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Sustainable versus conventional bonds: A comparative analysis of primary market spreads

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ABSTRACT

This paper provides a comparative analysis of the credit spreads and pricing of sustainable and conventional bonds issued by nonfinancial firms worldwide between 2012 and 2022. We find that sustainable and conventional bonds respond differently to common pricing factors, with investors placing less emphasis on credit ratings when pricing sustainable bonds. On average, there is no significant difference in credit spreads between sustainable and comparable conventional bonds, a result that holds across matched sample analysis and endogenous switching regression models. However, during the COVID-19 crisis, green and sustainability bonds were associated with significantly lower spreads, suggesting increased investor demand for ESG-linked instruments in periods of uncertainty. Finally, we show that contractual, macroeconomic, and firm-level characteristics influence the choice between sustainable and conventional bond issuance.

1. Introduction

The world is facing several interrelated critical problems such as climate change, cyclical droughts, ecosystem decline, and biodiversity losses (Cook et al., 2013; Nasir et al., 2019). As a response, since the Paris Climate Agreement in 2015, several industry guidelines were developed considering climate-related risks and integrating environmental, social, and governance (ESG) factors into investment decision-making processes (Cornell and Shapiro, 2021; Pollman, 2022; Edmans, 2023). The United Nations Commission on Trade and Development estimates that achieving the United Nations (UN) Sustainable Development Goals (SDGs) will require annual investments of $5 to $7 trillion from 2015 to 2030, leaving a yearly financing gap of $4.3 trillion (UNCTAD, 2022). Within this context, the finance sector plays a pivotal role in channeling private funds toward sustainable development and green growth.

Among available sustainable financing instruments, sustainable bonds represent a rapidly growing financial asset class. According to Refinitiv Deals Intelligence reviews, sustainable bond – green, social, sustainability, and sustainability-linked – issuance surpassed

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$1.0 trillion for the first time in 2021, an increase of 45% compared to 2020. In 2022, green bonds represented about 52% ($390.3 billion) of the sustainable bond market, about six times more than the 2015 levels.[1] Similarly, social and sustainability bonds verified a significant increase in their issuance in the last 5 years, with increases of 600% and 893%, respectively.[2] Despite the exponential growth of the sustainable bond market over the past decade – accounting for 9% of the overall bond market in 2022 – there is still a need for further analysis of how this asset class functions, particularly for bonds issued by nonfinancial firms. For instance, are sustainable bonds priced similarly to conventional corporate bonds? Are sustainable bond spreads lower than the spreads of similarly rated corporate bonds? Moreover, do these patterns hold across different categories, such as green, social, and sustainability bonds, and in both the pre- and COVID-19 periods? These are the questions we examine in this paper.

The question of whether companies should prioritize an ESG agenda – and whether capital markets effectively price such actions – remains unresolved. In equity markets, Berk and van Binsbergen (2025) contend that the impact of socially responsible investing on asset prices is likely to be limited under current levels of investor participation. In contrast, bond markets, though not institutionally segmented between sustainable and conventional instruments, may nonetheless exhibit systematic differences in how pricing factors are applied. These differences can arise from variations in investor mandates, fiduciary responsibilities, and regulatory incentives. For instance, investors with explicit ESG mandates may place greater weight on non-pecuniary considerations (Edmans and Kacperczyk, 2022), which could alter the relative importance of traditional credit risk indicators – even for bonds issued by the same firm. This framework allows us to investigate whether the pricing of sustainable bonds reflects distinct investor preferences or simply applies conventional risk models to bonds bearing an ESG label.

This paper contributes to two major strands of the literature. First, we add to the existing body of work on the determinants of bond spreads. While there is extensive theoretical and empirical literature on traditional corporate bond pricing (e.g., Collin-Dufresne et al., 2001; Elton et al., 2001; Campbell and Taksler, 2003; Hull et al., 2004; Titman et al., 2004; Longstaff et al., 2005; Chen et al., 2007; Bao et al., 2011; Flannery et al., 2012), research on the determinants of corporate sustainable bond spreads is virtually non-existent. Previous studies on sustainable bond pricing have focused almost exclusively on the presence of a negative yield spread between green and conventional bonds and its determinants, without delving into the specific factors influencing green bond spreads *vis-à-vis* conventional ones. Furthermore, to the best of our knowledge, we are the first to extend the analysis of bond spread determinants to social and sustainability bonds and compare these with traditional corporate bonds. The scarcity of empirical research in this area can be attributed to two main factors. First, the sustainable bond market is relatively recent and has only matured in the last few years, particularly for green bonds issued by nonfinancial firms. Second, in previous studies, authors have often combined green bonds issued by entities with significantly different characteristics – such as nonfinancial firms, banks, insurance companies, agencies, governments, municipalities, state-owned enterprises, and special purpose vehicles – where pricing determinants can vary widely (e.g., Marques and Pinto, 2020). We believe our study is the first to examine if sustainable versus conventional bonds are priced similarly and the impact of nonfinancial firms' accounting and market characteristics on sustainable bond pricing.[3]

The paper also contributes to the recent but growing literature that examines the 'greenium' phenomenon in bond markets, with a particular focus on green bonds. Two key strands of literature help explain this phenomenon. First, investors may have a 'taste' for holding bonds that finance environmentally friendly projects (Fama and French, 2007). Within this framework, investors are willing to trade off financial returns for environmental benefits, leading to green bonds being priced at a premium compared to non-green corporate bonds (Flammer, 2021; Löffler et al., 2021).[4] Second, green bonds may carry lower risks. On the one hand, 'green' certification, along with third-party reviews and periodic monitoring, helps reduce asymmetric information, particularly when heterogeneous investors possess different private information and varying abilities to screen firms (DeMarzo, 2005; Yu, 2005; Gao and Schmittmann, 2022). On the other hand, green assets can serve as a hedge against climate risks (Pedersen et al., 2021; Pástor et al., 2021).

Empirically, the existing literature presents mixed evidence, with findings varying based on the samples, periods analyzed, market type (primary or secondary), and different issuers. Our paper closely relates to the emerging empirical literature that examines this phenomenon in green bonds issued by corporates. While Tang and Zhang (2020) and Flammer (2021) focus on the impact of green bond issuance on announcement returns and real effects, they find no significant difference in the yields of green versus brown bonds. Conversely, several studies report a negative yield spread, ranging from 8 bps (Caramichael and Rapp, 2024) to 33 bps (Wang et al., 2020) in the primary market. Löffler et al. (2021) provide evidence of a "greenium" in both primary and secondary markets, with yields for green bonds being, on average, 15–20 bps lower than those of conventional bonds. However, these studies often mix different types of issuers with varying characteristics that could significantly influence bond pricing.

[1] Sustainable Finance Review, full year 2021 & 2022. Source: Refinitiv (https://www.refinitiv.com/dealsintelligence).

[2] Green and social bonds are bond instruments made available exclusively to (re)finance eligible green and social projects, respectively. Sustainability bonds are bond instruments exclusively applied to (re)finance a combination of both green and social projects. The International Capital Market Association released updated versions of Green Bond Principles and Social Bond Principles in 2021 and 2023, respectively. For further details see: https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks.

[3] We use a global dataset of sustainable bonds – including green, social, and sustainability bonds – and conventional bonds issued by nonfinancial firms. The dataset was constructed using a hand-matching procedure that links bond-level data from DCM Analytics with firm-level characteristics from Datastream.

[4] This argument is also supported by security design literature (e.g., Oldfield, 2000; Fender and Mitchell, 2005): segmented financial markets create the opportunity for the design of new securities to accomplish certain risk-return profiles desired by investors, who are available to pay a premium *vis-à-vis* comparable corporate bonds.

In our paper, we focus exclusively on standard green bonds issued by nonfinancial firms. Therefore, we exclude green project finance and securitized bonds, as well as those issued by financial institutions, and, unlike Wang et al. (2020) and Caramichael and Rapp (2024), we also exclude green bonds issued by state-owned enterprises.[5] The work most closely related to ours is by Fatica et al. (2021), who find that corporate green bonds are issued at a premium (–22 basis points). Although their study uses a global sample of green bonds issued by supranational institutions, corporates, and financial firms, they examine whether there is a greenium effect in primary markets for each issuer type separately, with particular attention to green bonds issued by financial firms. In contrast, our study focuses on green bonds issued by nonfinancial firms and investigates whether this potential greenium effect has changed due to the COVID-19 pandemic.

Therefore, we extend the existing literature by comparing the credit spreads of green, social, and sustainability (GSS) bonds[6] with those of comparable conventional bonds, while controlling for macroeconomic conditions, contractual terms, and firm-level characteristics likely to influence bond pricing. Our dataset is significantly larger and more comprehensive than those used in prior studies (e.g., Wulandari et al., 2018; Zerbib, 2019; Tang and Zhang, 2020; Wang et al., 2020; Azhgaliyeva et al., 2022; Cicchiello et al., 2022), covering a more recent time period and including 1,200 sustainable bonds – comprising 984 green bonds, 64 social bonds, and 152 sustainability bonds – worth €466.3 billion. To ensure a consistent and comparable sample, we restrict our analysis of conventional bonds to 2,615 bonds (worth €1,386.5 billion) issued by firms that have also issued at least one GSS bond during the sample period – referred to as 'switchers'.

We begin our analysis by examining whether sustainable bonds are priced similarly to conventional corporate bonds. The results suggest that sustainable and conventional bonds are priced differently, with investors relying on a broader set of pricing factors when evaluating sustainable bonds. While credit ratings remain an important determinant for both bond types, sustainable bond spreads are more strongly influenced by: (*i*) contractual features such as transaction size, currency risk, callability, and issuers' prior experience with green bonds; (*ii*) macroeconomic conditions, including market volatility and the COVID-19 pandemic; and (*iii*) firm-specific characteristics such as size and leverage. In contrast, conventional bond spreads are more responsive to bond maturity, the number of tranches, country risk, and issuer profitability and growth prospects. Additionally, our results show that investors place less reliance on credit ratings when pricing sustainable bonds compared to conventional corporate bonds.

We then assess whether sustainable bonds are issued at a premium relative to conventional bonds. Our findings show that, on average, sustainable bonds do not carry significantly lower credit spreads than comparable conventional bonds, once firm-level characteristics and potential endogeneity are properly accounted for. This result holds across multiple estimation strategies, matched sample analysis, and endogenous switching regression models. These findings challenge theoretical predictions that ESG-aligned bonds should trade at a premium due to non-pecuniary investor preferences (Fama and French, 2007; Pedersen et al., 2021; Pástor et al., 2021) or reduced information asymmetry (DeMarzo, 2005; Gao and Schmittmann, 2022).

However, we do find heterogeneity across sustainable bond types. Social bonds tend to exhibit modestly lower credit spreads relative to conventional bonds, while green and sustainability bonds do not consistently show a pricing advantage. Importantly, during the COVID-19 crisis,[7] both green and sustainability bonds were associated with significantly lower spreads compared to conventional bonds, suggesting that ESG-labeled debt became more attractive to investors in periods of heightened uncertainty. This finding aligns with recent evidence that ESG assets may offer downside protection during crises (e.g., Nofsinger and Varma, 2014; Billah et al., 2023) and contributes to the literature on the dynamics of the greenium under crisis conditions (e.g., Amiraslani et al., 2023; Arat et al., 2023; Giovanardi et al., 2023).

Lastly, we examine the characteristics associated with the decision to issue sustainable bonds. Our findings indicate that sustainable bond issuance is more likely among issuers with stronger credit ratings, suggesting that firms with better credit profiles are more inclined – or better positioned – to engage in ESG-aligned financing. This may reflect their greater capacity to meet the disclosure, certification, and reputational requirements associated with sustainable bond issuance. We also find that firms issuing sustainable bonds tend to be less leveraged and less profitable. Additionally, the COVID-19 crisis appears to have accelerated sustainable bond issuance, particularly social and sustainability bonds, often deployed to fund pandemic-related initiatives. These results underscore that the choice process is not purely cost-driven but shaped by a mix of issuer characteristics, market conditions, and strategic considerations.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and develops the research hypotheses. Section 3 describes the data, variables, and econometric methodology. Section 4 presents the main empirical results, examining the determinants of credit spreads, the relative pricing of sustainable and conventional bonds, and the role of crisis periods. Section 5 provides additional sensitivity and robustness analyses, including an examination of the factors influencing the choice between

[5] E.g., 40% and 50% of Löffler et al.'s (2021) and Flammer's (2021) samples, respectively, are composed of green bonds issued by financials. Wang et al. (2020) use a sample of 159 green bonds issued by 56 nonfinancial Chinese firms between January 2016 and June 2019, with about 2/3 of the sample being composed of enterprise green bonds, issued by state-owned enterprises, whose creditworthiness is tightly related to that of the Republic of China.

[6] Since the spread on sustainability-linked bonds varies over the life of the bond based on the achievement of specific KPIs, and to ensure comparability with conventional bonds, this study focuses solely on green, social, and sustainability bonds.

[7] Although the COVID-19 pandemic was not the only external shock during our sample period, it represents a uniquely abrupt and globally synchronized systemic event that simultaneously affected financial markets and firm-level financing conditions. Its impact on risk perceptions and ESG-related investment preferences make it particularly well suited for examining whether sustainable bonds exhibit differential pricing under conditions of heightened uncertainty.

sustainable and conventional bonds. Finally, Section 6 concludes and discusses the theoretical and practical implications of the findings.

2. Literature review and hypotheses

2.1. The financial economics of sustainable bonds

Green, social, sustainability, and sustainability-linked bonds play a key role in the financing of sustainable investment projects and have seen exponential growth in recent years. These types of bonds are also referred to as 'sustainable bonds' or 'ESG bonds' (Perote et al., 2023). In our sample, the first sustainable (green) bond was issued by the Swedish firm Aligera Holding AB in May 2014, with a tranche size of €33.1 million and a 5-year maturity. The largest issuance, with a tranche size of €2.2 billion and a maturity of 10.0 years, was closed in 2021 by Ford Motor Company.[8] Over the years, the bond market has financed a diverse array of project types, tranche sizes, seniorities, and maturities. However, what are the key characteristics of sustainable bonds that distinguish them from traditional corporate bonds?

Green bonds are instruments specifically issued to finance projects that support environmental sustainability, such as those aimed at achieving a net-zero emissions economy, protecting and restoring the environment, and adapting to climate change. On the other hand, social bonds fund projects designed to deliver social benefits or achieve positive social outcomes, including affordable basic infrastructure, access to essential services, affordable housing, employment generation, and food security. Sustainability bonds allocate their proceeds exclusively to (re)finance a combination of both green and social projects. In contrast, sustainability-linked bonds are issued for general business purposes, with their terms linked to the issuer's ESG-related performance, which is assessed through key performance indicators (KPIs) and sustainability performance targets (SPTs).

In this paper, we focus on standard sustainable bonds that exhibit three defining features. First, although the proceeds are earmarked for ESG-related projects, these bonds are backed by the issuer's general cash flows rather than solely by revenues from the funded projects, distinguishing them from project finance (Zhao et al., 2022). Second, they enable issuers to raise long-term capital for large-scale sustainable infrastructure investments that typically require significant upfront funding and offer returns over extended horizons (Flammer, 2021). Third, such bonds must comply with established sustainable finance standards, including the Green Bond Principles (GBP), Social Bond Principles (SBP), Sustainability Bond Guidelines (SBG), and Sustainability-Linked Bond Principles (SLBP).[9]

Sustainable bonds are subject to third-party authentication (Ehlers and Packer, 2017; Reboredo, 2018). Adhering to green, social, or sustainability bond standards requires significant managerial effort and resources, which can be costly for issuers, especially first-time issuers (Tang and Zhang, 2020). Consequently, sustainable bonds often incur additional transaction costs compared to traditional corporate bonds, as issuers must cover the expenses related to certification, as well as the ongoing supervision and reporting of the bond proceeds to ensure they are allocated to sustainable projects.

Moreover, environmentally and socially conscious long-term investors typically adopt a buy-and-hold strategy for green and social bonds, which may result in lower trading activity compared to conventional bonds, potentially leading to less volatile behavior. Hinsche (2022) notes that green bonds tend to be less correlated with other fixed-income securities, while Dong et al. (2022) demonstrate that including green bonds in a diversified portfolio offers better protection against downside risk and volatility related to climate, geopolitical, and economic factors compared to conventional bonds.

Recent theoretical work by Berk and van Binsbergen (2025) questions whether sustainability-related investment decisions materially affect asset pricing. Their model suggests that unless ESG-oriented investors represent a dominant share of market wealth, any impact on the cost of capital will be economically small. This argument is particularly compelling in equity markets, where investors can easily substitute between stocks. However, in bond markets – especially in primary issuance – factors such as reputational signaling, downside protection, and certification mechanisms (e.g., third-party reviews) can introduce differences in how investors assess risk. Amiraslani et al. (2023) provide empirical support for this, showing that ESG performance lowers bond spreads during trust-eroding crises.

In addition, sustainable bonds are contractual innovations that intend to tie a bond's yield to the borrower's ESG performance. Extant literature on performance pricing, highlights the importance of performance sensitive debt in mitigating agency costs and enhancing contract completeness (e.g., Roberts and Sufi, 2009; Costello and Wittenberg-Moerman, 2011; Christensen et al., 2021). As mentioned by Flammer (2021), sustainability-linked pricing adjustments may be used by investors to discipline borrowers' ESG activities and mitigate risks.

Therefore, despite theoretical expectations of market integration, sustainable bonds may still exhibit distinct pricing behavior due to investor preference heterogeneity and structural features of the debt market. Given the unique characteristics of sustainable bonds –

[8] Following the launch of its Sustainable Financing Framework, Ford announced its inaugural green bond issuance in 2021. The proceeds from this bond will be exclusively allocated to clean, zero-emission transportation projects, including initiatives focused on the sustainable design, development, and manufacturing of electric vehicles and batteries. John Lawler, Ford's Chief Financial Officer, emphasized this commitment, stating, 'We are contributing to the creation of a sustainable, zero-emissions world with healthy, thriving, and equitable communities.'.

[9] The GBP and SBP aim to promote the development of green and social projects, respectively, based on four central components: (*i*) use of proceeds; (*ii*) process for project evaluation and selection; (*iii*) management of proceeds; and (*iv*) reporting. The SLBP are based around the following core components: (*i*) selection of KPIs; (*ii*) calibration of SPTs; (*iii*) bond characteristics; (*iv*) reporting; and (*v*) verification.

in particular, their adherence to specific rules for the use of proceeds, impact measurement, reporting, and verification, and their pricing based on environmentally and socially related risks – it is expected that sustainable bonds and conventional bonds are priced differently by common factors. Investors may also rely less on credit ratings when pricing sustainable bonds compared to corporate bonds. Therefore, we propose the following hypothesis:

Hypothesis 1 (H1): Sustainable and conventional bonds are priced differently and, in relation to conventional bonds, investors rely more on factors other than credit ratings when pricing sustainable bonds.

2.2. Spreads across sustainable and corporate bonds

Firms issue GSS bonds for a range of strategic and financial reasons. A key motivation is signaling: by adhering to established sustainability standards and obtaining third-party certification, firms can credibly convey their ESG commitment to the market (Flammer, 2021). This reduces information asymmetries between issuers and investors and may increase transparency and trust. Additionally, GSS bonds help broaden the investor base by appealing to long-term or mission-driven capital providers with ESG mandates, many of whom exhibit buy-and-hold behavior, thereby contributing to pricing stability (Baker et al., 2018; Zerbib, 2019). However, not all issuers are equally committed to sustainability objectives. Some may pursue GSS issuance opportunistically to boost reputation or engage in greenwashing, where environmental or social benefits are overstated (Marquis et al., 2016; Tang and Zhang, 2020). Another major rationale for sustainable bond issuance lies in cost of capital considerations. If investors with ESG preferences are willing to accept lower returns in exchange for social or environmental impact, issuers may benefit from lower yields (Pástor et al., 2021; Gao and Schmittmann, 2022).[10]

Considering the cost of financing motivation, Fama (2021) argues that if investors value a firm's ESG actions, investment decisions that consider ESG criteria will be rewarded with higher share prices and lower costs of capital. This perspective is aligned with Fama and French's (2007) taste-based framework: if investors have a preference, or 'taste', for holding green bonds, these bonds will be priced at a premium relative to nongreen corporate bonds. Using asset pricing models that incorporate green investor preferences, Pedersen et al. (2021) and Pástor et al. (2021) demonstrate that green assets tend to have lower yields due to these preferences, and that they can serve as a hedge against climate risks. Gao and Schmittmann (2022) offer a model of the corporate green bond market under conditions of asymmetric information and provide insights into the factors that create a green bond premium: green bonds are priced at a premium over conventional bonds when there is information asymmetry, transition risk, and significant costs associated with greenwashing.

The security design literature also offers insight into the pricing of sustainable instruments. Market imperfections and segmentation can incentivize the creation of new securities targeted at investor niches (Duffie and Rahi, 1995; Riddiough, 1997). In this context, sustainable bonds may be structured to appeal to ESG-sensitive investors and may command a premium if their features (e.g., certification, ESG alignment, external review) reduce risk perception or increase investor utility. Oldfield (2000) and Fender and Mitchell (2005) suggest that intermediaries can benefit from creating bonds with customized risk-return characteristics, while DeMarzo (2005) and Yu (2005) argue that third-party certification can reduce adverse selection under asymmetric information. Against this background, we propose the following hypothesis:

Hypothesis 2 [H2]: Sustainable and conventional bond spreads differ significantly, with sustainable bonds exhibiting lower spreads than comparable conventional bonds.

The empirical literature on this so-called "greenium" is mixed. While some studies document a green bond premium, particularly in the primary market (Ehlers and Packer, 2017; Baker et al., 2018)*, others find the premium to vary depending on market, issuer type, and bond features. In secondary markets,* Hachenberg and Schiereck (2018) *and* Zerbib (2019) *report lower yields for green bonds, though the effect is generally small.* Fatica et al. (2021) *find a greenium for corporate green bonds* (–22 *basis points*)*, especially when bonds are externally reviewed or repeatedly issued.*

However, evidence for green corporate bonds is more nuanced. Wang et al. (2020) identify a significant greenium in China, particularly for CSR-aligned issuers. Löffler et al. (2021) report a consistent but moderate greenium in primary and secondary markets, especially for credible or euro-denominated green bonds. Caramichael and Rapp (2024) observe an 8 bps greenium for green corporate bonds, tied to demand pressure and issuer quality.

Conversely, other studies find no robust greenium. Karpf and Mandel (2018) initially report higher yields for municipal green bonds, though their conclusions are contested by Larcker and Watts (2020), who show that methodological choices affect findings. Using a within-firm matching design, Larcker and Watts (2020), Flammer (2021), and Tang and Zhang (2020) find that yield differences largely disappear when comparing bonds issued by the same firm in the same year. Flammer (2021) reports no statistically significant greenium, consistent with findings by Lau et al. (2022), who show that greenium effects are highly heterogeneous and depend on greenwashing risk.

In summary, while theoretical arguments and some empirical results support the existence of a greenium, the evidence is far from conclusive and highly context-specific. This motivates a closer investigation using a broader sample that includes green, social, and sustainability bonds issued by nonfinancial firms.

[10] For additional details on why firms choose sustainable over traditional bond financing, please refer to Section 1 of the online appendix.

2.3. Sustainable bonds and crisis periods

There is growing evidence that ESG-aligned financial instruments may behave differently during systemic crises. Nofsinger and Varma (2014) show that socially responsible mutual funds tend to outperform conventional funds during financial downturns, suggesting that investors may perceive ESG strategies as more resilient under stress. In fixed-income markets, Pham and Nguyen (2021) document diversification benefits from combining green and conventional bonds, while Azhgaliyeva et al. (2022) highlight the role of green bonds in mitigating the impact of extreme events such as oil market shocks. Amiraslani et al. (2023) further show that firms with stronger ESG performance experience lower bond spreads during trust-eroding episodes, attributing this effect to higher social capital and reputational credibility.

More recently, the COVID-19 pandemic has been treated as an exogenous market-wide stress event to evaluate the resilience and pricing dynamics of sustainable bonds. Perote et al. (2023) find that the pandemic had a significantly positive effect on green bond returns. Similarly, Billah et al. (2023) report that both sukuk and green bond indices displayed resilience to global risk factors and contagion during the pandemic. Giovanardi et al. (2023) show that green bonds with second-party certification exhibited higher liquidity and a stronger greenium during COVID-19, particularly in environmentally progressive countries. Arat et al. (2023) document that the yield differential between green and conventional bonds widened from 1.6 basis points before the pandemic to 3.5 basis points during the crisis. Aloui et al. (2023) find nonlinear investor responses to green monetary policy interventions, with significant differences between pre- and post-COVID periods.

Together, this evidence suggests that sustainable bonds may provide a form of downside protection during periods of heightened uncertainty. Enhanced investor trust, reputational capital, certification mechanisms, and ESG mandates may reduce perceived credit risk or support demand in stress environments, leading to relatively lower or more stable credit spreads compared to conventional bonds.

Complementary institutional evidence (Cheng et al., 2024) documents the rapid expansion and changing composition of sustainable debt markets during the pandemic, reinforcing the view that COVID-19 coincided with an acceleration in sustainable bond finance. Motivated by this literature, we examine whether crisis periods amplify pricing differences between sustainable and conventional bonds. Specifically, we test whether the relative spread differential becomes more negative when investor risk aversion and uncertainty increase. This leads to our third hypothesis:

Hypothesis [H3]: The difference in credit spreads between sustainable and conventional bonds is amplified (i.e., more negative) during crisis periods.

3. Data, methodology, and variable definition

3.1. Sample selection

Our sample consists of individual bond offerings extracted from DCM Analytics, covering the period from 2012 to 2022, which captures final pricing information at the time of issuance. DCM Analytics provides comprehensive data on bonds issued in the debt capital markets. While the database contains information on various bond types, we limit our analysis to bonds classified with a deal-type code of ‘corporate bond investment-grade’ or ‘corporate bond high-yield’. We also restrict the sample to securities issued by nonfinancial firms and those for which tranche size (in € million) is available. To analyze how credit spreads and pricing processes for sustainable bonds compare to those of similarly rated conventional bonds, we include only those issuances with the necessary information to compute credit spreads. Furthermore, we focus on bond tranches that are either fixed-rate or variable-rate, with yield to maturity data available. For variable-rate bonds, only those linked to the following indices are considered: Euribor, Euro Libor, USD Libor, and GBP Libor.

We exclude project finance bonds, synthetic securitization bonds, whole-business securitizations, perpetual bonds, and bonds with additional features such as step-up, caps, or floors. Bonds categorized as ‘fixed-rate convertible to floating rate note’, ‘fixed-rate adjustable’, ‘fixed-rate extendible’, ‘floating rate note extendible’, and ‘floating rate note convertible’ are also excluded. To enhance data completeness, we search Datastream for yield-to-maturity information for bonds with missing values. Since DCM Analytics and Datastream do not share a common identification code, we manually match borrower names. To mitigate the influence of outliers, we winsorize the tranche size, maturity, and credit spread at the 1st and 99th percentiles.

DCM Analytics provides information on the purpose of the projects financed by bond issuances. Sustainable bonds are certified by external entities and comply with current sustainable principles: green bonds adhere to the GBP, social bonds to the SBP, and sustainability bonds to both. To compare sustainable bonds with conventional bonds, we focus on standard green, social, and sustainability bonds, which represent a standard recourse-to-the-borrower debt obligation aligned with sustainable principles. We exclude Sustainability-Linked Bonds (SLBs), as these instruments have financial or structural characteristics that vary depending on the issuer’s achievement of predefined sustainability/ESG objectives. Additionally, we exclude conventional bonds issued by nonfinancial firms in sectors and countries that have no record of issuing sustainable bonds.

After applying these filters, our ‘full sample’ consists of 30,368 bonds with a total value of €13,192.7 billion, of which 29,168 bonds worth €12,726.5 billion are conventional bonds, and 1,200 bonds worth €466.3 billion are sustainable bonds. Among the sustainable bonds, 984 bonds worth €379.2 billion are green bonds, 64 bonds worth €22.9 billion are social bonds, and 152 bonds worth €64.0 billion are sustainability bonds. Panel A of Table 1 presents the industrial distribution of the full sample of tranches, Panel B details the tranche allocation by issuer location, while Panel C offers information on the top 10 issuers by bond type.

Panel A reveals that green bonds are predominantly issued by nonfinancial firms in the utilities (45.79%) and real estate (20.33%)

Table 1
Industrial and geographic distribution, and top issuers – full sample.

Panel A: Industrial distribution

Industrial category of issuer	**Conventional bonds**			**Green bonds**			**Social bonds**			**Sustainability bonds**		
	Number of tranches	**Total value** [€ Million]	**Percent of total value**	**Number of tranches**	**Total value** [€ Million]	**Percent of total value**	**Number of tranches**	**Total value** [€ Million]	**Percent of total value**	**Number of tranches**	**Total value** [€ Million]	**Percent of total value**
Commercial and Industrial												
Agriculture, Forestry and Fishing	354	97,860	0.77	19	7,458	1.97	0	0	0.00	4	1,305	2.04
Communications	1,574	1,161,613	9.13	13	7,567	2.00	0	0	0.00	7	3,586	5.60
Construction/Heavy Engineering	3,970	1,335,229	10.49	78	39,789	10.49	0	0	0.00	4	941	1.47
Manufacturing												
Chemicals, Plastic and Rubber	881	355,809	2.80	17	9,055	2.39	0	0	0.00	3	124	0.19
Food and Beverages	1,374	742,467	5.83	13	5,553	1.46	2	446	1.94	3	748	1.17
Machinery and Equipment	2,367	1,560,210	12.26	33	16,912	4.46	3	586	2.55	17	15,868	24.78
Steel, Aluminum and other Metals	646	205,203	1.61	13	4,857	1.28	0	0	0.00	3	1,369	2.14
Other	815	384,615	3.02	4	2,017	0.53	0	0	0.00	7	3,348	5.23
Mining and Natural Resources	581	253,444	1.99	7	1,189	0.31	0	0	0.00	0	0	0.00
Oil and Gas	2,046	1,250,544	9.83	4	1,381	0.36	0	0	0.00	0	0	0.00
Real Estate	3,869	1,019,314	8.01	301	77,084	20.33	13	7,196	31.31	43	13,255	20.70
Retail Trade	771	396,747	3.12	5	2,114	0.56	0	0	0.00	4	1,599	2.50
Services	2,922	1,642,110	12.90	5	1,476	0.39	7	2,635	11.46	12	4,954	7.74
Utilities	4,200	1,400,711	11.01	373	173,642	45.79	2	763	3.32	36	14,931	23.32
Transportation	2,242	750,593	5.90	92	27,341	7.21	37	11,359	49.42	6	1,645	2.57
Public Administration/ Government	7	5,380	0.04	0	0	0.00	0	0	0.00	1	291	0.45
Other (2)	549	164,614	1.29	7	1,799	0.47	0	0	0.00	2	71	0.11
Total	**29,168**	**12,726,464**	**100.00**	**984**	**379,233**	**100.00**	**64**	**22,985**	**100.00**	**152**	**64,035**	**100.00**

Panel B: Geographic distribution

Geographic location of issuer	**Conventional bonds**			**Green bonds**			**Social bonds**			**Sustainability bonds**		
	Number of tranches	**Total value** [€ Million]	**Percent of total value**	**Number of tranches**	**Total value** [€ Million]	**Percent of total value**	**Number of tranches**	**Total value** [€ Million]	**Percent of total value**	**Number of tranches**	**Total value** [€ Million]	**Percent of total value**
Europe	**6,729**	**3,170,020**	**24.91**	**581**	**237,414**	**62.60**	**15**	**7,666**	**33.35**	**67**	**24,995**	**39.03**
European Union	4,256	2,189,107	17.20	475	213,774	56.37	13	7,006	30.48	30	12,634	19.73
United Kingdom	1,336	626,390	4.92	39	16,438	4.33	2	660	2.87	37	12,361	19.30
Eastern Europe	98	60,870	0.48	2	469	0.12	0	0	0.00	0	0	0.00

(*continued on next page*)

Table 1 (*continued*)

Panel A: Industrial distribution

Industrial category of issuer	Conventional bonds			Green bonds			Social bonds			Sustainability bonds		
	Number of tranches	Total value [€ Million]	Percent of total value	Number of tranches	Total value [€ Million]	Percent of total value	Number of tranches	Total value [€ Million]	Percent of total value	Number of tranches	Total value [€ Million]	Percent of total value
Northern Europe	679	90,657	0.71	62	5,642	1.49	0	0	0.00	0	0	0.00
Western Europe	360	202,996	1.60	3	1,091	0.29	0	0	0.00	0	0	0.00
America	**13,670**	**7,622,329**	**59.89**	**189**	**86,211**	**22.73**	**7**	**3,041**	**13.23**	**42**	**28,575**	**44.62**
United States	11,640	6,931,834	54.47	134	70,464	18.58	7	3,041	13.23	35	25,751	40.21
Canada	1,407	460,359	3.62	41	9,945	2.62	0	0	0.00	1	340	0.53
Caribbean	8	2,562	0.02	0	0	0.00	0	0	0.00	0	0	0.00
Latin America	615	227,574	1.79	14	5,802	1.53	0	0	0.00	6	2,484	3.88
Asia	**8,271**	**1,785,564**	**14.03**	**206**	**54,581**	**14.39**	**42**	**12,278**	**53.42**	**34**	**8,081**	**12.62**
China	5,687	1,165,784	9.16	104	23,399	6.17	0	0	0.00	3	1,683	2.63
East Asia	1,916	392,973	3.09	93	27,727	7.31	42	12,278	53.42	31	6,398	9.99
South Asia	47	22,668	0.18	1	412	0.11	0	0	0.00	0	0	0.00
Southeast Asia	492	111,160	0.87	5	1,354	0.36	0	0	0.00	0	0	0.00
Western Asia	129	92,979	0.73	3	1,689	0.45	0	0	0.00	0	0	0.00
Australia/New Zealand	**448**	**135,868**	**1.07**	**5**	**952**	**0.25**	**0**	**0**	**0.00**	**9**	**2,384**	**3.72**
Africa	**50**	**12,683**	**0.10**	**3**	**75**	**0.02**	**0**	**0**	**0.00**	**0**	**0**	**0.00**
Total	**29,168**	**12,726,464**	**100.00**	**984**	**379,233**	**100.00**	**64**	**22,985**	**100.00**	**152**	**64,035**	**100.00**

Panel C: Top issuers

Conventional bonds			Green bonds		
Firm	**By value of deals**	**By number of deals**	**Firm**	**By value of deals**	**By number of deals**
Apple Inc	0.85%	0.28%	TenneT Holding BV	4.84%	2.74%
China Railway Corp	0.73%	0.24%	ENGIE SA	2.72%	1.42%
Oracle Corp	0.71%	0.15%	Societe du Grand Paris	2.18%	0.51%
Verizon Communications Inc	0.68%	0.22%	E.ON SE	2.12%	1.12%
T-Mobile USA Inc	0.65%	0.22%	Iberdrola Finanzas SAU	1.91%	0.91%
Comcast Corp	0.63%	0.23%	Volkswagen International Finance NV	1.45%	0.61%
Boeing Co	0.61%	0.21%	Orsted A/S	1.28%	0.81%
Amazon.com Inc	0.53%	0.14%	Energias de Portugal SA-EDP	1.19%	0.61%
International Business Machines Corp – IBM	0.51%	0.22%	Suez SA	1.13%	0.51%
CVS Health Corp	0.50%	0.11%	Electricite de France SA-EDF	1.08%	0.30%

Social bonds			Sustainability bonds		
Firm	**By value of deals**	**By number of deals**	**Firm**	**By value of deals**	**By number of deals**
East Nippon Expressway Co Ltd	31.32%	35.94%	Alphabet Inc	15.25%	3.95%
West Nippon Expressway Co Ltd	14.81%	10.94%	Housing New Zealand Ltd	3.51%	5.26%
Vonovia SE	10.44%	4.69%	Southern Water Services (Finance) Ltd	3.43%	3.29%
SBB Treasury Oyj	9.35%	4.69%	Southern California Edison Co	2.80%	2.63%
Ford Foundation	7.70%	6.25%	Severn Trent Utilities Finance plc	2.51%	2.63%
Icade Sante SAS	5.22%	3.13%	Koninklijke Philips NV	2.50%	1.97%
Oncor Electric Delivery Co LLC	3.32%	3.13%	Comision Federal de Electricidad – CFE	2.39%	1.32%

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Table 1 (*continued*)

Panel C: Top issuers

Conventional bonds				**Green bonds**		
Firm	**By value of deals**	**By number of deals**		**Firm**	**By value of deals**	**By number of deals**
Assura Financing plc	2.87%	3.13%		Cofinimmo SA/NV	2.34%	1.97%
Fujifilm Holdings Corp	2.55%	4.69%		Georgia Power Co	2.15%	1.32%
Royalty Pharma plc	2.21%	1.56%		Clarion Funding plc	2.05%	2.63%

Panel A reports the industry distribution of bond tranches. Panel B presents the geographic distribution based on the country of the issuing firm. Panel C highlights the largest issuers and their relative shares in the conventional and sustainable bond markets. The data cover the full sample of bond tranches with available credit spread and tranche amount information, issued globally between 2012 and 2022.

sectors. Social bonds are concentrated in the transportation (49.42%) and real estate (31.31%) sectors. Sustainability bond issuance is mainly found in the machinery and equipment (24.78%), utilities (23.32%), and real estate (20.70%) sectors. In contrast, conventional bonds exhibit a more diversified industrial pattern, with the largest shares issued by firms in the services (12.90%), machinery and equipment (12.26%), construction/heavy engineering (10.49%), and utilities (11.01%) sectors.

Panel B highlights significant geographic differences between conventional and sustainable bond issuances. Conventional bonds are largely concentrated in the U.S. (54.47%) compared to Europe (24.91%), whereas sustainable bonds are predominantly issued by European firms: 62.60% for green bonds, 33.35% for social bonds, and 39.03% for sustainability bonds.

Panel C identifies the leading issuers and their relative importance in each market. The top 10 issuers hold a smaller share of the conventional bond market (6.42%) compared to the sustainable bond market. In the latter, the top 10 issuers account for 19.90% of green bond volume, 89.80% of social bond volume, and 38.93% of sustainability bond volume. Notably, the top 10 issuers for each bond type differ from one another.

3.2. Methodology and variables

Our empirical analysis is based on a cross-sectional dataset of bond issuances. Each observation represents a unique bond *i* issued at a specific time *t*, where *t* refers to the exact issuance date. To investigate the pricing determinants of sustainable bonds − and to assess how the credit spreads of green, social, and sustainability bonds compare to those of similarly rated conventional corporate bonds-, we use the model described in equation (1).[11] The dependent variable is the *credit spread*, in basis points, is measured as the difference between the bond’s yield to maturity and the corresponding maturity-matched risk-free benchmark on the issuance date. We employ OLS regression techniques and adjust for heteroskedasticity. Due to time varying risk premia and cross-country differences, we estimate standard errors clustered by year and country.

$$\begin{aligned} Creditspread_{i,t} = \alpha_0 + \sum_{n=1}^{20} \beta_n Ratingdummy_{n,i,t} + \beta_{21} Notrated_{i,t} + \gamma Contractualcharacteristics_{i,t} + \varphi Macroeconomicfactors_t \\ + \delta Firmcharacteristics_{i,t} + \varepsilon_{i,t} \end{aligned}$$

A discussion of the variables used in the analysis follows. Table 2 provides detailed definitions and sources for all the variables included in the study. Section 2 of the online appendix offers a comprehensive review of the literature on the determinants of corporate bond spreads. Summary descriptive statistics for the full sample are presented in Section 3 of the online appendix.

3.2.1. Credit spread

Credit spread corresponds to the price for the risk associated with the bond at closing, defined as the margin yielded by the security at issue above a corresponding currency treasury benchmark with a comparable maturity – the option adjusted spread (OAS). This spread captures the issuer-specific credit and liquidity risks embedded in the bond at the time of issuance. Given that our sample includes both fixed-rate and floating-rate bonds, we standardize credit spreads across bond types by converting floating-rate bonds into their fixed-rate equivalents. Following Marques and Pinto (2020), to ensure comparability of credit spreads at issuance we converted floating rate bonds to fixed rates using fixed-for-floating rate swaps. This conversion was implemented per bond, using the appropriate quote for the swap matching the maturity of the bond and taken at the issuance date.[12] This methodology is applied uniformly across all bond categories, ensuring consistency in how credit risk is assessed across the full sample.

3.2.2. Core variables

To test hypothesis H2, we employ an indicator variable that equals one for *sustainable* bonds − those that adhere to the GBP, SBP, or SLP − and anticipate that sustainable bonds will exhibit lower credit spreads than comparable conventional bonds. Additionally, we create three dummy variables, each corresponding to a specific type of sustainable bond: *green bond*, *social bond*, and *sustainability bond*.

Credit ratings are a key determinant of corporate bond credit spreads (e.g., Elton et al., 2001; Hull et al., 2004; Titman et al., 2004; Longstaff et al., 2005; Marques and Pinto, 2020; Guedes and Pinto, 2023). There is also evidence that credit ratings similarly influence green bond premiums (Zerbib, 2019; Fatica et al., 2021). Hinsche (2022) finds that the negative green bond premium is more pronounced for issuers with A or AAA ratings. Following Cornaggia et al. (2017), credit ratings assigned by S&P or Moody's were converted to a numerical scale: AAA = Aaa = 1, AA+=Aa1 = 2, and so on, down to CC = 20. If a tranche has two ratings, we compute the average. Since these rating scales are inversely related to creditworthiness, we expect credit spreads to widen as ratings decrease. For bonds without a credit rating, we include a dummy variable, *not rated*, which equals 1 if the bond lacks a rating from S&P and/or Moody's, and 0 otherwise.

[11] We use a reduced-form model along the lines of existing pricing models for conventional corporate bonds (e.g., Gabbi and Sironi, 2005; Chen et al., 2007; Marques and Pinto, 2020) and green bonds (e.g., Fatica et al., 2021).

[12] We also consider the specific interest rate market (EUR Libor, USD Libor and GBP Libor) and even different reference rates within the same market (e.g., USD Libor 1M, USD Libor 3M, USD Libor 6M, and USD Libor 12M). The data on daily swap curves for maturities between 3 months and 50 years, and 3 interest rate market benchmarks with four different reference rates, were drawn from Datastream.

Table 2
Definition of variables and sources.

Variable name	Variable definition	Source
Dependent variable:		
Credit spread	Margin yielded by the security at issue above a corresponding currency treasury benchmark with a comparable maturity – the option adjusted spread (OAS).	DCM Analytics and Datastream
Independent variables:		
Core variables		
Sustainable	Dummy equal to 1 if a bond is classified as sustainable bond (green, social, and sustainability bonds), and 0 otherwise.	DCM Analytics
Green	Dummy equal to 1 if a bond is classified as green bond (instruments made available for the purposes of financing a 'green project'), and 0 otherwise.	DCM Analytics
Social	Dummy equal to 1 if a bond is classified as social bond (instruments made available for the purposes of financing projects designed to deliver social benefits or achieve positive social outcomes), and 0 otherwise.	DCM Analytics
Sustainability	Dummy equal to 1 if a bond is classified as sustainable bond (instruments made available for the purposes of (re)financing a combination of both green and social projects), and 0 otherwise.	DCM Analytics
Rating	Bond credit rating based on the S&P and Moody's rating at the time of bond issuance. The rating is converted as follows: AAA = Aaa = 1, AA+=Aa1 = 2, and so on until CC = 20. Code 0 = note rated.	DCM Analytics
Not rated	Dummy equal to 1 if the bond does not have a credit rating from S&P or Moody's, and 0 otherwise.	DCM Analytics
Contractual characteristics		
Subordinated	Dummy equal to 1 if the bond is subordinated, and 0 otherwise.	DCM Analytics
Maturity	Maturity of bonds, in years.	DCM Analytics
Transaction size	Bond transaction size. Transaction size is converted into Euro millions when necessary.	DCM Analytics
Number of tranches	The number of tranches per transaction/deal.	DCM Analytics
Currency risk	Dummy equal to 1 for bonds that are denominated in a currency different from the currency in the deal's nationality, and 0 otherwise.	DCM Analytics
Callable	Dummy equal to 1 if the bond has a call option, and 0 otherwise.	DCM Analytics
Experienced green	Dummy equal to 1 if the issuer has already issued a green bond previously, and 0 otherwise.	Authors'
Macroeconomic factors		
Volatility	The Chicago Board Options Exchange Volatility Index (VIX). VIX reflects a market estimate of future volatility.	Datastream
Country risk	S&P's country credit rating at close. The rating is converted as follows: AAA = 1, AA+=2, and so on until D = 22.	S&P Global Ratings
COVID-19	Dummy equal to 1 if the issue date belongs to the COVID-19 pandemic (from 1 February 2020 through to 31 December 2022), and 0 otherwise.	Authors'
Vigeo ESG Rating	Measures the country's ESG score of the bond issuer.	Datastream
Nonfinancial firms' characteristics		
Total assets	Firms' total assets measured in Euro million.	Datastream
Total debt to total assets	The ratio of total debt to total assets.	Datastream
Fixed assets to total assets	The ratio of fixed assets to total assets. Fixed assets include property, plant and equipment.	Datastream
Market to book	The sum of book value of liabilities and market value of equity divided by the book value of assets.	Datastream
Return on assets	The net income before preferred dividends minus preferred dividend requirement, divided by total assets.	Datastream

3.2.3. *Contractual characteristics*

Several studies have highlighted that, in addition to credit ratings, various contractual elements provide important insights into bond pricing (Zerbib, 2019; Hyun et al., 2020; Fatica et al., 2021; Löffler et al., 2021; Hinsche, 2022). These include factors such as subordination, maturity, deal size, number of tranches, currency risk, callability, and green bond issuance experience.

Investors generally perceive bonds with longer maturities as riskier than those with shorter terms, often demanding higher premiums for long-term securities. Larger green bond transactions tend to reduce the green bond premium, as observed by Hyun et al. (2020). Thus, we expect that larger issues will have a negative effect on spreads, with larger bonds exhibiting lower spreads.

Subordinated bonds, which rank lower in claim priority compared to senior debt, typically offer higher yields to compensate for the increased risk. To evaluate this, we include a *subordinated* dummy variable. We hypothesize that subordinated bonds will have a positive impact on credit spreads.

Regarding *currency risk*, we expect that tranches exposed to it will carry higher spreads. To measure the effect of currency risk, we use a dummy variable that equals 1 for bonds denominated in a currency different from that of the issuer's country, and 0 otherwise. We also assess the impact of callability on credit spreads. Callable bonds provide issuers with the option to redeem the bond before maturity, potentially allowing them to refinance at lower interest rates. However, this creates additional risk for investors, as they may miss out on future interest payments, thus warranting a higher spread. To account for this, we include a *callable* dummy variable, and we anticipate a positive effect on credit spreads.

Fatica et al. (2021) posit that repeated issuances in the green bond market provide informational benefits to investors as repeat issuers can signal their environmental commitment more effectively over time. To control for the impact of repeat issuers on credit spreads in the green bond market, we use an *experienced green* dummy variable. We expect a negative effect on credit spreads, as repeat issuers are likely to command lower spreads than new entrants.

Table 3
Univariate statistics – pricing features associated with bonds compared.

Variable of interest	Conventional bonds	Sustainable bonds			Variable of interest	Conventional bonds	Sustainable bonds		
		Green bonds	Social bonds	Sustainability bonds			Green bonds	Social bonds	Sustainability bonds
Univariate analysis – continuous variables									
Credit spread (bps)					**Tranche size (€ Million)**				
Number	2,615	984	64	152	Number	2,615	984	64	152
Mean	125.55	173.18	62.47	125.80	Mean	530.22	385.40	359.14	421.28
Median	108.9	134.25	25	99	Median	441.62	342.87	323.44	350.51
Rating [1–20 weak]					**Country risk [1–21 weak]**				
Number	2,615	984	64	152	Number	2,615	984	64	152
Mean	5.68	5.51	5.08	5.61	Mean	2.28	2.95	3.80	2.99
Median	6	7	5	6	Median	1	1	5	3
Vigeo ESG Rating					**Maturity (years)**				
Number	1,343	680	56	106	Number	2,615	984	64	152
Mean	77.38	79.54	74.19	76.81	Mean	12.60	9.05	9.25	11.99
Median	78.18	79.9	71.46	79.27	Median	10	7	7	10
Number of tranches					**Transaction size (€ Million)**				
Number	2,615	984	64	152	Number	2,615	984	64	152
Mean	2.38	1.48	2.20	1.79	Mean	1677.49	608.94	682.63	1054.11
Median	2	1	2	1	Median	657.61	400	712.30	431.32
Univariate analysis – dummy variables									
Subordinated					**Callable**				
Nr. of tranches	2,615	984	64	152	Nr. of tranches	2,615	984	64	152
Nr. of tranches with d = 1	17	18	0	0	Nr. of tranches with d = 1	1,641	1	22	98
% of total	0.7%	1.8%	0.0%	0.0%	% of total	62.8%	62.8%	34.4%	64.5%
Currency risk					**COVID-19**				
Nr. of tranches	2,615	984	64	152	Nr. of tranches	2,615	984	64	152
Nr. of tranches with d = 1	503	222	4	29	Nr. of tranches with d = 1	1,016	446	61	126
% of total	19.2%	22.6%	6.3%	19.1%	% of total	38.9%	45.3%	95.3%	82.9%

This table reports summary statistics for a global sample of sustainable bonds – including green, social, and sustainability bonds – and conventional bonds. The sample includes bond tranches issued between 2012 and 2022 by 'switchers', defined as nonfinancial firms that have issued both sustainable and conventional bonds during the sample period. The dataset is restricted to tranches with available information on credit spreads and tranche amounts. Data on bond characteristics were sourced from DCM Analytics and Datastream. Credit ratings are numerically coded as follows: AAA (Aaa) = 1, AA+ (Aa1) = 2, and so on, with higher values indicating lower credit quality, up to CC = 20. For a definition of the variables, see Table 2.

3.2.4. Macroeconomic controls

We also examine how macroeconomic factors influence credit spreads. To capture market *volatility*, we use the Chicago Board Options Exchange Volatility Index (VIX). Consistent with the findings of Löffler et al. (2021), we expect market volatility to have a positive effect on credit spreads. To account for *country risk*, we utilize S&P's sovereign credit rating, following the approach of Marques and Pinto (2020). We similarly expect a positive relationship between sovereign credit risk and credit spreads.

Several studies, including Crifo et al. (2017) and Hachenberg and Schiereck (2018), highlight the importance of ESG criteria as key nonfinancial information. To evaluate whether the ESG performance of the bond-issuing country affects credit spreads, we apply Vigeo's sustainability country ratings, following Crifo et al. (2017). We expect that higher Vigeo sustainability ratings will negatively impact credit spreads, reflecting lower risk.

3.2.5. Issuing firms' characteristics

In line with previous research (Wulandari et al., 2018; Marques and Pinto, 2020; Tang and Zhang, 2020; Wang et al., 2020; Cicchiello et al., 2022), we assess how firm-specific characteristics influence credit spreads. We include proxies for firm size (log of total assets), financial leverage (total debt to total assets), asset tangibility (fixed assets to total assets), growth opportunities (market-to-book value), and profitability (return on assets). We expect a negative relationship between credit spreads and firm size, asset tangibility, profitability, and growth opportunities. Conversely, we anticipate a positive relationship between financial leverage and credit spreads. Firm-specific accounting and market data are sourced from Datastream, referencing the fiscal year preceding the bond issuance.

3.3. Financial characteristics of sustainable versus conventional bonds

To ensure a consistent basis for comparison, we restrict our sample of conventional bonds to those issued by firms that have also issued at least one sustainable bond – green, social, or sustainability – during the sample period. This within-firm restriction enables us to isolate differences in spread determinants attributable to bond characteristics, rather than firm-level unobservables. In total, our final sample comprises 1,200 sustainable bonds and 2,615 conventional bonds issued by 585 unique nonfinancial firms across 2012–2022. We describe the sample, by loan typology, in Table 3. This section constitutes the most exhaustive such comparison in the literature.[13]

With respect to the relative pricing of sustainable versus conventional bonds, Table 3 shows that the average credit spread is economically higher for green bonds (173.2 bps) than for conventional bonds (125.6 bps) and social bonds (62.5 bps). In contrast, the average spread for sustainability bonds (125.8 bps) is nearly identical to that of conventional bonds. In terms of maturity, conventional bonds have the longest average term at 12.6 years, compared to shorter maturities for green (9.1 years) and social bonds (9.3 years), while sustainability bonds have a similar average maturity (12.0 years). The average credit rating of conventional and sustainable bonds appears comparable. However, the sovereign credit rating of the issuer's country tends to be better for conventional bonds, suggesting that sustainable issuance may be more common among firms in lower-rated jurisdictions.

The average transaction size for conventional bond deals is larger than that of green, social, or sustainability bond deals. Similar patterns hold for tranche size and the number of tranches per deal, suggesting that conventional bond issuances tend to be larger and more structured. According to the dummy variables reported in Table 3, approximately 2% of green bonds are subordinated, compared to only 0.7% of conventional bonds, with no subordination observed among social or sustainability bonds. The proportion of bonds issued with currency risk is similar between conventional (19.2%) and sustainability bonds (19.1%), but lower for social bonds (6.3%) and higher for green bonds (22.6%). The proportion of bonds with callable features is broadly comparable across groups, with 62.8% of conventional bonds and a similar share of green and sustainability bonds being callable. Finally, a significantly higher proportion of sustainable bonds were issued during the COVID-19 pandemic, with 45.3% of green, 95.3% of social, and 82.9% of sustainability bonds issued during this period, compared to 38.9% of conventional bonds. This suggests that the pandemic may have accelerated sustainable financing, particularly for social and sustainability bond instruments.

4. The pricing of sustainable versus conventional bonds

4.1. Determinants of sustainable and conventional bond credit spreads

A Chow test for structural breaks is employed to assess whether the credit spreads of sustainable and conventional bond issues are influenced differently by common pricing characteristics. Specifically, we test whether the pricing characteristics outlined in equation (1) are significant for both sustainable and conventional bonds and, if so, whether the coefficients are identical. In Section 2.1, we demonstrate that sustainable bonds vary across subcategories due to their distinct purposes and their adherence to specific green, social, and sustainability bond principles. Therefore, we apply the same methodology to examine whether green, social, and sustainability bonds are priced differently compared to conventional bonds. The results based on the samples in Table 3 indicate that sustainable and conventional bonds are distinct financial instruments, not only when considering the entire sample of sustainable bonds, but also when comparing each subsample with comparable conventional bonds. This conclusion is supported by the Chow test

[13] Since our analysis compares sustainable and conventional bonds within the same firm and year – and further employs a propensity score–matched sample – sectoral and country-level imbalances in sustainable bond issuance do not bias our aggregate results.

Table 4
Regression analyses of the determinants of credit spreads.

Dependent variable: Credit spread (bps)	[1] Conventional bonds	[1a] Conventional bonds with firms' characteristics	[2] Sustainable bonds	[2a] Sustainable bonds with firms' characteristics	[3] Green bonds	[3a] Green bonds with firms' characteristics	[4] Social bonds	[5] Sustainability bonds
Independent variables:								
Intercept	54.88***	−103.52***	604.33***	380.23**	660.29***	365.84**	−493.54*	739.38
	(0.000)	(0.000)	(0.000)	(0.048)	(0.000)	(0.047)	(0.062)	(0.138)
AA+	23.85***	29.63***	−50.36	−112.37	−39.64	−97.18		
	(0.000)	(0.000)	(0.126)	(0.172)	(0.453)	(0.681)		
AA	34.79***	−4.46	−1.46	13.36***	26.51	90.38		−86.63*
	(0.000)	(0.677)	(0.925)	(0.009)	(0.576)	(0.628)		(0.057)
AA-	23.19***	42.79***	−25.37	26.47***	−10.07	31.28***		−49.36
	(0.000)	(0.000)	(0.176)	(0.000)	(0.840)	(0.001)		(0.288)
A+	40.54***	−4.41	−19.12	46.12***	−7.01	131.89**	26.31	−20.14
	(0.000)	(0.719)	(0.205)	(0.003)	(0.882)	(0.039)	(0.470)	(0.607)
A	49.11***	22.02*	27.21*	43.42***	−8.98	132.07**	−16.03	−36.68
	(0.000)	(0.063)	(0.085)	(0.003)	(0.849)	(0.024)	(0.666)	(0.483)
A-	58.65***	29.74***	−16.54	41.90***	−5.28	136.67**	15.12	−37.05
	(0.000)	(0.008)	(0.296)	(0.009)	(0.911)	(0.030)	(0.790)	(0.439)
BBB+	73.95***	33.02***	9.94	47.48***	13.74*	143.09**	56.32	47.61
	(0.000)	(0.007)	(0.532)	(0.005)	(0.076)	(0.020)	(0.410)	(0.174)
BBB	85.70***	82.53***	35.20**	130.87**	41.41	122.36*		34.68
	(0.000)	(0.000)	(0.042)	(0.020)	(0.385)	(0.060)		(0.520)
BBB-	130.78***	76.99***	35.90**	109.96**	47.65	−96.80		−26.97
	(0.000)	(0.000)	(0.040)	(0.046)	(0.316)	(0.134)		(0.807)
BB+	166.07***	131.64***	121.14***	−65.59	124.90**	−67.64		136.67***
	(0.000)	(0.000)	(0.000)	(0.264)	(0.011)	(0.310)		(0.003)
BB	245.32***	195.67***	171.15***	−7.74	184.81***	1.14		194.12***
	(0.000)	(0.000)	(0.000)	(0.908)	(0.000)	(0.988)		(0.004)
BB-	277.49***	276.19***	302.25***		289.02***			
	(0.000)	(0.000)	(0.000)		(0.000)			
B+	212.40***	267.19***	259.51***		260.64***			
	(0.000)	(0.000)	(0.000)		(0.000)			
B	247.12***	200.56***	560.23***	346.35***	558.21***	330.88***		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
B-			315.00***		316.14***			
			(0.000)		(0.001)			
CCC+			54.21*		55.77			
			(0.083)		(0.309)			
Not rated	80.88***	171.61***	76.55***	−10.58	83.38*	−6.86	62.35***	208.11***
	(0.000)	(0.000)	(0.000)	(0.820)	(0.077)	(0.900)	(0.004)	(0.005)
Subordinated	50.42**	118.89***	40.00**	129.87***	32.83	139.65***		
	(0.033)	(0.000)	(0.043)	(0.000)	(0.113)	(0.000)		
Log maturity	19.76***	25.86***	−5.38	−6.48	−2.63	−13.67	−13.16	−0.24
	(0.000)	(0.000)	(0.239)	(0.444)	(0.616)	(0.159)	(0.192)	(0.990)
Log transaction size	−1.19	−7.53	−23.49***	−12.63**	−27.60***	−13.14**	23.27	−24.37**
	(0.630)	(0.291)	(0.000)	(0.013)	(0.000)	(0.014)	(0.213)	(0.020)
Number of tranches	−2.68**	−2.72*	1.27	7.06	4.32	7.71	2.33	6.16
	(0.036)	(0.087)	(0.705)	(0.114)	(0.237)	(0.128)	(0.671)	(0.528)
Currency risk	31.42***	26.51***	43.21***	46.50***	36.36***	41.72***	66.70	41.17*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.187)	(0.083)

(*continued on next page*)

Table 4 (*continued*)

Dependent variable: Credit spread (bps)	[1] Conventional bonds	[1a] Conventional bonds with firms' characteristics	[2] Sustainable bonds	[2a] Sustainable bonds with firms' characteristics	[3] Green bonds	[3a] Green bonds with firms' characteristics	[4] Social bonds	[5] Sustainability bonds
Callable	28.15***	18.38***	126.37***	125.02***	138.49***	129.24***	48.08	54.48**
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.448)	(0.017)
Experienced Green			−15.15**	−5.91	−37.03***	−27.43**		
			(0.034)	(0.645)	(0.002)	(0.026)		
Volatility	2.98***	3.47***	2.92***	2.87***	3.05***	2.84***	0.34	−0.29
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.749)	(0.820)
Country risk	2.82***	3.35**	2.33**	0.40	3.21***	0.54	32.23	−0.78
	(0.003)	(0.018)	(0.027)	(0.815)	(0.004)	(0.778)	(0.471)	(0.826)
COVID-19	−19.09	−5.93	−2.16	44.27*	14.45	51.51*	−23.15	16.70
	(0.258)	(0.564)	(0.928)	(0.097)	(0.593)	(0.052)	(0.251)	(0.536)
Log Total assets		−7.11***		−15.59**		−15.03**		
		(0.002)		(0.019)		(0.032)		
Total debt to total assets		133.63***		135.65***		120.34***		
		(0.000)		(0.000)		(0.003)		
Fixed assets to total assets		90.67		−135.68		−125.82		
		(0.441)		(0.431)		(0.460)		
Market to book value		−0.29*		0.66		2.74		
		(0.092)		(0.371)		(0.120)		
Return on assets		−1.86***		−0.34		0.15		
		(0.000)		(0.890)		(0.955)		
Use of proceeds fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2,615	1,318	1,200	369	984	333	64	152
Adjusted R^2	0.56	0.67	0.53	0.60	0.55	0.59	0.91	0.46
Rating dummies as as independent variables only								
Adjusted R^2	0.51	0.51	0.31	0.31	0.29	0.29	0.63	0.18
Differences in adjusted R^2	0.05	0.16	0.22	0.29	0.26	0.30	0.28	0.28

This table presents the results of OLS regressions examining the determinants of credit spreads for a global sample of sustainable and conventional bonds issued by nonfinancial firms between 2012 and 2022. The sample includes only those bonds for which both credit spread and tranche amount data are available. The category of sustainable bonds includes green, social, and sustainability (GSS) bonds. The conventional bond sample is restricted to bonds issued by firms that have also issued at least one GSS bond during the sample period, the switchers. Bond-level data were obtained from DCM Analytics, and firm-level data were sourced from Datastream. Models [1] through [5] are estimated on the full bond sample. Models [1a], [2a], and [3a] are estimated on a subsample for which detailed firm-level financial data are available. For each independent variable, the first row reports the estimated coefficient and the second row reports the p-value. Standard errors are heteroskedasticity robust and clustered at the country-year level. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. For a definition of the variables, see Table 2.

statistics – 16.1 for sustainable versus conventional bonds; 13.2 for green versus conventional bonds; 4.4 for social versus conventional bonds; and 14.2 for sustainability versus conventional bonds – all of which exceed the critical thresholds. Consequently, we analyze the determinants of credit spreads for each type of debt instrument separately.

Table 4 presents the results of estimating equation (1) using each of the four samples discussed in section 3.3. Models [1], [2], [3], [4], and [5] present pricing regression results for a sample of 2,615 conventional bonds, 1,200 sustainable bonds, 984 green bonds, 64 social bonds, and 152 sustainability bonds, respectively.[14] Table 4 presents the expected relationship between credit risk and credit spreads: bonds without ratings exhibit higher credit spreads, and as credit risk increases, so do credit spreads. For example, BBB + tranches have credit spreads that are significantly higher than AAA tranches – ranging from 9.9 to 143.1 bps across bond types. However, this relationship is non-linear, with the spread widening more sharply as credit quality declines.

We also estimate models [1], [2], [3], [4], and [5], using only not rated and credit rating dummies as independent variables, and find that these models yield adjusted R^2 values of 0.51, 0.31, 0.29, 0.63, and 0.18, respectively. This confirms that credit ratings are a key determinant of credit spreads for both conventional and sustainable bonds. Furthermore, when control variables beyond credit ratings are added, the adjusted R^2 increases more for sustainable bonds than for conventional bonds. For conventional bonds, the increase is only 0.05 in model [1], or 0.16 when firm characteristics are included (model [1a]). In contrast, for sustainable bonds, the adjusted R^2 increases by 0.22 and 0.29 in models [2] and [2a], respectively. Similarly, the increase is 0.26 and 0.30 for green bonds (models [3] and [3a]) and 0.28 for both social (model [4]) and sustainability bonds (model [5]). These findings suggest that investors do not rely solely on credit ratings when pricing either conventional or sustainable bonds. Moreover, additional information beyond the assigned rating appears to play a more prominent role in the pricing of sustainable bonds relative to conventional ones. Overall, the results are consistent with H1.

Interestingly, bond maturity is highly significant only for conventional bonds (models [1] and [1a]). Similarly, the number of tranches has a significant negative effect on credit spreads for conventional bonds but not for sustainable bonds. This suggests that conventional bond structures may be layered in a way that allows each tranche to benefit from credit protection provided by subordinated tranches. As expected, the subordinated bond dummy is positively and significantly associated with credit spreads for both conventional and sustainable bonds – specifically for green bonds in models [2], [2a], and [3a]. That is, higher subordination levels correspond to higher credit spreads, controlling for other factors.

The impact of transaction size on credit spreads is negative and significant for sustainable bonds in models [2] and [2a]: increasing the transaction size by €100 million reduces the spread by 46.9 bps in model [2] and by 25.3 bps in model [2a]. We also observe a positive liquidity effect for green (models [3] and [3a]) and sustainability bonds (model [5]). In contrast, transaction size does not significantly affect credit spreads for social bonds (model [4]). Similarly, the relationship is not statistically significant for conventional bonds.

The currency risk and callable bond dummies have a positive and significant effect on credit spreads across all bond types – except for social bonds. Notably, the magnitude of these effects is larger for sustainable bonds. For example, a currency mismatch increases the spread by 26.5 bps for conventional bonds (model [1a]), but by 46.5 bps for sustainable bonds (model [2a]). Similarly, a call option raises the spread by 18.4 bps for conventional bonds, compared to a much larger 125.0 bps for sustainable bonds.

Consistent with expectations, issuers with prior green bond issuance experience benefit from lower credit spreads (models [3] and [3a]), likely due to reduced learning costs and information asymmetry. Country risk is positively and significantly associated with credit spreads for conventional bonds, indicating that issuing from a BB + -rated country (rating = 11) rather than an AAA-rated country (rating = 1) raises spreads by 28.2 to 33.5 bps (models [1] and [1a]). This impact is insignificant for sustainable bonds in models [2a], [3a], [4], and [5]. This aligns with the results for credit ratings: instead of relying on the issuer's country risk, the pricing of sustainable bonds is influenced by other factors, such as the specific projects and the ESG objectives pursued by the issuers. Market volatility is positively and significantly related to credit spreads for both conventional and sustainable bonds, with the exception of models [4] and [5] (social and sustainability bonds). The COVID-19 dummy affects only sustainable bonds when firm-level controls are included (models [2a] and [3a]), showing a significant positive relationship.

Finally, Table 4 indicates that two firm-level characteristics – firm size and leverage – are significant predictors of lower credit spreads across all bond types. In model [1a], more profitable firms and those with higher market-to-book ratios also face lower spreads when issuing conventional bonds. However, these variables do not significantly affect spreads for sustainable bonds, particularly green bonds. We do not present models [4a] and [5a] due to the limited number of observations after adding firm-level controls (only 3 for social bonds and 33 for sustainability bonds).

Overall, our findings support H1: sustainable and conventional bonds are priced differently, and investors rely on additional factors beyond credit ratings, especially in the pricing of GSS bonds.

4.2. Do sustainable bonds offer lower credit spreads than comparable conventional bonds?

In this section, we investigate whether sustainable and conventional bond spreads differ significantly and whether green, social, and sustainability bonds are issued at a premium compared to conventional corporate bonds. If investors exhibit a preference or 'taste' for holding sustainable bonds, these bonds will be priced at a lower yield relative to conventional corporate bonds, supporting H2.

Table 5 presents the distribution of GSS bonds across credit rating categories for investment-grade bonds issued by switchers –

[14] Estimations have also been carried out by including year fixed effects multiplied by country fixed effects and results are available from the authors.

Table 5
Conventional, green, social, and sustainability bonds mean and median credit spreads by credit rating.

Credit rating	Conventional bonds			Green bonds			Social bonds			Sustainability bonds		
	Number	Credit spread		Number	Credit spread		Number	Credit spread		Number	Credit spread	
		Mean	Median		Mean	Median		Mean	Median		Mean	Median
2012–2022 Period												
AAA	6	82.5	78.0	2	71.7	71.7	0	0	0	8	80.8	75.9
AA+	87	77.8	75.0	4	79.1	69.5	0	0	0	0	0	0
AA	84	65.3	70.5	42	75.1	74.3	0	0	0	13	66.6	71.0
AA-	187	56.9	36.0	16	82.1	82.5	0	0	0	6	89.9	85.0
A+	378	95.3	90.0	45	117.2	105.0	37	20.2	20.0	23	84.63	87.0
A	182	113.7	107.8	65	117.4	120.0	5	32.0	17.0	18	101.6	95.0
A-	456	115.6	109.9	120	121.8	112.9	4	146	138	18	106.2	105.0
BBB+	423	151.1	137.0	139	136.7	122.4	4	179.7	181.8	23	151.2	144.5
BBB	236	168.6	164.8	109	191.6	176.0	0	0	0	14	175.7	143.8
BBB-	101	202.9	200.0	85	195.7	178.8	5	131.5	153.7	3	81.7	85.0
Pre-Covid period (from January 1, 2012 through to January 31, 2020)												
Credit rating	**Conventional bonds**			**Green bonds**			**Social bonds**			**Sustainability bonds**		
	Number	Credit spread		Number	Credit spread		Number	Credit spread		Number	Credit spread	
		Mean	Median		Mean	Median		Mean	Median		Mean	Median
AAA	2	65.4	65.4	1	80.0	80.0	0	0	0	3	58	54
AA+	51	71.5	68.0	3	91	82	0	0	0	0	0	0
AA	38	66.3	69.0	6	82.7	89.0	0	0	0	3	85.5	75.0
AA-	130	60.5	39.0	8	52.0	72.5	0	0	0	3	104	93
A+	195	87.4	87.5	11	112.4	110.0	2	22	22	0	0	0
A	141	102.3	103.8	20	113.2	116.6	0	0	0	1	98	98
A-	251	100.4	100.0	29	115.7	115.6	0	0	0	3	125.0	125.0
BBB+	256	142.7	130.0	36	120.9	117.3	1	79.5	79.5	4	110.3	102.9
BBB	127	161.1	165.0	22	178.5	117.2	0	0	0	2	270	270
BBB-	69	220.2	210.0	17	204.7	185.0	0	0	0	2	115.0	115.0
Covid period (from February 1, 2020 through to December 31, 2022)												
Credit rating	**Conventional bonds**			**Green bonds**			**Social bonds**			**Sustainability bonds**		
	Number	Credit spread		Number	Credit spread		Number	Credit spread		Number	Credit spread	
		Mean	Median		Mean	Median		Mean	Median		Mean	Median
AAA	4	91.0	91.5	1	63.4	63.4	0	0	0	5	94.2	77.2
AA+	36	86.7	80.0	1	42.5	42.5	0	0	0	0	0	0
AA	46	64.5	72.0	36	73.8	73.5	0	0	0	10	60.9	58.0
AA-	57	48.7	36.0	8	112.1	116.6	0	0	0	3	75.5	61.4
A+	183	103.7	93.0	34	118.8	102.5	35	20.0	20.0	23	84.6	87.0
A	41	152.6	135.0	45	119.2	120.0	5	32.0	17.0	17	101.8	95.0
A-	205	134.3	120.0	91	123.7	111.3	4	146	138	15	102.4	98.0
BBB+	167	163.8	155.0	103	142.2	124.1	3	213.1	181.8	19	159.8	145.0
BBB	109	177.3	164.5	87	194.9	176.0	0	0	0	12	160.0	135.0
BBB-	32	165.6	155.0	68	193.4	175.6	5	131.5	153.7	1	15.0	15.0

This table reports the number of observations, as well as the mean and median credit spreads, for conventional, green, social, and sustainability bonds, disaggregated by initial S&P and/or Moody's credit ratings. The sample includes only investment-grade bonds issued by switchers, defined as firms that issued both conventional and sustainable bonds during the sample period.

firms that issued both sustainable and conventional bonds during the 2012–2022 period. Among conventional bonds, only 0.3% are rated AAA. A similar proportion is observed for green bonds, while no social bonds are rated AAA. In contrast, sustainability bonds show a notably higher share in the top rating category, with 6.8% rated AAA. Most green bonds are concentrated in the lower investment-grade categories (BBB+, BBB, and BBB-), accounting for 53.1% of these bonds. Sustainability bonds, by comparison, have a distribution more closely aligned with that of conventional bonds, with 31.7% and 35.5% of bonds in the BBB category, respectively. The distribution remains broadly consistent when the sample is divided into the pre-COVID period (January 1, 2012-January 31, 2020) and the COVID period (February 1, 2020-December 31, 2022). For a detailed year-by-year breakdown of bond distributions, refer to Table 1 in the online appendix.

While the descriptive statistics in Table 5 provide initial insights into the pricing of sustainable versus conventional bonds, they also reveal mixed patterns across rating classes and time periods. In some cases, conventional bonds exhibit lower median credit spreads than sustainable bonds; in others – particularly during the COVID period – GSS bonds show more favorable pricing. For example, in the pre-COVID period, green bonds had lower median spreads than conventional bonds in the BBB+, BBB, and BBB- rating categories only. During the COVID period, this pattern becomes more pronounced across all GSS bond types. However, these univariate comparisons do not control for other pricing-relevant factors such as bond structure, issuer characteristics, or macroeconomic conditions. To rigorously evaluate whether sustainable bonds command a pricing advantage relative to comparable conventional bonds, we now turn to regression analysis that explicitly accounts for these micro- and macro-level determinants.

We begin our analysis by comparing credit spreads between sustainable and conventional bonds using Equation (1), augmented with a sustainable bond dummy variable, which equals 1 for green, social, or sustainability bonds, and 0 for conventional bonds. To address concerns related to bad control bias – particularly the inclusion of potentially endogenous firm- or bond-level variables – we adopt a sequential estimation strategy. Specifically, we estimate a series of models that progressively add control variables: starting

Table 6
The pricing of sustainable versus conventional bonds.

Dependent variable: Credit spread (bps)	[6] All bonds	[7] All bonds	[8] All bonds	[9] All bonds	[10] All bonds with firms' characteristics	[11] All bonds | Matched sample
Independent variables:						
Intercept	68.88***	135.23***	89.51*	187.46***	−59.55	−27.09
	(0.000)	(0.007)	(0.069)	(0.001)	(0.354)	(0.759)
Sustainable	18.23***	17.46***	28.23***	25.00***	3.04	1.73
	(0.000)	(0.008)	(0.000)	(0.000)	(0.753)	(0.833)
Not rated	72.41***	74.78***	87.75***	94.57***	171.08***	88.71***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subordinated		28.00*	33.30**	49.99***	89.04***	97.72***
		(0.061)	(0.029)	(0.002)	(0.000)	(0.010)
Log maturity		2.33	3.71**	11.29***	21.28***	12.75**
		(0.201)	(0.036)	(0.000)	(0.000)	(0.028)
Log transaction size		−4.38*	−5.53**	−9.68***	3.87	−0.28
		(0.089)	(0.029)	(0.000)	(0.234)	(0.949)
Number of tranches		−2.51*	−1.60	0.34	−1.36	−1.34
		(0.097)	(0.267)	(0.806)	(0.375)	(0.700)
Currency risk		33.17***	37.41***	33.99***	26.75***	52.28***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Callable		70.66***	68.14***	65.28***	41.81***	65.53***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experienced Green		−8.05	−13.43*	−11.79*	−7.68	−5.63
		(0.281)	(0.069)	(0.097)	(0.461)	(0.473)
Volatility			3.33***	3.06***	3.38***	3.00***
			(0.000)	(0.000)	(0.000)	(0.000)
Country risk			−0.57	2.74***	2.35**	2.12
			(0.435)	(0.000)	(0.022)	(0.113)
COVID-19			−37.39***	−14.33	7.21	7.60
			(0.000)	(0.279)	(0.506)	(0.555)
Log Total assets					−9.49***	
					(0.000)	
Total debt to total assets					136.47***	
					(0.000)	
Fixed assets to total assets					283.23***	
					(0.000)	
Market to book value					−0.22***	
					(0.000)	
Return on assets					−1.71***	
					(0.000)	
Credit rating fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Use of proceeds fixed effects	No	No	No	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	Yes	Yes
Year fixed effects	No	No	No	Yes	Yes	Yes
Number of observations	3,815	3,815	3,815	3,815	1,687	756
of which sustainable	1,200	1,200	1,200	1,200	375	378
of which conventional	2,615	2,615	2,615	2,615	1,312	378
Adjusted R^2	0.28	0.37	0.43	0.50	0.62	0.52

This table presents the results of OLS regressions examining the determinants of credit spreads for a global sample of sustainable and conventional bonds issued by nonfinancial firms between 2012 and 2022. The sample includes only those bonds for which both credit spread and tranche amount data are available. The category of sustainable bonds includes green, social, and sustainability (GSS) bonds. Bond-level data were obtained from DCM Analytics, and firm-level data were sourced from Datastream. The conventional bond sample is restricted to bonds issued by firms that also issued at least one GSS bond during the sample period (referred to as switchers). Model [10] focuses on a subsample of bonds with detailed issuer-level financial information. Model [11] is estimated on a subsample consisting of sustainable bonds and a matched sample of conventional bonds. The matched sample was created using a propensity score matching approach, employing a 1-to-1 matching algorithm that pairs each sustainable bond with the most similar conventional bond issued by the same firm in the same year, based on credit rating, bond size, and maturity. For each independent variable, the first row reports the estimated coefficient and the second row reports the p-value. Standard errors are heteroskedasticity robust and clustered at the country-year level. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. For a definition of the variables, see Table 2.

with rating dummies (model [6]), and then incrementally including contractual characteristics, macroeconomic factors, fixed effects, and finally firm-level financial variables (models [7] through [10]).

The results, presented in columns 1–4 of Table 6 for bonds issued by switchers (firms that issued both sustainable and conventional bonds in the sampling period), show that sustainable bonds are initially associated with higher credit spreads than conventional bonds. However, once firm-level characteristics are included in model [10] – which are key determinants of bond pricing – the coefficient on the sustainable dummy becomes statistically insignificant. This suggests that the initial spread difference may reflect firm-level differences rather than a premium or discount associated with sustainability per se. To further address potential endogeneity in the issuance decision, we follow the approach of Roberts and Whited (2013) and, similar to Flammer (2021), we re-estimate model [9] for a matched sample. We use a propensity score matching (PSM) approach to match each sustainable bond with the most comparable conventional bond, using a 1-to-1 matching algorithm that pairs each sustainable bond with the most similar conventional bond issued by the same firm in the same year, based on credit rating, bond size, and maturity. This procedure results in a final sample of 378 sustainable bonds matched with 378 quasi-identical conventional bonds. By design, the matched conventional bonds are issued by the same firms and are as similar as possible to the sustainable bonds, except that the latter are linked to ESG-related activities.

Results presented in column 6 of Table 6 show again that the sustainable bond spread does not differ significantly from that of matched conventional bonds..[15] These findings run counter to predictions in the theoretical literature on sustainable finance (e.g., Fama, 2021; Pedersen et al., 2021; Pástor et al., 2021; Gao and Schmittmann, 2022) as well as stakeholder theory (Freeman et al., 2012), which suggest that investors with ESG preferences may accept lower returns on sustainable instruments. Therefore, thus far and considering the three sustainable loan categories together in the same sample, our results do not support H2.

As shown in Table 3, the sample of sustainable bonds consists of 984 green bonds, 64 social bonds, and 152 sustainability bonds, all with available information on tranche/transaction size and spread. Table 7 presents the results of re-estimating the models from Table 6, where the sustainable dummy is replaced by three separate dummy variables for each sustainable bond category. The results from models [6a] to [9a] indicate that sustainability bonds do not exhibit statistically significant differences in credit spreads compared to conventional bonds. Interestingly, the findings suggest that green bonds are associated with higher credit spreads than comparable conventional bonds. In contrast, and in line with theoretical expectations, social bonds consistently exhibit lower credit spreads relative to conventional bonds across all model specifications.

However, when firm-level characteristics are included in model [10a], the coefficient for the green bond dummy becomes statistically insignificant, with only the social bond dummy remaining significant.[16] In the matched sample analysis (model [11a]), none of the sustainable bond dummies – green, social, or sustainability – are statistically significant. This indicates that credit spreads for sustainable bonds do not differ meaningfully from those of comparable conventional bonds. These results are consistent with findings by Tang and Zhang (2020) and Flammer (2021), who report no significant spread differentials between green and matched brown bonds. Our findings also align with Zerbib (2019) and, to a large extent, Lau et al. (2022), who conclude that investors may not systematically accept lower yields to finance environmental and social objectives.

Taken together, the evidence provides no robust support for a structural pricing advantage of green, social, or sustainability bonds relative to conventional bonds, and therefore does not support Hypothesis 2. Several factors may contribute to this result. First, information asymmetry and market frictions continue to complicate the pricing of sustainable bonds. Detailed contractual data – particularly for tranches with complete spread and rating information – remain limited. Second, ESG assessment methodologies lack full standardization, and cross-issuer comparability remains imperfect (Eren et al., 2022). As a relatively recent asset class, sustainable bonds may still be undergoing market learning and experimentation regarding contract design, certification practices, and the integration of ESG information into default risk assessments.

As market infrastructure matures and disclosure standards improve, pricing dynamics may evolve. Investors with ESG preferences may become more willing to accept lower expected returns in exchange for environmental or social impact, potentially generating a measurable greenium (Fama and French, 2007; Flammer, 2021; Löffler et al., 2021). In addition, sustainable bonds may serve as partial hedges against climate or transition risk (Pedersen et al., 2021; Pástor et al., 2021), while stronger certification and third-party verification could reduce information asymmetry and borrowing costs (DeMarzo, 2005; Yu, 2005; Gao and Schmittmann, 2022).

Overall, our findings contribute to the broader debate in sustainable finance concerning whether ESG preferences translate into measurable cost-of-capital effects. While taste-based and climate-risk hedging models predict a persistent greenium (Fama and French, 2007; Pástor et al., 2021), our evidence indicates that, in primary corporate bond markets, such pricing effects appear conditional rather than structural. In normal market conditions, sustainable labels alone do not reduce spreads once issuer fundamentals are controlled for. This interpretation is consistent with Berk and van Binsbergen (2025), who argue that the asset-pricing impact of ESG preferences may remain economically limited unless ESG-motivated capital represents a sufficiently large share of the market.

4.3. COVID-19 and the pricing of sustainable versus conventional bonds

In H3, we posit that the credit spread differential between sustainable and conventional bonds is amplified during crisis periods – that is, the spread differential becomes more negative in times of heightened uncertainty. To test this hypothesis, we interact a COVID-

[15] We also constructed an alternative PSM matching based on a wider vector of variables, namely rating, bond size, transaction size, maturity, number of tranches, callable, and currency risk. Untabulated results remain mostly unchanged, but the sample is considerably smaller.

[16] For social bonds, although they appear to be issued at lower spreads than comparable conventional bonds, these results should be interpreted with caution due to the limited sample size.

Table 7
The pricing of sustainable versus conventional bonds: category breakdown.

Dependent variable: Credit spread (bps)	[6a] All bonds	[7a] All bonds	[8a] All bonds	[9a] All bonds	[10a] All bonds with firms' characteristics	[11a] All bonds | Matched sample
Independent variables:						
Intercept	76.10***	135.05***	89.76*	186.64***	−58.33	21.72
	(0.000)	(0.008)	(0.071)	(0.001)	(0.363)	(0.807)
Green bond	25.90***	64.09***	74.09***	72.57***	40.36	34.66
	(0.000)	(0.000)	(0.000)	(0.000)	(0.109)	(0.169)
Social bond	−49.25***	−25.88***	−15.83**	−18.46***	−57.21***	−5.22
	(0.000)	(0.000)	(0.024)	(0.010)	(0.001)	(0.773)
Sustainability Bond	1.86	−2.66	7.20	1.15	−10.39	−4.78
	(0.819)	(0.733)	(0.354)	(0.886)	(0.102)	(0.542)
Not rated	63.32***	68.07***	80.88***	87.42***	179.34***	84.64***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subordinated		29.98**	34.98**	52.73***	89.09***	97.95***
		(0.044)	(0.021)	(0.001)	(0.000)	(0.010)
Log maturity		2.47	3.83**	11.50***	21.28***	12.76**
		(0.171)	(0.028)	(0.000)	(0.000)	(0.027)
Log transaction size		−4.15	−5.34**	−9.51***	3.13	−0.45
		(0.105)	(0.034)	(0.000)	(0.338)	(0.919)
Number of tranches		−2.29	−1.44	0.35	−1.19	−1.13
		(0.130)	(0.316)	(0.800)	(0.438)	(0.744)
Currency risk		30.56***	34.76***	31.16***	26.00***	52.04***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Callable		68.11***	65.42***	62.17***	41.92***	65.63***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experienced Green		−53.28***	−58.62***	−58.46***	−45.19*	−38.40
		(0.000)	(0.000)	(0.000)	(0.075)	(0.138)
Volatility			3.32***	3.02***	3.40***	2.99***
			(0.000)	(0.000)	(0.000)	(0.000)
Country risk			−0.52	2.87***	2.46**	2.01
			(0.469)	(0.000)	(0.016)	(0.132)
COVID-19			−35.48***	−14.84	7.87	6.71
			(0.000)	(0.269)	(0.490)	(0.594)
Log Total assets					−8.85***	
					(0.000)	
Total debt to total assets					134.63***	
					(0.000)	
Fixed assets to total assets					271.43***	
					(0.001)	
Market to book value					−0.20	
					(0.301)	
Return on assets					−1.63**	
					(0.011)	
Credit rating fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Use of proceeds fixed effects	No	No	No	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	Yes	Yes
Year fixed effects	No	No	No	Yes	Yes	Yes
Number of observations	3,815	3,815	3,815	3,815	1,687	756
of which green	984	984	984	984	339	309
of which social	64	64	64	64	3	12
of which sustainability	152	152	152	152	33	57
of which conventional	2,615	2,615	2,615	2,615	1,312	378
Adjusted R^2	0.29	0.38	0.44	0.51	0.62	0.52

This table presents the results of OLS regressions examining the determinants of credit spreads for a global sample of sustainable and conventional bonds issued by nonfinancial firms between 2012 and 2022. The sample includes only those bonds for which both credit spread and tranche amount data are available. The category of sustainable bonds includes green, social, and sustainability (GSS) bonds. Bond-level data were obtained from DCM Analytics, and firm-level data were sourced from Datastream. The conventional bond sample is restricted to bonds issued by firms that also issued at least one GSS bond during the sample period (referred to as switchers). Model [10a] focuses on a subsample of bonds with detailed issuer-level financial information. Model [11a] is estimated on a subsample consisting of sustainable bonds and a matched sample of conventional bonds. The matched sample was created using a propensity score matching approach, employing a 1-to-1 matching algorithm that pairs each sustainable bond with the most similar conventional bond issued by the same firm in the same year, based on credit rating, bond size, and maturity. Green bond is a dummy variable equal to 1 if the bond complies with the Green Bond Principles (GBP), and 0 otherwise. Social bond is a dummy variable equal to 1 if the bond complies with the Social Bond Principles (SBP), and 0 otherwise. Sustainability bond is a dummy variable equal to 1 if the bond complies with the Sustainability Bond Guidelines (SBG), and 0 otherwise. For each independent variable, the first row reports the estimated coefficient and the second row reports the p-value. Standard errors are heteroskedasticity robust and clustered at the country-year level. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. For a definition of the variables, see Table 2.

19 crisis dummy with the sustainable bond indicator. This specification allows us to examine whether the relative pricing of sustainable bonds changes during systemic stress, potentially reflecting investor non-pecuniary preferences, enhanced perceived resilience, or shifts in risk sentiment.

Although several macro-financial shocks occurred during our sample period (e.g., the 2014–2016 oil-price collapse, Brexit-related

Table 8
The pricing of sustainable versus conventional bonds in crisis periods.

Dependent variable: Credit spread (bps)	[12] All bonds	[13] All bonds	[14] All bonds	[15] All bonds	[16] All bonds with firms' characteristics	[17] All bonds | Matched sample
Independent variables:						
Intercept	58.45***	126.86**	85.16*	183.41***	−59.59	34.10
	(0.000)	(0.012)	(0.083)	(0.001)	(0.353)	(0.701)
Sustainable	32.82***	33.26***	38.28***	40.71***	3.20	16.14
	(0.000)	(0.000)	(0.000)	(0.000)	(0.798)	(0.591)
Sustainable*COVID-19	−29.29***	−26.80***	−15.45**	−23.53***	−17.26**	−19.19**
	(0.001)	(0.001)	(0.038)	(0.001)	(0.047)	(0.023)
COVID-19	19.67***	11.87***	32.68***	−5.49	7.29	17.06
	(0.000)	(0.000)	(0.000)	(0.685)	(0.507)	(0.214)
Not rated	75.80***	77.34***	89.08***	96.30***	171.12***	89.68***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subordinated		25.13*	31.93**	47.63***	89.03***	99.14***
		(0.095)	(0.035)	(0.003)	(0.000)	(0.009)
Log maturity		2.40	3.74**	11.39***	21.28***	13.15**
		(0.185)	(0.034)	(0.000)	(0.000)	(0.023)
Log transaction size		−4.26*	−5.42**	−9.58***	3.87	−0.29
		(0.099)	(0.032)	(0.000)	(0.234)	(0.948)
Number of tranches		−2.98**	−1.78	0.14	−1.36	−1.51
		(0.050)	(0.215)	(0.921)	(0.374)	(0.661)
Currency risk		33.08***	37.32***	33.98***	26.75***	52.77***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Callable		69.55***	67.87***	65.48***	41.82***	66.03***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experienced Green		−8.58	−13.79*	−12.38*	−7.67	−7.10
		(0.251)	(0.062)	(0.081)	(0.456)	(0.357)
Volatility			3.29***	3.04***	3.38***	3.00***
			(0.000)	(0.000)	(0.000)	(0.000)
Country risk			−0.58	2.69***	2.35**	2.11
			(0.427)	(0.000)	(0.022)	(0.110)
Log Total assets					−9.49***	
					(0.000)	
Total debt to total assets					136.46***	
					(0.000)	
Fixed assets to total assets					283.24***	
					(0.000)	
Market to book value					−0.22***	
					(0.000)	
Return on assets					−1.71***	
					(0.008)	
Credit rating fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Use of proceeds fixed effects	No	No	No	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	Yes	Yes
Year fixed effects	No	No	No	Yes	Yes	Yes
Number of observations	3,815	3,815	3,815	3,815	1,687	756
of which sustainable	1,200	1,200	1,200	1,200	375	378
of which conventional	2,615	2,615	2,615	2,615	1,312	378
Adjusted R^2	0.29	0.37	0.43	0.5	0.62	0.52

This table presents the results of OLS regressions examining the determinants of credit spreads for a global sample of sustainable and conventional bonds issued by nonfinancial firms between 2012 and 2022. The sample includes only those bonds for which both credit spread and tranche amount data are available. The category of sustainable bonds includes green, social, and sustainability (GSS) bonds. COVID-19 is a dummy variable equal to 1 if the bond was issued between February 1, 2020, and December 31, 2022, and 0 otherwise. Bond-level data were obtained from DCM Analytics, and firm-level data were sourced from Datastream. The conventional bond sample is restricted to bonds issued by firms that also issued at least one GSS bond during the sample period (referred to as switchers). Model [16] focuses on a subsample of bonds with detailed issuer-level financial information. Model [17] is estimated on a subsample consisting of sustainable bonds and a matched sample of conventional bonds. The matched sample was created using a propensity score matching approach, employing a 1-to-1 matching algorithm that pairs each sustainable bond with the most similar conventional bond issued by the same firm in the same year, based on credit rating, bond size, and maturity. For each independent variable, the first row reports the estimated coefficient and the second row reports the p-value. Standard errors are heteroskedasticity robust and clustered at the country-year level. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. For a definition of the variables, see Table 2.

uncertainty, and the 2018–2019 US-China trade tensions), we focus on COVID-19 because it represents an abrupt, global, and highly synchronized "risk-off" episode. The pandemic simultaneously affected funding conditions, investor risk appetite, and the valuation of non-financial attributes – including sustainability-related characteristics – across markets. To ensure that our results are not driven by other contemporaneous shocks, we include year fixed effects to absorb annual shifts in macroeconomic conditions and control for global market uncertainty using the VIX, a standard proxy for risk sentiment that directly influences credit spreads.

Table 8 presents the results of models [12] through [17], which replicate the specifications from Table 6, now incorporating the COVID-19 interaction term. Consistent with earlier results (Table 6), the sustainable bond dummy is positively and significantly associated with credit spreads in models [12] to [15], but becomes statistically insignificant once firm-level characteristics are included (model [16]) or when the analysis is restricted to the matched sample of conventional bonds (model [17]). Similarly, the COVID-19 dummy itself has a positive and significant effect on credit spreads, although this effect is observed only in models without year fixed effects (models [12] to [14]).

Most notably, the interaction term between the sustainable bond and COVID-19 dummies is negative and statistically significant across all model specifications, suggesting that during the COVID-19 crisis, sustainable bonds were associated with lower spreads relative to conventional bonds, even after controlling for bond- and firm-level factors. These findings support the notion that ESG-oriented bonds may offer downside protection or become more attractive to investors in times of elevated uncertainty, thereby supporting H3.

Table 9 presents the results of re-estimating the models from Table 7, this time interacting the green, social, and sustainability bond dummies with the COVID-19 dummy. This approach allows us to assess whether the spread of each category of sustainable bonds differed from that of conventional bonds during the pandemic period.

Consistent with previous findings, green bonds are associated with higher credit spreads than conventional bonds in the pre-COVID-19 period, as indicated by a positive and statistically significant coefficient on the green bond dummy across most specifications (except model [16a], which controls for firm characteristics). However, the significant and negative coefficient on the interaction term between the green and COVID-19 dummies suggests that this spread differential narrowed during the pandemic. In other words, the initially higher spread on green bonds was no longer statistically distinguishable from that of conventional bonds during the COVID period – consistent with the results in Table 7.

For social bonds, the results generally indicate no statistically significant difference in spreads relative to conventional bonds during the COVID-19 period. Although model [16a] suggests a potential pricing advantage, this result should be interpreted cautiously given the extremely limited sample size (three observations).

For sustainability bonds, we do not observe a significant spread differential in the pre-COVID period. However, the negative and statistically significant interaction term indicates that, during the pandemic, sustainability bonds were issued at lower spreads than comparable conventional bonds. This pattern suggests that crisis conditions strengthened the relative pricing of sustainability bonds.

Overall, these findings are consistent with recent evidence documenting a crisis-period greenium during COVID-19 (e.g., Arat et al., 2023; Giovanardi et al., 2023; Caramichael and Rapp, 2024; Zaghini, 2024) and with studies showing that investor demand for sustainable assets intensified during the pandemic (e.g., Aloui et al., 2023). Importantly, the emergence of a pricing advantage only during periods of systemic stress suggests that ESG characteristics may operate as a state-contingent pricing factor rather than a permanent one. In normal market conditions, sustainable and conventional bonds appear to have similar credit spreads once issuer fundamentals are controlled for. During crisis episodes, however, ESG attributes may function as a credibility, resilience, or trust signal, mitigating perceived downside risk and supporting demand. This interpretation reconciles the absence of an average greenium with the crisis-specific differential observed in our analysis.

Taken together, these results provide empirical support for H3 and indicate that ESG-linked bonds, particularly green and sustainability bonds, benefit from relatively more favorable pricing during periods of elevated uncertainty.

5. Additional sensitivity tests

5.1. Bond pricing and borrowing choice

To address potential selection bias and endogeneity in the decision to issue sustainable bonds, we implement an endogenous switching regression model following Lokshin and Sajaia (2004). This approach jointly estimates (*i*) the firm's choice between issuing a sustainable versus a conventional bond, and (*ii*) the credit spread equation conditional on that choice. By modeling both selection and outcome equations simultaneously, this method accounts for unobserved heterogeneity that may influence both the bond issuance decision and its pricing, thereby enhancing the validity of our empirical findings.

We estimate the endogenous switching regression using the full information maximum likelihood (FIML) method, jointly modeling the credit spread equations (models [18] and [19] in Table 10) along with a probit selection equation. In the selection stage, the firm's choice between issuing a sustainable or conventional bond is modeled as a function of contractual characteristics, macroeconomic variables, and firm-level financial indicators.[17] The empirical model consists of the following three equations:

$$Creditspreadsustainablebonds_{i,t} = \alpha_0 + \gamma Contractualcharacteristics_{i,t} + \varphi Macroeconomicfactors_t + \delta Firmcharacteristics_{i,t-1} + \varepsilon_{i,t}$$

[17] We implement a FIML method to simultaneously estimate binary and continuous parts of the model in order to yield consistent standard errors. For further analysis, see Lokshin and Sajaia (2004).

Table 9
The pricing of sustainable versus conventional bonds in crisis periods: category breakdown.

Dependent variable: Credit spread (bps)	[12a] All bonds	[13a] All bonds	[14a] All bonds	[15a] All bonds	[16a] All bonds with firms' characteristics	[17a] All bonds | Matched sample
Independent variables:						
Intercept	65.46***	128.12**	87.13*	181.44***	−56.78	−31.59
	(0.000)	(0.012)	(0.080)	(0.001)	(0.378)	(0.722)
Green bond	36.00***	72.61***	78.31***	79.94***	38.87	26.28*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.128)	(0.065)
Green bond*COVID-19	–23.39**	−19.19**	−8.00**	−13.74*	−4.20*	−16.91**
	(0.011)	(0.019)	(0.031)	(0.067)	(0.069)	(0.040)
Social bond	−59.15***	−31.90*	−26.36	−1.43	−18.77**	25.11
	(0.000)	(0.054)	(0.243)	(0.929)	(0.040)	(0.168)
Social bond*COVID-19	−0.57	−0.81	9.64	−20.27	−57.35***	−34.72
	(0.945)	(0.963)	(0.680)	(0.236)	(0.000)	(0.208)
Sustainability Bond	17.51	14.23	16.49	25.22	–23.00	16.20
	(0.150)	(0.212)	(0.146)	(0.311)	(0.160)	(0.269)
Sustainability bond*COVID-19	−29.00*	−26.65*	−12.47**	−30.87**	15.02	−27.40**
	(0.056)	(0.062)	(0.037)	(0.031)	(0.393)	(0.012)
COVID-19	19.33***	11.61***	33.03***	−8.66	6.61	15.75
	(0.000)	(0.000)	(0.000)	(0.526)	(0.566)	(0.248)
Not rated	67.30***	70.95***	82.12***	90.42***	179.03***	89.24***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subordinated		27.39	34.20**	51.03***	89.24***	98.87***
		(0.068)	(0.024)	(0.002)	(0.000)	(0.010)
Log maturity		2.55	3.86**	11.59***	21.26***	13.08**
		(0.157)	(0.027)	(0.000)	(0.000)	(0.023)
Log transaction size		−4.11	−5.29**	−9.47***	3.14	−0.57
		(0.109)	(0.035)	(0.000)	(0.337)	(0.899)
Number of tranches		−2.75*	−1.54	0.23	−1.19	−1.22
		(0.071)	(0.285)	(0.869)	(0.438)	(0.724)
Currency risk		30.47***	34.71***	31.02***	26.16***	52.24***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Callable		66.98***	65.38***	62.57***	41.56***	66.59***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experienced Green		−52.08***	−57.84***	−57.14***	46.63*	−38.61
		(0.000)	(0.000)	(0.000)	(0.068)	(0.134)
Volatility			3.30***	3.01***	3.41***	3.00***
			(0.000)	(0.000)	(0.000)	(0.000)
Country risk			−0.52	2.86***	2.45**	2.04
			(0.471)	(0.000)	(0.017)	(0.123)
Log Total assets					−8.81***	
					(0.000)	
Total debt to total assets					134.82***	
					(0.000)	
Fixed assets to total assets					270.86***	
					(0.001)	
Market to book value					−0.20	
					(0.294)	
Return on assets					−1.61**	
					(0.012)	
Credit rating fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Use of proceeds fixed effects	No	No	No	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	Yes	Yes
Year fixed effects	No	No	No	Yes	Yes	Yes
Number of observations	3,815	3,815	3,815	3,815	1,687	756
of which green	984	984	984	984	339	309
of which social	64	64	64	64	3	12
of which sustainability	152	152	152	152	33	57
of which conventional	2,615	2,615	2,615	2,615	1,312	378
Adjusted R^2	0.29	0.38	0.44	0.51	0.62	0.53

This table presents the results of OLS regressions examining the determinants of credit spreads for a global sample of sustainable and conventional bonds issued by nonfinancial firms between 2012 and 2022. The sample includes only those bonds for which both credit spread and tranche amount data are available. The category of sustainable bonds includes green, social, and sustainability (GSS) bonds. COVID-19 is a dummy variable equal to 1 if the bond was issued between February 1, 2020, and December 31, 2022, and 0 otherwise. Bond-level data were obtained from DCM Analytics, and firm-level data were sourced from Datastream. The conventional bond sample is restricted to bonds issued by firms that also issued at least one GSS bond during the sample period (referred to as switchers). Model [16a] focuses on a subsample of bonds with detailed issuer-level financial information. Model [17a] is estimated on a subsample consisting of sustainable bonds and a matched sample of conventional bonds. The matched sample was created using a propensity score matching approach, employing a 1-to-1 matching algorithm that pairs each sustainable bond with the most similar conventional bond issued by the same firm in the same year, based on credit rating, bond size, and maturity. Green bond is a dummy variable equal to 1 if the bond complies with the Green Bond Principles (GBP), and 0 otherwise. Social bond is a dummy variable equal to 1 if the bond complies with the Social Bond Principles (SBP), and 0 otherwise. Sustainability bond is a dummy variable equal to 1 if the bond complies with the Sustainability Bond Guidelines (SBG), and 0 otherwise. For each independent variable, the first row reports the estimated coefficient and the second row reports the p-value. Standard errors are heteroskedasticity robust and clustered at the country-year level. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. For a definition of the variables, see Table 2.

$$Creditspreadconventionalbonds_{i,t} = \alpha_0 + \gamma Contractualcharacteristics_{i,t} + \varphi Macroeconomicfactors_t + \delta Firmcharacteristics_{i,t-1} + \varepsilon_{i,t}$$

$$I^*_{i,t} = \delta_0 (Creditspreadsustainablebonds_{i,t} - Creditspreadconventionalbonds_{i,t}) + \gamma Contractualcharacteristics_{i,t} + \varphi Macroeconomicfactors_t + \delta Firmcharacteristics_{i,t-1} + u_{i,t}$$

where the third equation models bond selection: if $I^*_i > 0$, then firm i issues a sustainable bond; otherwise it issues a conventional bond. We adjust for heteroscedasticity and due to time varying risk premia and cross-country differences, we estimate standard errors clustered by year and country. Based on the Wald test statistic for the independence of equations, we fail to reject the null hypothesis that the selection and outcome equations are independent. This suggests that the firm's choice between issuing a sustainable or conventional bond does not systematically influence the pricing of the bond, reinforcing the validity of treating the issuance decision and pricing as separable processes in our main analysis.

To examine further if characteristically similar bond tranches, which differ by deal type, have different spreads, we computed the average treatment effect (ATE) for spreads of sustainable versus conventional bonds. We used models [1] and [2] of Table 4 and obtained the correct standard errors (as we account for the errors in the selection equation) for the ATE through bootstrapping. The results confirm that sustainable bond spreads do not differ significantly from those of conventional bonds issued by switchers – firms that issued both bond types during the sample period. This finding is inconsistent with H2, which posits that sustainable bonds should command lower spreads, but in line with previous results. However, results presented in Table 10 reaffirm that the influence of contractual, macroeconomic, and firm-level characteristics on credit spreads differs between sustainable and conventional bonds. Moreover, non-rating information plays a more prominent role in the pricing of sustainable bonds. These findings are consistent with earlier results and provide further support for H1.

Although a comprehensive analysis of the determinants underlying the choice between sustainable and conventional bond financing is beyond the scope of this paper, Table 10 reveals several noteworthy patterns. The findings suggest that the likelihood of sustainable bond issuance increases as credit ratings improve – that is, higher-rated deals are more often associated with sustainable bonds. This pattern may indicate that sustainable bond issuance is primarily driven by firms with stronger credit profiles, which may face fewer constraints in aligning with ESG frameworks and more easily meet the disclosure and certification requirements often associated with sustainable debt. It may also reflect investor preference for sustainable instruments issued by financially sound firms.

In addition, nonfinancial firms tend to rely on conventional bonds for longer-term funding, while the COVID-19 pandemic appears to have increased the likelihood of sustainable bond issuance, especially for social and sustainability bonds, which were often used to fund pandemic-related responses.

With respect to firm-level characteristics, sustainable bond issuance is more common among firms that are less leveraged and less profitable. Although this may appear counterintuitive, it could reflect self-selection by firms aiming to enhance their credibility and access to capital through sustainability-linked financing, or a desire to tap investor segments more tolerant of lower financial performance in exchange for ESG alignment.

These findings highlight the complexity of the financing decision and suggest that the choice between sustainable and conventional bonds may be shaped by a combination of strategic positioning, market segmentation, and issuer fundamentals. We view a more in-depth investigation into the determinants of firms' sustainable bond financing choices as a promising avenue for future research.

5.2. Additional controls

To further validate the findings presented in Tables 6–9, we conduct several additional robustness analyses. First, we examine whether the inclusion of variables excluded from the baseline regressions due to data limitations – such as deal fees and the Vigeo ESG rating (Crifo et al., 2017) – affects our results. Although incorporating these controls reduces the sample size, the core findings remain unchanged. This suggests that our conclusions are not driven by omitted pricing components or alternative ESG rating measures.

Second, we test the geographic robustness of our results by re-estimating the models for subsamples of bonds issued by firms located in the European Union, the United Kingdom, and the United States. These regions together account for 77.7% of sustainable bond issuance and 76.6% of conventional bond issuance in our dataset. The results remain qualitatively consistent across regions. In addition, we include year-by-country fixed effects to control for unobserved macroeconomic and institutional heterogeneity at the country level.

Third, to ensure that our findings are not sensitive to the structure of time controls, we replace year fixed effects with quarter fixed effects. The inclusion of quarter fixed effects allows us to absorb unobserved macro-financial conditions and contemporaneous shocks common to all issuances within each quarter. The results, reported in Section 6 of the Online appendix, remain qualitatively unchanged, indicating that our conclusions are robust to alternative specifications of time effects. Across all robustness checks, the main inferences remain stable, reinforcing the validity of our primary findings.

Table 10
Endogenous switching regression models.

Dependent variable:	[18]		[19]	
Credit spread (bps)	Conventional bonds	Sustainable bonds	Conventional bonds	Sustainable bonds
Independent variables:				
Intercept	−70.78	543.94	48.60	350.59**
	(0.805)	(0.711)	(0.776)	(0.030)
Rating	7.80**	−1.80	7.67***	−2.78
	(0.011)	(0.934)	(0.000)	(0.301)
Subordinated	52.15	98.19	111.05***	167.99***
	(0.603)	(0.593)	(0.007)	(0.000)
Log maturity	16.07**	−14.91	20.00***	−27.84
	(0.016)	(0.809)	(0.000)	(0.127)
Log transaction size	1.59	–32.39*	−6.44	−9.89**
	(0.919)	(0.063)	(0.402)	(0.031)
Number of tranches	1.48	−11.57	−4.86**	7.60
	(0.873)	(0.826)	(0.016)	(0.183)
Currency risk	34.60	1.57	43.03***	33.97**
	(0.146)	(0.991)	(0.000)	(0.030)
Callable	14.85**	124.20***	0.60	84.53***
	(0.046)	(0.000)	(0.945)	(0.000)
Volatility	3.61*	−0.65	3.89***	2.98***
	(0.081)	(0.963)	(0.000)	(0.000)
Country risk	6.21*	11.38**	−2.08	−3.30
	(0.086)	(0.028)	(0.603)	(0.222)
Covid-19	−79.24	96.61	−72.91	−41.89
	(0.255)	(0.820)	(0.987)	(0.346)
Log Total assets			−9.62**	–23.31***
			(0.024)	(0.000)
Total debt to total assets			112.63***	190.27***
			(0.000)	(0.005)
Fixed assets to total assets			62.49	−112.81
			(0.232)	(0.599)
Market to book value			−0.16	−1.14
			(0.542)	(0.156)
Return on assets			0.64**	−0.57
			(0.029)	(0.794)

Dependent variable: Probability of observing:	Sustainable versus Conventional bonds	Sustainable versus Conventional bonds
Independent variables:		
Intercept	2.12	1.51
	(0.620)	(0.654)
Rating	−0.44**	−0.04**
	(0.047)	(0.012)
Subordinated	0.09	1.00**
	(0.933)	(0.014)
Log maturity	−0.11*	−0.11*
	(0.061)	(0.052)
Log transaction size	−0.12	−0.06
	(0.659)	(0.727)
Number of tranches	−0.09	−0.09
	(0.683)	(0.295)
Currency risk	−0.12	−0.21
	(0.786)	(0.332)
Callable	0.46*	0.24
	(0.080)	(0.292)
Volatility	−0.02	−0.02*
	(0.668)	(0.076)
Country risk	0.08	0.06
	(0.124)	(0.284)
Covid-19	0.84**	1.01***
	(0.037)	(0.005)
Log Total assets		−0.03
		(0.693)
Total debt to total assets		−0.84**
		(0.017)
Fixed assets to total assets		−2.36
		(0.372)

(*continued on next page*)

Table 10 (*continued*)

Dependent variable:	[18]		[19]	
Credit spread (bps)	Conventional bonds	Sustainable bonds	Conventional bonds	Sustainable bonds
Market to book value			0.00	
			(0.543)	
Return on assets			−0.03	**
			(0.032)	
Use of proceeds fixed effects	Yes		Yes	
Industry fixed effects	Yes		Yes	
Year fixed effects	Yes		Yes	
Number of observations	3,815		1,687	
Average treatment effect	7.31		6.43	
	(0.234)		(0.344)	
Wald chi2	156.88***		239.70***	
Log pseudolikelihood	–23,826.92		−10,341.62	
Wald test of indep. equations	0.43		0.82	

This table presents the results of estimating endogenous switching regression models for a global sample of sustainable and conventional bonds issued by nonfinancial firms between 2012 and 2022. The sample includes only those bonds for which both credit spread and tranche amount data are available. The category of sustainable bonds includes green, social, and sustainability (GSS) bonds. Bond-level data were obtained from DCM Analytics, and firm-level data were sourced from Datastream. The conventional bond sample is restricted to bonds issued by firms that also issued at least one GSS bond during the sample period (referred to as switchers). We implement the full information maximum likelihood (FIML) method to simultaneously estimate binary and continuous parts of the model in order to yield consistent standard errors. For each independent variable, the first row reports the estimated coefficient and the second row reports the p-value. Standard errors are heteroskedasticity robust and clustered at the country-year level. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. For a definition of the variables, see Table 2.

5.3. A deal-level analysis

As shown in Table 3, the average number of tranches per deal ranges from 1.5 for green bonds to 2.4 for conventional bonds. In multi-tranche deals, issuers often structure tranches to appeal to investors with different risk-return preferences. Therefore, a firm's total cost of borrowing is determined not by any single tranche, but by the weighted average pricing across all tranches within the deal. To capture this, we compute the weighted average spread (WAS) for each bond deal, calculated as the sum of the product of each tranche's share of the total transaction amount and its corresponding credit spread. We apply the same weighting approach to other deal-level characteristics, such as weighted average maturity (WAM) and weighted average rating (WAR). Consistent with our tranche-level findings, the results indicate that the WAS for sustainable and conventional bond deals does not differ significantly in the full sample. Consistent with the tranche-level analysis, during the COVID-19 period, we observe a reduction in WAS for green and sustainability bond deals relative to comparable conventional deals, suggesting that investors may have priced these instruments more favorably in times of crisis.

6. Conclusion

This paper provides a comprehensive analysis of primary market pricing for sustainable bonds −green, social, and sustainability (GSS) − relative to conventional bonds. Using a switcher-based design and a propensity score-matched sample, we compare bonds issued by the same firm under similar contractual conditions. Our findings indicate that sustainable and conventional bonds are not priced identically, but the differences in credit spreads are conditional rather than structural.

We document that investors appear to rely less heavily on traditional credit ratings when pricing sustainable bonds relative to conventional bonds. This suggests that ESG attributes and certification mechanisms may partially substitute for conventional credit signals in certain contexts. However, once firm-level fundamentals are controlled for, sustainable bonds do not exhibit a systematic pricing advantage in normal market conditions. This result is robust across multiple estimation techniques, including matched sample regressions and endogenous switching regression models.

From a theoretical perspective, our findings contribute to the ongoing debate on whether ESG preferences translate into measurable cost-of-capital effects. While taste-based and climate-risk hedging models predict a persistent greenium, our evidence indicates that such pricing effects are state-contingent. In tranquil periods, sustainable labels alone do not reduce spreads once issuer risk characteristics are properly accounted for. During the COVID-19 crisis, however, green and sustainability bonds were associated with relatively lower spreads, suggesting that ESG attributes may function as a credibility or resilience signal under systemic stress. These results reconcile the absence of an average greenium with the crisis-specific differential observed in our analysis.

The practical implications are threefold. First, for corporate issuers, sustainable bond issuance should not be viewed as a guaranteed mechanism for lowering borrowing costs in normal market conditions. Instead, its benefits may be strategic, reputational, or crisis-contingent. Firms with stronger credit profiles appear better positioned to access sustainable debt markets, indicating that ESG financing complements rather than substitutes traditional credit strength.

Second, for institutional investors, our findings suggest that integrating sustainable bonds into fixed-income portfolios does not systematically imply yield sacrifice under normal conditions. However, the relative pricing advantage observed during crisis periods indicates that ESG-aligned bonds may enhance portfolio resilience when uncertainty rises.

Third, for policymakers and regulators, the absence of a structural greenium highlights the importance of improving disclosure standards, ESG taxonomy harmonization, and certification credibility. Incomplete standardization, rating divergence (Berg et al., 2022), and limited comparability across ESG metrics (Eren et al., 2022) contribute to persistent information asymmetry. Strengthening transparency and harmonizing ESG evaluation methodologies may improve pricing efficiency and support capital allocation toward sustainable projects.

The primary limitation of this study remains the quality and availability of historical data. Sustainable bond markets are still evolving, and data on key pricing components – such as tranche-level spreads and consistent ESG measures – remain limited, particularly for social and sustainability bonds. As regulatory frameworks mature – such as the EU Taxonomy Regulation (EU 2020/852) and the SEC's ESG disclosure initiatives – future research will be better positioned to assess whether improved standardization generates more persistent pricing differentials.

Overall, our findings suggest that sustainable bond pricing reflects a market in transition. ESG attributes do not yet generate a structural cost-of-capital advantage, but they may provide conditional benefits in periods of systemic stress. Understanding this distinction is essential for evaluating the effectiveness of sustainable finance as a mechanism for reallocating capital toward environmental and social objectives.

CRediT authorship contribution statement

João Pinto: Conceptualization, Methodology, Validation, Writing – review & editing, Supervision. **Diva Ribeiro:** Writing – original draft, Software, Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jimonfin.2026.103586.

Data availability

The authors do not have permission to share data.

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