



UNIVERSIDADE CATÓLICA PORTUGUESA

Do sustainable bonds have lower spreads than traditional corporate bonds?

José Manuel Ferreira Padrão de Morais

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José Manuel Ferreira Padrão de Morais

Under supervision of

Professor João Filipe Monteiro Pinto

Faculdade de Economia e Gestão da Universidade Católica Portuguesa do
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Resumo

Nesta dissertação procede-se à investigação sobre a possível existência de um *greenium* no mercado obrigacionista; i.e., se as obrigações sustentáveis, emitidas por empresas, são transacionadas com um *spread* mais baixo que obrigações convencionais. Através de uma amostra composta por 974 obrigações sustentáveis emparelhadas com 974 obrigações convencionais, aplicamos um método de regressão OLS para testar a existência de um *premium* em obrigações sustentáveis. Os nossos resultados não indicam qualquer diferença significativa entre os *spreads*, com exceção para obrigações sociais e particularmente obrigações sociais emitidas por empresas europeias, emitidas por empresas na indústria financeira e emitidas por empresas na indústria de energia. No entanto, devido a um baixo número de obrigações sociais nas nossas amostras, os resultados relativos a obrigações sociais não são robustos.

Palavras-chave: ESG, sustentabilidade, obrigações sustentáveis, obrigações empresariais, obrigações verdes, obrigações sociais, obrigações de sustentabilidade, *greenium*, finanças sustentáveis.

Número de palavras: 8 430 palavras

Abstract

This study investigates whether corporate sustainable bonds trade at lower spreads than corporate conventional bonds. Using a dataset 974 sustainable bonds paired with 974 conventional bonds, we employed an OLS regression method to test for the existence of this sustainable bond premium. Results indicate no significant difference between spreads, with exception to social bonds, particularly social bonds from European issuers, from issuers in the Finance industry and issuers in the Utility & Energy industry. However, due to a low representation of social bonds in our samples, the results for social bonds are not robust.

Keywords: ESG, sustainability, sustainable bonds, corporate bonds, green bonds, social bonds, sustainability bonds, greenium, sustainable finance.

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Chapter 1

Introduction

In 2007, the European Investment Bank issued the “climate awareness bond”, now deemed by many as the first sustainable bond ever created. Since then, sustainable bonds have become increasingly popular, with sustainable bond issuance totalling around \$800.20 billion in 2024, a 9% increase from 2023 (LSEG, 2024).

One phenomenon that has been discussed within literature relating to sustainable bonds is the greenium effect – a yield discount observed in green bonds when compared to conventional bonds. Similarly to greenium, researchers have debated whether the same phenomenon seems to exist with the other types of sustainable bonds, including sustainability and social bonds. Proponents of this phenomenon argue that investors are willing to accept lower returns in exchange for financing projects with positive environmental and social impact (Hinsche, 2021; Macaire & Naef, 2023; Packer & Ehlers, 2017; Preclaw & Bakshi, 2015). Empirical research on greenium shows mixed results. Some studies confirm the existence of greenium (Hinsche, 2021; Macaire & Naef, 2023; Packer & Ehlers, 2017; Preclaw & Bakshi, 2015), with the magnitude of the phenomenon being influenced by credit rating (Hinsche, 2021), sector of the issuer (Hinsche, 2021) and external certifications (Hyun et al., 2020). Other studies find no significant yield discount (Flammer, 2021; Larcker & Watts, 2020; Pinto & Ribeiro, 2024). Hyun et al (2020) finds no significant yield discount, unless the bond is certified by external reviewers (e.g., by Climate Bonds Initiative).

This study intends to understand if corporate sustainable bonds, in general and divided by sustainable bond type, trade at significantly lower yields than

comparable corporate conventional bonds. We also aim to understand if the geographical region and industry of the issuer influence the existence and the magnitude of the premium. To conduct this analysis, we utilize two samples. Firstly, a sample composed of 1,948 bonds, of which 974 are conventional and 974 are sustainable. We call this our “full sample”. Secondly, a sample of 1,088 bonds, of which 544 are conventional and 544 are sustainable. We call this our “restricted sample”. Both samples were created using a matching methodology, which matches sustainable bonds with a conventional bond issued by the same company and within 365 days of the issuance date of the sustainable bond. However, for the restricted sample, we apply an additional filter where the difference of maturity dates between the matched conventional and sustainable bonds can't be higher than 365 days. Based on these two samples, we employ an OLS regression method further discussed in chapter 3.

Our findings show no significant difference in spreads between sustainable bonds and conventional bonds in general and this result holds for green and sustainability bonds. Social bonds do show a significant premium of -22.13 bps and -19.39 bps in our full and restricted matched samples, respectively.

Sustainable bonds issued in Europe also show no significant premium, with exception for social bonds, with a weakly significant premium of -25.55 bps, according to our restricted sample. As for North America, none of the sustainable bond types show significant difference of spread when compared to conventional bonds.

Social bonds in the Finance and Utility & Energy industries show a significant premium of -21.04 bps and -42.58 bps in our full and restricted matched samples, respectively. Contrary to expectations, sustainability bonds in the Real Estate/Property industry show a discount of 90.95 bps and 141.21 bps in our full and restricted matched samples, respectively. However, our full sample contains

only 4 sustainability bonds in the Real Estate/Property industry and our restricted sample shows only 1, therefore, the results are not robust. Social bonds are, also, the sustainable bond type with less representation in our sample. Social bonds amount to approximately 7% (71 social bonds) and 8% (43 social bonds) of the total sustainable bonds in our full and restricted matched samples, respectively. The low sample also raises concerns regarding the reliability of the results found for social bonds.

The remainder of this thesis is structured as follows: Chapter 2 contains a literature review on ESG, sustainable investing and greenium. Chapter 3 shows the sample selection and methodology used in this study. Chapter 4 presents the results of the study for the full sample and the restricted sample. Chapter 5 offers a summary of the results, some implications of the findings and directions for future research.

Chapter 2

Literature Review

2.1 Environmental, Social, Governance (ESG) and sustainable investing

ESG can be defined as a framework that includes environmental, social and governance factors, such as greenhouse gas emissions in terms of environmental factors, disclosure in terms of governance factors and workplace health and satisfaction in terms of social factors (Li et al., 2021) .

Sustainable investing consists of taking ESG factors into account when making investment decisions, leading to increased funding and investments in sustainable economic activities and projects (European Commission, n.d.).

Although there are several types of sustainable bonds, most literature on this topic focuses, primarily, on green bonds. Given this fact, most of the theoretical and empirical literature that will be discussed refers mainly to green bonds.

The European Investment Bank's "climate awareness bond" issued in 2007 is the first green bond issued worldwide. Since then, sustainable bonds have become increasingly popular, with sustainable bond issuance totalling around \$800.20 billion in 2024, a 9% increase from 2023 (LSEG, 2024) . Several factors contributed to the continued growth of sustainable bonds. Namely, the reported existence of a green bond premium (greenium), which means that green bonds are reported to have lower yields/spreads than comparable conventional bonds. This is a considerable advantage that green bonds, and possibly other types of sustainable bonds, hold for issuers. However, there are also advantages for investors. For example, Bloomberg (2024) reports that their Global Aggregate

Green, Social and Sustainability (GSS) index returns for 2023 is 9.94%, about 423bps above the returns of their Global Agg Index. The evolution of sustainable bonds is marked by some key events that occurred since the introduction of the European Investment's Bank "climate awareness bond" in 2007.

A key catalyst for the development of this market was the introduction of the Green Bond Principles (GBP) (ICMA, 2021a) by the International Capital Market Association (ICMA) (Packer & Ehlers, 2017) and subsequent introduction of the Social Bond Principles (SBP) (ICMA, 2023a), Sustainability Bond Guidelines (SBG) (ICMA, 2021b) and Sustainability-linked Bond Principles (SLBP) (ICMA, 2023b).

As its widely known, central banks accept securities as collateral to provide loans to financial institutions. In 2018, the People's Bank of China (PBoC) broadened the asset classes accepted as collateral to include green bonds and gave them priority over other financial bonds (Macaire & Naef, 2023). This decision by the PBoC was extremely important for the development of sustainable finance, as it showed that emerging markets, such as China, are also focused on its development.

The OECD estimates that an annual investment of USD 6.9 trillion will be required in infrastructure until 2030 to fulfil climate development objectives. This is because existing water, building, energy and transport infrastructure contribute for over than 60% of global greenhouse gas emissions. Hence, large investments are required for the transformation of existing infrastructure systems. According to OECD (2018), deploying resources, both private and public, is an essential part of generating the funds required for sustainable infrastructure. Therefore, debt instruments such as green bonds will play a crucial role in this transition to a more sustainable economy.

In 2020, the European Central Bank (ECB) announced that sustainability-linked bonds will be accepted as collateral for credit operations and for monetary policy purposes, in the Eurosystem (European Central Bank, 2020). In 2021, the ECB announced the incorporation of climate considerations into their monetary policy (European Central Bank, 2021). Continuing Europe's role in the growth of sustainable finance, the European Commission promised to issue up to EUR 250 billion in green bonds, as part of the Next Generation EU (NGEU) program, with the goal of supporting the transition towards a greener Europe (Hinsche, 2021). This decision led the EU to be one of the biggest green bond issuers (Hinsche, 2021).

2.1.1 Types of sustainable bonds

There are four main types of ESG bonds,¹ which are green, social, sustainability and sustainability-linked bonds. Green bonds are any type of bond instrument where the proceeds will be applied to finance eligible Green Projects (ICMA, 2021a). Social bonds are any type of bond instrument where the proceeds will be applied to finance eligible Social Projects (ICMA, 2023a). Sustainability bonds are any type of bond instrument where the proceeds will be applied to finance a combination of both Green and Social Projects (ICMA, 2021b).

Sustainability-linked bonds (SLBs) have a particular characteristic that is not shared by the other typologies: In green, social, and sustainability bonds, the proceeds of the bond instrument or an equivalent amount will be exclusively applied to finance or re-finance green or social projects, depending on the bond type. SLBs are different in the sense that the proceeds of the bond may or may not be used to finance or re-finance sustainable projects. Instead, SLBs are bond

¹ In this paper, we use the terms sustainable finance and ESG synonymously.

instruments where the financial and/or structural characteristics vary depending on the issuer's achievement of specific ESG goals. Given this, issuers explicitly pledge to make future improvements in sustainability outcomes within a predetermined timeframe, facing the consequence of increased costs paid to the bondholders if they do not meet the predefined goals (ICMA, 2023b).

2.1.2 Greenium

Greenium is the premium paid by bondholders for a specific green bond when compared with a similar conventional bond (Agliardi & Agliardi, 2021). Hence, greenium is the phenomenon where investors decide to reduce their returns and, therefore, corporations are able to reduce their funding costs by issuing green bonds, rather than conventional bonds. Several studies were developed to understand if investors were really giving up some of their returns due to the appeal of sustainability and green projects (Agliardi & Agliardi, 2021; Hinsche, 2021; Hyun et al., 2020; Larcker & Watts, 2020; Macaire & Naef, 2023; Packer & Ehlers, 2017; Preclaw & Bakshi, 2015; Wang et al., 2020; Baker et al. 2018; Arat et al. 2023; Löffler et al. 2021; Pinto & Ribeiro 2024; Caramichael & Rapp, 2022; Tang & Zhang, 2020; Flammer, 2021; Karpf & Mandel, 2018; Lau et al., 2022; Bour, 2019)

Current literature on the existence of greenium and its underlying drivers is mixed. By analysing the public green bond market from September 2014 until June 2021, Hinsche (2021) provides evidence of a significant greenium in the public green bond market, as well as that the greenium is influenced by issuer sector and credit rating, with a mean greenium of -1.8 bps for AAA rated green bonds and -2.4 bps for supranational green bonds. Arat et al. (2023) found that, although green bonds do have a negative premium when compared to conventional bonds, credit rating influences the size of this phenomenon, as they find that issuers with better credit ratings show a smaller greenium effect.

Preclaw & Bakshi (2015) also found a 17 bps gap between the spread of green bonds and comparable conventional bonds. Packer & Ehlers (2017) compared the credit spreads at issuance of a cross-section of 21 green bonds issued between 2014 and 2017 with the credit spreads at issuance of conventional bonds of the same issuers at the closest possible issue date. The mean difference in their sample is around 18 bps, further contributing to the literature confirming the existence of a green bond premium. They also determine that the yield difference is greater for riskier borrowers, indicating that the issuer's credit rating affects the green bond premium. Löffler et al. (2021) also finds that the yield for green bonds is, on average, 15-20 bps lower than conventional bonds on the primary and secondary markets.

Monetary policy from central banks can also affect the yield differential between green bonds and other bonds. Macaire & Naef (2023) concluded that, after PBoC's decision to accept and prefer green bonds as eligible securities as collateral in 2018, there was a 46 bps yield difference between green bonds and non-green bonds. Before 2018, the yield difference between green and non-green bonds stood at 32 bps, meaning that the policy amplified the yield difference between green and non-green bonds. Wang et al. (2020) also shows that green bonds have a lower spread than otherwise similar conventional bonds, at issue. Specifically, an average of 34 bps negative difference when compared to similar conventional bonds in the Chinese market.

Baker et al. (2018) provides an overview of U.S. municipal green bond markets, where they find that green municipal bonds are issued at a premium of around 6 bps when compared to similar conventional bonds.

Periods of extreme volatility can also affect the greenium phenomenon. As per Arat et al. (2023), the greenium widens during times of extreme market stress,

given that their results indicate a greenium of 1.6 bps before the outbreak of COVID-19 and a greenium of 3.5 bps during the COVID-19 pandemic.

Caramichael & Rapp (2022) show an interesting finding related to the greenium phenomenon, where they found that, on average, green corporate bonds do have a lower spread than conventional bonds, but only from 2019 onwards. The authors attribute the existence of greenium due to demand pressure at issuance, following the growth of the sustainable asset management industry, due to EU regulation.

Despite the results from the literature identified above, we still also have several articles disproving the existence of a green bond premium. By analysing over 600 matched pairs of green and non-green securities, Larcker & Watts (2020) concluded that these green securities had no significant yield premium. Tang & Zhang, (2020) found no consistently significant premium for green bonds. According to Hyun et al. (2020), on average, there is no significant green bond premium. However, green bonds that are certified by an external reviewer enjoy a premium of about 6 bps and green bonds that obtain a Climate Bonds Initiative certificate show a premium of around 15 bps. These results indicate that greenness information indicators, such as external reviews and certifications, significantly affect the green bond premium. Flammer (2021) also finds no pricing differences between green bonds and quasi-identical brown bonds.

As mentioned above, Baker et al. (2018) found that green municipal bonds in the U.S. are issued at a premium. However, Karpf & Mandel (2018) found a positive yield difference between municipal green bonds and conventional bonds, albeit Baker et al. (2018) and Larcker & Watts (2020) do point out that the results in Karpf & Mandel (2018) are biased due to taxation, as the authors compare taxable and non-taxable bonds.

Lau et al. (2022) also finds that, on average, greenium does not exist. However, the authors do explain that the existence of greenium varies among individual green bonds and their findings suggest that a key factor underlying the variation is that the green bonds are subject to the risk of greenwashing to different extents.

Findings from Pinto & Ribeiro (2024) show no significant premium for sustainable bonds versus similar conventional bonds. These findings are consistent for green, social and sustainability bonds.

The main focus of this paper will be to understand this possible existence of a premium in these instruments. This paper will consider three of the main sustainable bond types, which are green, social and sustainability bonds. The results will also be sub-sampled to understand the differences between each sustainable bond type and to understand if the geographical region and industry of the issuer influence the existence and the magnitude of the premium. Hence, the hypotheses are as follows:

Hypothesis 1: Corporate sustainable bonds, in general, trade at significantly lower spreads than comparable corporate conventional bonds

2.1.3 ICMA's principles, external reviewers and certifications

ICMA (2021b) developed a set of principles, which act as “a collection of voluntary frameworks with the stated mission and vision of promoting the role that global debt capital markets can play in financing progress towards environmental and social sustainability.”. The principles developed by ICMA outline best practices when issuing bonds serving social and/or environmental purposes through global guidelines and recommendations that promote transparency and disclosure (ICMA, 2021b). These principles are the previously mentioned Green Bond Principles (GBP), Social Bond Principles (SBP) and

Sustainability-Linked Bond Principles (SLBP). The GBP and SBP outline key core components, which are utilising the proceeds to finance or re-finance eligible sustainable projects (green or social, depending on the bond type), a process to evaluate and select eligible sustainable projects, management and tracking of the proceeds with a high level of transparency and reporting updated information on how the proceeds are used, which needs to be renewed on an annual basis until full allocation of the proceeds (ICMA, 2021a; ICMA, 2023a).

Numerous organizations began to provide green label certifications that demonstrate compliance to particular definitions of green, depending on the certification. One of these organizations is the Climate Bond Initiative (CBI), which offers a certification process for green bonds. The CBI's Climate Bonds Standard sets sector-specific eligibility criteria to assess an asset's low carbon value and determine its appropriateness for issuance as a green bond. One limitation of the CBI standard is that it does not require continuous monitoring and verification, meaning it does not require ongoing checks to ensure the eligibility criteria continues to be satisfied (Packer & Ehlers, 2017).

Green bond index providers also act as institutions of certification, as they identify financial bonds as green via a stated methodology. Most, if not all, green bond indices show consistency with the Green Bond Principles. However, each of them also outlines other factors such as size, liquidity and industry sectors where the proceeds are utilized (Packer & Ehlers, 2017).

On the recent editions of the Green Bond Principles, it is recommended that green bond issuers use external reviews. *Moody's Green Bond Assessments* was the first public methodology developed by a ratings agency for evaluating green bonds (Packer & Ehlers, 2017). The Green Bond Assessments (GBAs) are used to evaluate the relative likelihood that bond proceeds will be invested in

environmentally friendly projects. Standard & Poors also provides certifications through their Standard & Poor's Green Evaluations (Packer & Ehlers, 2017).

Flammer (2021) finds that the stock market reacts favourably to announcements of green bond issuance, with an even stronger response observed for green bonds that are certified by independent third parties, which shows another advantage for green bond issuers to certify their bonds externally. Current literature also documents a connection with non-financial disclosure and greenium: Bour (2019) shows that for each type of disclosure, the green bond premium increases by 24 bps. The study also shows that external reviews are the critical determinants of the increase of the green bond premium.

2.1.4 Arguments for corporate sustainable bond issuance

Sustainable bond proceeds are restricted to finance or re-finance sustainable projects, when it comes to green, social and sustainability bonds (ICMA, 2021a;ICMA, 2023a;ICMA, 2021b). Sustainability-linked bonds do not restrict the issuer to finance sustainable projects, however, the issuer is committing to future improvements in sustainability, as the structural characteristics of the instrument vary depending on the issuer hitting predefined ESG objectives(ICMA, 2023b). Hence, raising funds through a sustainable bond restricts the corporation's investment policies. Knowing this, corporations must see some advantage in sustainable bonds, in order to accept such a restriction. Current literature on this topic focuses mainly on green bonds, however, there are four main arguments to why a corporation issues a sustainable bond over a traditional bond.

The first argument is that sustainable bonds may serve as a credible signal of the company's commitment towards environmental and social causes. This is called the signalling argument. According to Loumiotis & Serafeim (2022),

sustainability-linked lending acts as a signalling mechanism of ESG credentials, which is in line with this argument. Kim et al. (2025) also finds that high-transparency Sustainability-linked loans borrowers use this instrument to “certify” preexisting ESG commitments, which is also consistent with this argument. Flammer (2021) also found significant evidence consistent with the signalling argument, as companies show improved environmental performance after issuance

Issuing sustainable bonds can be used so that the companies portray themselves as environmentally and socially responsible, but without taking any tangible actions. This is called the greenwashing argument. Although Kim et al. (2025) show evidence in line with the signalling argument for high-transparency borrowers, it also shows evidence for the greenwashing argument for low-transparency borrowers, as low-transparency sustainability-linked loan borrowers exhibit deteriorating ESG performance after issuance. Carrizosa & Ghosh (2023) provide evidence consistent with the greenwashing argument, as their results suggest that for a considerable number of loan contracts, the magnitude of the penalty for negative sustainability-linked performance is quite small and the reward for positive performance is quite small as well. The small penalty paired with the small reward incentivize issuers to not follow-up with sustainability commitments.

The third argument is the cost of capital argument. If sustainable bond investors are willing to sacrifice some financial returns for environmental and societal benefits, companies may issue sustainable bonds to secure more affordable financing. This is the cost of capital argument. Literature surrounding this argument is divided, with some authors finding that sustainable bonds are issued at a premium when compared to conventional bonds (Hinsche, 2021; Arat et al., 2023; Preclaw & Bakshi, 2015; Packer & Ehlers, 2017; Löffler et al., 2021;

Macaire & Naef, 2023; Wang et al., 2020; Baker et al., 2018; Caramichael & Rapp, 2022; Bour, 2019) and other authors finding that issuers are not able to secure more affordable financing through issuance of sustainable bonds instead of conventional bonds (Larcker & Watts, 2020; Hyun et al., 2020; Flammer, 2021; Baker et al., 2018; Karpf & Mandel, 2018; Lau et al., 2022; Tang & Zhang, 2020; Pinto & Ribeiro, 2024).

The last argument for the issuance of sustainable bonds consists on the firm looking to improve liquidity and stock price. Findings from Tang & Zhang (2020)

Chapter 3

Sample selection and methodology

3.1. Methodology

To investigate how sustainable bond credit spreads compare with similar conventional corporate bonds, we use a model relatively similar to existing pricing models for conventional and green bonds (e.g. Marques & Pinto, 2020; Fatica et al., 2021; Pinto & Ribeiro, 2024). The dependent variable in the model is the credit spread in basis points (bps). OLS regression techniques adjusted for heteroskedasticity are employed and due to time varying risk premia and cross-country differences, we estimate standard errors clustered by year and country. The econometric model can be seen directly below.

$$\begin{aligned} \text{Credit spread}_{i,t} &= \alpha_0 + \beta_1 \text{Sustainable dummy}_{i,t} \\ &+ \sum_{n=2}^{19} \beta_n \text{Rating dummy}_{n,i,t} + \beta_{21} \text{Not rated}_{i,t} \\ &+ \gamma \text{Contractual characteristics}_{i,t} + \varphi \text{Macroeconomic factors}_t + \varepsilon \end{aligned}$$

Given our interest in analysing pricing differences between different types of sustainable bonds, we also use a similar model that contains a dummy variable for each sustainable bond instead of a single dummy variable for all sustainable bonds. This model can be seen directly below.

$$\begin{aligned}
\text{Credit spread}_{i,t} &= \alpha_0 + \beta_1 \text{Green dummy}_{i,t} + \beta_2 \text{Social dummy}_{i,t} \\
&+ \beta_3 \text{Sustainability dummy}_{i,t} \\
&+ \sum_{n=4}^{19} \beta_n \text{Rating dummy}_{n,i,t} + \beta_{23} \text{Not rated}_{i,t} \\
&+ \gamma \text{Contractual characteristics}_{i,t} + \varphi \text{Macroeconomic factors}_t \\
&+ \varepsilon
\end{aligned}$$

Table 1 provides detailed definitions and sources for all variables included in the study. A discussion of the variables used in the analysis follows.

Table 1: 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 (OAS).	DCM Analytics
Independent variables:		
<i>Core variables</i>		
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, and 0 otherwise.	DCM Analytics
Social	Dummy equal to 1 if a bond is classified as social bond, and 0 otherwise.	DCM Analytics
Sustainability	Dummy equal to 1 if a bond is classified as sustainable bond, and 0 otherwise.	DCM Analytics
Rating	Bond issuer 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
<i>Contractual characteristics</i>		
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	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 sustainable	Dummy equal to 1 if the issuer has already issued a green bond previously, and 0 otherwise.	Authors'
<i>Macroeconomic factors</i>		
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

3.1.1 Credit spread

Credit spread is the margin yielded by a security at issue over a corresponding currency treasury benchmark with a comparable maturity. It's the price for the risk associated with a bond tranche at issuance.

3.1.2 Core variables

We employ a dummy variable that equals one for sustainable bonds and 0 for conventional bonds. We also create three dummy variables that correspond to each of the three sustainable bond types: green, social and sustainability bond. We anticipate a negative impact on spread.

Credit ratings are one of the most important determinants of corporate bond credit spreads, both for conventional and green bonds (eg Elton et al. 2001; Marques & Pinto, 2020; Zerbib, 2019; Kapraun et al., 2021). In this study, due to unavailability of bond credit ratings information at the time of issuance and at the tranche level, the issuer credit rating at the time of issuance was used instead. These ratings are assigned by S&P, Moody's or Fitch. If an issuer has two or three ratings at the time of issuance, we compute the average. The ratings were converted to a numerical scale (AAA = 1, AA+=2 and so on, down to CCC - = 19), following Pinto & Ribeiro (2024). We expect credit spreads to widen as ratings decrease. For bonds with no information about issuer rating at the time issuance, we include a dummy variable, not rated, which equals 1 if the bond does not have issuer rating information and 0 otherwise.

3.1.3. Contractual characteristics

There are several contractual characteristics that provide important insights into bond pricing (Hyun et al., 2020; Kapraun et al., 2021; Nanayakkara & Colombage, 2018; Marques & Pinto, 2020; Fatica et al., 2021)

The maturity of the bond is one of factors that affect bond pricing, with a positive relationship with the bond spread. Hence, investors often demand higher spreads for bonds with longer maturities, as they perceive these to be riskier than bonds with shorter terms (Hyun et al., 2020).

As reported by Hyun et al. (2020) and Kapraun et al. (2021), corporate bond spreads are also affected by the issue size of the bond. We expect an inverse relationship between the issue size and the spread of the bond.

Subordination is another characteristic that is expected to impact a bond's spread. A subordinated bond grants the buyer a lower priority claim on the issuer's assets when compared to senior debt holders. As this represents a risk to the bondholder, a higher yield is typically provided as compensation. To evaluate the effect of subordination on the bond's spread, we use a dummy variable that equals 1 for subordinated bond tranches and 0 otherwise. We expect a positive relationship between subordination and credit spread. Marques & Pinto (2020) found significant impact of subordination in corporate bond spreads.

We expect that tranches exposed to currency risk will carry higher spreads. As per Nanayakkara & Colombage (2018), bonds denominated in local currency have tighter spreads than bonds denominated in foreign currency. Our expectations are in line with the above.

Callable bonds allow the issuer to buy the bond back before its maturity date at a set price, the call price, which allows the issuer to refinance themselves in the

future, if the conditions are favourable to the issuer. However, this represents a risk for investors, given that if the issuer redeems the bond, investors will miss out on future interest payments, hence, these bonds typically have higher spreads, as evidenced by Fatica et al. (2021).

Fatica et al. (2021) also shows that green bonds from issuers that are experienced in the green bond market (i.e. issuers that issued green bonds in the past) have lower spreads. Given this finding, we use a dummy variable named *experienced sustainable* to control for the impact of repeat issuers on credit spreads of sustainable bonds. A negative effect on credit spreads is expected.

3.1.4 Macroeconomic controls

Credit spreads are also influenced by macroeconomic factors. Our model looks to capture macroeconomic factors, such as volatility and country risk.

Following the approach of Marques & Pinto (2020), to capture volatility, we use the Chicago Board Options Exchange Volatility Index (VIX). We expect a positive relationship between volatility and credit spreads.

Also following the approach of Marques & Pinto (2020), we utilize S&P's sovereign credit rating to account for country risk. Similar to our credit rating variable mentioned above, we transform S&P's sovereign rating system into a numerical scale (AAA+ =1, AA+ = 2 and so on). We expect a positive relationship between country risk and credit spreads.

3.2 Sample selection

3.2.1 Full sample

The sample of bond issues used in this study was extracted from DCM Analytics, which is a tool that provides comprehensive data on debt issuances. The sample contains information on corporate bond issues at the tranche level, specifically bond tranches from companies issued between 04/06/2013 and 10/12/2024, classified with a deal-type code of 'corporate bond investment grade' or 'corporate bond high-yield'.

The sustainable bonds are certified by external entities: the green bonds comply with the GBP, the social bonds comply with the SBP and the sustainability bonds comply with both sets of guidelines.

The sample is restricted to bond tranches that contained information about the pricing date, the spread to benchmark of the bond tranche, and have information on tranche maturity and size.

We apply a 1-to-1 matching method that aims to match each sustainable bond with a similar conventional bond. To find the best match, we used a specific set of criteria. Each pair of conventional and sustainable bonds has to be issued by the same firm and have no more than 365 days of difference between issuance dates. In some cases, we had several conventional bonds fulfilling the criteria outlined above for a specific sustainable bond. In this scenario, we chose the conventional bond with the least difference of maturity dates to the sustainable bond. This method resulted in a final sample of 974 sustainable bond tranches paired with 974 conventional bond tranches. Onwards, this sample will be referred to as the full sample.

To restrict variation in the difference of maturity dates between the matched bonds, we use a second sample which consists on bond matches from the full

sample where the difference in maturity dates between the matched bonds is restricted to a maximum of 365 days. By applying this restriction, we get a sample of 544 sustainable bonds paired with 544 conventional bonds. Onwards, this sample will be referred to as the restricted sample.

The full sample consists of 974 sustainable bond tranches, paired with 974 conventional bond tranches. The sustainable bond tranches have a total value of €496.12 billion, of which 775 tranches worth €384.90 billion are green bonds, 71 tranches worth €46.98 billion are social bonds and 128 tranches worth €64.24 billion are sustainability bonds. The conventional bond tranches have a total value of €535.46 billion. Green bonds amount to around 37.31% of the total tranche value in full sample for sustainable and conventional bonds and around 77.68% of the total tranche value of sustainable bonds in the sample. In terms of number of tranches, green bonds amount to around 79.57% of the sustainable bonds in the full sample. As for social bonds, these amount to around 4,55% of the total tranche value of all bonds in the full sample, around 9.47% of the total tranche value of sustainable bonds in the full sample and 7,29% of the number of sustainable bond tranches in the sample. To finalize, sustainability bonds amount to 6.61% of the total tranche value of sustainable and conventional bonds in the full sample, 26.78% of the total tranche value of only sustainable bonds in the full sample and 13.14% of the number of sustainable bond tranches in the full sample.

Table 2 presents the distribution of the full sample across different industries and bond types. Table 3 shows the distribution per country where the bond issuer is located.

In the full sample, firms belonging to a total of 24 industries issue conventional bonds, a total of 23 industries issue green bonds, 7 industries issue social bonds and 19 industries issue sustainability bonds. The industries with most

conventional bond tranches issued in the full sample are Finance (48.15%), Utility & Energy (17.76%) and Real Estate/Property (12.42%).

Regarding green bonds, the Finance industry accounts for 45.29% of the total green bond tranches by value issued in the full sample, followed by Utility & Energy with 20% and Real Estate with 14.71%.

Financial firms issued 80.28% of all social bonds in the full sample, followed by Transportation with 7.04% and Real Estate with 4.23%.

Regarding the industrial distribution, the top issuing industries in the full sample for sustainability bonds are Finance (47.66%), Utility & Energy (13.28%) and Transportation (5.47%).

According to Table 3, the top geographical regions in the full sample are Europe, with 50.82% of all bond tranches in the full sample, followed by North America with 25.77%, Japan with 8.52% and North Asia with 7.60%.

Table 2: Industrial distribution – Full sample

Industrial category of issuer	Conventional bonds				Green bonds				Social bonds				Sustainability bonds			
	Number of tranches	Total tranche value	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value	Percentage of total tranche value (%)	Percentage of total tranches (%)
		(Face)				(Face)				(Face)		(Face)				(Face)
		[€ Million]				[€ Million]				[€ Million]				[€ Million]		
Utility & Energy	173	79,084.44	14.77	17.76	155	79,637.27	20.69	20.00	1	381.40	0.81	1.41	17	6,875.88	10.70	13.28
Real Estate/Property	121	35,731.84	6.67	12.42	114	33,750.73	8.77	14.71	3	2,300.00	4.90	4.23	4	1,004.49	1.56	3.13
Finance	469	304,697.68	56.90	48.15	351	196,423.01	51.03	45.29	57	41,379.25	88.07	80.28	61	32,671.26	50.86	47.66
Professional Services	6	3,223.35	0.60	0.62	5	2,658.77	0.69	0.65	-	-	-	-	1	16.66	0.03	0.78
Transportation	45	12,643.87	2.36	4.62	33	9,422.51	2.45	4.26	5	1,387.91	2.95	7.04	7	1,828.88	2.85	5.47
Computers & Electronics	21	18,045.35	3.37	2.16	15	11,102.28	2.88	1.94	-	-	-	-	6	4,418.04	6.88	4.69
Dining & Lodging	2	892.57	0.17	0.21	0	0.00	0.00	0.00	-	-	-	-	2	1,330.40	2.07	1.56
Chemicals	10	4,299.16	0.80	1.03	9	4,042.77	1.05	1.16	-	-	-	-	1	58.06	0.09	0.78
Holding Companies	4	1,155.58	0.22	0.41	3	1,081.57	0.28	0.39	-	-	-	-	1	35.35	0.06	0.78
Forestry & Paper	3	1,264.19	0.24	0.31	2	956.73	0.25	0.26	-	-	-	-	1	449.50	0.70	0.78
Insurance	31	17,511.97	3.27	3.18	21	11,016.72	2.86	2.71	2	714.20	1.52	2.82	8	4,122.10	6.42	6.25
Healthcare	11	9,212.22	1.72	1.13	5	3,615.95	0.94	0.65	2	567.03	1.21	2.82	4	3,192.88	4.97	3.13
Construction/Building	11	3,867.82	0.72	1.13	10	4,260.52	1.11	1.29	-	-	-	-	1	313.39	0.49	0.78
Mining	3	1,089.36	0.20	0.31	3	922.33	0.24	0.39	-	-	-	-	-	-	-	-
Telecommunications	19	18,311.33	3.42	1.95	15	10,836.50	2.82	1.94	-	-	-	-	4	1,588.99	2.47	3.13
Retail	6	3,716.80	0.69	0.62	5	3,501.34	0.91	0.65	-	-	-	-	1	600.00	0.93	0.78
Food & Beverage	14	8,101.26	1.51	1.44	10	4,619.95	1.20	1.29	1	253.90	0.54	1.41	3	1,574.23	2.45	2.34
Metal & Steel	3	634.38	0.12	0.31	2	252.30	0.07	0.26	-	-	-	-	1	449.62	0.70	0.78
Consumer Products	7	3,012.59	0.56	0.72	4	1,185.49	0.31	0.52	-	-	-	-	3	1,248.00	1.94	2.34
Auto/Truck	8	5,425.87	1.01	0.82	8	5,092.92	1.32	1.03	-	-	-	-	-	-	-	-
Government	3	2,888.61	0.54	0.31	1	204.77	0.05	0.13	-	-	-	-	2	2,460.48	3.83	1.56
Aerospace	2	532.08	0.10	0.21	2	224.55	0.06	0.26	-	-	-	-	-	-	-	-
Agribusiness	1	58.66	0.01	0.10	1	58.66	0.02	0.13	-	-	-	-	-	-	-	-
Oil & Gas	1	61.49	0.01	0.10	1	30.74	0.01	0.13	-	-	-	-	-	-	-	-
Total	974	535,462.48	100	100	775	384,898.38	100	100	71	46,983.69	100	100	128	64,238.20	100	100

This table provides information on the industry of issuers in our full sample. The information in the table is divided by loan type (conventional, green, social and sustainability). The number of tranches column details the amount of bond tranches in each industry in the sample. The total tranche value column provides the sum of the tranche value for all bond tranches in the sample that belong to the specific industry. The percentage of total tranche value details the relative weight in terms of tranche value that the specific industry has in each loan type. The percentage of total tranches details the relative weight in terms of number of tranches that the specific industry has in each loan type.

Table 3: Geographical distribution – Full sample

Geographic location of issuer	Conventional bonds				Green bonds				Social bonds				Sustainability bonds			
	Number of tranches	Total tranche value (Face) [€ Million]	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value (Face) [€ Million]	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value (Face) [€ Million]	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value (Face) [€ Million]	Percentage of total tranche value (%)	Percentage of total tranches (%)
Europe	495	277,848.57	51.89	50.82	426	222,318.44	57.76	54.97	37	28,407.59	60.46	52.11	32	14,803.40	23.04	25.00
North America	251	171,593.63	32.05	25.77	185	104,483.98	27.15	23.87	16	12,923.68	27.51	22.54	50	32,551.12	50.67	39.06
Japan	83	28,694.36	5.36	8.52	67	17,729.56	4.61	8.65	7	1,700.71	3.62	9.86	9	1,349.91	2.10	7.03
North Asia	74	23,406.22	4.37	7.60	49	16,468.96	4.28	6.32	9	3,627.07	7.72	12.68	16	5,482.49	8.53	12.50
Latin America	24	6,467.98	1.21	2.46	13	4,100.01	1.07	1.68	1	186.76	0.40	1.41	10	2,908.45	4.53	7.81
Australasia	24	17,380.34	3.25	2.46	16	10,553.21	2.74	2.06	-	-	-	-	8	5,506.30	8.57	6.25
India Subcontinent	3	1,072.13	0.20	0.31	1	396.16	0.10	0.13	1	137.89	0.29	1.41	1	278.90	0.43	0.78
Southeast Asia	6	2,883.41	0.54	0.62	5	1,661.57	0.43	0.65	-	-	-	-	1	633.82	0.99	0.78
Africa	2	59.27	0.01	0.21	2	83.65	0.02	0.26	-	-	-	-	-	-	-	-
Middle East	12	6,056.57	1.13	1.23	11	7,102.83	1.85	1.42	-	-	-	-	1	723.80	1.13	0.78
Total	974	535,462.48	100	100	775	384,898.38	100	100	71	46,983.69	100	100	128	64,238.20	100	100

This table provides information on the geographical region of issuers in our full sample. The information in the table is divided by loan type (conventional, green, social and sustainability). The number of tranches column details the amount of bond tranches in each geographical region in the sample. The total tranche value column provides the sum of the tranche value for all bond tranches in the sample that belong to the geographical region. The percentage of total tranche value details the relative weight in terms of tranche value that the geographical region has in each loan type. The percentage of total tranches details the relative weight in terms of number of tranches that the specific geographical region has in each loan type.

3.2.2 Restricted sample

The restricted sample consists of 544 sustainable bond tranches, paired with 544 conventional bond tranches. The sustainable bond tranches have a cumulative value of €282.19 billion, of which 429 tranches worth €214.49 billion are green bonds, 43 tranches worth €30.57 billion are social bonds and 72 tranches worth €37.13 billion are sustainability bonds. The conventional bond tranches have a cumulative value of €318.41 billion. Green bonds amount to around 35.71% of the total tranche value in full sample for sustainable and conventional bonds and around 76.01% of the total tranche value of sustainable bonds in the sample. In terms of number of tranches, green bonds amount to around 79.01% of the sustainable bonds in the full sample. As for social bonds, these amount to around 5.09% of the total tranche value of all bonds in the full sample, around 10.83% of the total tranche value of sustainable bonds in the full sample and 7.92% of the number of sustainable bond tranches in the sample. To finalize, sustainability bonds amount to 6.18% of the total tranche value of sustainable and conventional bonds in the full sample, 13.16% of the total tranche value of only sustainable bonds in the full sample and 13.08% of the number of sustainable bond tranches in the full sample.

In table 4, we can see the distribution of the restricted sample across different industries and bond type. In table 5, we show the distribution per country where the issuer of each bond is located.

In the restricted sample, we have a total of 22 industries issuing conventional bonds, a total of 19 industries issuing green bonds, 5 industries issuing social bonds and 14 industries issuing sustainability bonds. The industries with most conventional bond tranches issued in the restricted sample are Finance (57.72%), Utility & Energy (12.68%) and Real Estate/Property (11.40%).

As for green bonds, the Finance industry accounts for 55.01% of the total green bond tranches in the restricted sample, followed by Utility & Energy with 14.69% and Real Estate/Property with 13.75%.

The top issuing industry for social bonds in the restricted sample is Finance with 79.07% of all social bonds in the restricted sample, followed by Transportation with 9.30% and Healthcare and Real Estate/Property with 4.65% each.

Finalising the industrial distribution, the top issuing industries in the restricted sample for sustainability bonds are Finance with 61.11% of all sustainability bonds in the restricted sample, Utility & Energy with 8.33% and Insurance with 6.94%.

In table 5, we can see the restricted sample divided between geographical regions of the issuing company. The top geographical regions in the restricted sample are Europe, with 47.98% of all bond tranches in the sample, followed by North America with 26.65%, Japan with 9.56% and North Asia with 8.09%.

Table 4: Industrial distribution – Restricted sample

Industrial category of issuer	Conventional bonds				Green bonds				Social bonds				Sustainability bonds			
	Number of tranches	Total tranche value	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total tranche value	Percentage of total tranche value (%)	Percentage of total tranches (%)
		(Face)				(Face)				(Face)		(Face)				(Face)
Utility & Energy	69	29,180.73	9.16	12.68	63	26,766.94	12.48	14.69	-	-	-	-	6	2,586.77	6.97	8.45
Real Estate/Property	62	17,314.23	5.44	11.40	59	15,745.38	7.34	13.75	2	1,450.00	4.74	4.65	1	75.58	0.20	1.41
Finance	314	212,389.66	66.70	57.72	236	134,783.26	62.84	55.01	34	26,903.26	88.01	79.07	44	22,830.69	61.49	61.97
Professional Services	3	3,116.19	0.98	0.55	3	2,061.37	0.96	0.70	-	-	-	-	-	-	-	-
Transportation	23	6,724.01	2.11	4.23	16	4,673.42	2.18	3.73	4	1,300.55	4.25	9.30	3	373.94	1.01	4.23
Computers & Electronics	11	10,974.17	3.45	2.02	8	6,629.75	3.09	1.86	-	-	-	-	3	1,899.49	5.12	4.23
Dining & Lodging	1	437.66	0.14	0.18	-	-	-	-	-	-	-	-	1	891.07	2.40	1.41
Chemicals	6	2,257.69	0.71	1.10	5	2,175.14	1.01	1.17	-	-	-	-	-	58.06	0.16	0.00
Holding Companies	1	139.82	0.04	0.18	1	136.52	0.06	0.23	-	-	-	-	-	-	-	-
Forestry & Paper	1	446.75	0.14	0.18	-	-	-	-	-	-	-	-	1	449.50	1.21	1.41
Insurance	14	9,312.69	2.92	2.57	8	4,828.90	2.25	1.86	1	348.43	1.14	2.33	5	3,082.42	8.30	7.04
Healthcare	4	3,052.01	0.96	0.74	1	659.69	0.31	0.23	2	567.03	1.85	4.65	1	1,156.98	3.12	1.41
Construction/Building	4	1,904.57	0.60	0.74	3	1,904.37	0.89	0.70	-	-	-	-	1	313.39	0.84	1.41
Mining	2	449.94	0.14	0.37	2	191.57	0.09	0.47	-	-	-	-	-	-	-	-
Telecommunications	12	11,720.80	3.68	2.21	9	6,703.82	3.13	2.10	-	-	-	-	3	1,402.41	3.78	4.23
Retail	2	1,343.83	0.42	0.37	2	1,774.99	0.83	0.47	-	-	-	-	-	-	-	-
Food & Beverage	6	3,932.63	1.24	1.10	5	3,099.48	1.45	1.17	-	-	-	-	1	457.16	1.23	1.41
Metal & Steel	1	64.63	0.02	0.18	1	105.09	0.05	0.23	-	-	-	-	-	-	-	-
Consumer Products	2	959.83	0.30	0.37	2	617.45	0.29	0.47	-	-	-	-	-	-	-	-
Auto/Truck	3	1,520.01	0.48	0.55	3	1,412.02	0.66	0.70	-	-	-	-	-	-	-	-
Government	1	640.23	0.20	0.18	-	-	-	-	-	-	-	-	1	1,550.15	4.18	1.41
Aerospace	2	532.08	0.17	0.37	2	224.55	0.10	0.47	-	-	-	-	-	-	-	-
Agribusiness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oil & Gas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	544	318,414.13	100	100	429	214,493.69	100	100	43	30,569.27	100	100	71	37,127.60	100	100

This table provides information on the industry of issuers in our restricted sample. The information in the table is divided by loan type (conventional, green, social and sustainability). The number of tranches column details the amount of bond tranches in each industry in the sample. The total tranche value column provides the sum of the tranche value for all bond tranches in the sample that belong to the specific industry. The percentage of total tranche value details the relative weight in terms of tranche value that the specific industry has in each loan type. The percentage of total tranches details the relative weight in terms of number of tranches that the specific industry has in each loan type.

Table 5: Geographical distribution - Restricted sample

Geographic location of issuer	Conventional bonds				Green bonds				Social bonds				Sustainability bonds			
	Number of tranches	Total value (Face) [€ Million]	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total value (Face) [€ Million]	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total value (Face) [€ Million]	Percentage of total tranche value (%)	Percentage of total tranches (%)	Number of tranches	Total value (Face) [€ Million]	Percentage of total tranche value (%)	Percentage of total tranches (%)
Europe	261	153,254.45	48.13	47.98	222	110,786.29	0.52	51.75	22	19,428.91	63.56	51.16	17	7,966.17	21.46	23.61
North America	145	111,067.80	34.88	26.65	107	67,473.27	31.46	24.94	10	8,594.26	28.11	23.26	28	19,669.13	52.98	38.89
Japan	52	20,626.42	6.48	9.56	41	11,697.92	5.45	9.56	5	1,359.45	4.45	11.63	6	1,063.92	2.87	8.33
North Asia	44	13,233.38	4.16	8.09	32	10,416.29	4.86	7.46	4	862.01	2.82	9.30	8	2,659.42	7.16	11.11
Latin America	10	2,198.09	0.69	1.84	3	485.16	0.23	0.70	1	186.76	0.61	2.33	6	1,222.53	3.29	8.33
Australasia	19	13,112.28	4.12	3.49	14	9,222.45	4.30	3.26	-	-	-	-	5	3,543.73	9.54	6.94
India Subcontinent	3	1,072.13	0.34	0.55	1	396.16	0.18	0.23	1	137.89	0.45	2.33	1	278.90	0.75	1.39
Southeast Asia	2	719.62	0.23	0.37	2	747.56	0.35	0.47	-	-	-	-	-	-	-	-
Africa	1	19.11	0.01	0.18	1	20.40	0.01	0.23	-	-	-	-	-	-	-	-
Middle East	7	3,110.85	0.98	1.29	6	3,248.17	1.51	1.40	-	-	-	-	1	723.80	1.95	1.39
Total	544	318,414.13	100	100	429	214,493.69	100	100	43	30,569.27	100	100	72	37,127.60	100	100

This table provides information on the geographical region of issuers in our restricted sample. The information in the table is divided by loan type (conventional, green, social and sustainability). The number of tranches column details the amount of bond tranches in each geographical region in the sample. The total tranche value column provides the sum of the tranche value for all bond tranches in the sample that belong to the geographical region. The percentage of total tranche value details the relative weight in terms of tranche value that the geographical region has in each loan type. The percentage of total tranches details the relative weight in terms of number of tranches that the specific geographical region has in each loan type.

3.3 Financial characteristics of sustainable versus conventional bonds

In table 6 we describe our full sample, according to the variables in our model, divided by loan typology.

In table 7 we describe our restricted sample, according to the variables in our model and divided by loan typology.

Conventional bonds show a higher average credit spread in our full and restricted matched samples, with around 137.97 bps on average in the full sample and 123.44 bps in the restricted sample, while green bonds have an average of 133.94 bps and 122.76 in the full and restricted matched samples, respectively. Sustainability bonds show an average of 133.44 bps in the full sample and 120.55 in the restricted sample, while social bonds have an average of 113.99 bps and 107.37 bps in the full and restricted matched samples, respectively.

Sustainability bonds show the highest average rating in both the full and restricted matched samples, followed by social bonds with the second highest average rating, conventional bonds with the third and green bonds with the lowest average rating, in both the full and restricted matched samples. Given the inverse relationship between the rating numerical scale and creditworthiness, green bonds appear to present the highest creditworthiness.

Regarding maturity, green bonds show the highest average maturity in both samples, followed by conventional bonds, sustainability bonds and social bonds.

Sustainability bonds show the highest average transaction size in the full sample, however, conventional bonds hold the highest average transaction size in the restricted sample.

Sustainability bonds also show the highest average country risk in the full sample and in the restricted sample.

As for volatility, social bonds show the highest volatility in both samples, followed by sustainability bonds with the second highest in both samples, conventional bonds with the third highest in both samples and green bonds with the lowest average volatility.

Table 6 and table 7 also show that around 51% of all conventional bonds in the full sample are subordinated. This is considerably higher than the 3% visible for green and social bonds and 7% visible for sustainability bonds. However, in the restricted sample, all loan types show similar proportions of subordinated bond tranches. Around 2% of all conventional, green and social bonds in the restricted sample are subordinated, while around 3% of sustainability tranches are subordinated.

Conventional, green and sustainable bonds show similar proportions of tranches with currency risk, with around 30% to 35% of all bond tranches of these loan types in both samples having the currency risk dummy variable equal to 1. Social bonds have around 21% of tranches with the currency risk dummy variable equal to 1 in both samples.

Proportion of not rated bond tranches is also similar between both samples, with the percentage of bond tranches lacking rating information in the full sample being 17%, 18%, 10% and 13% for conventional, green, social and sustainability bonds respectively. As for the restricted sample, the proportions are identical, with the exception of social bonds where around 10% of all social bond tranches lack rating information.

Regarding callability, values are also similar for all loan types, with around 50% to 55% of all bond tranches for each loan type being callable bonds in the full sample and with around 44% to 53% of all bond tranches for each loan type being callable in the restricted sample.

As mentioned before, the experienced sustainable variable measures if the issuer of a sustainable bond has issued sustainable bonds in the past. Around 21% of all green bonds in the full sample and around 31% of all green bonds in the restricted sample have this dummy variable equal to 1. As for social bonds, around 30% of all social bonds in the full sample and 51% of all social bonds in the restricted sample have this dummy variable equal to 1, while 18% of all sustainability bonds in the full sample and 26% of all sustainability bonds in restricted sample have this dummy variable equal to 1.

Table 6: Univariate statistics – pricing features associated with bonds compared – Full sample

Variable of interest	Convention al bonds	Sustainable bonds			Variable of interest	Convention al bonds	Sustainable bonds		
		Green bonds	Social bonds	Sustainabili ty bonds			Green bonds	Social bonds	Sustainabili ty bonds
<i>Univariate analysis - continuous variables</i>									
Credit spread (bps)					Country risk [1-xx weak]				
Number	974	775	71	128	Number	974	775	71	128
Mean	137.97	133.94	113.99	133.44	Mean	2.41	2.21	3.06	3.41
Median	115	113.90	105	99	Median	1	1	2	1
Rating [1-xx weak]					Volatility				
Number	974	775	71	128	Number	974	775	71	128
Mean	5.51	5.46	5.62	5.72	Mean	19.67	19.01	20.63	20.42
Median	6	6	6	6	Median	17.89	17.48	19.59	19.04
Transaction size (€ Million)					Maturity				
Number	974	775	71	128	Number	974	775	71	128
Mean	968.81	702.78	870.14	990.10	Mean	8.00	8.11	6.39	7.94
Median	549.99	500.00	750.00	501.97	Median	6	6	5.0	6.1
<i>Univariate analysis - dummy variables</i>									
Subordinated					Callable				
Nr. of tranches	974	775	71	128	Nr. of tranches	974	775	71	128
Nr. of tranches with d=	498	24	2	9	Nr. of tranches with d=	498	391	38	69
% of total	51%	3%	3%	7%	% of total	51%	50%	54%	54%
Currency risk					Experienced sustainable				
Nr. of tranches	974	775	71	128	Nr. of tranches	974	775	71	128
Nr. of tranches with d=	309	224	15	44	Nr. of tranches with d=	0	161	21	23
% of total	32%	29%	21%	34%	% of total	0%	21%	30%	18%
Not Rated									
Nr. of tranches	974	775	71	128					
Nr. of tranches with d=	170	140	7	17					
% of total	17%	18%	10%	13%					

This contains summary statistics for characteristics of bond issuances in our full sample, divided by loan type. Information on the characteristics of bond issuances was obtained from DCM Analytics and S&P Global Ratings. The rating is based on the S&P, Moody's and Fitch ratings at the time of bond issuance. The rating is converted as follows: AAA = Aaa = 1, AA+ = Aa1 = 2, and so on. For a definition of variables, see Table 1. Note that in the dummy variables section, "Nr. of tranches with d =" should read "Nr. of tranches with d = 1".

Table 7: Univariate statistics – pricing features associated with bonds compared – Restricted sample

Variable of interest	Convention al bonds	Sustainable bonds			Variable of interest	Convention al bonds	Sustainable bonds		
		Green bonds	Social bonds	Sustainabili ty bonds			Green bonds	Social bonds	Sustainabili ty bonds
Univariate analysis - continuous variables									
Credit spread (bps)					Country risk [1-xx weak]				
Number	544	429	43	72	Number	544	429	43	72
Mean	123.44	122.76	107.37	120.55	Mean	2.36	2.12	3.12	3.31
Median	105	105.05	100	96.5	Median	1	1	3	2
Rating [1-xx weak]					Volatility				
Number	544	429	43	72	Number	544	429	43	72
Mean	5.28	5.15	5.67	5.81	Mean	19.27	18.65	20.58	20.49
Median	6	5.5	6	6	Median	17.80	17.21	19.59	19.31
Transaction size (€ Million)					Maturity				
Number	544	429	43	72	Number	544	429	43	72
Mean	1075.62	715.71	899.82	839.07	Mean	7.16	7.48	5.82	6.84
Median	639.24	500.00	830.50	500.00	Median	5.00	5.46	5.00	5.00
Univariate analysis - dummy variables									
Subordinated					Callable				
Nr. of tranches	544	429	43	72	Nr. of tranches	544	429	43	72
Nr. of tranches with d=	13	8	1	2	Nr. of tranches with d=	240	191	23	32
% of total	2%	2%	2%	3%	% of total	44%	45%	53%	44%
Currency risk					Experienced sustainable				
Nr. of tranches	544	429	43	72	Nr. of tranches	544	429	43	72
Nr. of tranches with d=	192	145	9	26	Nr. of tranches with d=	0	135	23	19
% of total	35%	34%	21%	36%	% of total	0%	31%	53%	26%
Not Rated									
Nr. of tranches	544	429	43	72					
Nr. of tranches with d=	94	79	6	9					
% of total	17%	18%	14%	13%					

This contains summary statistics for characteristics of bond issuances in our restricted sample, divided by loan type. Information on the characteristics of bond issuances was obtained from DCM Analytics and S&P Global Ratings. The rating is based on the S&P, Moody's and Fitch ratings at the time of bond issuance. The rating is converted as follows: AAA = Aaa = 1, AA+ = Aa1 = 2, and so on. For a definition of variables, see Table 1. Please note that in the dummy variables section, "Nr. of tranches with d =" should read "Nr. of tranches with d = 1".

Chapter 4

Results

4.1 Main results

Table 8 presents the results of 4 models. In model [1] and model [1a], we utilize our entire full sample, to understand the impact of the sustainable label and the impact of the green, social and sustainability label in the bond's credit spread. In model [2] and model [2a] we utilize our entire restricted sample to also measure the impact of the labels mentioned above in the bond's credit spread.

According to models [1] and [2], sustainable bonds are issued at a premium. More specifically, model [1] indicates that sustainable bonds have a premium of -0.98 and model [2] indicates that sustainable bonds have a premium of -2.37. However, this evidence is not statistically significant, as indicated by the p-values visible directly below the coefficient of the sustainable variable for models [1] and [2]. According to these results, we reject H1.

Models [1a] and [2a] show significant evidence that social bonds are trading at a premium. Model [1a] shows that social bonds are issued at a premium of -22.3 bps and model [2a] indicates that social bonds are issued at a premium of -19.39 bps.

As for green bonds, models [1a] and [2a] show a non-significant impact of the green label on credit spreads. Model [1a] even shows a very small positive coefficient for the variable, albeit with a p-value larger than 0.9.

Sustainability bonds also show no significant impact on credit spread, according to models [1a] and [2a], with a coefficient of -1.09 for model [1a] and a coefficient of -8.17 for model [2a].

Table 8: Regression analysis of the determinants of credit spreads – Full and restricted samples

Dependent variable:	[1]	[1a]	[2]	[2a]
Credit spread (bps)	Full sample	Full sample with GSS dummies	Restricted sample	Restricted sample with GSS dummies
Independent variables:				
Intercept	-89.06 (0.187)	-94.19 (0.186)	-154.43 (0.003)	-161.40 (0.002)
Sustainable	-0.98 (0.846)		-2.37 (0,604)	
Green		0.47 (0.924)		-0.15 (0.975)
Social		-22.13 (0.009)	***	-19.39 (0.036)
Sustainability		-1.09 (0.910)		-8.17 (0.362)
Rating	14.74 (0.000)	14.70 (0.000)	16.48 (0.000)	16.59 (0.000)
Not rated	105.06 (0.000)	105.74 (0.000)	117.14 (0.000)	118.14 (0.000)
Subordinated	10.80 (0.101)	10.69 (0.099)	58.86 (0.001)	59.11 (0.001)
Log Maturity	35.62 (0.000)	35.34 (0.000)	18.61 (0.002)	18.1 (0.004)
Log transaction size	-1.77 (0.492)	-1.58 (0.539)	2.93 (0.139)	3.15 (0.113)
Currency risk	17.83 (0.006)	16.86 (0.009)	24.67 (0.000)	23.72 (0.001)
Callable	30.78 (0.000)	31.21 (0.000)	30.27 (0.001)	30.64 (0.001)
Experienced sustainable	5.30 (0.308)	6.19 (0.229)	6.43 (0.234)	7.47 (0.168)
Volatility	1.95 (0.000)	1.96 (0.000)	2.26 (0.014)	2.28 (0.013)
Country risk	8.26 (0.005)	8.42 (0.004)	2.98 (0.135)	3.19 (0.111)
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Number of observations	1,948	1,948	1,088	1,088
<i>of which sustainable</i>	974	974	544	544
<i>of which conventional</i>	974	974	544	544
Adjusted R ²	0.38	0.38	0.39	0.39

This table presents the results of an OLS regression analysis of the determinants of bond credit spreads for: a sample of 1,948 bonds, of which 974 are conventional bonds and 974 are sustainable bonds - model [1] and [1a]; a sample 1,088 bonds, of which 544 are conventional bonds and 544 are sustainable bonds - model [2] and [2a]. Table 1 contains a definition of variables. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. The t-statistics reported in parentheses are based on heteroskedasticity-consistent standard errors. Due to time-varying risk premia and cross-country differences, we estimate standard errors clustered by year and country.

4.2 Pricing of sustainable versus conventional bonds by region

Around 75% of issuers of bonds in both our full and restricted matched samples are from Europe or North America. As we have quite a large representation of sustainable bonds issued by companies from these two regions, we can understand if there's any difference in the impact of sustainable bonds on credit spreads between companies from these two regions. For this purpose, we filter our full and restricted matched samples for bonds issued by European companies and bonds issued by North American companies. Table 9 shows models [3], [3a], [4], [4a], [5], [5a], [6], [6a] with the purpose of helping us understand how the region of the issuer influences the impact of the sustainable label and the green, social and sustainability labels on credit spread.

Sustainable bonds appear to be issued at 10.03 bps higher than conventional bonds in Europe, according to our model [3]. This result is only weakly significant, however, it contraries the idea of a sustainable premium for European bonds. Considering our restricted sample, we still see a positive coefficient of 6.28 on the sustainable variable, however, we see that the result is no longer statistically significant.

Green and sustainability bonds show positive coefficients in Europe for both the full and restricted matched samples, indicating that these sustainable bond types are issued with higher spreads than conventional bonds in Europe. However, these results are not statistically significant. In North America, the green and sustainability label do not appear to have any significant impact on credit spreads.

Model [5a] shows that social bonds are issued at around 25 bps lower than conventional bonds in Europe. This result is only weakly significant, but it is in line with the results from models [1a] and [2a].

Table 9: Regression analysis of the determinants of credit spreads by region – Full and restricted samples

Dependent variable:	[3]	[3a]	[4]	[4a]	[5]	[5a]	[6]	[6a]
Credit spread (bps)	Full sample - Europe	Full sample (GSS) - Europe	Full sample - North America	Full sample (GSS) - North America	Restricted sample - Europe	Restricted sample (GSS) - Europe	Restricted sample - North America	Restricted sample (GSS) - North America
Independent variables:								
Intercept	-229.41 *** (0.001)	-238.17 *** (0.001)	-245.03 *** (0.000)	-244.22 *** (0.000)	-262.62 *** (0.001)	-281.34 *** (0.000)	-258.51 *** (0.002)	-255.40 *** (0.002)
Sustainable	10.03 * (0.090)		-3.45 (0.581)		6.28 (0.302)		-9.25 (0.257)	
Green		9.39 (0.106)		-3.81 (0.541)		6.11 (0.313)		-7.85 (0.270)
Social		-7.61 (0.457)		-8.67 (0.441)		-25.55 * (0.096)		-14.81 (0.424)
Sustainability		25.76 (0.106)		-1.56 (0.859)		26.60 (0.161)		-13.66 (0.340)
Rating	15.78 *** (0.000)	15.71 *** (0.000)	17.26 *** (0.000)	17.28 *** (0.000)	16.60 *** (0.000)	16.48 *** (0.000)	20.04 *** (0.000)	20.10 *** (0.000)
Not rated	126.29 *** (0.000)	126.25 *** (0.000)	127.05 *** (0.000)	127.25 *** (0.000)	126.23 *** (0.000)	127.24 *** (0.000)	155.68 *** (0.000)	156.29 *** (0.000)
Subordinated	18.22 ** (0.037)	17.70 ** (0.044)	4.75 (0.567)	4.61 (0.581)	40.67 (0.233)	41.06 (0.227)	18.58 (0.519)	19.26 (0.524)
Log Maturity	21.26 *** (0.008)	21.15 *** (0.008)	30.84 *** (0.000)	30.83 *** (0.000)	8.03 (0.402)	6.98 (0.465)	22.74 *** (0.001)	22.32 *** (0.002)
Log transaction size	4.69 * (0.062)	5.19 ** (0.040)	2.01 (0.291)	1.97 (0.296)	9.07 ** (0.011)	10.26 *** (0.005)	3.14 (0.156)	2.91 (0.167)
Currency risk	21.37 *** (0.005)	20.23 *** (0.008)	-4.48 (0.522)	-4.67 (0.512)	23.36 ** (0.012)	21.11 ** (0.019)	-10.93 (0.103)	-11.96 * (0.083)
Callable	24.74 ** (0.011)	24.92 ** (0.011)	-4.55 (0.694)	-4.28 (0.704)	26.91 ** (0.012)	27.49 *** (0.009)	-9.71 (0.442)	-9.36 (0.439)
Experienced sustainable	-1.13 (0.863)	-0.05 (0.995)	1.06 (0.825)	1.41 (0.769)	-4.23 (0.592)	-0.96 (0.902)		11.85 (0.157)
Volatility	2.52 *** (0.000)	2.51 *** (0.000)	2.98 *** (0.000)	2.98 *** (0.000)	1.48 (0.104)	1.41 (0.117)		3.56 *** (0.001)
Country risk	10.45 *** (0.001)	10.33 *** (0.000)	36.02 *** (0.000)	35.94 *** (0.000)	8.40 *** (0.006)	8.44 *** (0.004)		38.87 *** (0.000)
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	990	990	502	502	520	520	290	290
of which sustainable	495	495	251	251	260	260	145	145
of which conventional	495	495	251	251	260	260	145	145
Adjusted R ²	0.43	0.43	0.60	0.60	0.43	0.43	0.63	0.63

This table presents the results of an OLS regression analysis of the determinants of bond credit spreads for: a sample of 990 bonds from European issuers, of which 495 are conventional bonds and 495 are sustainable bonds - model [3] and [3a]; a sample of 502 bonds from North American issuers, of which 251 are conventional bonds and 251 are sustainable bonds - model [4] and [4a]; a sample of 520 bonds from European issuers, of which 260 are conventional bonds and 260 are sustainable bonds – model [5] and [5a]; a sample of 290 bonds from North American issuers, of which 145 are conventional bonds and 145 are sustainable bonds – model [6] and [6a]. Table 1 contains a definition of variables. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. The t-statistics reported in parentheses are based on heteroskedasticity-consistent standard errors. Due to time-varying risk premia and cross-country differences, we estimate standard errors clustered by year and country.

4.3 Pricing of sustainable versus conventional bonds by industry

The top issuing industries for sustainable bonds in our full and restricted matched samples are Finance, Utility & Energy and Real Estate/Property. With that in mind, we want to understand how the pricing of sustainable bonds differs between industries.

Models [7], [7a], [8], [8a], [9], [9a], [10], [10a], [11], [11a], [12], [12a] show how the industry of a sustainable bond influences the impact of the sustainable label and green, social and sustainability labels on credit spread.

Models [7] and [8] show negative coefficients for the sustainable variable, indicating that sustainable bonds are issued with lower spreads than conventional bonds in the Finance industry. However, the results are statistically insignificant. Although also statistically insignificant, models [7a] and [8a] indicate that green bonds are issued with a higher spread than conventional bonds in the Finance industry, while sustainability bonds present a lower spread when compared to conventional bonds, but also statistically insignificant. Social bonds are issued at -21.04 bps of spread when compared to conventional bonds with significant evidence, according to model [7a]. However, when considering our restricted sample in model [8a], social bonds are issued at -16.24 bps of spread, but with no statistical significance. Although the result in model [6a] does not have statistical significance, the social variable has a p-value of 0.113, which is close to weak significance. Given the small sample of social bonds from the finance industry in our restricted sample, the result from model [7a] appears to be a better representation of the impact of the social label on credit spreads.

The sustainable label does not show significant impact for bonds in the Utility & Energy industry, according to the models [9] and [10]. The green and

sustainability label also show no significant impact for bonds in this industry, as visible in models [9a] and [10a], with some of the coefficients for the sustainable, green and sustainability variables even being positive in models [9], [10], [9a] and [10a]. The social label appears to have significant impact for bonds in this industry, as per [9a]. However, our full sample only contains 1 social bond in the Utility & Energy industry, which is a very weak sample size and raises concerns regarding the reliability of the result.

As for Real Estate/Property, we can see that the sustainable label does not have significant impact on credit spread, according to models [11] and [12]. It's also relevant to mention that the coefficients for the sustainable variable in these models are positive. The green and social labels also show no significant impact, as per models [11a] and [12a]. In regards to the sustainability label, the results in model [11a] indicate high statistical significance that sustainability bonds are issued at 90.95 bps higher than conventional bonds in this industry. Looking at model [12a], we can see a similar result, as it indicates that sustainability bonds are issued at 141.21 bps higher than conventional bonds in the Real Estate/Property industry. However, our full sample only has 4 sustainability bonds in the Real Estate/Property industry and our restricted sample only has 1 sustainability bond in the Real Estate/Property, hence, the results are not robust.

Table 10: Regression analysis of the determinants of credit spreads by industry – Full and restricted samples

Dependent variable:	[7]	[7a]	[8]	[8a]	[9]	[9a]	[10]	[10a]	[11]	[11a]	[12]	[12a]	
Credit spread (bps)	Full sample - Finance	Full sample (GSS) - Finance	Restricted sample - Finance	Restricted sample (GSS) - Finance	Full sample - Utility & Energy	Full sample (GSS) - Utility & Energy	Restricted sample - Utility & Energy	Restricted sample (GSS) - Utility & Energy	Full sample - Real Estate/Property	Full sample (GSS) - Real Estate/Property	Restricted sample - Real Estate/Property	Restricted sample (GSS) - Real Estate/Property	
Independent variables:													
Intercept	-70.75 (0.243)	-77.05 (0.201)	-132.34 (0.028)	** -139.03 (0.025)	** -294.31 (0.041)	** -286.68 (0.039)	-50.94 (0.607)	-49.05 (0.621)	557.28 (0.005)	*** 529.14 (0.008)	280.85 (0.195)	241.14 (0.279)	
Sustainable	-0.86 (0.889)		-0.31 (0.952)		-0.18 (0.988)		9.12 (0.472)		7.97 (0.459)		1.23 (0.939)		
Green		2.18 (0.720)		1.48 (0.776)		-2.79 (0.817)		8.78 (0.496)		1.35 (0.903)		-1.01 (0.952)	
Social		-21.04 (0.025)	**	-16.24 (0.113)		-42.58 (0.021)	**			25.15 (0.510)		-11.90 (0.542)	
Sustainability		-7.11 (0.572)		-1.67 (0.899)		26.12 (0.364)		14.54 (0.353)		90.95 (0.003)	***	141.21 (0.000)	***
Rating	18.62 (0.000)	*** 18.52 (0.000)	*** 19.65 (0.000)	*** 19.78 (0.000)	*** 24.29 (0.000)	*** 24.56 (0.000)	*** 28.48 (0.000)	*** 28.50 (0.000)	*** 7.21 (0.020)	** 8.87 (0.003)	*** 14.31 (0.001)	*** 15.51 (0.000)	
Not rated	86.17 (0.000)	*** 85.09 (0.000)	*** 86.87 (0.000)	*** 87.76 (0.000)	*** 175.69 (0.000)	*** 176.90 (0.000)	*** 162.19 (0.000)	*** 162.54 (0.000)	*** 81.53 (0.004)	*** 99.26 (0.000)	*** 148.23 (0.001)	*** 162.36 (0.001)	
Subordinated	11.98 (0.211)	10.36 (0.273)	56.18 (0.002)	*** 55.68 (0.003)	*** -2.43 (0.839)	*** -2.43 (0.837)	*** 124.78 (0.000)	*** 125.15 (0.000)	6.28 (0.736)	3.39 (0.861)			
Log Maturity	64.11 (0.000)	*** 63.96 (0.000)	*** 48.52 (0.000)	*** 47.99 (0.000)	*** 39.53 (0.000)	*** 38.99 (0.000)	*** 21.70 (0.005)	*** 21.78 (0.005)	*** -35.45 (0.004)	*** -34.24 (0.005)	*** -20.87 (0.087)	* -23.69 (0.050)	
Log transaction size	-2.59 (0.359)	-2.35 (0.401)	1.13 (0.647)	1.39 (0.585)	3.96 (0.507)	3.71 (0.522)	-6.84 (0.255)	-6.92 (0.249)	*** -25.54 (0.009)	** -24.99 (0.011)	* -22.69 (0.054)	* -20.96 (0.082)	
Currency risk	16.70 (0.009)	*** 15.61 (0.014)	** 17.52 (0.005)	*** 16.65 (0.008)	*** 16.96 (0.313)	*** 17.54 (0.281)	35.94 (0.114)	36.17 (0.111)	70.92 (0.003)	*** 71.51 (0.003)	*** 80.32 (0.027)	** 78.50 (0.035)	
Callable	21.29 (0.020)	** 23.11 (0.012)	** 16.89 (0.039)	** 17.29 (0.039)	* 30.29 (0.077)	* 29.35 (0.074)	* 27.22 (0.303)	* 27.15 (0.305)	*** 93.79 (0.000)	*** 96.34 (0.000)	*** 98.11 (0.002)	*** 100.14 (0.002)	
Experienced sustainable	4.18 (0.541)	4.77 (0.487)	3.99 (0.510)	5.17 (0.387)	-9.39 (0.341)	-9.02 (0.368)	-24.29 (0.134)	-25.37 (0.141)	6.35 (0.579)	10.95 (0.319)	11.07 (0.535)	14.06 (0.456)	
Volatility	1.29 (0.012)	** 1.32 (0.010)	** 1.19 (0.088)	* 1.23 (0.078)	*** 2.26 (0.000)	*** 2.19 (0.000)	*** 1.44 (0.246)	*** 1.43 (0.251)	*** 4.67 (0.003)	*** 4.70 (0.002)	** 5.48 (0.037)	** 5.72 (0.031)	
Country risk	2.74 (0.208)	3.19 (0.143)	0.02 (0.992)	0.23 (0.920)	*** 18.33 (0.005)	*** 17.96 (0.003)	*** 12.40 (0.003)	*** 12.40 (0.003)	* 5.22 (0.096)	* 5.37 (0.087)	2.98 (0.536)	3.03 (0.533)	
Industry fixed effects	No	No	No	No	No	No	No	No	No	No	No	No	
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Number of observations	938	938	626	626	346	346	138	138	242	242	124	124	
of which sustainable	469	469	313	313	173	173	69	69	121	121	112	112	
of which conventional	469	469	313	313	173	173	69	69	121	121	112	112	
Adjusted R ²	0.44	0.44	0.47	0.47	0.54	0.54	0.57	0.57	0.39	0.39	0.38	0.38	

This table presents the results of an OLS regression analysis of the determinants of bond credit spreads for: a sample of 938 bonds from issuers in the finance industry, of which 469 are conventional bonds and 469 are sustainable bonds - model [7] and [7a]; a sample of 626 bonds from issuers in the finance industry, of which 313 are conventional bonds and 313 are sustainable bonds - model [8] and [8a]; a sample of 346 bonds from issuers in the Utility & Energy industry, of which 173 are conventional bonds and 173 are sustainable bonds – model [9] and [9a]; a sample of 138 bonds from issuers in the Utility & Energy industry, of which 69 are conventional bonds and 69 are sustainable bonds – model [10] and [10a]; a sample of 242 bonds from issuers in the Real Estate/Property industry, of which 121 are conventional bonds and 121 are sustainable bonds – model [11] and [11a]; a sample of 124 bonds from issuers in the Real Estate/Property industry, of which 112 are conventional bonds and 112 are sustainable bonds – model [12] and model [12a]. Table 1 contains a definition of variables. ***, ** and * indicate that the reported coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. The t-statistics reported in parentheses are based on heteroskedasticity-consistent standard errors. Due to time-varying risk premia and cross-country differences, we estimate standard errors clustered by year and country

Chapter 5

Conclusion

This study aimed to understand if corporate sustainable bonds trade at significantly lower spreads than comparable conventional bonds. With this objective in mind, we analyse a set of corporate sustainable bonds with a matched sample of corporate conventional bonds, issued by the same company and within a maximum interval of 365 days. For the purpose of further controlling for variables that affect bond spreads, we also conducted an analysis with a restricted matched sample, which filtered the original full matched sample to only contain conventional bonds with a maturity within a maximum interval of 365 days.

Results from both the full and the restricted matched samples suggest no significant difference in spreads between sustainable bonds and conventional bonds. These results hold for green and sustainability bonds. However, our findings indicate a significant premium of -22.13 bps and -19.39 bps for social bonds in our full and restricted matched samples, respectively. Concerning European and North American social bonds, we found no significant premium for North American social bonds and a premium of -25.55 bps for European social bonds, albeit with weak significance. We also found a significant premium of -21.04 bps and -42.58 bps for social bonds in the Finance and Utility & Energy industries, respectively. Contrary to expected, sustainability bonds in the Real Estate/Property industries show a significant discount of 90.95 bps and 141.21 bps in our full and restricted matched samples, respectively. However, our full matched sample contains 4 sustainability bonds in the Real Estate/Property industry and our restricted sample shows only 1. Therefore, the results are not robust and generalisable. Social bonds are, also, the sustainable bond type with

less representation in our sample. Social bonds amount to approximately 7% (71 social bonds) and 8% (43 social bonds) of the total sustainable bonds in our full and restricted matched samples, respectively. The low sample also raises concerns regarding the reliability of the results found for social bonds.

The rapid rise of sustainable bonds raised several questions among participants of the fixed income markets regarding the advantages of these financial instruments. Sustainable bonds (green, social and sustainability bonds in specific) limit the types of projects that can be financed by the proceeds of these financial instruments and often require additional controls to receive and maintain relevant certifications, which increase the cost that these companies incur when issuing sustainable bonds. Even without a direct cost advantage from lower spreads from sustainable bonds, issuers still show interest in issuing these financial instruments, which is visible by the growth of the sustainable bond market. As explained above in section 2.1.4, there are several possible reasons that can explain the increase in popularity of these instruments. This work aimed to understand if the cost of capital argument was valid. Policymakers also play a crucial role in the growth of the sustainable bond markets. The introduction of policies or the increasing stringency of existing policies that aim to combat climate change represent possible financial costs to a company, if the company does not comply with this new regulation. Given the possibility of new policies that would translate to increasing costs to a company, companies are now facing a new type of financial risk. Climate-related regulation increases the cost of debt of affected firms, especially pollution-intensive ones (Kempa & Moslener, 2022).

As the sustainable bonds market continues to grow, our findings suggest that the pricing of sustainable bonds is not significantly different from the pricing of conventional bonds, in general. This study found significant premium for social bonds, however, due to a low sample of social bonds, the results are not robust.

Although this study found no significant difference and considering findings from Kempa & Moslener (2022), sustainable bonds can still be an attractive financial instrument for issuers, in order to signal their commitment to reduce their pollution levels, as lack of action against climate change can increase the firm's cost of capital in the future. Further research should aim to understand if the firm's cost of capital and, specifically, if the firm's cost of debt can be affected by sustainable factors and to understand if the growing interest from investors on ESG factors will create a sustainable premium. Our findings contribute to the literature by showing that companies, currently, do not have any direct cost advantage in issuing sustainable bonds over conventional bonds. However, it is not clear if companies will have a cost advantage in the future, as the need for sustainable projects increases, therefore increasing investor demand. Policymakers can also create new regulations to take action on climate change, such as increased costs for companies without ESG policies and tax advantages for companies with good ESG policies, which will directly impact firm risk and, therefore, spread. There are avenues for future research.

Generative AI and AI-Assisted Technologies

Statement

During the preparation of my written work/thesis, “Do sustainable bonds have lower spreads than traditional corporate bonds?”, ChatGPT was used for tasks such as data analysis, with the prompts listed at the end of the document in the Prompt List section. After using this tool/service, I reviewed and edited the content as necessary and take full responsibility for the publication's content. I also declare that I am aware of and respect the Artificial Intelligence Conduct Rules of the Católica Porto Business School.

Prompts List

- I have an excel file. How do I pass it to a database and how can I be able to use SQL on it? Please use Python for this.
- Now I need to transform a table in my database into an Excel file? Can you show me how to do it with a similar approach to the one above?

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