated coefficients on the remaining dummy variables capture differences in the dependent variable relative to the reference category, whose effect is absorbed by the constant term.

controls for macroeconomic and policy-related factors that vary across European countries and over time — such as inflation, interest rates, or fiscal conditions — ensuring that the coefficient β , which captures the greenium, is estimated holding constant country-specific conditions in each year. Sector-Year FE controls for industry-specific shocks and time-varying factors — such as sectoral demand, technological trends, or regulatory changes — ensuring that the coefficient β is estimated holding constant sector-specific conditions in each year. By conditioning on sector-year and country-year FE, the coefficient β is identified by comparing green and conventional bonds issued within the same sector, country and year, at equal bond maturity and issue type. This specification therefore allows for a more credible and consistent estimation of the greenium.

The pooled cross-sectional regression is a valuable framework in the context of our analysis also because it is not only suitable for testing a direct hypothesis, such as the existence of the greenium, but also well suited to conducting more detailed ancillary analyses, such as heterogeneity analyses.

From an econometric standpoint, a heterogeneity analysis relaxes the assumption of a homogeneous treatment effect by allowing the estimated coefficient of interest to vary systematically across observable characteristics. Rather than imposing a single average effect, this approach evaluates whether the relationship between the explanatory variable of interest and the outcome differs across subsamples or across values of selected characteristics. Empirically, this is achieved through subsample estimations or interaction terms, while holding the baseline specification and fixed-effects structure constant.

In our paper, the heterogeneity analysis is conducted through subsample estimations, whereby the initial sample is divided according to each category within a given variable.¹⁸ The same econometric specification is then applied to each subsample, and the resulting coefficient estimates are then compared in order to assess whether the effect is homogeneous across the entire variable or instead varies systematically

¹⁸The variable used to partition the sample is omitted as a control from the baseline regression, since it is constant within subsamples.

across its categories.

We study heterogeneity by issue type, regions and emission groups to assess whether the estimated greenium effect is homogeneous or varies in the reported dimensions. For regions, the full sample of corporate bonds is partitioned into four geographical areas based on the issuer’s country of belonging: Northern Europe, Western Europe, Southern Europe and Eastern Europe while for emission groups each sector in the dataset has been assigned to one of three categories: Low-emission, Medium-emission, or High-emission — according to its overall greenhouse gas intensity and environmental impact.¹⁹

From a statistical perspective, the decision to aggregate observations into broader groups is mainly because estimating separate regressions at a granular level would lead to a large number of small subsamples, reducing the precision and reliability of the estimated coefficients due to the limited number of observations and the higher variance. Grouping observations into broader categories instead allows us to increase the number of observations within each group, improving the robustness and comparability of the estimates.

To conclude, all reported models in this section are estimated using heteroskedasticity-consistent (HC1) standard errors to correct for potential non-constant variance in the residuals.

II. Difference in Differences

As a second empirical approach, we estimate a difference-in-differences (DiD) specification to examine how firm-level outcomes (i.e., cost of debt) evolve following the issuance of a corporate green bond. The DiD methodology is an empirical strategy designed to identify causal effects by comparing the evolution of an outcome variable before and after a treatment, between treated and control observations.

Specifically, we build up an identification strategy that exploits the fact that different

¹⁹The classification of sectors into emission groups is based on sector-level greenhouse gas intensity indicators obtained from Refinitiv TRBC classification, which provide information on average emissions and environmental impact at the industry level.

firms in the dataset become green issuers at different points in time, allowing us to compare the evolution of their cost of debt before and after the first green issuance. In empirical terms, we compare the yield to maturity of bonds issued before and after the first green issuance for each firm classified as valid ²⁰ in the dataset, in order to test whether entering the green bond market leads to a reduction in the firm’s overall cost of debt.

From an operational perspective, our DiD model can be presented as follows:

$$YTM_{i,t} = \alpha + \beta (Treated_i \times PostFirm_{i,t}) + \gamma X_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (4)$$

where i indexes firms, t indexes years. Accordingly, $YTM_{i,t}$ denotes the yield to maturity of bonds issued by firm i in year t . The set of bond-level control variables is denoted by $X_{i,t}$. Issuer and year fixed effects are captured by μ_i and λ_t , respectively. Lastly, the coefficient β associated with the interaction term $Treated_i \times PostFirm_{i,t}$ represents the difference-in-differences estimator and captures the causal effect of becoming a green issuer on the firm’s overall cost of debt.

The interaction term is composed of the product between two variables:

Treated identifies the set of bonds (both green and brown) issued by firms that, during the observation period, will become green bond issuers. For this reason, the variable takes the value 1 for every bond associated with these firms – regardless of whether the specific bond is green or brown – and 0 for all bonds from firms that do not undergo this transition. This variable plays a crucial role, as it determines the subgroup of observations on which the entire DiD analysis is based, making it possible to compare the evolution of the cost of debt for firms that, at some point, start issuing green bonds, by contrasting their pre- and post-treatment periods.

PostFirm identifies, for each bond issued by a valid firm, whether the issuance occurred before or after the company became a green issuer.

²⁰Valid firms are issuers that (i) issue both green and conventional bonds during the sample period, (ii) have at least one conventional bond issuance prior to their first green bond, and (iii) issue at least one bond after the first green issuance, thereby ensuring a well-defined pre- and post-treatment structure.

In practice, for every observation (that is, for every bond), the variable checks the following condition:

$$PostFirm_{i,t} = \begin{cases} 1 & \text{if } IssuanceYear_{i,j} \geq FirstGreenYear_i, \\ 0 & \text{otherwise.} \end{cases}$$

If the issuance year of bond j by firm i is greater than or equal to the firm's *FirstGreenYear*²¹, the observation is classified as belonging to the post-treatment period ($PostFirm = 1$). Conversely, if the bond was issued before the firm ever issued a green bond, the variable takes the value 0.

Treated x PostFirm is the crucial variable, because it enables us to define the treated group, the control group and the treatment of our difference-in-differences analysis.

Its logic is straightforward: it takes the value 1 whenever a bond j is issued by a valid firm i in the period after the firm's first green bond issuance. The set of all such observations constitutes the treated group in the DiD analysis. Conversely, the variable equals 0 whenever a bond j is issued by the same firm i before its first green bond. These observations form the control group of the analysis.

Thus, the comparison is performed within the same firms, between their pre-treatment and post-treatment periods. For the sake of clarity, the "treatment" in this framework is defined as "becoming a green issuer".

Lastly, we introduce both issuer FE and year FE, to control for all firm-specific characteristics as well as for all macroeconomic shocks that commonly affect bond yields across years.

²¹FirstGreenYear indicates for each issuer, the year of its first green bond issuance, namely when each firm enters the green bond market.

RESULTS

OLS Regressions. As an initial step, the analysis explores the raw relationship between bonds' yield to maturity at issuance and the green label. **Table 2** presents the estimated coefficients for the baseline regression, without including any controls or fixed effects.

Table 2
Baseline OLS Regression Results

| <i>Dependent variable: YTM</i> | | | | |
|--------------------------------|----------|------------|--------|---------|
| | Estimate | Std. Error | T-stat | P-value |
| const | 0.0360 | 0.0004 | 84.010 | < 0.01 |
| GREEN | -0.0067 | 0.0009 | -6.939 | < 0.01 |
| $R^2 = 0.010$ | | | | |

This table reports the estimated coefficients from the baseline specification in Equation (1). The dependent variable is the *yield to maturity at issuance*. The sole explanatory variable is *GREEN*, a dummy equal to one for green bonds and zero for conventional bonds. The classification of green bonds follows an instrument-level approach based on the LSEG Refinitiv green bond definition, whereby bonds are identified as green according to their issuance characteristics and sustainability label. The dataset contains observations for 4,662 different bonds, issued by European corporations between 2016 - 2025. Standard errors are computed using heteroskedasticity-consistent (HC1) variance-covariance estimates to allow for potential non-constant residual variance across bonds.

The coefficient of interest β is negative and statistically significant. This indicates that green bonds tend to be issued at a lower yield to maturity relative to conventional bonds, on average. It is important to underline that this estimate does not isolate a causal effect²² of the green label, as no controls or fixed effects are included at this stage. However, these results provide preliminary evidence in support of the existence of a greenium, suggesting that green and conventional corporate bonds are priced differently on average.

A negative coefficient can be interpreted in two complementary ways. On one

²²A causal effect refers to the change in bond yields that would occur if the same bond were issued as green rather than conventional, holding all other characteristics constant.

hand, consistent with theoretical models of sustainable asset pricing, it may capture investors’ willingness to accept lower yields in order to derive utility from the positive environmental impact of green bonds (e.g., [Pedersen et al. \(2021\)](#)). On the other hand, the yield differential may reflect lower underlying risk and better future profitability, as green issuers could be less exposed to climate-related and transition risks, thereby justifying lower required returns (e.g., [Bolton and Kacperczyk \(2021\)](#)).²³

Then, we extend the baseline specification by introducing bond-level controls and fixed effects in order to assess whether green bonds trade at systematically tighter spreads than conventional bonds once observable characteristics and unobserved heterogeneity are taken into account. **Table 3** summarizes the results across alternative models.

Table 3
Extended OLS Regression Results

| <i>Dependent variable: YTM</i> | | | |
|--------------------------------|------------------------|----------------------|------------------------|
| | (1) | (2) | (3) |
| GREEN | -0.0067*** (0.0009) | -0.0014* (0.0007) | -0.0019*** (0.0006) |
| Controls | | Yes | Yes |
| Country-Year FEs | | | Yes |
| Sector-Year FEs | | | Yes |
| No. of obs. | 4,662 | 4,662 | 4,662 |
| R^2 | 0.010 | 0.268 | 0.671 |

This table reports the estimated coefficients from three different specifications of Equation (1). The dependent variable is the *yield to maturity at issuance*. The main explanatory variable of interest is the *GREEN* dummy. Column (1) reports the baseline regression without controls or fixed effects. Column (2) presents a controlled specification including three types of controls: *Log Maturity* (expressed in logarithmic form to mitigate the influence of extreme values and improve the model’s explanatory power), *issue-type* and *economic-sector* controls. Column (3) further extends the specification by including Country-year and Sector-year fixed effects. The sample consists of 4,662 bonds issued by European corporations between 2016 and 2025. Standard errors, computed using heteroskedasticity-consistent (HC1) variance-covariance estimators to account for potential heteroskedasticity, are reported in parentheses.

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

²³Distinguishing empirically between these alternative channels lies beyond the scope of this paper, which is primarily concerned with assessing the existence of a greenium.

Table 3 reports the derivation of our greenium estimates by systematically introducing control variables first and fixed effects then, into the baseline regression (1). As outlined above, starting with a simple univariate regression of yield to maturity on the green bond indicator variable in Column (1), we observe a negative and statistically significant coefficient estimate. In addition, upon incorporating bond-level controls and fixed effects (Columns (2) and (3)), the coefficient on the green bond indicator variable remains significantly negative, although its magnitude and level of statistical significance vary across regression specifications.

The negative regression coefficients β across all specifications suggest the presence of a greenium, while holding bond-level characteristics constant and accounting for time-varying sectoral and country-level heterogeneity. Additionally, the increases in adjusted R-squared in Columns (2) and (3) indicate that much of the variation in yield to maturity at issuance can be captured by controlling for sector-year and country-year fixed effects.

Empirically, we observe a large change in the coefficient estimates when moving from the baseline regression to the controlled specifications, with a greenium declining from 67 to 14 basis points. This pattern suggests that a large portion of the yield differential observed in the baseline specification reflects differences in observable bond characteristics between green and conventional bonds, such as maturity, issue type, and economic sector. Subsequently, adding fixed effects to the controlled specification leads to a slight increase in the estimated coefficient on the green bond indicator variable, yielding a greenium of 19 basis points in the most rigorous specification reported in Column (3). This pattern suggests that unobserved heterogeneity at the sectoral and country level, captured by the fixed effects, was partially offsetting the greenium in the previous model.

Taking the results in Column (3) as reference, as they are derived from Equation (3) which provides the most credible and consistent estimation of the greenium, green bonds in our sample are issued at yields that are on average about 19 basis points lower relative to conventional bonds. This estimate suggests that, on average, corporate bond issuers pay a lower interest rate on their green bonds, holding all other factors constant. Relative to the average yield to maturity at issuance in the corresponding

regression sample (see **Table 1**), this corresponds to a yield reduction of roughly 5% for a green bond issuance relative to a conventional one.²⁴

This pricing advantage is economically meaningful, but at the same time, may be reduced by green bonds' compliance costs (certification, monitoring, and reporting) and a longer issuance process, particularly for complex green projects and small or first-time issuers.

Overall, our empirical findings are also consistent with the predominant strand of the literature documenting the existence of a greenium in corporate bond markets. In particular, our results, both in terms of magnitude and statistical significance, are consistent with the findings of [Carmichael and Rapp \(2024\)](#), who state that "a truly statistically significant greenium of around 15 basis points emerges only after 2019, coinciding with the growth of the sustainable asset management industry following the introduction of EU regulation".²⁵ This interpretation closely matches our empirical setting, as our extended dataset until 2025 captures the delayed effects of all the sustainable finance policies, whose impact on market pricing has become more visible over time. Moreover, our estimated greenium is also consistent with the range of magnitudes documented in earlier studies on the European corporate bond market, such as [Gianfrate and Peri \(2019\)](#) or [Pietsch and Salakhova \(2022\)](#), who report yield differentials between 14 and 19 basis points. Taken together, these findings confirm the presence of a statistically and economically meaningful greenium in European corporate bond markets and motivate a deeper discussion of its underlying drivers.

Heterogeneity Analysis. Next, we conduct a more granular analysis to investigate the drivers of the greenium by identifying the variables or dimensions along which differences in yields at issuance originate and the greenium is more or less pronounced. The results for each variable are reported in **Table 4**, while a graphical representation is provided in [Figure A.1](#) in the Appendix.

²⁴The percentage is obtained by dividing the estimated greenium of 19 basis points by the sample average yield at issuance, yielding a relative yield differential of approximately 5%. This comparison is intended to illustrate the economic magnitude of the estimated effect.

²⁵See the LITERATURE REVIEW section.

Table 4
Heterogeneity Analysis Results

| <i>Dependent variable: YTM</i> | | | | |
|-----------------------------------|------------------------|------------|--------|----------|
| | GREEN Coef. | Std. Error | R^2 | No. Obs. |
| <i>Panel A: By Region</i> | | | | |
| Eastern Europe | −0.0091 [*] | (0.0050) | 0.5683 | 419 |
| Northern Europe | −0.0040 ^{***} | (0.0010) | 0.5435 | 1159 |
| Southern Europe | −0.0038 [*] | (0.0020) | 0.5115 | 473 |
| Western Europe | −0.0031 ^{***} | (0.0009) | 0.4754 | 2611 |
| <i>Panel B: By Emission Group</i> | | | | |
| Low-emission | −0.0025 ^{**} | (0.0012) | 0.6888 | 1161 |
| Medium-emission | −0.0022 ^{***} | (0.0007) | 0.7149 | 1855 |
| High-emission | −0.0021 | (0.0015) | 0.6685 | 1646 |
| <i>Panel C: By Issue Type</i> | | | | |
| Investment Grade Corporate | −0.0013 ^{**} | (0.0006) | 0.6448 | 3685 |
| High Yield Corporate | −0.0089 ^{***} | (0.0031) | 0.6678 | 737 |
| Emerging Market Corporate | −0.0067 | (0.0049) | 0.8102 | 240 |

This table reports the estimated coefficient for each variable of interest. Each coefficient is obtained from a separate group-specific regression, estimated using the same empirical specification, with the sample restricted to the relevant subgroup. For each sub-regression the number of observations is reported in the last column, and is obtained by aggregating individual observations into broader categories to improve the comparability and the robustness of the estimates. The dependent variable is the *yield to maturity at issuance*, while the main explanatory variable of interest is the *GREEN* dummy. Standard errors, computed using heteroskedasticity-consistent (HC1) variance-covariance estimators to account for potential heteroskedasticity, are reported in parentheses.

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Panel A reports regional heterogeneity results. Regional heterogeneity analysis investigates whether the greenium differs across major European regions. To this end, the full sample of corporate bonds is partitioned into four geographical areas based on the issuer’s country of belonging.²⁶ Reported results in **Table 4** show that the estimated greenium is negative across all the regions, indicating that green bonds generally offer lower yields than comparable conventional bonds. However, both the magnitude and the statistical significance of the effect vary across regions:

²⁶As stated in EMPIRICAL STRATEGY, Pooled OLS subsection.

In Northern and Western Europe, the coefficients are negative and above all highly significant (***) confirming the existence of a strong and consistent greenium in markets traditionally more advanced in sustainable finance, such as Scandinavia, France and the Netherlands. In Eastern and Southern Europe the coefficients are still negative but their significance is weaker (*), indicating that in these countries green bond markets are still in an earlier stage of development and so greenium appears less pronounced and less consistently priced in countries such as Italy, Spain or Poland.

Our findings on regional heterogeneity are aligned with the paper by [Grishunin et al. \(2023\)](#), which analyses the determinants of the greenium in European corporate green bond markets, finding consistent evidence of a greenium only in selected markets such as the UK and the Netherlands, while its statistical significance is weak or even negligible elsewhere.

Panel B reports sectoral heterogeneity results. Sectoral heterogeneity analysis allows us to test whether the yield differential between green and conventional bonds varies systematically across sectors with different environmental profiles. To this end, once again the full sample of corporate bonds is partitioned into three categories: Low-, Medium- and High-emission according to their overall greenhouse gas intensity and environmental impact.²⁷ Results reported in **Table 4** show that the greenium remains negative across all emission groups, indicating that green bonds generally yield less than conventional ones regardless of the sector's emission intensity. However, the magnitude and the statistical significance of the effect vary again:

In low- and medium-emission sectors, the coefficients are negative and statistically significant (** or ***), while in high-emission sectors, the coefficient is smaller and not statistically significant, suggesting that the greenium weakens in the most polluting industries, where investors may discount the credibility or impact of green labels and exhibit stronger concerns about greenwashing. In highly polluting industries (e.g., Industrials), green bond issuances are often perceived as marginal relative to the firm's core business. This may reduce the investor's willingness to accept lower

²⁷See EMPIRICAL STRATEGY, Pooled OLS subsection.

yields on corporate green bonds compared with bonds issued by firms operating in less polluting sectors, where such issuances instead may signal a broader transition of the whole firm toward a more sustainable business profile. Our evidence that the greenium is weaker in high-emission sectors is consistent with existing literature. For instance, [Aswani and Rajgopal \(2022\)](#) find that green bonds issued by firms in highly polluting sectors trade at higher yields than those issued by less polluting firms, reflecting elevated perceived risk and lower investor confidence. They further show that firms with higher pre-issuance emissions do not exhibit significant reductions in emissions after issuing green bonds, and this of course impacts the magnitude and significance of the greenium.

Panel C reports the results of the issue-type heterogeneity analysis. This analysis examines whether the yield differential between green and conventional bonds varies across different credit risk segments. In fact, in this case bond categories are not constructed ex-post but were already defined in the dataset, which includes three types of corporate bonds: Investment Grade corporate, High Yield corporate, and Emerging Market corporate. Results in **Table 4** show that the estimated greenium remains negative across all issue types. However, the magnitude and statistical significance of the effect vary substantially with the issuer's credit risk profile:

The greenium is larger and highly significant for High Yield corporate (***) and Investment Grade corporate (**) bonds, while it is smaller and not statistically significant for Emerging Market corporate bonds. This pattern suggests that the greenium is stronger in mature and developed markets, while it weakens in emerging ones, where investors are likely to prioritize other sources of risk, such as credit risk, over environmental considerations.

Existing evidence in the literature supports our findings. In particular, [Zerbib \(2019\)](#) directly documents that green bond premia are stronger for investment-grade bonds, while [Bachelet et al. \(2019\)](#) show that the greenium is more likely to emerge in mature market segments characterized by higher liquidity and transparency. By contrast, the effect weakens in less developed environments, such as emerging markets, where other sources of risk tend to dominate bond pricing.

Taken together, the results highlight that the greenium is not a uniform phenomenon across the corporate bond market, but varies systematically in its magnitude and statistical significance across regions, sectors, and issue types.

Difference in Differences. After presenting consistent evidence of a greenium at the bond-level, the final step of our analysis is a difference-in-differences specification. The aim is to assess whether firms experience changes in their overall cost of debt after becoming green issuers, shifting from a bond-level to a firm-level analysis. The DiD results are presented in **Table 5**.

Table 5
DiD Evidence on Firms' Cost of Debt

| <i>Dependent variable: YTM</i> | | | | |
|--------------------------------|----------|------------|--------|---------|
| | Estimate | Std. Error | z-stat | P-value |
| Treated x PostFirm | -0.0005 | (0.0010) | -0.623 | 0.533 |
| Controls | | | | |
| Issuer FE | | | | Yes |
| Year FE | | | | Yes |
| No. of obs. | | | | 936 |
| R^2 | | | | 0.746 |

This table presents the difference-in-differences estimate for the main variable of interest. The dependent variable is the *yield to maturity at issuance*. The explanatory variable is the interaction term $Treated \times PostFirm$, where Treated identifies bonds issued by firms that become green bond issuers, and PostFirm captures the bond's issuance period relative to the firm's first green bond.

No additional controls are included, as identification relies on within-firm variation over time in the difference-in-differences framework. The specification includes two types of fixed effects: *Issuer fixed effects*, which absorb all time invariant firm-specific characteristics, and *Year fixed effects*, which control for common macroeconomic shocks affecting all issuers in a given year. The restricted sample consists of 936 bonds issued by European corporations that become green bond issuers over the period 2016–2025. Heteroskedasticity-consistent (HC1) standard errors are reported in parentheses.

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

The estimated coefficient β on $Treated \times PostFirm$ captures the average change in firms' cost of debt following the first green bond issuance. The coefficient itself is

negative but, most importantly, not statistically significant at any conventional level, indicating no evidence of a causal impact of green bond issuance on firms' cost of debt.²⁸ This result leads to a clear conclusion: while a greenium emerges at the bond-level, it does not translate into a measurable reduction in firms' overall cost of debt. In other words, entering the green bond market does not appear to generate a systematic decrease in an issuer's cost of debt.

In line with our findings, [Flammer \(2021\)](#) documents that the effects of green bond issuance are not consistent with a cost-of-capital channel, according to which the issuance of green bonds would provide a cheaper source of debt financing for the firm as a whole. Similarly, [Tang and Zhang \(2020\)](#) explicitly test a financing-cost channel where green bond issuance attracts investors with green mandates, pushing up green bond prices and lowering firms' cost of capital, yet their results fail to find consistent evidence.

CONCLUSION

The central finding of our research shows how the green label of a corporate bond plays a relevant role in the pricing of green bonds in the European primary bond markets. Our analysis provides robust evidence of a greenium at the bond level, with an average yield differential of 19 basis points between green corporate bonds and comparable conventional bonds. This result suggests that, in European corporate bond markets, investors not only value environmentally sustainable projects but are also willing to accept lower yields on bonds financing such projects.

Furthermore, empirical evidence shows that both the magnitude and the statistical significance of the greenium depend on the market environment in which bonds are issued. This pricing advantage emerges more clearly where financial markets are mature, where sustainability considerations are central and firms' environmental commitments are easier to assess. By contrast, the greenium weakens in environments in which investors are more likely to prioritize other sources of risk over environ-

²⁸In econometric terms, the coefficient is not distinguishable from zero.

mental attributes, such as less developed markets or highly polluting sectors. This evidence highlights that greenium is not a homogeneous phenomenon, but varies systematically across market conditions. Building on bond-level evidence, the study subsequently shows how the pricing advantage associated with green bonds is a strictly instrument-specific phenomenon and does not appear to reflect a reassessment of issuers' underlying credit risk, meaning that becoming a green bond issuer does not affect the firms' overall financing conditions.

This study calls for future research. First, since the absence of granular credit risk measures (e.g., ratings) can affect the final outcomes, future research could provide more refined measures of credit risk in order to better distinguish investor preferences and risk-based explanations of the greenium. Second, due to the fact that the use of a binary green bond variable as the sole indicator of sustainability may affect the empirical results as it abstracts from differences in the credibility, scope, and environmental impact of the underlying green projects across issuers, future research could introduce alternative measures, for instance, by differentiating certified and non-certified green bonds, to capture heterogeneity in the quality and credibility of green bonds. Third, although the OLS specifications with rich controls and fixed effects reduce potential biases in the estimation of the greenium, they do not fully overcome identification concerns. In this vein, future research could therefore rely on complementary empirical strategies such as matching methods, to strengthen identification and deepen our understanding of the mechanisms underlying the greenium. Fourth, since the analysis focuses on a confined geographic area (i.e., Europe), future research could broaden the analysis by considering other markets and a longer time horizon to examine the persistence of the greenium.

In conclusion, these findings confirm that sustainability considerations are priced in European corporate bond markets through green-labeled instruments. Such instruments allow firms, on the one hand, to finance specific green projects at more favorable borrowing costs and, on the other, enable investors to direct their capital towards investments that reflect their environmental concerns.

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APPENDIX

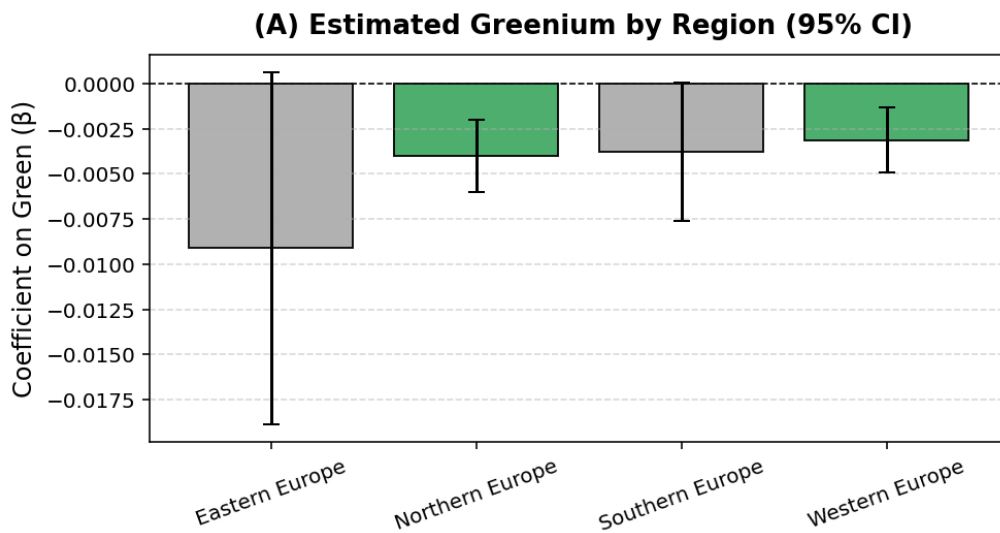
A. ADDITIONAL FIGURES

Figure A.1

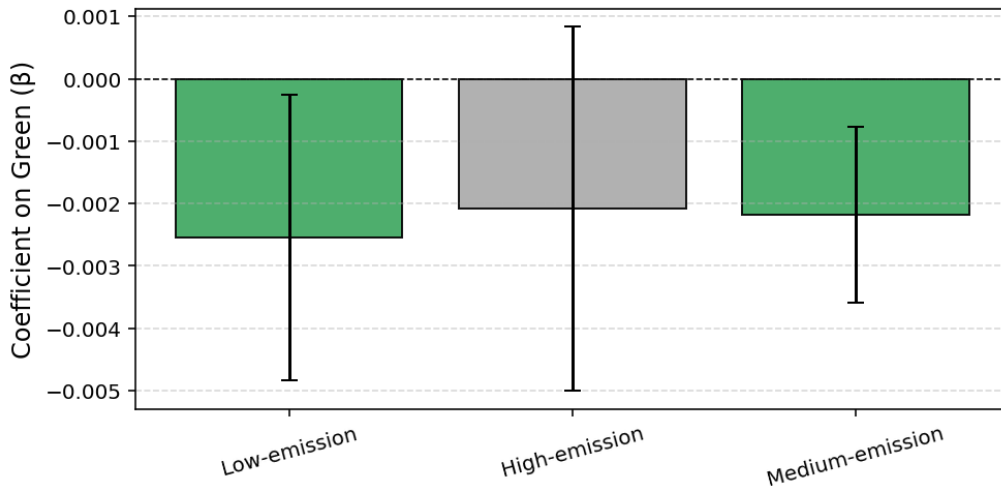
Heterogeneity Analysis: Graphical Evidence

This figure provides a graphical summary of the heterogeneity analysis results reported in **Table 4**. Panel (A) illustrates regional heterogeneity, Panel (B) reports sectoral heterogeneity, and Panel (C) shows heterogeneity by issue type. Each panel displays the estimated coefficient of the GREEN dummy obtained from group-specific regressions.

Vertical bars represent 95% confidence intervals around the estimated coefficients. Bars are colored in green when the corresponding coefficient is statistically significant at the 5% and 1% levels, and in gray when the coefficient is only marginally significant (10%) or not statistically significant. Negative coefficients indicate lower yields at issuance for green bonds relative to comparable conventional bonds.



(B) Estimated Greenium by Emission Group (95% CI)



(C) Estimated Greenium by Issue Type (95% CI)

