



# Green Bonds in a Green Stock Market?

## How shareholders perceive the issuance of green bonds in Europe.

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## **Abstract**

Environmental concerns have been gaining increasing attention worldwide, and the financial sector has been no exception to this trend. In this scenario, green bonds have emerged as an attractive financial instrument for firms to issue debt and finance sustainability-related projects. This study is focused on evaluating how shareholders react to the issuance of corporate green bonds and how that reaction changes in comparison to non-green bonds and in periods of heightened environmental regulation. Using a dataset of 1,748 bonds issued in European Union countries between 2013 and 2023, the analysis employs descriptive statistics and panel data regressions. The main findings indicate that the issuance of green bonds can contribute to positive and statistically significant cumulative abnormal returns, although these stock market reactions do not tend to change significantly in periods of intense environmental regulation. Additionally, there were no significant findings indicating that after issuing green bonds, companies experience lower cost of debt or higher profitability. This paper contributes to the existing literature surrounding green bonds and impact investing, highlighting the financial benefits of such actions.

**Title:** Green Bonds in a Green Stock Market? How shareholders perceive the issuance of green bonds in Europe

**Author:** Gabriela Silva de Souza

**Keywords:** Green bonds; ESG; Financial Markets; Corporate Financing.

## **Resumo**

As preocupações com o meio ambiente vêm ganhando cada vez mais atenção em todo o mundo, e o setor financeiro não tem sido exceção a essa tendência. Nesse cenário, os títulos verdes surgiram como um instrumento financeiro atraente para as empresas emitirem dívidas e financiarem projetos relacionados à sustentabilidade. O foco deste estudo é avaliar como os acionistas reagem à emissão de *green bonds* corporativos e como essa reação muda em comparação com as debêntures convencionais e em períodos de maior regulamentação ambiental. Usando um conjunto de dados de 1.748 debêntures emitidas em países da União Europeia entre 2013 e 2023, a análise empregou estatísticas descritivas e regressões de dados em painel. Os principais resultados indicam que a emissão de títulos verdes pode contribuir para retornos anormais cumulativos positivos e estatisticamente significativos, embora essas reações do mercado de ações não tendam a mudar significativamente em períodos de regulamentação ambiental intensa. Além disso, não houve resultados significativos que indiquem que, após a emissão de títulos verdes, as empresas tenham um custo de dívida menor ou maior lucratividade. Este artigo contribui para a literatura existente sobre títulos verdes e investimento de impacto, destacando os benefícios financeiros de tais ações.

**Título:** Green Bonds em um mercado de ações verde? Como acionistas recebem emissões de títulos verdes na Europa

**Autor:** Gabriela Silva de Souza

**Palavras-chave:** ESG; Títulos verde; Emissões de Dívida; Financiamento Corporativo.

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## 1. Introduction

In today's world, where environmental challenges become increasingly pressing, sustainability and green initiatives have been gaining significant attention. This trend has become evident in financial markets, where the awareness of environmental issues becomes increasingly prominent as investors and companies recognize the importance of sustainability.

Amid this scenario, a recent financial instrument has emerged: green bonds. Green bonds are bonds issued by corporations, governments and various entities, in which the funds raised are directed into sustainable projects.

The first green bond was a Climate Awareness Bond issued by the European Investment Bank (EIB) in 2007. In the years that followed, other development banks issued green debt, but only in 2013 were the first corporate green bonds issued, and many corporations soon followed. By 2017, Morgan Stanley called the scenario of that year a 'Green Bond Boom', after the global issuances of the instrument doubled from 2015 to 2016 and again in 2017.

This trend was reflected in Europe. During the past ten years, corporate green bonds experienced such an upward trend in its popularity in the financial markets that the total amount issued per year in the European Union increased from USD 335 million in 2013 to USD 43.4 billion in 2023, as demonstrated in the chart below.

**Chart 1 – Green Bond Issuances in Europe (in USD million)**

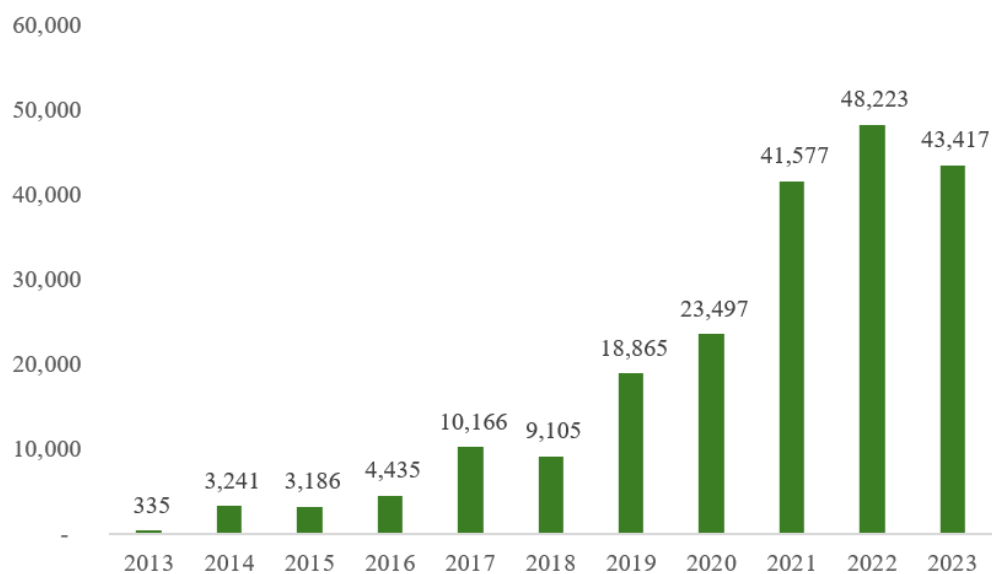


Chart created by the author with data from Refinitiv

Given the relevance and financial market interest in green bonds, researchers have also developed a curiosity about it in recent years. Tang and Zhang (2020) demonstrated that green bond issuances have a positive impact on stocks, leading to a 1.4% cumulative abnormal return over a 21-day event window, and this effect can be even more significant for first-time issuers. In addition, the authors identified that companies that issue the instrument have increased institutional ownership and greater stock liquidity. These findings are consistent with the results of Flammer (2021), with the addition that the latter also observed that green bond issuances are associated with improved environmental ratings and lower CO<sup>2</sup> emissions by the issuers.

This study aims to comprehensively investigate the stock market's reactions to issuance of corporate green bonds in the European Union, including an analysis of shareholders' reactions to the issuances of green bonds in comparison to conventional bonds and how these reactions changed after the European Green Deal, which was presented in 2019.

Additionally, aiming at understanding what are the firm-specific effects of green bond issuances, this paper investigates whether firms that issue green bonds experience a decrease in their cost of debt or higher profitability in the period following their first issuance of green bonds.

By using a sample of 1,743 bonds comprised of 728 green bonds and 1,015 conventional bonds issued in the European Union between 2013 and 2023 and performing several different descriptive and regression analyses, results suggested that around the news of issuances of green bonds, companies experience positive and statistically significant cumulative abnormal returns. These results were consistent across different models and event windows.

When analyzing the effects of green bonds on firm-specific characteristics over time, there were no statistically significant changes in the cost of debt and net profitability of the firms in the sample for the period before and after their first issuance of green bonds.

The primary contribution of this paper is to foster further awareness of the benefits of green bonds, with the aim of encouraging financing for sustainable projects in general, but with a focus in Europe. In addition, this research contributes to the growing literature on sustainable finance and green bonds by using a large dataset that includes bonds issued between 2013 – when the first corporate green bond was issued – and 2023. Using a case study methodology, it allows for a comparative analysis of green and non-green bonds, providing valuable insights into their impacts in the financial markets.

This dual contribution not only enhances understanding of the benefits of green bonds for corporations, but also provides a robust empirical foundation for future research and practical applications in finance, investment strategy, and policymaking.

Following this introductory chapter, this paper is organized as follows: the next chapter provides a literature review of green bonds, followed by the explanation of the data collected for this research, as well as the methodology employed, analysis of results and conclusion.

## **2. Literature Review**

### **2.1. Corporate Bonds**

The capital structure of firms results from decisions regarding how they will finance their assets. These decisions yield a dynamic capital structure, reflecting the proportion between equity and debt financing.

The subject of capital structure has been a central focus of academic research, leading to the development of various theoretical frameworks. Modigliani and Miller (1958) proposed that the average cost of capital remains constant regardless of a firm's capital structure. However, in a subsequent study, Modigliani and Miller (1963) reconsidered their model by incorporating taxes, concluding that while equity costs rise with increased leverage due to heightened financial risk, the benefit from debt's tax shield outweighs this increase, making debt financing preferable under certain conditions.

Building on these foundations, the Trade-off Theory suggests that firms will rely on debt financing up to the point where the tax benefits of debt are offset by the costs associated with high leverage, thus establishing an optimal debt level (Myers, 2001). While the Pecking Order Theory, developed by Myers and Majluf (1984) and further elaborated by Myers (1984), focuses on informational asymmetry. According to this theory, firms follow a financing hierarchy, preferring internal resources over external financing options to minimize information-related costs.

In all of the theories mentioned above, debt and leverage play a central part in corporate financing, evidencing the importance of debt issuance through bonds. When investigating the valuation effects of corporate debt issuance, Eckbo (1985) found that, on average, stock markets react negatively to the news of debt issuances. The author also elaborates that the loss on valuation is too large to be explained by transaction costs, indicating the presence of a negative

information effect. The results seem to be in line with the asymmetric information models developed by Miller and Rock (1985) and Myers and Majluf (1984), which predict a negative market reaction to unanticipated external financing.

Aiming to understand long-term debt issues, Badoer and James (2016) discovered that market conditions and the variation in the supply of long-term Treasury are important determinants of the issuance of long-term corporate bonds. Furthermore, the authors observed that debt issuances of 20 years or more are more common for highly rated firms.

## **2.2. Environmental Factors and the Financial Markets**

The growing need for addressing environmental challenges has led to significant shifts in financial markets as investors, corporations, and policymakers increasingly recognize the need to align financial practices with sustainability. In a similar trend, researchers have also focused on exploring the complex relationship between environmental factors and financial markets, aiming to understand how sustainability influences financial outcomes, as discussed below.

There is substantial research investigating the consequences to investors of corporate social responsibility (CSR) and sustainability-friendly initiatives by firms. Amid this background, it has been proven that firms with higher CSR have lower cost of equity than firms with lower regard for corporate social responsibility (Ghoul, Guedhami, Kwok & Mishra, 2011; Ng & Rezaee, 2015; Breuer, Müller, Rosenbach & Salzmann, 2018) and that firms with higher ESG engagement show lower risks (Hoepner, Oikonomou, Sautner, Starks & Zhou, 2024; Cai, Cui & Jo, 2016).

Within the broad concept of Environmental, Social and Governance (ESG), previous work has also evidenced that environmental practices specifically can be very beneficial for firms, either by reducing cost of capital or by generating positive reactions from shareholders (e.g. Ghoul et al, 2011; Flammer, 2013).

## **2.3. Environmental Regulation**

Environmental regulation has become a critical aspect of politics worldwide, driven by the need to address the urgent matter that is climate change. Europe has been one of the leading regions in terms of environmental regulation. In the past years, the region has established thorough frameworks to regulate environmental practices aimed at promoting sustainable development and growth. One of the most comprehensive of these frameworks is the European Green Deal,

which was presented in December 2019, and aims, among others, at reducing greenhouse gas (GHG) emissions by 55% by 2030.

In order to understand how institutional investors perceive different risks, Krueger, Sautner and Starks (2019), performed a research survey with institutional investors in which they discovered that investors generally believe that regulatory climate risks have important implications for their portfolio firms and when explaining why they incorporate such risks into their portfolio, investors respond due to moral/legal implications, amid other reasons, highlighting the important consequences to firms arising from environmental regulation.

Aiming at investigating the relationship between climate regulation and corporate bonds performance, Seltzer, Starks and Zhu (2022) discovered that firms that have poor environmental performance generally experience lower credit ratings and higher bond yield spreads, especially when they are located in states in the US with stricter environmental regulations. Additionally, the authors analyzed the impact of the December 2015 Paris Agreement in the bond market, concluding that after the agreement, bonds from firms in high carbon-emitting sectors experienced an average decrease in credit ratings when compared to other firms, supporting the hypothesis that credit risk analysts do consider changes in climate regulations when evaluating climate factors that can impact firms' risks.

#### **2.4. Green Bonds**

The first green bond was issued by the European Investment Bank (EIB) in 2007. It was a Climate Awareness Bond whose proceeds were directed to renewable energy and energy efficiency. Other institutions followed the EIB in the following years, and by the end of 2012, a total of USD 7.8bn had been issued worldwide in bonds labelled as green, composed mostly of a few bonds issued each year, and it was only in 2013 that this market experienced significant growth. 2013 was the year that the first corporate green bonds were issued by Électricité de France (EDF), Vasakronan and Bank of America, and by the end of the year, the market had grown to approximately USD 15bn outstanding (Boulle, 2014).

Since then, the green bond market has been growing and gaining relevance each year, leading researchers to also increasingly investigate green bonds and their implications in the financial markets and to investors.

Reboredo, Ugolini and Aiube (2020) investigated the correlation between green bonds and several other investment instruments, finding that green bonds are strongly correlated with

treasury and corporate bonds in both the US and the EU, however, this relation was not found between green bonds and other asset classes such as stocks and high-yield corporate bonds, suggesting that such bonds can be a tool for investors in portfolio hedging and risk diversification.

Still investigating the financial characteristics of green bonds, but this time in the US market, Baker, Bergstresser, Serafeim and Wurgler (2022) found that green bonds do sell for a moderate premium in an analysis controlled for holding characteristics and the yield and credit curves. The researchers concluded that in general, green bonds are issued at after-tax yields around 5 to 9 basis points lower than those of ordinary bonds, which suggests that green bonds are priced as if they were around half a notch more highly rated than ordinary bonds.

Flammer (2023) studied the impact of green bonds in the US carbon emissions at the aggregate level. The researcher discovered that an issuance of \$1,000 of green bonds per capita can result in a subsequent decrease in emissions around 0.9 – 1.4 per cent, and results can be even stronger for bonds that are certified by third parties, highlighting the importance of corporate governance and the relevance of green bonds as an important tool regarding climate change.

When investigating specificities of the corporate green bond market, Flammer (2021) discovered that this instrument is more common in industries in which the environment is essential for firms' operations, and that green bonds are prevalent mainly in China, the US and Europe. The paper also observes that the stock market responds positively to announcements of issuances of green bonds, although this reaction is stronger for first-time issuers and for bonds that are certified by independent third parties.

Furthermore, Flammer (2021) concluded that firms that issue corporate green bonds experience an improvement in environmental performance in the long run, as measured by the ASSET4 environment rating and reduction of CO<sub>2</sub> emissions. These findings corroborate with the signaling argument, that suggests that firms that issue corporate green bonds do indicate a subsequent improvement in their environmental performance.

Looking at firm-specific consequences of having issued green bonds, it has been shown that the stock prices of issuers react positively to green bond issuance announcements. Tang and Zhang (2020) found that there is a 1.4% cumulative abnormal return for a 21-day event window around the announcement of green bond issuers, and this reaction can be even more expressive for first-time issuers. The researchers also found multiple evidence of the “investor attention” channel

of green bonds – in the days surrounding the green bond issuance, firms experience higher stock turnover, a spike in Google search volume and an increase in institutional ownership, mainly arising from domestic investment advisers and pension funds.

This paper differs from the existing literature discussed above by aiming to compare European market reactions to green bond vs non-green bond announcements. Additionally, this research will focus on understanding how investor reactions differ in periods of intense environmental regulation, mainly during the announcement of the European Green Deal, providing a comprehensive look and understanding of the green bond market and of the effects of stock markets to changes in regulations, a current gap in research. Lastly, the data collected for this research includes a period of the past 10 years, thus capturing the majority of the European corporate green bond market to date.

Given this context, this study investigates the financial benefits of firms having issued green bonds, first through the stock market reactions, and then through firm-specific characteristics, that is, investigating if after having issued such bonds, firms experience higher profitability through the green projects invested in or lower cost of debt from the green bonds evidence of firms' commitment to sustainability. Therefore, this paper studies the following hypotheses:

H<sub>1</sub>: Do European stock markets react positively to the announcement of issuance of green bonds? Is this reaction statistically significant and different from the one to the announcement of non-green bonds?

H<sub>2</sub>: Does this reaction change during periods of more intense environmental regulation?

H<sub>3</sub>: Do green bonds result in a lower cost of debt to firms?

In the following sections, you will find how the data was gathered and the methodology structured to investigate the hypotheses described above.

### **3. Data**

#### **3.1. Data Description**

In order to investigate the hypothesis and research questions mentioned previously, the datasets used in this study comprise both bond and firm-specific data. The first was built by extracting from LSEG Refinitiv all bonds issued within the countries of the European Union (EU) between January 2013 and December 2023, as well as extracting the following variables: issuer name,

ticker and sector, bond coupon and maturity, issue date, currency, country of issue and of issuer, amount issued, green bond flag, use of proceeds, first announcement date, issuer public or private and parent or subsidiary.

Only bonds issued by publicly held firms or by direct subsidiaries of public firms were kept in the final dataset, following Tang and Zhang (2020). Additionally, bonds that had no first announcement date were excluded as the announcement date is crucial for the execution of the event study, as detailed in the Methodology section.

The dataset comprised of firm-specific data was built from Refinitiv Datastream. Daily stock prices for the 10-year period were extracted, as well as the Total Assets, Revenues, EBITDA, Net Income, Total Debt, Total Common Equity, Return on Equity, Interest Expense, Book to Market and Total Debt to Common Equity data. These variables were extracted for all of the firms present in the bond list, considering the same time period from 2013 to 2023.

The initial dataset was comprised of a total of 868 green bonds issued by 158 firms, and 71,063 conventional bonds issued by 3,221 unique issuers. After having filtered the dataset to keep only bonds with the date of first announcement of the issuance, and issued by public companies or direct subsidiaries of public companies with stock prices available from 300 days before the announcement of the bonds to 10 days after the announcement, the final dataset used in this paper was comprised of 728 green bonds issued by 129 different firms, and 1,015 non-green bonds issued by 886 distinct firms.

## **3.2. Descriptive Statistics**

### **3.2.1. Green Bonds**

The descriptive statistics presented in this section provide an overview of the final dataset comprising 728 green bonds issued by 129 publicly listed firms across the various countries in the European Union. The table 1 below shows the composition of the bonds issued per year, with the corresponding amount issued in that year and the average amount issued per bond.

The first corporate green bond was issued in 2013, consequently, the dataset begins in that year, reflecting the early stages of the green bond market at the year. A consistent upward trajectory in the number of green bond issuances is evident from the data, indicating its growing acceptance as a financial instrument by firms and by the market overall. However, there are notable declines in bond issuance in 2022 and 2023. This decline can be attributed to the global

economic challenges that emerged in the aftermath of the Covid-19 pandemic, including increased interest rates and tighter monetary policies.

The total amount issued in green bonds within the EU demonstrates a substantial increase over the period analyzed, from beginning at USD 335 million in 2013, the annual issuance value of the instrument reached over USD 36 billion by 2023. This remarkable growth highlights the expanding scale and acceptance of green bonds within the European capital markets, as well as the increasing demand for sustainability-linked investment opportunities.

**Table 1 – Summary Statistics of Green Bond Data**

| Year | Number of Green Bonds Issued | Total Amount Issued (USD mn) | Average Issuance per Bond (USD mn) |
|------|------------------------------|------------------------------|------------------------------------|
| 2013 | 1                            | 335                          | 335                                |
| 2014 | 8                            | 3,192                        | 399                                |
| 2015 | 7                            | 1,757                        | 251                                |
| 2016 | 8                            | 3,228                        | 403                                |
| 2017 | 25                           | 7,976                        | 319                                |
| 2018 | 33                           | 6,376                        | 193                                |
| 2019 | 64                           | 16,092                       | 251                                |
| 2020 | 142                          | 18,707                       | 132                                |
| 2021 | 220                          | 35,002                       | 159                                |
| 2022 | 118                          | 40,105                       | 340                                |
| 2023 | 102                          | 36,308                       | 356                                |

**Chart 2 – Green Bond Evolution from 2013 to 2023**

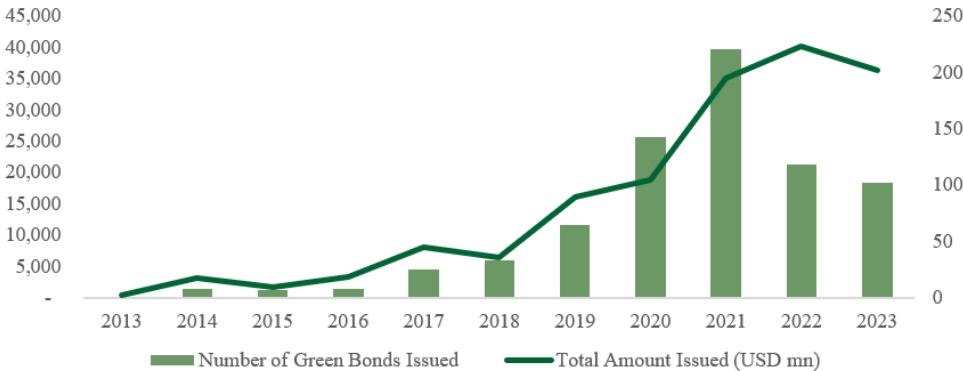


Chart created by the author with data from Refinitiv

In order to provide insight into the geographical distribution of green bond issuances in Europe, below is a map chart with the breakdown of number of issuances per country. Within this dataset, Germany stands out as the leading country in terms of number of green bonds issued, with a total of 293 bonds over the 10-year period studied. Next is Sweden, with 224 issuances, while France ranks third, with 103 green bonds issued over the period. The distribution of these bonds, as illustrated in the map below, underscores the significant role of these countries in the growth of green bonds in the EU market.

**Chart 3 – Map Chart of the Green Bonds Issued in the EU from 2013 to 2023**

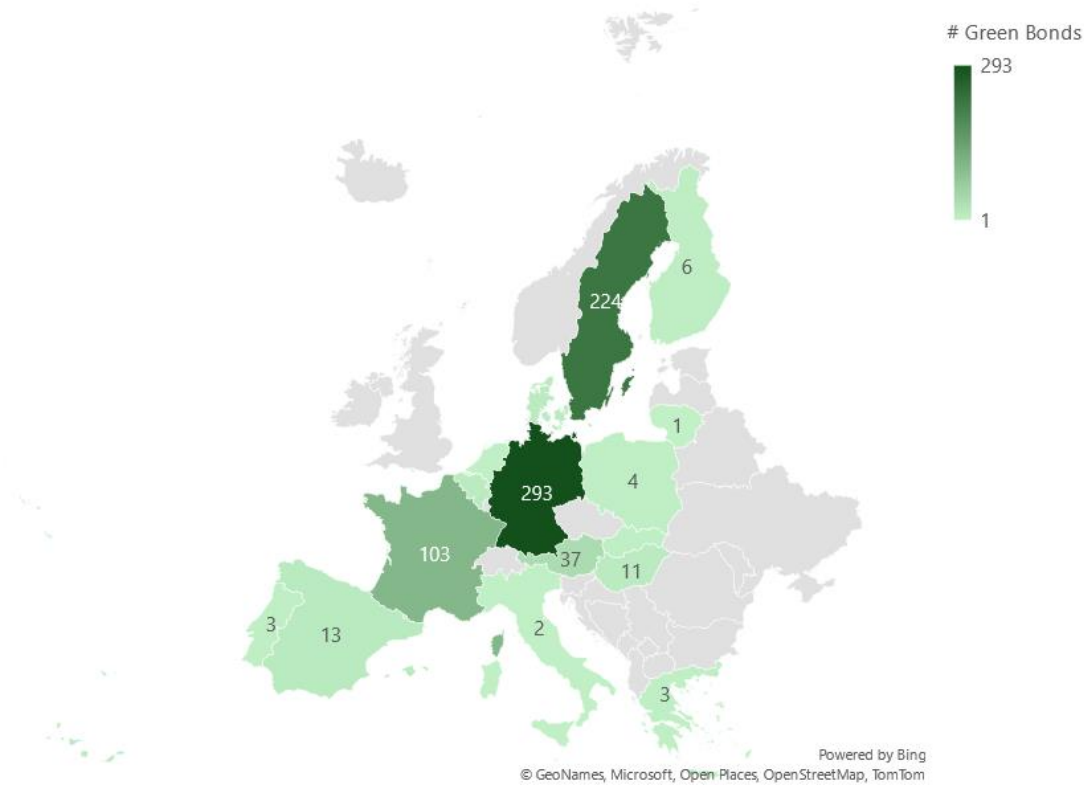


Chart created by the author with data from Refinitiv

Lastly, Table 2 below presents the key characteristics of green bond issuers, as well as their descriptive statistics over the 10-year period of the sample. As shown in the table, in general, issuers of green bonds are large, profitable firms, with an average total asset of EUR 164 million and an average EBITDA margin of 47.87%. The table also evidences that the sample is mostly comprised of value firms, as the price-to-book ratio presents an average of 1.3x, therefore, the multiple is not high.

**Table 2 – Descriptive Statistics of Green Bond Issuers**

| <b>Variable</b>           | <b>Obs</b> | <b>Mean</b> | <b>Std<br/>Deviation</b> | <b>Min</b> | <b>Max</b>   |
|---------------------------|------------|-------------|--------------------------|------------|--------------|
| EBITDA Margin (%)         | 1,096      | 47.87       | 65.26                    | - 143.66   | 359.51       |
| Total Assets (EUR k)      | 1,096      | 164,000.00  | 408,000.00               | 1.75       | 2,660,000.00 |
| Leverage (Debt-to-Equity) | 1,096      | 2.07        | 214.59                   | 1.47       | 11.44        |
| Price-to-Book             | 1,096      | 1.30        | 1.39                     | 0.15       | 32.32        |
| Return on Equity (%)      | 1,096      | 8.53        | 15.25                    | - 96.59    | 258.12       |

The metrics presented above refer to all yearly observations collected for the issuers of green bonds during a 10-year period, from 2013 to 2023.

### 3.2.2. Conventional Bonds

For comparison, the dataset of conventional bonds (also referred to as standard bonds) used in this analysis includes 1,015 bonds issued by 886 distinct firms operating in the European Union between 2013 and 2023. The descriptive statistics for these instruments are summarized in Table 3, below, which outlines the number of conventional bonds issued annually, the corresponding total issuance amount in millions of U.S. dollars, and the average issuance value per bond.

**Table 3 – Summary Statistics of Conventional Bonds**

| <b>Year</b> | <b>Number of<br/>Conventional<br/>Bonds</b> | <b>Total Amount<br/>Issued (USD mn)</b> | <b>Average Issuance<br/>per Bond (USD mn)</b> |
|-------------|---|---|---|
| 2013        | 104   | 9,402                                   | 90  |
| 2014        | 141   | 12,120                                  | 86  |
| 2015        | 104   | 16,260                                  | 156   |
| 2016        | 74  | 8,747                                   | 118   |
| 2017        | 106   | 13,720                                  | 129   |
| 2018        | 70  | 7,580                                   | 108   |
| 2019        | 72  | 8,651                                   | 120   |
| 2020        | 81  | 9,155                                   | 113   |
| 2021        | 108   | 16,850                                  | 156   |
| 2022        | 48  | 6,342                                   | 132   |
| 2023        | 68  | 7,159                                   | 105   |

The conventional bond market, like its green counterpart, is influenced by a combination of macroeconomic factors and firm-specific financial characteristics. As reflected in the data, the

number of conventional bonds issued fluctuated throughout the observed period, evidencing the inherent volatility of the bond market. This volatility stems from changing market conditions, varying levels of investor demand, and shifting financing requirements of firms.

Despite this fluctuation, a clear upward trend appears when considering the broader timeline, with the total amount issued growing from USD 9.4 billion in 2013 to a peak of USD 16.8 billion in 2021. However, similar to the green bond market, the issuance volume declined in 2022 and 2023, likely due to tightening monetary conditions and rising interest rates that increased the cost of borrowing in capital markets.

**Chart 4 – Conventional Bonds Evolution from 2013 to 2023**

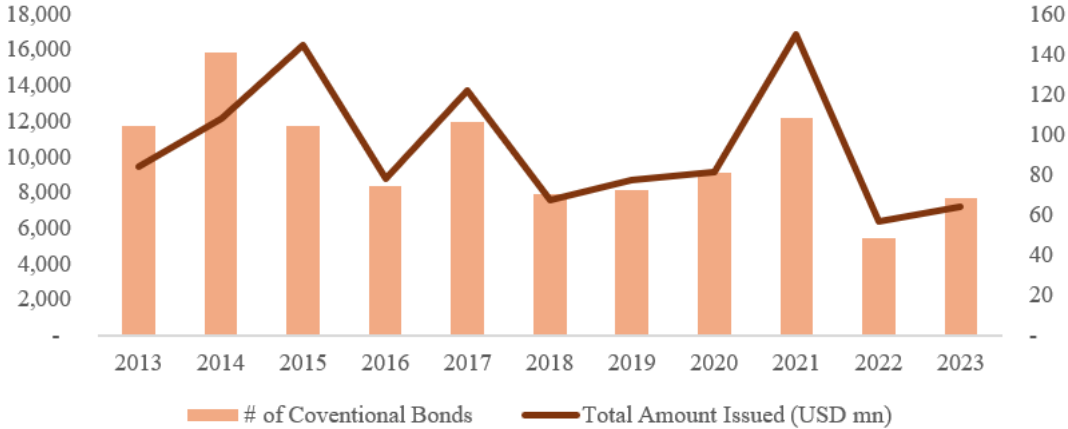
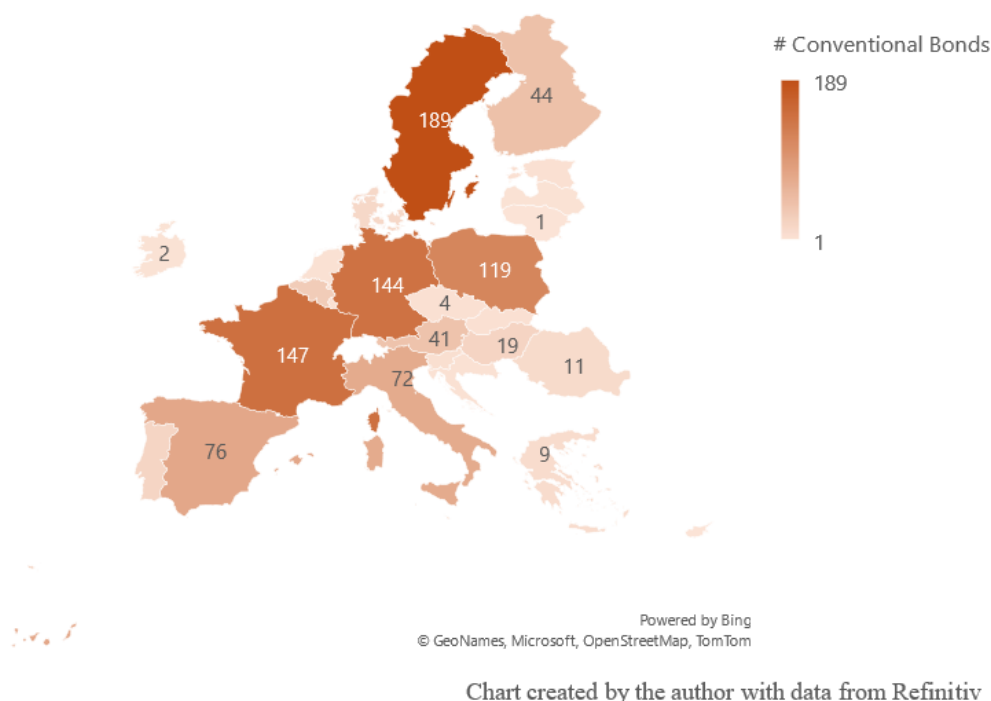


Chart created by the author with data from Refinitiv

In terms of geographic distribution, the leading countries in conventional bond issuance within the sample are Sweden, with 189 bonds, France, with 147 bonds, and Germany, with 144 bonds issued over the ten-year period. These countries, which also dominate the green bond market, play a central role in shaping the European bond market landscape. The map chart present below further illustrates the geographical distribution of this sample of conventional bond issuances across the EU, after having been filtered as described in the previous section.

**Chart 5 – Map Chart of the Conventional Bonds Issued in the EU from 2013 to 2023**



#### **4. Methodology**

The goal of this paper is to measure and analyze the impact of issuances of green bonds in the European financial markets. For this purpose, the methodological approach applied follows an event study, as this methodology is precisely used for the investigation of stock market reactions to event announcements.

One of the main aspects of this methodology is the definition of parameters such as the event day and window. For this study, the event day ( $d = 0$ ) used is the first announcement date, following previous studies (Krüger, 2015; Tang & Zhang, 2020; Flammer, 2021). According to Flammer (2021), the announcement date of the bond issuance should be preferred rather than the issuance date because it is the first that captures the day in which the information is provided to the market and incorporated by it, while on the issuance date, no new information is conveyed.

As to the event windows, the main event window analyzed is 5 days before and 10 days after the event day, that is,  $[-5, 10]$ , also in accordance with previous papers (Tang & Zhang, 2020; Flammer, 2021). However, the  $[-10, 10]$  event window, present in Tang and Zhang (2020), was

checked for robustness. These parameters were used for measuring the stock market reactions to both issuances of green and of conventional bonds, with the aim of comparing the reactions to these events.

The expected returns of each firm  $i$  are computed using three different models: CAPM, developed by Sharpe (1964) and Lintner (1965), Fama and French 3-factor model (Fama & French, 1993) and Fama and French 5-factor model (Fama & French, 2015). All data collected and used in the construction of the three models was extracted from Fama and French European 3 Factors and Fama and French European 5 Factors, present and regularly updated in Kenneth French's website.

For the CAPM model, the coefficients  $\alpha$  and  $\beta$  of each firm were estimated through Ordinary Least Squares (OLS) regressions using an estimation window starting 300 days before the event day until 50 days before it, as used by Tang and Zhang (2020). Market excess return is the return on Europe's value-weighted market portfolio minus the US one month T-bill rate. The model follows the equation below.

$$(i) \quad R_{it} = \alpha_i + \beta_{i,m} \times R_{m,t} + \varepsilon_{i,t}$$

Where  $R_{it}$  represents the expected return of stock  $i$  at a time  $t$ ;  $R_{m,t}$  is the market's excess returns at a moment  $t$ , and  $\varepsilon_{i,t}$  represents the residuals. After having estimated the coefficients, the expected return of each stock on a given day of the estimation window follow the equation below, according to the CAPM model:

$$(ii) \quad \hat{R}_{it} = \hat{\alpha} + \hat{\beta}_{i,m} \times R_{m,t}$$

For the Fama and French 3-factor (FF3) and 5-factor (FF5) models, the coefficients  $\alpha$  and  $\beta$  were also estimated through OLS regressions as explained above, however, following the two equations below:

$$(iii) \quad \text{FF3: } R_{it} = \alpha_i + \beta_{1\ i,m} \times R_{m,t} + \beta_{2\ i,s} \times SMB_t + \beta_{3\ i,v} \times HML_t + \varepsilon_{i,t}$$

$$(iv) \quad \text{FF5: } R_{it} = \alpha_i + \beta_{1\ i,m} \times R_{m,t} + \beta_{2\ i,s} \times SMB_t + \beta_{3\ i,v} \times HML_t + \beta_{4\ i,p} \times RMW_t + \beta_{5\ i,l} \times CMA_t + \varepsilon_{i,t}$$

Where  $R_{it}$  represents the expected return of stock  $i$  at time  $t$ ;  $R_{m,t}$  is the market's excess returns at a moment  $t$ . In accordance with Fama and French (2015),  $SMB_t$  represents Small Minus Big and is the average of the returns on small stock portfolios minus big stock portfolios at a moment

$t$ ;  $HML_t$ , High Minus Low, is the average of the returns on high book-to-market portfolios minus low book-to-market portfolios in Europe at a time  $t$ ;  $RMW_t$ , or Robust Minus Weak, represents the average return on the robust operating profitability portfolios minus the average return on the weak operating profitability portfolios at a time  $t$ ;  $CMA_t$  is Conservative Minus Aggressive and represents the average return on conservative investment portfolios minus the average return on aggressive investment portfolios, and  $\varepsilon_{i,t}$  represents the residuals.

After having estimated the coefficients of FF3 and FF5, the expected return of each stock on a given day of the estimation window follows the equations below.

$$\begin{aligned} \text{(v)} \quad \text{FF3: } \hat{R}_{it} &= \hat{\alpha}_i + \hat{\beta}_{1\ i,m} \times R_{m,t} + \hat{\beta}_{2\ i,s} \times SMB_t + \hat{\beta}_{3\ i,v} \times HML_t \\ \text{(vi)} \quad \text{FF5: } \hat{R}_{it} &= \hat{\alpha}_i + \hat{\beta}_{1\ i,m} \times R_{m,t} + \hat{\beta}_{2\ i,s} \times SMB_t + \hat{\beta}_{3\ i,v} \times HML_t + \\ &\quad \hat{\beta}_{4\ i,p} \times RMW_t + \hat{\beta}_{5\ i,l} \times CMA_t \end{aligned}$$

Finally, for each model, the daily abnormal return (AR) is represented by:  $AR_{it} = R_{it} - \hat{R}_{it}$ , while the Cumulative Abnormal Return (CAR) of each firm was computed by adding up the daily abnormal returns within the specific time windows.

After having calculated the CAR, in order to investigate whether there is any relationship between the market reaction and the issuance of green bonds, the following regression was run:

$$\text{(vii)} \quad CAR_{it} = \beta_0 + \beta_1 green\_bond_{it} + \alpha_i + \lambda_t + u_{it}$$

Where  $i$  indexes firm,  $t$  indexes time,  $green\_bond$  is a dummy variable representing green bonds,  $\alpha_i$  represents firm fixed effects,  $\lambda_t$  represents time fixed effects, and  $u$  is the error term.

With the purpose of increasing the robustness of the model, a second regression was run considering, in addition to the equation above, an interaction term between the firm and time fixed effects. The interaction term was added in order to account for time-varying firm-specific effects, which improves the accuracy of the regression by controlling for unobserved heterogeneity that changes across firms and time periods simultaneously. Therefore, the second regression was performed with the structure below.

$$\text{(viii)} \quad CAR_{it} = \beta_0 + \beta_1 green\_bond_{it} + \gamma (time \times firm) + u_{it}$$

As a second goal of this study is to verify whether stock market reactions to these events change during periods of more intense environmental regulation, a second set of regressions will be run. In this scenario, it is considered that the years after 2019 have a more intense environmental

regulation, considering that 2019 was the year of presentation of the European Green Deal. Therefore, in addition to the parameters set above, these regressions will include an interaction term between the CAR observed around the event window and the dummy variable regulation, resulting in the following equation:

$$(ix) \quad CAR_{it} = \beta_0 + \beta_1 green\_bond_{it} + \beta_2 post\_2019_t + \beta_3 (green\_bond_{it} \times post\_2019_t) \alpha_i + \lambda_t + u_{it}$$

As the assignment of bonds as green or not is not random and aiming at understanding in more detail the effect of issuing a green bond in the stock market, a synthetic control method was performed.

The synthetic control method was introduced by Abadie and Gardeazabal (2003), in which the authors construct a synthetic control region using a placebo study, to estimate the economic growth that the Basque Country would have had in the absence of terrorism (Abadie, Diamond & Hainmueller, 2010).

Furthermore, according to Abadie, Diamond and Hainmueller (2010), in comparative case studies, researchers compare samples of units exposed to a particular intervention of interest to an unexposed sample and, by using the synthetic control methods it is possible to produce a quantitative inference in comparative case studies.

Therefore, in this study, in order to construct a control group of comparable standard bonds, each green bond in the dataset was matched to its nearest non-green neighbor using Stata's `teffects nnmatch`. The matching was done regarding three parameters: issue year of the bonds, country of issuance and company sector, as disclosed by Refinitiv. The aim in using this approach is to control for observable differences between treated and control groups, reducing selection bias and improving the validity of the estimated treatment effects.

After the matching, a balance of covariates is done between the treated and control groups to ensure that the procedure has effectively reduced systematic differences in the observable characteristics used, ensuring that the treatment effect, in this case, the difference in CAR, can be attributed to the bond type rather than confounding factors.

Lastly, in order to investigate potential reasons as to why investors react differently to the issuance of corporate green bonds, in addition to discovering if green bond issuances have an effect on a company's cost of debt or on its financial performance, panel regressions were

performed comparing these characteristics in the period before and after the green bond issuance.

The regressions were done with firm data gathered for the issuers of green bonds analyzed previously, in a period from 2013 to 2023, however, we considered only the observations regarding the year before and the year after the first green bond issuance by that firm – please note that subsequent issuances were not considered for this analysis.

The regressions were performed in accordance with the following equations:

$$(x) \quad \text{Cost of Debt} = \alpha + \beta_1 PtB_{it} + \beta_2 ROE_{it} + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 Ebitda_{it} + \beta_6 PostBond_{it}$$

$$(xi) \quad \text{Profitability} = \alpha + \beta_1 PtB_{it} + \beta_2 ROE_{it} + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 Kd_{it} + \beta_6 PostBond_{it}$$

Please refer to Table 4 below for the name and calculation of each variable present in the equations above.

**Table 4 – List and Description of the Variables**

| <b>Name</b>                 | <b>Abbreviation</b>  | <b>Calculation Equation</b>   |
|-----------------------------|----------------------|---|
| <b>Dependent Variables</b>  |                      |   |
| Cost of Debt                | <i>Kd</i>            | Interest Expense / Average of Last Year's and Current Year's Total Debt |
| Net Profitability           | <i>Profitability</i> | Net Income / Revenues   |
| <b>Independent Variable</b> |                      |   |
| Post Green Bond             | <i>PostBond</i>      | Dummy Variable  |
| <b>Control Variables</b>    |                      |   |
| Price to Book               | <i>PtB</i>           | Price / Book Value per Share  |
| Size                        | <i>Size</i>          | ln(Total Assets)  |
| Leverage                    | <i>Lev</i>           | Total Debt to Equity  |
| EBITDA Margin               | <i>Ebitda</i>        | EBITDA / Revenues   |
| Return on Equity            | <i>ROE</i>           | Net Income / Average of Last Year's and Current Year's Equity           |

Note that Kd represents the cost of debt; Ln is the natural logarithm; EBITDA represents the earnings before interest, taxes, depreciation and amortization; and PostBond is a dummy variable that equals 1 if true and 0 if not true.

## 5. Discussion of Results

### 5.1. Stock Market Reactions to Issuances of Green Bonds

The initial regression analysis performed in this study involved a standard regression that included all bonds in the sample, encompassing both green and conventional bonds. This approach aimed at exploring whether the type of bond issued has a significant impact on the

cumulative abnormal returns (CARs) of the issuing firms during two distinct event windows: a 16-day window [-5, +10] and a 21-day window (-10, +10) surrounding the bond issuance date. The results derived from this regression model are presented below.

**Table 5 – Regression Results of Cumulative Abnormal Returns per Model**

| <b>Event Window</b> | <b>[-5, 10]</b>     | <b>[-10, 10]</b>    |
|---------------------|---------------------|---------------------|
| CAPM_CAR (p.p.)     | 0.0334***<br>(8.18) | 0.0281***<br>(4.54) |
| FF3_CAR (p.p.)      | 0.0349***<br>(7.94) | 0.0334***<br>(5.44) |
| FF5_CAR (p.p.)      | 0.0342***<br>(7.10) | 0.0293***<br>(4.68) |
| Observations        | 1,743               | 1,743               |

The table shows the results regarding the regression of equation (vii) presented in the Methodology section. Followed by the variables are the coefficients, with the t-stat below them in parenthesis. The \*\*\* evidence statistical significance at the 1% level.

The regression results presented in Table 5 above indicate that the issuance of green bonds is statistically significant across all models analyzed, confirming a consistent positive market reaction. This significance holds for both the 16-day event window [-5, 10] and the 21-day event window [-10, 10], demonstrating that shareholders respond positively to announcements of corporate green bond issuances.

Among the models, the CAPM specification reports the highest cumulative abnormal returns (CARs). For the 16-day event window, the CAPM model shows a CAR of 0.033 percentage points, significant at the 1% confidence level. Similarly, for the longer 21-day event window, the estimated CAR is 0.028 percentage points, also significant at the 1% level. These findings highlight the market's recognition of green bond announcements as value-enhancing events.

The results are consistent with prior research. Flammer (2021) found a statistically significant CAR of 0.489% over a similar event window of 16 days by using a global green bond sample, while Tang and Zhang (2020) reported an even higher CAR of 1.04% for global green bond issuances. Although these values are larger than the estimates from the sample used in this study, they reinforce the broader pattern of positive market reactions to green bond announcements.

The Fama-French three-factor (FF3) and five-factor (FF5) models further validate these findings. The FF3 model reports a CAR of 0.035 percentage points for the 16-day window and

0.033 percentage points for the 21-day window, both statistically significant. The FF5 model yields slightly lower, but still significant, CARs of 0.034 percentage points for the 16-day window and 0.029 percentage points for the 21-day window.

**Table 6 – Regression Results of CARs estimated with interaction term of fixed effects**

| Event Window    | [-5, 10]            | [-10, 10]          |
|-----------------|---------------------|--------------------|
| CAPM_CAR (p.p.) | 0.0334***<br>(4.38) | 0.0281**<br>(2.02) |
| 3FF_CAR (p.p.)  | 0.0349***<br>(4.23) | 0.0334**<br>(2.44) |
| 5FF_CAR (p.p.)  | 0.0342***<br>(3.69) | 0.0293**<br>(2.08) |
| Observations    | 980                 | 980                |

The table shows the results regarding the regression of equation (viii) presented in the Methodology section. Followed by the variables are the coefficients, with the t-stat below them in parenthesis. The \*\*\* and \*\* evidence statistical significance at the 1% and 5% levels, respectively.

In Table 6 located above are presented the results of the regression that was run with an interaction of firm and time fixed effects, following the equation viii explained in the previous section. Similarly to the previous results, the CARs estimated through this model are generally positive and statistically significant, contributing to the view that the news of issuances of corporate green bonds are well received by the stock market in Europe.

Overall, these results provide robust empirical support for the first hypothesis tested in this study, that is, that news of green bond issuances are positively received by shareholders. The statistical significance across multiple models further supports the credibility of the findings, suggesting that investors positively reassess a firm's value upon the issuance of green bonds. This financial market reaction reinforces the previous literature that good environmental practices by firms generate positive attention from shareholders, as analyzed by Flammer (2013).

In fact, following the implementation of the Synthetic Control Method (SCM) described in the previous section, results demonstrated that the matched dataset had a balanced structure. More specifically, the variance ratio for the matched dataset posted between 0.9 and 1.1, indicating that the dataset closely approximated a balanced comparison since values neared 1 across all scenarios analyzed.

With this balance confirmed, the SCM results are presented in Table 7 below. The analysis focused on estimating the Average Treatment Effect (ATE) for green bond issuances compared to their non-green bond counterparts using the same structure as before, the two event windows: one of 16 days [-5, 10] and another of 21 days [-10, 10], as well as three different return models, CAPM, Fama-French 3-factor model (FF3), and Fama-French 5-factor model (FF5).

**Table 7 – Results of the Synthetic Control Method Matching**

| <b>Event Window</b>      | <b>[-5, 10]</b> | <b>[-10, 10]</b> |
|--------------------------|-----------------|------------------|
| <b>CAPM Model</b>        |                 |                  |
| Average Treatment Effect | 0.0352***       | 0.0437***        |
| Robust Standard Error    | 0.0085          | 0.0098           |
| <i>z-value</i>           | 4.13            | 4.45             |
| Observations             | 1,743           | 1,743            |
| <b>FF3 Model</b>         |                 |                  |
| Average Treatment Effect | 0.0304***       | 0.0387***        |
| Robust Standard Error    | 0.1165          | 0.0126           |
| <i>z-value</i>           | 2.61            | 3.07             |
| Observations             | 1,743           | 1,743            |
| <b>FF5 Model</b>         |                 |                  |
| Average Treatment Effect | 0.0303***       | 0.0376***        |
| Robust Standard Error    | 0.0105          | 0.0119           |
| <i>z-value</i>           | 2.88            | 3.14             |
| Observations             | 1,743           | 1,743            |

The table above shows the average treatment effect, standard error and z-score of the synthetic control method between treated observations (green bonds) and non-treated observations (standard bonds). Results are segregated between two event windows and three different models. The \*\*\* show statistical significance at the 1% level.

The table above highlights the estimated ATEs, robust standard errors, and corresponding z-scores for treated observations (green bonds) compared to non-treated observations (comparable standard bonds). The estimates are reported separately for each event window and each asset pricing model employed.

The results imply that, on average, firms issuing green bonds experience a statistically significant increase in their cumulative abnormal returns (CARs) compared to firms issuing standard bonds. This positive treatment effect holds across both event windows when CARs are calculated using the CAPM model, with highly significant ATEs of 0.035 percentage points for the 16-day window and 0.044 percentage points for the 21-day event window.

Similarly, the FF3 and FF5 models provide further evidence supporting these findings. In both the 16-day and the 21-day event windows, the ATEs calculated through the models are positive and statistically significant.

Overall, these findings confirm one of the hypotheses tested in this paper: that stock market reactions to green bond announcements are positive and statistically significant, with observable differences from reactions to non-green bond issuances. The consistent significance of the ATEs across multiple models and event windows evidences the robustness of the results and highlights the value attributed by investors to sustainability-linked financial instruments.

For the purpose of testing if the stock market's reactions to news of issuances of corporate green bonds change during periods of stricter environmental regulation, a model was carried out with an interaction term between the green bond variable and a dummy variable indicating if each observation is from 2019 or afterwards, aiming at investigating if the announcement of the European Green Deal, in December 2019, had any impact on the shareholders' reactions to the issuances of corporate green bonds. The results from this model are detailed in Table 8 below.

**Table 8 – Regression Results of Cumulative Abnormal Returns with Interaction Term**

| <b>Event Window</b>    | <b>[-5, 10]</b>      | <b>[-10, 10]</b>    |
|------------------------|----------------------|---------------------|
| <b>CAPM Model</b>      |                      |                     |
| Green Bond             | 0.0401***<br>(5.54)  | 0.0433***<br>(4.06) |
| Post 2019              | 0.0431***<br>(4.42)  | 0.0268**<br>(1.96)  |
| Green Bond # Post 2019 | -0.0088<br>(-1.11)   | -0.0204<br>(-1.75)  |
| Observations           | 1,743                | 1,743               |
| <b>FF3 Model</b>       |                      |                     |
| Green Bond             | 0.0401***<br>(5.16)  | 0.0435***<br>(4.10) |
| Post 2019              | 0.0431***<br>(4.10)  | 0.0194<br>(1.43)    |
| Green Bond # Post 2019 | -0.0069<br>(-0.82)   | -0.0136<br>(-1.17)  |
| Observations           | 1,743                | 1,743               |
| <b>FF5 Model</b>       |                      |                     |
| Green Bond             | 0.04147***<br>(4.86) | 0.0393***<br>(3.64) |
| Post 2019              | 0.0451***<br>(3.92)  | 0.0093<br>(0.67)    |
| Green Bond # Post 2019 | -0.0097<br>(-1.03)   | -0.0135<br>(-1.14)  |
| Observations           | 1,743                | 1,743               |

The table shows the coefficient  $\beta$  of each variable in the regression of the equation (ix) presented in the Methodology section. Results are segregated between two event windows and three different models. Below the coefficients and in parentheses are the t-stats. The \*\*\* and \*\* evidence statistical significance at the 1% and 5% levels, respectively.

The results from the analysis reveal how the stock market's reactions to green bond issuances evolve over time as environmental regulation becomes stricter. Across all three models—CAPM, FF3, and FF5 – the coefficient for green bond issuances is consistently positive and statistically significant at the 1% level. This indicates a strong and favorable market reaction to green bond announcements, suggesting that investors respond positively to the issuance of green financial instruments. The magnitude of this effect ranges from 0.0401 to 0.0435 percentage points, reflecting a positive CAR during the two event windows analyzed.

The post-2019 variable also shows a positive and significant effect in most models, particularly for the shorter event window [-5, 10], evidence that, in general, the investor sentiment regarding bonds in general improved after 2019, reflecting broader market conditions possibly related to the spread of the Covid-19 pandemic in early 2020, and its strong effects on the global economy with lower interest rates, higher inflation, among other specific responses. However, note that this effect on the post-2019 variable weakens under the longer event window [-10, 10], especially under the FF5 model, where the statistical significance is lost.

The interaction term between green bonds and post-2019 reveals a different dynamic. Although the coefficient is consistently negative across models and event windows, it fails to reach statistical significance in any specification. This indicates that there is no clear evidence that the market's response to green bond issuances has significantly changed after 2019.

These findings point to a robust and persistent green bond effect, however, the influence of the European Green Deal in the market returns was not persistent nor statistically significant, implying that the second hypothesis of this paper was not confirmed, that is, it cannot be concluded that stock market reactions to the issuance of green bonds become more intense during periods of stricter environmental regulation.

These particular results differ from the existing literature by Krueger, Sautner and Starks (2019), and Seltzer, Starks and Zhu (2022), as both papers found that analysts and investors do value and analyze firms differently during times of stricter environmental regulation.

**5.2. Firm-specific Characteristics Post Issuance**

This subsection is dedicated to the last methodology applied to this paper, with the goal of analyzing if there are any significant changes to cost of debt and to the profitability of green bond issuers before and after their first issuance of green bonds.

Firstly, below are presented the correlation tables for the two models – model number 1 has the cost of debt as dependent variable, and model 2 has the profitability as dependent variable. As shown below, the two models are fairly well balanced, however, since the variables PtB and Lev have a strong correlation (0.8888), the variable Leverage was omitted from the model as to avoid multicollinearity issues.

**Table 9 – Correlation Matrix**

| (1)           | Kd            | PtB     | ROE     | Size    | Lev     | Ebitda  | Post-Bond |
|---------------|---------------|---------|---------|---------|---------|---------|-----------|
| Kd            | 1.0000        |         |         |         |         |         |           |
| PtB           | -0.0714       | 1.0000  |         |         |         |         |           |
| ROE           | -0.1406       | 0.2995  | 1.0000  |         |         |         |           |
| Size          | -0.3412       | 0.0050  | -0.0422 | 1.0000  |         |         |           |
| Lev           | -0.1780       | 0.8888  | 0.2516  | 0.2409  | 1.0000  |         |           |
| Ebitda        | -0.0735       | -0.0070 | 0.3428  | -0.2209 | -0.0377 | 1.0000  |           |
| Post-Bond     | -0.0590       | 0.0589  | 0.0244  | 0.0105  | 0.0487  | 0.0288  | 1.0000    |
| (2)           | Profitability | PtB     | ROE     | Size    | Lev     | Kd      | Post-Bond |
| Profitability | 1.0000        |         |         |         |         |         |           |
| PtB           | -0.0027       | 1.0000  |         |         |         |         |           |
| ROE           | 0.3849        | 0.2995  | 1.0000  |         |         |         |           |
| Size          | -0.1829       | 0.0050  | -0.0422 | 1.0000  |         |         |           |
| Lev           | -0.0476       | 0.8888  | 0.2516  | 0.2409  | 1.0000  |         |           |
| Kd            | -0.1098       | -0.0714 | -0.1406 | -0.3412 | -0.1780 | 1.0000  |           |
| Post-Bond     | 0.0311        | 0.0589  | 0.0244  | 0.0105  | 0.0487  | -0.0590 | 1.0000    |

The table above presents two correlation matrixes – the first includes the variables present in the equation model (x) presented in the previous section. The second matrix presents the variables of the equation model (xi), also presented previously.

Overall, the variables behave in line with the expected. The Cost of Debt (Kd) has a negative relation with all other variables in the model, indicating that firms with higher price-to-book ratio, higher ROE and Size, and with higher profitability are correlated with having a lower average cost of debt. Additionally, the variable of interest Post-Bond also has a negative, although low, correlation with the Kd, suggesting that after firms issue green bonds, they tend to experience a decrease in their cost of third-party financing.

Regarding the second model, the correlation table suggests that firms with higher cost of debt, higher leverage and size tend to experience lower profitability, while an increase in the Return on Equity is associated with higher profitability. Furthermore, the table also points at a low however positive correlation between profitability and the post-green bond variable, suggesting that after firms issue their first green bond, they tend to experience an increase in their profitability.

In Table 10 below are presented the regressions results for both models – model 1 has Cost of Debt (Kd) as a dependent variable, and model 2 has the Profitability as dependent variable, while PostBond is the dummy variable indicating if the observations are from before or after the first green bond issuance by the firms in the sample.

**Table 10 – Panel Regression Results**

| <b>Model</b>      | <b>(1)</b>            | <b>(2)</b>            |
|-------------------|-----------------------|-----------------------|
| PostBond          | 0.0045<br>(0.60)      | 0.0749<br>(0.88)      |
| PtB               | -0.0003<br>(-0.51)    | -0.0507***<br>(-7.26) |
| ROE               | 0.0221<br>(0.70)      | 2.6056***<br>(8.39)   |
| Size              | -0.0909***<br>(-6.57) | 0.0123<br>(0.07)      |
| Ebitda            | -0.0220***<br>(-4.32) |                       |
| Kd                |                       | -2.8968***<br>(-3.62) |
| Issuer FE         | Yes                   | Yes                   |
| Year FE           | Yes                   | Yes                   |
| No of Firms       | 111                   | 111                   |
| R-squared Overall | 0.1191                | 0.1382                |
| R-squared Within  | 0.3192                | 0.4661                |
| Observations      | 305                   | 305                   |

The table shows the panel regression results performed. Model 1 has the cost of debt as dependent variable and refers to the equation (x) presented in the Methodology section. Model 2 has net profitability as dependent variable and refers to the equation (xi), also presented in the previous section. Coefficients are presented with their t-stats below in parentheses. The \*\*\* indicates a statistical significance of 1%.

The results reveal that the variable of interest PostBond has a low and statistically insignificant coefficient in Model 1, suggesting that the issuance of green bonds does not appear to

significantly influence firms' cost of debt. These results are surprising in light of the current literature indicating that firms with higher Corporate Social Responsibility attributes experience lower cost of equity and lower cost of capital (Ghoul et al, 2011; Kwok & Mishra, 2011).

However, the results might have been conflicting due to the different way CSR is measured in this study – the papers referenced do not consider green bonds as a signal for higher CSR, and green bonds, although they do signal a firm's commitment to ESG, it is also inserted in a broader context of corporate financing and financial markets and it is influenced by these other factors as well.

Similarly, other firm-specific variables, including PtB and ROE did not show significance. We did find a negative and statistically significant relation between a firm's size and operational profitability and its cost of debt, indicating that firms that have higher profit and that are bigger and have a larger availability of assets tend to have lower cost of capital, in line with the common knowledge in corporate finance. The R-squared of 11.91% suggests moderate explanatory power, indicating that while some variation in the cost of debt is captured, much remains unexplained.

Similarly, in Model 2, the dependent variable PostBond again did not reach statistical significance, however, its positive coefficient points at a potential, although weak, association between green bond issuances and increased profitability.

Regarding the control variables, price-to-book presents a strong and negative effect on profitability, suggesting that firms with higher valuation multiples experience lower profitability, notably related to market expectations embedded in higher stock prices. ROE presented a significant positive coefficient, confirming its role as a key indicator of financial performance, as companies with higher returns also present enhanced profitability. Additionally, the cost of debt variable showed a significant and negative relation with profitability, reflecting the direct impact of financing costs on a firm's bottom line.

In conclusion, statistically meaningful relationships between green bond issuances and firms' average cost of debt or profitability were not found in this sample. Both the cost of debt and the profitability are more sensitive to firm-specific metrics, such as Size and EBITDA Margin in case of the first, and Return on Equity, Price-to-Book and Cost of Debt for the latter. The presence of issuer and year fixed effects in model helps control for potential heterogeneity,

increasing the robustness of the models despite the relatively low explanatory power, as measured by the R-squared.

## **6. Conclusion**

This research investigated how the stock market reacts to the issuance of green bonds in the European Union during the 10-year period between 2013 and 2023. The empirical analysis performed provided strong evidence that such announcements are associated with positive and statistically significant market responses.

Across various event windows and asset pricing models – including the Capital Asset Pricing Model (CAPM), Fama-French three-factor (FF3), and five-factor (FF5) models – the results consistently indicated that firms experience cumulative abnormal returns (CARs) following green bond announcements. Notably, the CAPM model reveals CARs of 0.033 percentage points for the 16-day event window [-5, 10] and 0.028 percentage points for the 21-day window [-10, 10], both significant at the 1% level.

Similarly, the FF3 and FF5 models corroborate these findings with slightly higher CAR estimates. These results align with previous research by Flammer (2021) and Tang and Zhang (2020), reinforcing the notion that the market values sustainability-linked financial instruments.

The robustness of these findings was further confirmed through the Synthetic Control Method (SCM). The estimated Average Treatment Effects (ATEs) for green bond issuances were consistently positive and statistically significant, with the CAPM model indicating ATEs of 0.035 percentage points for the 16-day window and 0.044 percentage points for the 21-day window. This positive response suggests that investors do recognize the economic importance of green bond issuances, and the importance of sustainability-linked topics in the financial markets.

When investigating the potential impact of the European Green Deal announced in December 2019, however, the results did not support the hypothesis that stricter environmental regulations intensified market reactions. Although the coefficients for green bonds remained positive and significant post-2019, the interaction term between green bonds and the post-2019 period was not statistically significant. This indicates that the European Green Deal's announcement did not substantially influence investors' responses to green bond issuances, diverging from a previous study by Krueger, Sautner, and Starks (2019) in which the authors found that portfolio managers do incorporate climate regulatory risks in their analyses.

Additionally, the analysis of firm-specific characteristics post-green bond issuance revealed mixed results. The panel regression analysis showed that the dummy variable PostBond, which indicated if an observation was from before or after the green debt issuance, was not significantly associated with changes in either cost of debt or profitability.

While the cost of debt appears more sensitive to firm-specific metrics such as Size and EBITDA Margin, profitability is primarily influenced by Return on Equity, Price-to-Book, and Cost of Debt. The lack of significance for the variable of interest suggests that green bond issuances alone may not directly translate into improved financial metrics.

In general, this study demonstrated the European financial markets' favorable view of green bonds, providing evidence of their value in enabling firms to issue debt to support their sustainable projects. These findings contribute to fostering awareness of the financial benefits of green bonds and to the growing body of literature on green bonds, which underscores their significance in aligning corporate financing with environmental objectives.

Lastly, it is important to acknowledge that this research does have its limitations. In this case, they include the size of the dataset of conventional bonds available for the matching, which was highly decreased due to the availability of the date of the first announcement of issuance of the green bonds, and due to gaps in stock prices for the dates encompassing all the estimation and event windows. Additionally, it is important to note that the green bond data has a large majority of its bonds issued in only three countries – Germany, Sweden and France.

Another limitation is the manner in which the periods of heightened environmental regulation were defined. In this paper, only one method was used to determine which periods contained intense environmental policies. However, in future research, other methods could be employed to gain a more comprehensive understanding of this context.

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