



UNIVERSIDADE CATÓLICA PORTUGUESA

A comparative analysis of spreads:

Green bonds versus Corporate bonds

Sérgio Henrique Pereira Feliciano

Católica Porto Business School

2022



UNIVERSIDADE CATÓLICA PORTUGUESA

A comparative analysis of spreads: Green bonds versus Corporate bonds

Dissertation presented to the Universidade Católica Portuguesa to obtain the
Master's degree in Finance

by

Sérgio Henrique Pereira Feliciano

Under the supervision of
Prof. João Filipe Monteiro Pinto

Católica Porto Business School
2022

Agradecimentos

Quero dedicar este trabalho à minha família que sempre me apoiou e acreditou em mim. Agradecer à Francisca por estar sempre a apoiar-me e a motivar-me durante todo o percurso.

Um agradecimento ao Professor Doutor João Filipe Monteiro Pinto que sempre se mostrou disponível para esclarecer todas as minhas questões e sempre me orientou ao longo da elaboração do trabalho.

Resumo

Green Bonds são instrumentos financeiros que têm vindo a ganhar popularidade na última década. Este estudo investiga o volume de green bonds emitidas por empresas não financeiras em países da zona euro durante o período 2013-2021 e faz uma análise comparativa das suas características com as das obrigações tradicionais.

O principal objetivo deste trabalho académico é contribuir para os estudos relacionados com green bonds e investigar se estes instrumentos financeiros possuem spreads mais baixos quando comparados com corporate bonds com as mesmas características. Utiliza-se uma amostra de 223 green bonds e 2,610 corporate bonds obtidas da base de dados DCM Analytics, para efetuar esta análise, controlando-se por outras variáveis que afetam o spread, tais como fatores macroeconómicos e características contratuais.

Os resultados sugerem que as green bonds não têm spreads mais baixos do que as corporate bonds comparáveis, argumentando que as green bonds não são consideradas uma fonte de capital com custos de financiamento mais baixos. Os resultados também permitem concluir que as variáveis que captam o risco de crédito são as que mais impacto têm nos spreads das obrigações.

Palavras-chave: Climate change; Green bonds; Spreads; Environmental social and governance (ESG); Corporate social responsibility (CSR)

Abstract

Green bonds are financial instruments that are becoming progressively more popular. This study investigates the volume of green bonds issued by non-financial firms in eurozone countries during the period 2013 and 2021 and makes a comparative analysis of their characteristics with those of traditional bonds.

The main objective of this academic research is to contribute to the studies related to green bonds and investigate if these financial instruments have lower spreads when compared to corporate bonds with the same characteristics. We use a sample of 233 green bonds and 2,610 corporate bonds obtained from DCM Analytics database to perform this analysis, controlling for other variables that affect the spread, such as macroeconomic factors and contractual characteristics.

The results suggest that green bonds do not have lower spreads than comparable corporate bonds, arguing that green bonds are not considered a financial source with lower borrowing costs. Results also show that credit risk-related variables are those that have the strongest impact on bond spreads, for both green and traditional corporate bonds.

Keywords: Climate change; Green bonds; Spreads; Environmental social and governance (ESG); Corporate social responsibility (CSR)

Table of Contents

<i>Agradecimientos</i>	<i>v</i>
<i>Resumo</i>	<i>vii</i>
<i>Abstract</i>	<i>viii</i>
<i>Table of Contents</i>	<i>x</i>
<i>Table of Tables</i>	<i>xii</i>
<i>Introduction</i>	<i>14</i>
<i>1. Literature Review</i>	<i>17</i>
1.1. Environmental Risk	<i>17</i>
1.2. Environmental, Social, and Governance (ESG) and Green Bonds	<i>21</i>
1.3. Corporate Social Responsibility (CSR) and Shareholders' Wealth	<i>24</i>
1.4. Greenwash and Ethical Decisions	<i>25</i>
1.5. Bonds Spreads Determinants	<i>26</i>
1.6. Cost of Capital	<i>29</i>
1.7. Green Bonds and Non-Green Bonds yield differences.....	<i>30</i>
<i>2. Hypotheses</i>	<i>33</i>
<i>3. Methodology and Data</i>	<i>35</i>
3.1. Sample Section.....	<i>35</i>
3.2. Regression Models and Variables.....	<i>38</i>
3.2.1. Spread	<i>39</i>
3.2.2. Green Bond	<i>39</i>
3.2.3. Credit Rating.....	<i>39</i>
3.2.4. Contractual Characteristics.....	<i>40</i>
3.2.5. Macroeconomic Factors.....	<i>40</i>
3.3. Summary Statistics.....	<i>41</i>
<i>4. Univariate Analysis</i>	<i>42</i>
<i>5. Regression Results</i>	<i>44</i>
5.1 Do green bonds have lower yield spreads than other similar conventional bonds?	<i>44</i>
5.2. Are credit risk-related variables significant determinants of green bond spreads?	<i>45</i>
5.3. Contractual Characteristics and Macroeconomic Factors	<i>46</i>

<i>Conclusion</i>	51
<i>Bibliography</i>	53
<i>Appendices</i>	61

Table of Tables

Table 1- Geographic Distribution	37
Table 2- Industrial Distribution.....	37
Table 3- Bonds issued by year.....	38
Table 4- Green Bonds and Coporate Bonds summary statistics	41
Table 5- Dummy Variables.....	41
Table 6- Univariate analysis.....	43
Table 7- Regression Analysis.....	49

Introduction

Climate change topics have been discussed in many corporate finance studies. It is urgent that companies and organizations adopt responsible behavior to mitigate climate risk and contribute positively to society and the environment (Stroebel & Wurgler, 2021). Environmental, social, and governance (ESG) aspects can have an impact on a firm's financial and non-financial performance, and the main objective of this academic research is to provide evidence related to green bonds and whether these instruments may lead or not to a cheaper financial source.

This work tries to answer the following question: "Do green bonds have lower yield spreads than other similar conventional bonds?" There are studies that conclude that green bonds have lower yields than other comparable bonds, but we also have research that provides the opposite conclusion. On the one hand, many studies (Zerbib, 2019; Gianfrate & Peri, 2019; Fatica et al., 2021; Immel et al., 2021; Baker et al., 2018) state that green bonds have lower spreads than comparable corporate bonds. On the other hand, other studies (Flammer, 2021; Tang & Zhang, 2020; Larcker & Watts, 2020) contradicts the previous results as no evidence was found to support that green bonds have a premium when compared to corporate bonds. Moreover, this academic research is conducted to investigate whether variables related to credit risk are significant determinants of green bond spreads. Furthermore, other topics related to green bonds are mentioned in the literature review, for example, if green bonds are connected to greenwash scenarios (Flammer, 2021) or if the issuance of these debt instruments contributes to positive reactions of firms' stocks (Tang & Zhang, 2020).

For this purpose, this study uses a regression model similar to the studies conducted by Marques & Pinto (2020) to analyze the effects of credit risk related

variables, contractual characteristics, and macroeconomic factors on bond spreads. In order to study if a bond being considered green has an effect on the spread, we use a dummy variable (Tang & Zhang, 2020; Immel et al., 2021; Flammer, 2021) to verify if this characteristic is significant.

The results of this study indicate that green bonds do not have lower spreads than comparable corporate bonds. In addition, the results also conclude that credit risk variables are significant determinants of green bond spreads.

Since climate change is currently a very debated topic, and green bonds are instruments to finance environmental projects, it makes sense to develop a study on these financial tools in order to contribute to the studies already conducted.

This work is organized as follows. Chapter 1 discusses extant literature related to green bonds, climate change, ESG, CSR, green initiatives, bond spread determinants, and cost of capital. Chapter 2 presents the hypotheses. Chapter 3 describes the regression model and the variables used and presents univariate analysis that shows statistical tests for distribution differences between green bonds and corporate bonds. Chapter 4 presents the regression results and main results. Finally, a conclusion summarizes the main results, and presents limitations as well as suggestions for future research.

Chapter 1

1. Literature Review

1.1. Environmental Risk

Climate change has been a very debated topic in recent times in society (Bartram et al., 2022). Humphrey & Li (2021) have focused on the importance of reducing global warming and examine the relationship between families and the Principles for Responsible Investment (PRI). They conclude that families who adopt these principles have substantially lower emission levels and a considerable rise in their funds. Studies conducted by Azar et al. (2021) help to understand the influence of investors on a firm's carbon footprint. The authors collected carbon footprint records, and the results support the argument that companies influenced by certain large investors (i.e., BlackRock, Vanguard, and State Street Global Advisors) appear to be more capable of cutting their pollution levels. Stroebel & Wurgler (2021) contributed to the connection involving finance and climate aspects. According to the authors, global warming is an existential and urgent point being debated by scientists, which reveals the need to act to solve this situation. According to Liao et al. (2021) "as a negative externality, air pollution has long been confirmed as an important determinant of mortality rate, respiratory disease, mental health, and subjective illness". Wang et al. (2021) try to explain how pollution levels impact companies' plans related to employees. The authors revealed the fact that poor air quality is a significant determinant aspect affecting human resources. Similarly, Li et al. (2020) explored the effect of atmospheric pollution on work performance. In the end, according to the results, environmental degradation generates a cost factor for the financial system.

Furthermore, many studies have been conducted to describe procedures for identifying solutions for carbon risk reduction methods. For example, Andrew et al. (2010) suggest that carbon emissions should be associated with a tax rate, arguing that these types of policies are an alternative tool to stimulate market participants to reduce their environmental impact. The results conclude that carbon taxation could be a way to help society prevent climate change. Another example is the case presented by Pestel & Wozny (2021) that documented in detail the introduction of a special type of area in German cities, named “Low Emission Zones,”. The findings demonstrated that the creation of these areas is an appropriate measure for reducing pollution levels.

Ng & Rezaee (2020) document how business sustainability and transparency aspects influence stock value information quality. In this paper, it is demonstrated that non-financial environmental, social, and governance (ESG) sustainable quantifiable metrics are connected with market volatility. According to this analysis, investors are concerned about both company economic conditions and ESG efficiency, which seems to have consequences for companies and investors. Other theoretical studies (Jia & Li, 2020) explore the influence of three aspects related to uncertainty, specifically, economic policy, climate change, and political conflicts, on an organization’s sustainable initiatives. The results suggest that in uncertainty situations, firms with greater sustainability strategies are more valuable, and institutions that are more profitable are managed better in terms of sustainability when confronted with national uncertainty. Studies conducted by Kim et al. (2021) focus on the relationships involving global firms and green innovation. The authors recognized that global organizations’ green proceedings are stimulated by exposure to international economies that increasingly have stricter environmental rules. In general, the review shows that green technological transformation represents a significant component of business valuation for international organizations.

According to Krueger et al. (2020), environmental threats carry financial repercussions for many companies. Although the findings show that investors evaluate climate concerns as significant investment issues, the market itself is only in the initial phases of this evaluation. In the end, the authors believe that long-term and bigger entrepreneurs seem to be better positioned for a decarbonized economic scenario. Theoretical studies conducted by Nguyen & Phan (2020) indicate that increasing carbon exposure is associated with a higher chance of financial distress; that encourages businesses to reduce their economic leverage. The results illustrate that global emissions are a significant indicator of business capital structure and that restrictive environmental rules may have negative consequences on firm's financial performance. Safiullah et al. (2021) used a database to investigate the influence of a firm's carbon emissions on credit ratings. Their findings suggest that companies that generate a significant carbon footprint have more cash flow instability, which leads to poor credit ratings. In addition, Painter (2020) argues that bonds with poor credit quality produce increased issuing costs for climate change governments. The main outcome was that the degree of exposure to climate change risk has a large impact on long-term municipal bonds but not on short-term bonds. Furthermore, the findings show that when evaluating climate change risks, the system takes into consideration disparities in credit ratings, and at the same time, investors tend to respond to news about environmental issues, indicating that global warming is one of the most important aspects affecting investment choices.

Klassen & McLaughlin (1996) identified a framework that connects efficient environmental planning with higher projected profitability, particularly evaluated by stock market returns. The authors conclude that positive returns were identified with effective environmental management, and negative returns were observed with inefficient environmental management. In accordance with these findings, Gareil & Petit-Romec (2021) concluded that companies that

implement environmentally friendly practices have higher stock performance. Furthermore, Bolton & Kacperczyk (2021) investigated if carbon emissions have an impact on stock market returns. The data suggests that stocks of companies with high carbon emissions generate better returns, and therefore the findings support the hypothesis that investors are asking for monetary funds based on their carbon emission vulnerability. On the contrary, Chan & Walter (2014) explored the influence of socially responsible investing on stock performance. The results support the notion that enterprises with improved environmental standards are associated with long-term excess returns for investors, implying that there seems to be a green premium on companies' stocks with these types of environmental regulations. Moreover, according to Balachandran & Nguyen (2018), in comparison to non-polluters, enterprises that are considered big polluters have a lower chance of paying dividends, implying that carbon emissions are connected to firms' dividend policies.

In contrast, Hulshof & Mulder (2020) investigated the association involving renewable sources of energy and profitability. The findings show that enterprises focus on profitability and growth, implying that organizations only consider environmental planning using renewable energy if it helps them achieve their profit and financial targets. Chegut et al. (2019) focused on studying energy efficiency and the cost of sustainable architecture. Although clean and renewable energy have a significant effect in cutting the carbon footprint of projects, sustainable construction has mostly omitted production costs and takes more time to conclude. These studies have focused on the economic obstacles and market errors, which could illustrate why economically efficient green building approaches are taking longer than expected to catch on. Ehlers et al. (2021) argues for the hypothesis of banks considering the consequences of change in environmental policy. The authors discovered a considerable carbon premium through the combination of loan datasets with carbon footprint records. The

findings support the notion that only global emissions originally created by the company's internal capabilities are charged, and even though self-described green financial institutions tend to lend less to significant big polluters than other credit intermediaries, they do not appear to demand a larger carbon premium.

1.2. Environmental, Social, and Governance (ESG) and Green Bonds

Pástor et al. (2021) provided support for an economic method that takes environmental, social, and governance (ESG) factors into account. The authors mention that sustainable investments generate low estimated returns in equilibrium situations because market participants prefer to keep these types of financial instruments and mitigate climate risk. Hartzmark & Sussman (2019) also debated sustainable developments, arguing that market participants consider these investments and positions to be a strong and important firm characteristic. Particularly, Reboredo (2018) examined the dynamics of the correlation between green finance instruments, specifically green bonds, and the financial system. The data revealed that both the green bond and fixed-income markets are significantly connected.

According to Tang & Zhang (2020), "Green bonds are newly developed financial instruments with the specific goals of improving environmental impacts and social welfare". Flammer (2021) describes corporate green bonds as a financial instrument used to fund beneficial environmental initiatives. In this article, the author indicates that investors react positively to issuance statements, and the main conclusion is that when firms issue green bonds, they clearly express their sustainability efforts. Gianfrate & Peri (2019) describes green bonds as one of the most promising alternatives for supporting the mobilization of economic resources for sustainable investment. According to the research, this

financial instrument might play a significant role in promoting a green and sustainable economic system without exposing issuers to a financial disadvantage. In order to study this green financial asset, Ferrer et al. (2021) examined the connection between the green bond market and energy industries. The results suggest that green bonds could emerge as a helpful instrument in the campaign against environmental issues. Similarly, Jin et al. (2020) investigated possible hedging strategies to mitigate carbon market risk. The authors concluded that the green bond index is a cost-efficient and productive carbon risk hedging technique. However, there is also evidence that green bonds may have negative aspects for firms. For example, Hachenberg & Schiereck (2018) argue that green bonds issuance is associated with additional expenses such as extra evaluations or required process validation. In accordance with these findings, Larcker & Watts (2020) also support the theory that issuing green bonds is associated with additional costs.

Furthermore, a preliminary examination conducted by Capelle-Blancard et al. (2019) explored if a country's ESG approaches affect financing costs in global financial markets. The authors believe that high ESG behavior has an economic impact because it communicates a government's dedication to sustainability. It was also discovered that ESG performance and sovereign bond spreads have a substantial negative correlation. As a result, it seems that ESG characteristics are priced in sovereign bond markets and that good ESG metrics are linked to reduced government bond spreads and, consequently, decreased risk of default. In addition, Baker et al. (2021) explored the link between government risk management in ESG areas and firm-level initial public offerings (IPO) underpricing. As reported in the article, the findings suggest that IPO underpricing appears to be lower in countries with higher ESG governance ratings and those with better risk management strategies.

Tang & Zhang (2020) focused on the possible benefits for shareholders and the effects of green bond issuance on firms. The main conclusions reached by the authors were that green finance statements had a beneficial effect on stock prices and that when green bonds are issued, stock liquidity increases. As a result, the research reveals that the company's green bond issuance benefits the current shareholders. In line with these findings, Flammer (2021) also supports the theory that issuing green bonds is related to beneficial stock market responses.

Larcker & Watts (2020) found benefits related to green bonds, arguing that these debt instruments appear to help investors' diversification. In the same way, Hammoudeh et al. (2020) revealed that green bonds may be included in diversified investment portfolios because there was no correlation between these green finance resources and other financial funds. Similarly, Agliardi & Agliardi, (2021) also debated the positive aspects that green bonds appear to have, arguing that these financial tools demonstrate the capacity to contribute to the capital market's stabilization. In contrast, Reboredo et al. (2020) showed that there existed a significant link between green bonds and government bonds. However, the studies also argue that green bonds are a beneficial strategy to manage risk diversification, but only if they are acquired in a portfolio composed of high-yield corporate bonds or energy stocks, because although the authors found a strong connection between green bonds and treasury bonds, the relationship between green bonds and high-yield corporate bonds and energy debt instruments was considered a weak connection.

On the other hand, Ramiah et al. (2013) argued that green initiatives could not have the beneficial effects they should have. The findings suggest that one of the green approaches' objectives is to impose restrictions on firms with higher levels of environmental pollution. However, it is mentioned that these firms are not being affected by such initiatives, implying that they are demanding higher prices from consumers.

Additionally, it is also important to describe green bonds as an instrument that creates social value. Paranque & Revelli (2019) discussed to determine if green bonds may be recognized as an ethical approach with a substantial effect that generates not only economic value but also ethical and social value. As a result, the study revealed that green bonds should be part of a social initiative instead of being regulated like many other asset classes based on portfolio optimization.

1.3. Corporate Social Responsibility (CSR) and Shareholders' Wealth

Flammer (2015) focused on the impact of shareholder approaches connected to corporate social responsibility (CSR) on profitability. The researcher found that CSR initiatives result in higher accounting and financial performance, suggesting that these initiatives provide value and benefits. Riedl & Smeets (2017) connected data to determine why investors maintain socially responsible mutual funds. The authors discovered that social preferences and social signals both influence socially responsible investment choices. The main point presented by the data was that investors are prepared to sacrifice financial returns to invest according to their social norms. In addition, Dyck et al. (2019) presented additional facts related to environmental and social achievements, showing that businesses are improving their social initiatives because investors are demanding these efforts. Ferrell et al. (2016) found that very well-governed enterprises, which are less vulnerable to agency issues, interact more in CSR themes. As a result, it was proved that CSR and value have a positive association, with CSR reducing the unfavorable relationship involving institutional ownership and value.

According to previous studies conducted by Cai et al. (2016), firm factors explain just a small portion of the difference in corporate social performance

(CSP) evaluations. The authors concluded that changes in national characteristics, such as economic phases or culture, are more associated with variations in CSP than firm aspects. Edmans (2011) investigated the link between employee happiness and stock returns. In the end, the conclusion was that socially responsible investing (SRI) focused on employee satisfaction might boost investment efficiency, which strongly suggests that corporate social responsibility initiatives generate value. Similarly, Deng et al. (2013) examined merger official statement returns, comparing both high and low CSR enterprises to answer the value effect topic. The findings indicate that due to the positive market responses to companies linked with higher CSR ratings, CSR actually boosts enterprise value.

Stellner et al. (2015) investigated if better CSR efficiency leads to decreased credit risk and if ESG are connected with this correlation. The authors found that a country's ESG quality moderates the relationship between corporate social performance (CSP) and credit risk, and only if good CSP is identified by the environment could it be considered risk-reducing and compensated with higher ratings.

1.4. Greenwash and Ethical Decisions

Amore & Bennedsen (2016) studied the connection between corporate governance and environmental development inside enterprises. The researchers demonstrate that poorly managed companies produce fewer green applications as a proportion of all their advances. Therefore, the study found that insufficient corporate governance might be a serious barrier to environmental benefits. An example of a negative situation is described in previous research conducted by Lyon & Montgomery (2015), that was dedicated to studying the concept of

“greenwash”, which corresponds to information that manipulates society into having unrealistically favorable ideas around an enterprise’s environmental procedures. It is essential to investigate greenwash scenarios and provide additional studies to identify and classify the different greenwash forms to analyze their effects on business performance and society. For example, it is possible to debate whether a green bond can be considered a type of greenwash. For instance, Flammer (2021) contradict this position, arguing that green bonds contribute in a positive way to environmental behavior.

Moreover, Borghesi et al. (2014) evaluated the numerous variables that encourage decision makers to adopt what are considered ethical choices. The researchers observe that such types of investments differ significantly among industries and are connected to different business elements. It was also verified that firms with more institutional ownership are considerably less inclined to invest in CSR, suggesting that certain CSR initiatives are conducted for the private advantage of a company’s executives rather than for the benefit of shareholders.

1.5. Bonds Spreads Determinants

It is important to understand the components of a bond spread, and which factors affect this value the most. Tang & Yan (2010) argue that firm-level indicators are connected to a large amount of credit spreads, with macroeconomic factors contributing to a smaller percentage. Marques & Pinto (2020) also provide research related to debt instrument pricing, arguing that credit ratings are a crucial pricing factor, but also variables such as country risk, market volatility, maturity, and the reputation of financial intermediaries that

also affect bond spreads. In addition, Gemmill & Keswani (2011) analyzed aspects that influence corporate bond spreads. The main points reveal that credit spreads present higher values when investors have expectations of significant losses. In the end, these results appear to support the theory that credit risk is a defining factor of bonds spreads.

Since it is essential to evaluate and measure credit risk, it is important to describe credit rating agencies and their effects on firms' operations. According to Driss et al. (2019) "ratings provide a useful risk measure for investors who lack the resources or skills to assess credit risk". Credit rating agencies are necessary because they analyze debt issuers' financial status and are responsible for reducing information asymmetry involving economic agents (Aktas et al., 2021). Kisgen (2019) provide evidence related to credit rating agencies, more specifically Moody's, arguing that these organizations have the capacity to influence decision-making. According to the results, when Moody's changes its proceeds for evaluating businesses, it generates an effect on company's ratings, implying that these organizations have a substantial effect on firm's activities. Aoki (2021) collected information in order to examine the connection between bank interactions and bond spreads. The findings suggest that the existence of a possible disagreement involving banks and bondholders may have a significant effect on bond spreads, causing their increase in conflict situations. Furthermore, Davydenko & Strebulaev (2007) argued that firms' strategic actions have an effect on bond spreads, confirming that companies that are able to renegotiate their financial obligations in a simple way, are linked to higher spreads.

Kim & Stock (2014) point out that "the volatility of interest rates plays numerous important roles in finance theory and practice". Kim & Stock (2014) investigated the influence of interest rate volatility on yield bond spreads. According to the authors, interest rate volatility is strongly connected to yield spreads, demonstrating that macroeconomic factors are related to this variable.

Helwege et al. (2014) studied liquidity indicators to verify in which way they illustrate the effects on bonds' spreads. Although the authors argue that bond yields are in part determined by liquidity, they also mention that there is a part of the spread that remains unknown. Similarly, Chen et al. (2007) also studied liquidity and its relationship with bond spreads. As a result, the authors observed that bonds that present good liquidity parameters are associated with lower spreads. Chen et al. (2011) concluded that liquidity risk is positively related to bond spreads, arguing that measuring liquidity risk is an important procedure for studying bond spreads.

In accordance with Liu et al. (2007), one factor that must be taken into account is that investors' taxation is not properly considered on bond spreads. According to the authors, the tax rates applied on investment-grade bonds have an impact on those bond spreads, implying that higher taxes are associated with higher bond spreads. In the same way, Liu et al. (2006) argued that taxes are not being considered in frameworks that try to summarize bond spreads, suggesting that taxation contributes to higher yields and that taxes are a variable that should be recognized when examining bond spreads. Similarly, Elton et al. (2001) also stated that taxes are ignored in many studies related to bond spreads, arguing that taxes are a determining factor when studying bond spreads.

Güntay & Hackbarth (2010) conducted studies to evaluate a possible connection between bond spreads and forecast dispersion. According to the results, the authors demonstrated that these two parameters are positively related, arguing that dispersion scenarios will require higher bond spreads. In addition, Mann & Powers (2003) investigated if call options on bonds, which are used by firms that are facing uncertainty and fewer investment choices (Chen et al., 2010), have an impact on their pricing. As a result, the authors discovered that callable bonds have a higher yield than non-callable comparable bonds, indicating that call options may influence bond spreads. Furthermore, Lu et al.

(2010) provided evidence connecting bond spreads with information asymmetry. The authors argue that investors demand an information premium in situations with high uncertainty. In line with these findings, Han & Zhou (2014) also supported the argument of an information premium, suggesting that information asymmetry should be considered a significant bond spread determinant. Moreover, John & Reisz (2010) indicated that investors will require higher yields on debt instruments related to firms that demonstrate longer periods of uncertainty, supporting the argument that uncertainty and information asymmetry are significant bond spreads determinants.

1.6. Cost of Capital

Sharfman & Fernando (2008) argue that positive environmental strategic planning is linked with reduced financial costs. The results imply that, despite higher resource efficiency that coincides with better ecological risk evaluation, these activities are compensated by the capital markets. Chava (2014) examined how the environmental characteristics of a company affect its cost of capital. This research found that market participants request higher returns on stocks associated with companies that have a negative impact on the environment than those who do not have these issues. In accordance with Huynh et al. (2020) there is a strong linkage involving drought risk and equity financing. The calculations indicate that the cost of equity for entities facing extreme drought is much greater when compared with organizations that are not exposed to this scenario. Essentially, the data reveals that investors demand a larger interest rate on drought-affected enterprises. In the same way, Javadi & Masum (2021) discovered that businesses in climate-vulnerable areas pay much larger spreads on conventional bank loans to finance their operations. The findings indicate that

exposing a firm's consumers to climate risk has a negative impact on that firm's borrowing costs.

The costs of not being environmentally and socially responsible were also debated by Crifo et al. (2015) that explored the influence of ESG planning on equity funding. As a result, it was noticed that non-financial efficiency has an effect on business valuation and resource allocation, and the main outcome was that business owners who fail to identify ESG challenges will deal with restricted access to private equity and an increase in the cost of capital, contributing to value destruction. Eichholtz et al. (2019) supported the link connecting environmental actions and a company's cost of capital. The data suggests that loans for sustainably sourced structures show smaller spreads when compared with loans made for conventional projects.

El Ghouli et al. (2011) investigated how CSR impacts the cost of equity. For this study, various methods were used to evaluate this topic. It was discovered that businesses with higher CSR ratings and those that invest in climate policy have lower equity financing costs. In addition, Goss & Roberts (2011) also studied CSR and its relationship with the cost of debt. As a result, it was discovered that companies facing social responsibility problems have much higher financial costs than those who are more conscientious. In a similar way, Breuer et al. (2018) evaluated the impact of CSR approaches on the cost of equity, assuming various degrees of creditor rights. In the end, the study reveals that in cases where a company is involved in CSR through territories with high investor protection, the equity financial costs decrease.

1.7. Green Bonds and Non-Green Bonds yield differences

Díaz & Escribano (2021) explored how adhering to a sustainability index affects energy enterprises' financial expenses. According to the data, it was

recognized that renewable energy entities have a reduced cost of debt because of the premium that investors are ready to spend on the debt instruments generated by these companies.

In particular, there are studies on yield differences between a green bond and a similar traditional bond that have been published. According to Immel et al. (2021) “the green bond premium is defined as the incremental yield investors receive for holding a green bond over its equivalent non-green counterpart”. Zerbib (2019) illustrates the influence of environmental aspects on bond market values using green bonds. For this investigation, the model used consisted of an observation methodology based on a process to measure the yield disparity when comparing a green bond with a comparable typical bond. The major findings appear to lead to a negative premium, suggesting that this type of bond’s yield is lower than a comparable classic bond. Similarly, Immel et al. (2021) found a negative premium on green bonds, arguing that investors sacrifice potential returns for the purpose of investing in line with their green preferences. Gianfrate & Peri (2019) also support the argument that green bonds have a negative premium, implying that market participants are willing to pay in order to invest according to their environmental preferences. These results appear to support the argument that green bonds may be a useful option to get a cheaper financial source. In the same way, Fatica et al. (2021) also argue that green bonds have a pricing advantage, but only if issued by supranational organizations because this pricing benefit was not verified in financial entities. The authors agree that in the case of firms issuing these financial instruments, they are compensated with a lower cost of debt. In line with these findings, other studies conducted by Baker et al. (2018) also debated the pricing of these instruments, arguing that green bonds have lower yields than other comparable bonds.

On the other hand, Flammer (2021) contradict the previous findings because no pricing difference was identified, which means no pricing distinction between

green bonds and equivalent debt instruments announced by the same company. Larcker & Watts (2020) also supports the hypothesis of no distinction in pricing between green bonds and similar conventional bonds. The authors apply a matching procedure to evaluate a scenario of a green bond premium, showing that there is no evidence that supports the existence of a premium generated by green bonds. Similarly, Tang & Zhang (2020) also contradict the presence of a green bond premium on these types of financial instruments, arguing that green bonds do not have lower yields when compared with ordinary corporate bonds, implying that green bonds' primary benefits are not lower borrowing costs.

Chapter 2

2. Hypotheses

This section presents the formulated hypotheses dully backed by extant literature on green bond spreads.

There are several studies available on the differences between green bond and corporate bond yields. Zerbib (2019), Gianfrate & Peri (2019), and Fatica et al. (2021) argue that green bonds have lower yields than comparable corporate bonds, reinforcing the argument that green bonds are a financial instrument that provides a lower cost of capital. Flammer (2021), Tang & Zhang (2020), and Larcker & Watts (2020) find no evidence that green bonds have lower yields than comparable corporate bonds, contradicting the theory that there is a green bond premium.

Given the opposing positions on this topic, it seems useful to study green bonds and examine whether there is a pricing advantage related to this debt instrument. Therefore, we want to test the following hypothesis (H1): green bonds have lower spreads than comparable corporate bonds.

As stated before, there are many factors that have a significant impact on bond spreads. Gabbi & Sironi (2005) mention that credit ratings are the most defining factor on bond spreads. Kim & Stock (2014) confirm that volatility is positively related to bond spreads. Mann & Powers (2003) demonstrate that a bond with a call option has a higher yield when compared to a similar bond without this option embedded. Marques & Pinto (2020) state that factors such as the number of banks, number of tranches, maturity, currency risk, and subordination level should be considered when studying bond spreads.

Since many studies conclude that variables related to credit risk are the most significant determinants of bond spreads, we want to verify whether these

variables are, in fact, significant for green bonds also. Therefore, we want to test the following hypothesis (H2): credit risk-related variables are significant determinants of green bond spreads.

Chapter 3

3. Methodology and Data

3.1. Sample Section

This section describes the data that used in this work. Data was extracted from DCM Analytics, which is a database that contains a high volume of data related to bond instruments.

This study compares green bonds with non-green bonds in order to verify if there is a green bond premium. Before using regression techniques to study these financial instruments, it was necessary to filter the excel file in order to have a final excel document ready to be analyzed.

The initial sample was formed by the bonds issued between the 2010-2021 period by non-financial companies located in euro zone countries, which corresponded to 31,228 observations. After the extraction of the data, we noticed that green bonds did not have observations for the years of 2010, 2011, and 2012, so we removed these years from the sample and stayed with the observations between the 2013-2021 period. We also verified that some countries did not have observations for green bonds, so it was necessary to remove them from the sample. These countries were Malta, Estonia, Slovakia, and Slovenia. The currency's data is in Euros and the spreads are in basis points.

On the "Deal Type" classification, we only selected "Corporate Bond-High Yield", "Corporate Bond-Investment-Grade" and "Medium-Term Note". Following this action, we filtered the "Security Type" variable and eliminated the fields that did not show observations for green bonds. After this selection, we

looked into the “Green Bond Instrument Type” field and verified which bonds were considered green bonds.

After all these adjustments, we ended up with 2,833 observations, of which 223 were green bonds and 2,610 were non-green bonds. The 223 green bonds have 318 tranches, and the 2,610 non-green bonds have 4,318 tranches.

Panel A of Table 1 presents the geographic distribution of green bond and corporate bond issuers. It is possible to observe that France is the country with the highest number of green bond tranches, which represents a percentage of green bond total value of 25.40%, while Greece and Austria are the countries with the lowest green bond total value. On the other hand, Germany is the country with the highest number of corporate bond tranches, which corresponds to a significant percentage of corporate bond total value of 41.33%, while Greece, as well as green bonds, is the country with the lowest number of corporate bond tranches, which only represents 0.42% of corporate bonds total value.

Panel B of Table 2 presents the industrial distribution of green bonds and corporate bonds. Utilities are the sector that has more green bond tranches when compared with other sectors. However, in the corporate bond field, Telecommunications is the sector that leads because, even though this sector does not have the highest number of tranches, it has the highest percentage of corporate bond total value.

Panel C of Table 3 presents the bonds issued by year. Although the year of 2021 was the year where green bonds were issued in greater numbers, 2020 was the year where there was verified more corporate bond issuance.

Table 1- Geographic Distribution

Panel A: Geographic Distribution						
Geographic location of originator/issuer	Green Bonds			Corporate bonds		
	Number of tranches	Total value [€ Million]	Percent of total value	Number of tranches	Total value [€ Million]	Percent of total value
Austria	4	1550	0.83%	59	24001.09	0.87%
Belgium	3	1950	1.05%	79	26167.29	0.95%
Finland	13	4031.15	2.16%	145	49288.71	1.79%
France	69	47344.64	25.40%	1118	737139.77	26.77%
Germany	57	37075	19.89%	1652	1138008.70	41.33%
Greece	3	1170	0.63%	38	11690.14	0.42%
Ireland	22	11912.50	6.39%	95	48029.05	1.74%
Italy	31	17850	9.57%	395	271956.20	9.88%
Luxembourg	6	2400	1.29%	53	25185.84	0.91%
Netherlands	59	33113.37	17.76%	335	233610.13	8.48%
Portugal	12	7967.54	4.27%	71	20060.97	0.73%
Spain	39	20061.81	10.76%	278	168635.12	6.12%
Total	318	186,426.01	100%	4,318	2,753,773.01	100%

Table 2- Industrial Distribution

Panel B: Industrial distribution						
Industrial category of originator/issuer	Green Bonds			Corporate bonds		
	Number of tranches	Total value [€ Million]	Percent of total value	Number of tranches	Total value [€ Million]	Percent of total value
Agribusiness	1	500.00	0.27%	1	11	0.00%
Auto/Truck	9	7,400.00	3.97%	664	423,425.37	15.38%
Chemicals	5	3,300.00	1.77%	239	124,288.26	4.51%
Computers & Electronics	6	3,606.10	1.93%	564	455,118.17	16.53%
Construction/Building	13	4,122.41	2.21%	198	78,604.62	2.85%
Consumer Products	1	750.00	0.40%	74	31,373.79	1.14%
Forestry & Paper	9	3,906.36	2.10%	51	12,801.39	0.46%
Insurance	9	6,300.00	3.38%	117	70,900.31	2.57%
Machinery	3	1,075.00	0.58%	98	50,181.64	1.82%
Metal & Steel	16	9,212.50	4.94%	139	69,794.76	2.53%
Oil & Gas	2	1,000.00	0.54%	320	246,769.12	8.96%
Real Estate/Property	33	14,322.06	7.68%	426	216,589.82	7.87%
Telecommunications	3	2,450.00	1.31%	525	456,430.86	16.57%
Transportation	28	14,880.00	7.98%	367	194,487.62	7.06%
Utility & Energy	180	113,601.59	60.94%	535	322,996.77	11.73%
Total	318	186,426.01	100%	4,318	2,753,773.01	100%

Table 3- Bonds issued by year

Panel C: Bonds by Year						
Year	Green Bonds			Corporate Bonds		
	Number of tranches	Total value [€ Million]	Percent of total value	Number of tranches	Total value [€ Million]	Percent of total value
2013	1	1,400.00	0.75%	390	184,735.34	6.71%
2014	13	8,568.78	4.60%	438	242,248.18	8.80%
2015	17	8,694.64	4.66%	380	238,527.38	8.66%
2016	15	8,654.40	4.64%	456	293,499.38	10.66%
2017	28	17,400.00	9.33%	562	375,569.97	13.64%
2018	20	11,130.90	5.97%	473	295,048.87	10.71%
2019	45	27,750.00	14.89%	573	387,991.66	14.09%
2020	64	39,799.56	21.35%	599	410,133.39	14.89%
2021	115	63,027.73	33.81%	447	326,018.84	11.84%
Total	318	186,426.01	100%	4,318	2,753,773.01	100%

3.2. Regression Models and Variables

In order to study the impact of the independent variables on spreads (dependent variable in basis points - bps), we used the following model (Marques & Pinto, 2020). To investigate the effects of the independent variables on the spread, we applied an OLS regression. To obtain more accurate results, we use robust coefficients to adjust for possible heteroskedasticity issues. Considering varying risk premia and cross-country differences, it was necessary to estimate standard errors clustered by year and country (Marques & Pinto, 2020).

All the variables are fully described in Appendix A, along with the predicted effects of these independent variables on spread.

$$\begin{aligned}
\text{Yield Spread}_{i,t} = & \beta_0 + \beta_1 \times \text{Green Bond}_{i,t} \\
& + \gamma \times \text{Contractual Characteristics}_{i,t} + \varphi \times \text{Macroeconomic factors}_t \\
& + \varepsilon_{i,t}
\end{aligned}$$

3.2.1. Spread

The spread variable corresponds to the dependent variable that is going to be quantified (in basis points) based on the independent variables that we considered in the research.

3.2.2. Green Bond

This variable corresponds to a dummy variable that takes the value 1 if the bond is a green bond, and 0 otherwise (Tang & Zhang, 2020; Immel et al., 2021; Flammer, 2021).

3.2.3. Credit Rating

Credit ratings, alongside credit rating agencies, are indeed a crucial bond spread determinant (Marques & Pinto, 2020; Driss et al., 2019; Aktas et al., 2021; Gabbi & Sironi, 2005).

In this sample, the tranches have associated one credit rating provided by S&P, Moody's or Fitch, which is linked to a number, following the following method: AAA=1, AA+=2, AA=3, and so on until DDD=21 (Marques & Pinto, 2020; Gabbi & Sironi, 2005). There are tranches that are not rated and tranches that have a credit rating, and to control this situation, we use a dummy variable named rated tranche that takes the value of 1 if the tranche has a credit rating provided by a credit rating agency, and 0 otherwise (Marques & Pinto, 2020). In order to study

the scenarios where credit rating agencies provide different ratings for the same tranche, we use a dummy variable named rating discordance that takes the value of 1 if the ratings are different and 0 if the ratings have the same value (Marques & Pinto, 2020; Gabbi & Sironi, 2005).

3.2.4. Contractual Characteristics

In addition to the variables related to credit risk, variables related to other contractual characteristics are also important in the study of bond spreads (Marques & Pinto, 2020; Gabbi & Sironi, 2005; Elton et al., 2001). These variables were selected to try to explain spread differences. The variables that were used in the study related to contractual characteristics were the maturity of the bond, deal value, number of tranches, number of banks, if the bond has a call option or not, currency risk, if the bond is fixed priced or not, and whether the tranches are subordinated or not (Marques & Pinto, 2020).

3.2.5. Macroeconomic Factors

In the field of macroeconomic factors, we collected information related to volatility, country risk, and EUSA5y-Libor3M. The volatility variable was obtained from the Chicago Board Options Exchange Volatility Index (Marques & Pinto, 2020). Country risk was measured by converting the ratings of S&P Global Ratings into numbers following this method: AAA=1, AA+=2, AA=3, and so on until DDD=21 (Marques & Pinto, 2020; Gabbi & Sironi, 2005). In order to study the effects of macroeconomic factors on bond spreads, we use the yield curve slope measured (EUSA5y-Libor3M) as the difference between the 5-year Euro swap rate and the 3-month Libor rate (Marques & Pinto, 2020).

3.3. Summary Statistics

Panel D of Table 4 describes the summary statistics of the continuous variables that were used to study green bonds and corporate bonds, while Panel E of Table 5 presents the summary statistics for dummy variables.

Table 4- Green Bonds and Coporate Bonds summary statistics

Panel D: Continuous Variables												
Variable of interest	Green Bonds						Corporate bonds					
	Num ber	Me an	Medi an	Std. Dev	M in	Ma x	Num ber	Mea n	Medi an	Std. Dev.	M in	Max
<i>Contractual characteristics</i>												
Tranche Spread to Benchmark (bp)	223	173.22	125.80	129.69	17	734	2,610	216.12	153.10	178.61	-11	1303.00
Rating Tranche	223	8.17	8	2.76	0	16	2,610	7.80	8	4.05	0	18.0
Number of Banks	223	6.45	6.0	3.61	1	20	2,610	5.86	5	4.23	1	30
Number of tranches	223	1.43	1	0.71	1	5	2,610	1.65	1	1.09	1	7
Maturity	223	11.72	8.52	11.77	2.41	60.56	2,610	8.35	7.03	7.02	1.02	100.09
Deal Value	223	835.99	600	598.09	5.9	423.46	2,610	1055.09	600	1245.71	1	8291.87
<i>Macroeconomic factors</i>												
Country Risk	223	4.46	3	3.75	1	14	2,610	3.78	2	3.76	1	21
Volatility	223	19.10	17.11	8.71	9.78	66.04	2,610	16.81	14.42	7.48	9.15	66.04
5yTB	223	62.67	77.3	51.80	-50	180.2	2,610	84.35	86.7	58.96	-65	183.5

Table 5- Dummy Variables

Panel E: Dummy Variables						
Variable of interest	Green Bonds			Corporate bonds		
	Number	% of total	Std. Dev.	Number	% of total	Std. Dev.
Rating Discordance	223	44.84%	0.50	2,610	42.26%	0.49
Currency Risk	223	4.93%	0.22	2,610	16.74%	0.37
Callable	223	82.06%	0.38	2,610	63.87%	0.48
Subordinated	223	9.42%	0.29	2,610	2.53%	0.16
Rated Tranche	223	97.76%	0.15	2,610	90.11%	0.30
Fixed Rate	223	95.52%	0.21	2,610	84.75%	0.36

4. Univariate Analysis

This section presents the Wilcoxon rank-sum test for continuous variables and Fisher's exact test for dummy variables.

It is possible to verify that the spread of green bonds is, on average, lower than the spread of corporate bonds, with a 1% level significance (173.22 basis points for green bonds and 216.12 basis points for corporate bonds), which means that based on these values, it appears that green bonds have lower spreads than comparable corporate bonds (H1). The country risk variable is, on average and with a 1% level of significance, higher for green bonds (4.46) than for corporate bonds (3.78). Similarly, the number of banks variable is also, on average, higher for green bonds (6.45 banks) than for corporate bonds (5.86 banks), with a 1% level of significance. On the contrary, the number of tranches is on average with a significance level between the 1% level and the 5% level, lower for green bonds than for corporate bonds.

The maturity is significantly higher for green bonds when compared to corporate bonds (11.72 years for green bonds and 8.35 for corporate bonds). In the same way, volatility presents a higher value for green bonds (19.10) than for corporate bonds (16.81), with a 1% significance level.

In the end, the EUSA5y-Libor3M is, on average, lower for green bonds (62.67) when compared to corporate bonds (84.35), with a 1% level significance.

Table 6- Univariate analysis

Variable of interest	Green Bonds	Corporate bonds		Variable of interest	Green Bonds	Corporate bonds
<i>Univariate analysis - continuous variables</i>						
Spread (bps)				Maturity years		
Number	223	2,610		Number	223	2,610
Mean	173.22	216.12	***	Mean	11.72	8.35 ***
Median	125.80	153.10		Median	8.52	7.03
Rating Tranche				Volatility		
Number	223	2,610		Number	223	2,610
Mean	8.17	7.80		Mean	19.10	16.81 ***
Median	8	8		Median	17.11	14.42
Country Risk				5yTB		
Number	223	2,610		Number	223	2,610
Mean	4.46	3.78	***	Mean	62.67	84.35 ***
Median	3	2		Median	77.3	86.7
Number of Banks				Deal Value		
Number	223	2,610		Number	223	2,610
Mean	6.45	5.86	***	Mean	835.99	1,055.09
Median	6.0	5		Median	600	600
Number of tranches						
Number	223	2,610				
Mean	1.43	1.65	**			
Median	1	1				
<i>Univariate analysis - dummy variables</i>						
Rating Discordance				Rated Tranche		
Number	223	2,610		Number	223	2,610
Nr. of observations with d=1	100	1,103		Nr. of observations with d=1	218	2,352 ***
% of total	44.8%	42.26%		% of total	97.8%	90.11%
Currency Risk				Fixed Rate		
Number	223	2,610		Number	223	2,610
Nr. of observations with d=1	11	437	***	Nr. of observations with d=1	213	2,212 ***
% of total	4.9%	16.74%		% of total	95.5%	84.75%
Callable				Subordinated		
Number	223	2,610		Number	223	2,610
Nr. of observations with d=1	183	1,667	***	Nr. of observations with d=1	21	66 ***
% of total	82.1%	63.87%		% of total	9.4%	2.53%

Note: This information table presents summary statistics for a sample of both green bonds and corporate bonds issued between 2013 and 2021. The data was obtained from DCM Analytics. We use the Wilcoxon rank-sum test for continuous variables and the Fisher's exact test for discrete ones to test for identical distributions in contractual characteristics. Bond rating is available based on S&P, Moody's, and Fitch rating at the time of bond issuance. The rating is linked to a number as follows: AAA = 1, AA+ = 2, AA = 3, and so on until DDD = 21. For a detailed description of the variables, see Appendix A. (***) indicates significant difference at the 1% level. (**) indicates significant difference between the 1% level and the 5% level. (*) indicates significant difference at the 10% level.

Chapter 4

5. Regression Results

5.1 Do green bonds have lower yield spreads than other similar conventional bonds?

This section presents the results of the study as well as the impact of each variable on bond spreads. The full sample consists of 2,833 observations, of which 223 are green bonds and 2,160 are corporate bonds. In order to compare green bond spreads to corporate bond spreads, we created a dummy variable that takes the value of 1 if the bond is considered a green bond, and 0 otherwise (Tang & Zhang, 2020; Immel et al., 2021; Flammer, 2021).

Model (1) was estimated based on the full sample without fixed effects. Models (2) and (3) represent green bond samples and corporate bond samples without fixed effects, respectively.

The results suggest that the green bond dummy variable coefficient is negative and statistically significant, at the 1% level, indicating that the spread of a green bond is lower than a comparable corporate bond for Model (1) only.

However, when re-estimating the model with fixed effects the impact of green bond dummy variable becomes insignificant. Model (4) includes the full sample alongside firm fixed effects, and models (5) and (6) are related to the green bond sample and corporate bond sample with fixed effects, respectively. The findings suggest that the green bond dummy variable is not statistically significant, implying that green bonds do not have lower spreads than comparable corporate bonds, and for this reason, we reject H1 (green bonds have lower spreads than comparable corporate bonds). These results imply that investors are not willing to sacrifice returns to invest according to their environmental preferences

(Flammer, 2021). The results appear to support the argument that pricing factors such as credit ratings, volatility, or the number of banks, are still the most defining factors of bond spreads. The findings are in line with Flammer (2021), who also mentions that green bonds do not have lower yields than comparable traditional bonds. Tang & Zhang (2020) also demonstrate that although green bond issuance improves stock performance, they do not have pricing advantages when compared to comparable corporate bonds. Similarly, the results are also in line with Larcker & Watts (2020), because the authors never found evidence that supports the argument that green bonds have a premium that allows issuers to have a pricing advantage.

5.2. Are credit risk-related variables significant determinants of green bond spreads?

In this case, we consider the following variables as being variables related to credit risk: rated tranche, rating tranche, and rating discordance. For the purpose of evaluating and describing the impact of the independent variables on the spreads, we will only focus on the models with fixed effects.

According to the results, it is possible to verify that rated tranche has a negative impact on bond spreads, at the 1% level, for all samples. This means that the fact that a bond having a rating provided by a credit rating agency is indeed a crucial factor with an effect on bond spreads. In this case, rated tranche has a negative impact on bond spreads, and this effect is stronger in the corporate bond sample (-499.77 basis points). These findings are in line with the results provided by Marques & Pinto (2020), who also conclude that a bond with a credit rating has a lower spread, at the 1% level, than a bond without a credit rating, and it is also possible to confirm that this effect is present not only in the corporate bond

and the green bond samples (-499.77 bps and -269.47 bps, respectively) but in the full sample too (-492.92 bps).

The rating tranche variable is also statistically significant at the 1% level, which means that the worse the rating, the higher the bond spread. This variable has a stronger effect in both the full sample and the corporate bond sample (46.11 bps and 46.8 bps, respectively), while in the green bond sample the effect is slightly lower (35.70 bps).

Similarly, the dummy variable for rating discordance has a positive effect on the spread for all samples, at the 1% level. In the full sample, the effect of this variable increases the spread by 42.41 bps, while in the green bond sample the spread increases by 37.69 bps. For the corporate bond sample, the effect on the spread is also positive and increases the spread by 42.57 bps.

After analyzing these 3 variables, we accept H2 (credit risk-related variables are significant determinants of green bond spreads) because these variables are statistically significant for all samples, including the green bond sample.

5.3. Contractual Characteristics and Macroeconomic Factors

The deal value is not statistically significant for any sample. Considering the maturity variable, it is expected to have a positive effect on the spread (Marques & Pinto, 2020). The variable is statistically significant at the 1% level and have a positive effect on bond spreads in the full sample (1.99 bps) and also in the corporate bond sample (2.39 bps). However, this variable is not significant in the green bond sample.

The subordinated variable, which is expected to have a positive impact on the spread (Marques & Pinto, 2020), is not significant for the green bond sample. In contrast, this variable is statistically significant for both the full sample and the corporate bond sample (at the 10% and 5% level, respectively), with a positive effect on the spread (35.33 bps for the full sample and 47.69 bps for the corporate bond sample).

The currency risk variable is expected to have a positive impact on spreads (Marques & Pinto, 2020). However, it appears that this variable is not statistically significant for any of the samples. In the same way, it is also expectable that a bond with an embedded call option has a higher spread than a comparable bond without this option (Mann & Powers, 2003). According to the results, the callable variable is indeed statistically significant at the 1% level for both the full sample (27.12 bps) and the corporate bond sample (23.26 bps). As for the green bond sample, the callable variable is also significant at the 5% level, with an increase in the spread by 44.20 bps. As to the fixed rate variable, it is not statistically significant for the green bond sample. In contrast, this variable is statistically significant at the 5% level, with an increase in the spread for both the full sample and the corporate bond sample (17.90 bps and 17.59 bps, respectively).

The number of banks has a negative impact on the bond spread (Marques & Pinto, 2020), which means that the higher the number of banks involved, the lower the bond spread (-2.44 bps for the full sample and -2.74 bps for the corporate bond sample), and this effect is significant only for the full sample and for the corporate bond sample (1% level for both samples). On the contrary, this variable is not significant for the green bond sample. Considering the variable number of tranches, this one is not statistically significant for any sample, with the exception of the green bond sample, where the impact is positive (25.26 bps) at the 10% level, meaning that the higher the number of tranches, the higher the green bond spread.

The country risk variable is significant only for the corporate bond sample at the 10% level, while it is not significant for the remaining samples. The effect is positive and increases the spread by 2.43 bps, implying that the worse the country's rating, the higher the spread of the bonds (Marques & Pinto, 2020). The volatility variable is statistically significant at the 1% level for all samples. As expected, this effect is positive for all samples (Kim & Stock, 2014), being very similar in the full sample and in the corporate sample (3.19 bps and 3.28 bps, respectively), and slightly lower for the green bond sample (2.98 bps). Finally, the EUSA5y-Libor3M variable does not have any effect on the spread in any sample, which means that this variable is not statistically significant.

Table 7- Regression Analysis

Dependent variable:	[1]	[2]	[3]	[4]	[5]	[6]
Spread (bps)	Full Sample	Green Bond Sample	Corporate Bond Sample	Full Sample	Green Bond Sample	Corporate Bond Sample
Independent variables:						
_Cons	200.96 *** (21.33)	180.98 *** (65.33)	196.24 *** (20.83)	262.71 *** (58.75)	387.01 *** (59.24)	169.30 *** (31.29)
Green Bond	-42.73 *** (8.79)			-8.67 (7.85)		
Deal Value	0.003 (0.005)	-0.04 * (0.02)	0.003 (0.005)	0.007 (0.005)	-0.02 (0.02)	0.01 (0.01)
Rated Tranche	-472.08 *** (17.68)	-371.59 *** (71.34)	-477.81 *** (18.42)	-492.92 *** (19.03)	-269.47 *** (62.51)	-499.77 *** (20.46)
Discordance	41.54 *** (5.54)	36.62 *** (13.51)	41.21 *** (5.87)	42.41 *** (5.29)	37.69 *** (11.96)	42.57 *** (5.80)
Maturity	1.44 *** (0.40)	-1.43 * (0.85)	1.94 *** (0.37)	1.99 *** (0.35)	-0.06 (1.05)	2.39 *** (0.34)
Rating Tranche	43.91 *** (1.29)	38.23 *** (4.46)	44.57 *** (1.33)	46.11 *** (1.37)	35.79 *** (4.66)	46.8 *** (1.45)
Subordinated	74.07 *** (16.33)	99.08 *** (32.93)	81.99 *** (17.47)	35.33 * (21.27)	64.04 (51.64)	47.69 ** (21.25)
Currency risk	4.91 (7.34)	-31.35 (26.85)	6.58 (7.17)	3.99 (7.11)	15.75 (30.74)	5.2 (6.99)
Callable	8.55 * (6.74)	10.97 (17.87)	5.48 (7.39)	27.12 *** (6.88)	44.2 ** (18.39)	23.26 *** (7.22)
Fixed rate	27.39 *** (10.08)	9.90 (34.05)	26.27 ** (10.20)	17.90 ** (8.63)	-4.29 (30.81)	17.59 ** (8.80)
N ^o of banks	-3.11 *** (0.90)	3.07 (2.76)	-3.41 *** (0.93)	-2.44 *** (0.80)	-0.68 (1.88)	-2.74 *** (0.82)
N ^o of tranches	0.12 (5.67)	22.29 (18.42)	0.66 (5.85)	-0.87 (5.36)	25.26 * (14.28)	-0.99 (5.67)
Country risk	1.83 (1.72)	-5.99 ** (2.61)	2.38 (1.79)	1.78 (1.41)	-2.48 (2.58)	2.43 * (1.46)
Volatility	2.61 *** (0.46)	1.4 * (0.72)	2.79 *** (0.47)	3.19 *** (0.50)	2.98 *** (0.69)	3.28 *** (0.53)
5yTB	0.02 (0.06)	0.03 (0.12)	0.004 (0.06)	-0.04 (0.12)	0.39 (0.35)	-0.08 (0.12)
Industry fixed effects	no	no	no	yes	yes	yes
Year fixed effects	no	no	no	yes	yes	yes
Observations	2,833	223	2,610	2833	223	2610
R ²	0.65	0.64	0.65	0.69	0.78	0.69

Note: This table provides the OLS regression results of the determinants of bond spreads for the full sample with and without fixed effects, but also for the samples of green bonds and corporate bonds separately with and without fixed effects. Model (1) is the full sample with 2833 observations without fixed effects, model (2) is the green bond sample with 223 observations without fixed effects, model (3) is the corporate bond sample with 2,610 observations with fixed effects, model (4) is the full sample with 2,833 observations with fixed effects, model (5) is the green bond sample with 223 observations with fixed effects, and model (6) is the corporate bond sample with 2610 observations with fixed effects. (**), (*), and (*) indicate that the coefficients are significantly different from zero at the 1%, 5% and 10% levels, respectively. The t-statistics presented in parentheses are based on heteroskedasticity-consistent standard errors. Because of the time varying risk premia and cross-country differentials, we estimate standard errors clustered by year and country.

Conclusion

This academic research provides a comparative analysis between green bond and corporate bond spreads.

Results suggest that the green bond dummy variable does not have significant effects on bond spreads, which means that there are no differences between green bonds and comparable traditional bonds. These findings indicate that investors are not willing to pay to invest according to their environmental preferences, implying that climate change and green initiatives are factors that are not enough to make market participants sacrifice potential returns for these aspects (Flammer, 2021; Tang & Zhang, 2020; Larcker & Watts, 2020).

Furthermore, the findings are in line with the studies conducted by Marques & Pinto (2020); Gabbi & Sironi (2005); and Elton et al. (2001), who argue that credit rating variables are statistically significant and have a strong impact on bond spreads, confirming that credit ratings are a crucial bond spread determinant.

Generally, corporate finance studies on the relationship between ESG, CSR, and economic value are divided. Most of the studies find a positive link between ESG and CSR behavior and business valuation as well as financial results (El Ghoul et al., 2011; Goss & Roberts, 2011; Breuer et al., 2018). A body of literature and published articles investigate concepts related to green debt instruments, ESG, or CSR (Gillan et al., 2021). However, some studies mention the opposite ideas on the same topic. As a result, there are many contradictory interpretations and outcomes that are not properly addressed, contributing significantly to even more discussions with a need for more investigation.

In addition, we recognize some limitations on these studies. Possible issues could be the quality of the data and not considering some variables that could be analyzed to get better regression results.

Finally, we recommend future studies related to this topic because green bonds are a recent and innovative financial product (Flammer, 2021) and, because of that, there are probably fewer observations and a lack of data for this financial instrument. It would be interesting to understand more in detail what factors are still causing market participants to not invest more in green bonds. Another interesting topic would be to study more deeply the reasons why companies are not able to issue green bonds as frequently as corporate bonds. Studies related to governance would also be interesting, in order to analyze if there are significant incentives for companies to issue green bonds.

Bibliography

- Agliardi, E., & Agliardi, R. (2021). Pricing climate-related risks in the bond market. *Journal of Financial Stability, 54*.
- Aktas, N., Petmezas, D., Servaes, H., & Karampatsas, N. (2021). Credit ratings and acquisitions. *Journal of Corporate Finance, 69*.
- Amore, M. D., & Bennedsen, M. (2016). Corporate governance and green innovation. *Journal of Environmental Economics and Management, 75*, 54–72.
- Andrew, J., Kaidonis, M. A., & Andrew, B. (2010). Carbon tax: Challenging neoliberal solutions to climate change. *Critical Perspectives on Accounting, 21*(7), 611–618.
- Aoki, Y. (2021). The effect of bank relationships on bond spreads: Additional evidence from Japan. *Journal of Corporate Finance, 68*.
- Azar, J., Duro, M., Kadach, I., & Ormazabal, G. (2021). The Big Three and corporate carbon emissions around the world. *Journal of Financial Economics, 142*(2), 674–696.
- Baker, E. D., Boulton, T. J., Braga-Alves, M. v., & Morey, M. R. (2021). ESG government risk and international IPO underpricing. *Journal of Corporate Finance, 67*.
- Baker, M., Bergstresser, D., Serafeim, G., & Wurgler, J. (2018). Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds. *Harvard Business School*.
- Balachandran, B., & Nguyen, J. H. (2018). Does carbon risk matter in firm dividend policy? Evidence from a quasi-natural experiment in an imputation environment. *Journal of Banking and Finance, 96*, 249–267.
- Bartram, S. M., Hou, K., & Kim, S. (2022). Real effects of climate policy: Financial constraints and spillovers. *Journal of Financial Economics, 143*(2), 668–696.

- Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*, 142(2), 517–549.
- Borghesi, R., Houston, J. F., & Naranjo, A. (2014). Corporate socially responsible investments: CEO altruism, reputation, and shareholder interests. *Journal of Corporate Finance*, 26, 164–181.
- Breuer, W., Müller, T., Rosenbach, D., & Salzmann, A. (2018). Corporate social responsibility, investor protection, and cost of equity: A cross-country comparison. *Journal of Banking and Finance*, 96, 34–55.
- Cai, Y., Pan, C. H., & Statman, M. (2016). Why do countries matter so much in corporate social performance? *Journal of Corporate Finance*, 41, 591–609.
- Capelle-Blancard, G., Crifo, P., Diaye, M. A., Oueghlissi, R., & Scholtens, B. (2019). Sovereign bond yield spreads and sustainability: An empirical analysis of OECD countries. *Journal of Banking and Finance*, 98, 156–169.
- Chan, P. T., & Walter, T. (2014). Investment performance of “environmentally-friendly” firms and their initial public offers and seasoned equity offers. *Journal of Banking and Finance*, 44(1), 177–188.
- Chava, S. (2014). Environmental externalities and cost of capital. *Management Science*, 60(9), 2223–2247.
- Chegut, A., Eichholtz, P., & Kok, N. (2019). The price of innovation: An analysis of the marginal cost of green buildings. *Journal of Environmental Economics and Management*, 98, 102248.
- Chen, L., Lesmond, D. A., Wei, J., Amihud, Y., Booth, L., Butler, K., Cao, M., Hull, J., Kalimipalli, M., Kan, R., Mcmcurdy, T., Roberts, G., Spatt, C., Tian, Y., White, A., & Yu, X. (2007). Corporate Yield Spreads and Bond Liquidity. *Journal of Finance*, LXII(1).
- Chen, T. K., Liao, H. H., & Tsai, P. L. (2011). Internal liquidity risk in corporate bond yield spreads. *Journal of Banking and Finance*, 35(4), 978–987.
<https://doi.org/10.1016/j.jbankfin.2010.09.013>

- Chen, Z., Mao, C. X., & Wang, Y. (2010). Why firms issue callable bonds: Hedging investment uncertainty. *Journal of Corporate Finance*, *16*(4), 588–607.
- Crifo, P., Forget, V. D., & Teyssier, S. (2015). The price of environmental, social and governance practice disclosure: An experiment with professional private equity investors. *Journal of Corporate Finance*, *30*, 168–194.
- Davydenko, S. A., & Strebulaev, I. A. (2007). Strategic Actions and Credit Spreads: An Empirical Investigation. *Journal of Finance*, *LXII*(6).
- Deng, X., Kang, J. Koo, & Low, B. S. (2013). Corporate social responsibility and stakeholder value maximization: Evidence from mergers. *Journal of Financial Economics*, *110*(1), 87–109.
- Díaz, A., & Escribano, A. (2021). Sustainability premium in energy bonds. *Energy Economics*, *95*, 105113.
- Driss, H., Massoud, N., & Roberts, G. S. (2019). Are credit rating agencies still relevant? Evidence on certification from Moody's credit watches. *Journal of Corporate Finance*, *59*, 119–141.
- Dyck, A., Lins, K. v., Roth, L., & Wagner, H. F. (2019). Do institutional investors drive corporate social responsibility? International evidence. *Journal of Financial Economics*, *131*(3), 693–714.
- Edmans, A. (2011). Does the stock market fully value intangibles? Employee satisfaction and equity prices. *Journal of Financial Economics*, *101*(3), 621–640.
- Ehlers, T., Packer, F., & de Greiff, K. (2021). The pricing of carbon risk in syndicated loans: Which risks are priced and why? *Journal of Banking and Finance*.
- Eichholtz, P., Holtermans, R., Kok, N., & Yönder, E. (2019). Environmental performance and the cost of debt: Evidence from commercial mortgages and REIT bonds. *Journal of Banking and Finance*, *102*, 19–32.
- el Ghouli, S., Guedhami, O., Kwok, C. C. Y., & Mishra, D. R. (2011). Does corporate social responsibility affect the cost of capital? *Journal of Banking and Finance*, *35*(9), 2388–2406.

- Elton, E. J., Gruber, M. J., Agrawal, D., & Mann, C. (2001). Explaining the rate spread on corporate bonds. *Journal of Finance*, *56*(1), 247–277.
- Fatica, S., Panzica, R., & Rancan, M. (2021). The pricing of green bonds: Are financial institutions special? *Journal of Financial Stability*, *54*, 100873.
- Ferrell, A., Liang, H., & Renneboog, L. (2016). Socially responsible firms. *Journal of Financial Economics*, *122*(3), 585–606.
- Ferrer, R., Shahzad, S. J. H., & Soriano, P. (2021). Are green bonds a different asset class? Evidence from time-frequency connectedness analysis. *Journal of Cleaner Production*, *292*.
- Flammer, C. (2015). Does corporate social responsibility lead to superior financial performance? A regression discontinuity approach. *Management Science*, *61*(11), 2549–2568.
- Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*, *142*(2), 499–516.
- Gabbi, G., & Sironi, A. (2005). Which factors affect corporate bonds pricing? Empirical evidence from eurobonds primary market spreads. *European Journal of Finance*, *11*(1), 59–74.
- Garel, A., & Petit-Romec, A. (2021). Investor rewards to environmental responsibility: Evidence from the COVID-19 crisis. *Journal of Corporate Finance*, *68*.
- Gemmill, G., & Keswani, A. (2011). Downside risk and the size of credit spreads. *Journal of Banking and Finance*, *35*(8), 2021–2036.
- Gianfrate, G., & Peri, M. (2019). The green advantage: Exploring the convenience of issuing green bonds. *Journal of Cleaner Production*, *219*, 127–135.
- Gillan, S. L., Koch, A., & Starks, L. T. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*, *66*.
- Goss, A., & Roberts, G. S. (2011). The impact of corporate social responsibility on the cost of bank loans. *Journal of Banking and Finance*, *35*(7), 1794–1810.

- Güntay, L., & Hackbarth, D. (2010). Corporate bond credit spreads and forecast dispersion. *Journal of Banking and Finance*, *34*(10), 2328–2345.
- Hachenberg, B., & Schiereck, D. (2018). Are green bonds priced differently from conventional bonds? *Journal of Asset Management*, *19*(6), 371–383.
- Hammoudeh, S., Ajmi, A. N., & Mokni, K. (2020). Relationship between green bonds and financial and environmental variables: A novel time-varying causality. *Energy Economics*, *92*.
- Han, S., & Zhou, X. (2014). Informed bond trading, corporate yield spreads, and corporate default prediction. *Management Science*, *60*(3), 675–694.
- Hartzmark, S. M., & Sussman, A. B. (2019). Do Investors Value Sustainability? A Natural Experiment Examining Ranking and Fund Flows. *Journal of Finance*, *74*(6), 2789–2837.
- Helwege, J., Huang, J. Z., & Wang, Y. (2014). Liquidity effects in corporate bond spreads. *Journal of Banking and Finance*, *45*(1), 105–116.
- Hulshof, D., & Mulder, M. (2020). The impact of renewable energy use on firm profit. *Energy Economics*, *92*.
- Humphrey, J. E., & Li, Y. (2021). Who goes green: Reducing mutual fund emissions and its consequences. *Journal of Banking and Finance*, *126*.
- Huynh, T. D., Nguyen, T. H., & Truong, C. (2020). Climate risk: The price of drought. *Journal of Corporate Finance*, *65*.
- Immel, M., Hachenberg, B., Kiesel, F., & Schiereck, D. (2021). Green bonds: shades of green and brown. *Journal of Asset Management*, *22*(2), 96–109.
- Javadi, S., & Masum, A.-A. (2021). The impact of climate change on the cost of bank loans. *Journal of Corporate Finance*, *69*, 102019.
- Jia, J., & Li, Z. (2020). Does external uncertainty matter in corporate sustainability performance? *Journal of Corporate Finance*, *65*.
- Jin, J., Han, L., Wu, L., & Zeng, H. (2020). The hedging effect of green bonds on carbon market risk. *International Review of Financial Analysis*, *71*.

- John, K., & Reisz, A. S. (2010). Temporal resolution of uncertainty, disclosure policy, and corporate debt yields. *Journal of Corporate Finance*, 16(5), 655–678.
- Kim, D. H., & Stock, D. (2014). The effect of interest rate volatility and equity volatility on corporate bond yield spreads: A comparison of noncallables and callables. *Journal of Corporate Finance*, 26, 20–35.
- Kim, I., Pantzalis, C., & Zhang, Z. (2021). Multinationality and the value of green innovation. *Journal of Corporate Finance*, 69.
- Kisgen, D. J. (2019). The impact of credit ratings on corporate behavior: Evidence from Moody's adjustments. *Journal of Corporate Finance*, 58, 567–582.
- Klassen, R. D., & McLaughlin, C. P. (1996). The Impact of Environmental Management on Firm Performance. *Management Science*, 42(8), 1199–1214.
- Krueger, P., Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *Review of Financial Studies*, 33(3), 1067–1111.
- Larcker, D. F., & Watts, E. M. (2020). Where's the greenium? *Journal of Accounting and Economics*, 69(2–3).
- Li, C. K., Luo, J. hui, & Soderstrom, N. S. (2020). Air pollution and analyst information production. *Journal of Corporate Finance*, 60.
- Liao, L., Du, M., & Chen, Z. (2021). Air pollution, health care use and medical costs: Evidence from China. *Energy Economics*, 95.
- Liu, S., Shi, J., Wang, J., & Wu, C. (2007). How much of the corporate bond spread is due to personal taxes? *Journal of Financial Economics*, 85(3), 599–636.
- Liu, S. X., Qi, H., & Wu, C. (2006). Personal taxes, endogenous default, and corporate bond yield spreads. *Management Science*, 52(6), 939–954.
- Lu, C. W., Chen, T. K., & Liao, H. H. (2010). Information uncertainty, information asymmetry and corporate bond yield spreads. *Journal of Banking and Finance*, 34(9), 2265–2279.
- Lyon, T. P., & Montgomery, A. W. (2015). The Means and End of Greenwash. *Organization and Environment*, 28(2), 223–249.

- Mann, S. v., & Powers, E. A. (2003). Indexing a bond's call price: An analysis of make-whole call provisions. *Journal of Corporate Finance*, 9(5), 535–554.
- Marques, M. O., & Pinto, J. M. (2020). A comparative analysis of ex ante credit spreads: Structured finance versus straight debt finance. *Journal of Corporate Finance*, 62.
- Ng, A. C., & Rezaee, Z. (2020). Business sustainability factors and stock price informativeness. *Journal of Corporate Finance*, 64.
- Nguyen, J. H., & Phan, H. v. (2020). Carbon risk and corporate capital structure. *Journal of Corporate Finance*, 64.
- Painter, M. (2020). An inconvenient cost: The effects of climate change on municipal bonds. *Journal of Financial Economics*, 135(2), 468–482.
- Paranque, B., & Revelli, C. (2019). Ethico-economic analysis of impact finance: The case of Green Bonds. *Research in International Business and Finance*, 47, 57–66.
- Pástor, L., Stambaugh, R. F., & Taylor, L. A. (2021). Sustainable investing in equilibrium. *Journal of Financial Economics*, 142(2), 550–571.
- Pestel, N., & Wozny, F. (2021). Health effects of Low Emission Zones: Evidence from German hospitals. *Journal of Environmental Economics and Management*, 109.
- Ramiah, V., Martin, B., & Moosa, I. (2013). How does the stock market react to the announcement of green policies? *Journal of Banking and Finance*, 37(5), 1747–1758.
- Reboredo, J. C. (2018). Green bond and financial markets: Co-movement, diversification and price spillover effects. *Energy Economics*, 74, 38–50.
- Reboredo, J. C., Ugolini, A., & Aiube, F. A. L. (2020). Network connectedness of green bonds and asset classes. *Energy Economics*, 86.
- Riedl, A., & Smeets, P. (2017). Why Do Investors Hold Socially Responsible Mutual Funds? *Journal of Finance*, 72(6), 2505–2550.

- Safiullah, M., Kabir, M. N., & Miah, M. D. (2021). Carbon emissions and credit ratings. *Energy Economics*, 100.
- Sharfman, M. P., & Fernando, C. S. (2008). Environmental risk management and the cost of capital. *Strategic Management Journal*, 29(6), 569–592.
- Stellner, C., Klein, C., & Zwergel, B. (2015). Corporate social responsibility and Eurozone corporate bonds: The moderating role of country sustainability. *Journal of Banking and Finance*, 59, 538–549.
- Stroebel, J., & Wurgler, J. (2021). What do you think about climate finance? In *Journal of Financial Economics* (Vol. 142, Issue 2, pp. 487–498). Elsevier B.V.
- Tang, D. Y., & Yan, H. (2010). Market conditions, default risk and credit spreads. *Journal of Banking and Finance*, 34(4), 743–753.
- Tang, D. Y., & Zhang, Y. (2020). Do shareholders benefit from green bonds? *Journal of Corporate Finance*, 61.
- Wang, L., Dai, Y., & Kong, D. (2021). Air pollution and employee treatment. *Journal of Corporate Finance*, 70.
- Zerbib, O. D. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking and Finance*, 98, 39–60.

Appendices

Appendix A: Variable definitions

Variable name	Variable definition	Source	Expected impact on credit spread	
			GB	CB
Dependent variable:				
Tranche Spread to Benchmark (bp)	Margin yielded by the security at issue above a corresponding currency treasury benchmark with a comparable maturity (OAS). Floating rate bonds were converted to fixed rates using fixed-for-floating rate swaps.	DCM Analytics and Datastream		
Independent variables:				
<i>Contractual characteristics</i>				
Rated tranche	Dummy equal to 1 if the bond has a credit rating from S&P or Moody's, and 0 otherwise.	DCM Analytics	-	-
Rating tranche	Bond 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 D=22.	DCM Analytics	+	+
Rating discordance	Dummy equal to 1 if S&P and Moody's assign a different credit rating for the same tranche, 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	-	+
Subordinated	Dummy equal to 1 for tranches that are subordinated, and 0 otherwise.	DCM Analytics	+	+
Number of tranches	The number of tranches per transaction.	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	+	+
Fixed rate	Dummy equal to 1 if a bond is fixed price, and 0 otherwise.	DCM Analytics	-	+
Green Bond	Dummy equal to 1 if a bond is green bond, and 0 otherwise	DCM Analytics	-	-
Number of banks	The number of financial institutions participating in bond issuance, as bookrunners, underwriters or servicers.	DCM Analytics	-	-
Callable	Dummy equal to 1 if the bond has a call option, and 0 otherwise.	DCM Analytics	+	+
<i>Macroeconomic factors</i>				

Volatility	The Chicago Board Options Exchange Volatility Index (VIX). VIX reflects a market estimate of future volatility.	Datastream	+	+
EUSA5y-Libor3M	The slope of the Euro swap curve. Obtained as the difference between the five-year Euro swap rate and the 3-month Libor rate.	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	-	+