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The impact on a company's stock price following the issuance of green bonds

João Filipe Pinto Gonçalves

Master in Finance

Supervisor:
PhD Pedro Manuel de Sousa Leite Inácio, Assistant Professor,
ISCTE Business School

March, 2024

BUSINESS SCHOOL

Department of Finance

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The conclusion of this dissertation signifies, for the time being, the end of my academic journey. The successful culmination of this journey, leading to the finalization of my master's thesis, was solely achievable due to the support of some people.

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Resumo

Ao longo da última década, houve um imenso crescimento na emissão de obrigações verdes. Este estudo procura explorar como os investidores respondem à emissão destas obrigações por empresas cotadas europeias não financeiras. Para conduzir esta investigação, recolhemos dados de 67 empresas europeias que emitiram obrigações verdes entre novembro de 2013 e dezembro de 2022. O conjunto de dados consiste em 211 obrigações, das quais 141 são obrigações verdes e 70 são obrigações convencionais. Para avaliar o seu impacto, conduzimos um estudo de evento centrado na data do anúncio da emissão. Utilizámos o modelo de mercado para estimar os parâmetros, possibilitando o cálculo dos retornos anormais e retornos anormais acumulados.

Observou-se um retorno anormal médio acumulado de 0,54% na janela de evento de dois dias, abrangendo o dia do anúncio e o dia seguinte. Comparativamente, o retorno anormal médio acumulado, durante a mesma janela de evento foi de 0,22% para os títulos convencionais.

A nossa análise revelou retornos significativos e positivos especificamente associados aos anúncios de obrigações verdes inaugurais para a empresa. Por outro lado, os anúncios subsequentes não exibiram resultados estatisticamente significativos. A análise de regressão corroborou estas conclusões, sugerindo que apenas a primeira emissão de obrigações verdes fomenta uma reação positiva e notável no mercado. As nossas descobertas sugerem que a emissão de títulos verdes é uma ação ambientalmente responsável, mas a sua influência diminui nas emissões subsequentes. Este declínio ocorre porque, a partir do momento em que uma empresa emite o seu primeiro título verde, o mercado toma conhecimento do compromisso da empresa em apoiar projetos ambientalmente sustentáveis.

Palavras-chave: Sustentabilidade, Finanças Verdes, Obrigações Verdes, Estudo de Evento, Retornos Anormais

Classificação JEL: G14, Q56

Abstract

Over the past decade, there has been an immense growth in the issuance of green bonds. This study seeks to explore how investors respond to the introduction of these bonds by public non-financial European companies. To conduct this investigation, we collected data from 67 European companies which issued green bonds between November 2013 and December 2022. The dataset consists of 211 bonds, comprising 141 green bonds and 70 conventional bonds. To evaluate the impact, we conducted an event study centred around the announcement date. We utilized the market model to estimate the parameters, enabling the computation of abnormal returns and cumulative abnormal returns.

We observed a cumulative average abnormal return of 0.54% within the two-day event window, covering the day of announcement and the subsequent day for green bonds. Comparatively, the cumulative average abnormal return during the same event window for conventional bonds was just 0.22%.

Our analysis also revealed significant and positive returns specifically associated with the companies' initial green bond announcements. However, subsequent announcements did not exhibit significant results. Regression analysis echoed these findings, suggesting that solely the first issuance of green bonds exerts a positive and noteworthy influence on the market. Our findings suggest that issuing green bonds is seen as an environmentally responsible action, yet its influence diminishes with subsequent issuances. This decline occurs because once a company issues its first green bond, the market becomes acquainted with the company's commitment to endorsing environmentally sustainable projects.

Keywords: Sustainability, Green Finance, Green Bonds, Event-study, Abnormal Returns

JEL Classification System: G14, Q56

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Glossary of Acronyms

AAR: Average Abnormal Return

AR: Abnormal Return

ASAR: Average of the Standardized Abnormal Returns

ASCAR: Average of the Standardized Cumulative Abnormal Returns

CAAR: Cumulative Average Abnormal Return

CAD: Canadian Dollar

CAPM: Capital Asset Pricing Model

CAR: Cumulative Abnormal Return

CBI: Climate Bonds Initiative

CBS: Climate Bonds Standard

CNY: Chinese Yuan

COP21: 21st Conference of the Parties

EIB: European Investment Bank

ESG: Environmental, Social and Governance

EU-GBS: European Green Bond Standard

EUR: European Monetary Currency

GBP: Green Bond Principles

GSS+: Green, Social, Sustainability, Sustainability-linked, and transition bonds

ICMA: International Capital Market Association

ISIN: International Security Identification Number

MCAR: Median of Cumulative Abnormal Returns

NZD: New Zealand Dollar

OECD: Organization for Economic Cooperation and Development

OLS: Ordinary Least Squares

ROA: Return on Assets

S&P: Standard and Poor´s

SAR: Standardized Abnormal Returns

SCAR: Standardized Cumulative Abnormal Returns

SDGs: Sustainable Development Goals

UK: United Kingdom

UNFCCC: United Nations Framework Convention on Climate Change

UoP: Use of proceeds

USD: United States Dollar

VIF: Variance Inflation Factor

Introduction/Executive Summary

The matter of climate change has become increasingly prominent in the global economy. This theme has an impact on both the decision-making process of managers and the decision-making process of investors. In recent years, corporations have increasingly prioritized enhancing their Environmental, Social, and Governance (ESG) indices to address this issue. Climate change is increasingly harming economic growth, disturbing natural balance, and hindering sustainable development. It is imperative for all governments, organizations, and enterprises to promptly pursue solutions that address climate change (Tran et. al., 2020). These solutions should facilitate the achievement of growth objectives while minimizing environmental consequences. From an economic perspective, environmental sustainability acts as a driving force for seeking new investment opportunities or mitigating economic and reputational risks. It plays a key role in determining portfolio investment choices (Cioli et. al., 2021).

The Paris Agreement was introduced by the United Nations Framework Convention on Climate Change (UNFCCC) during the 21st Conference of the Parties (COP21) in Paris in December 2015, as a measure to combat climate change. The objective of the agreement is to restrict the increase in global temperatures to a level far below 2 degrees Celsius, preferably within a range of 1.5 degrees Celsius in relation to pre-industrial levels. Green finance, particularly through the use of green bonds, holds significant promise in addressing climate change and promoting the transition to a more sustainable economy.

Green bonds possess the same financial characteristics as conventional bonds. However, the main distinction lies in the allocation of the proceeds, which is exclusively directed towards funding projects or activities that have a positive impact on the environment or climate. These bonds have emerged as a compelling option for certain companies to mitigate their environmental footprint while maintaining competitiveness. This phenomenon is especially noticeable in areas where environmental considerations carry substantial importance (Lebelle et al., 2020). As a result, the market for green bonds has consistently grown over the last ten years, and this trend is expected to continue in the future.

This thesis aims to explore the response of the stock market to announcements regarding green bonds issued by publicly traded non-financial European corporations. To investigate this, we inspected 211 bonds—141 categorized as green and 70 as conventional—issued by a total of 67 European companies, spanning from November 2013 to December 2022. Using this dataset, we initially conducted an independent event study, following the MacKinlay (1997) method, for both green and conventional bond announcements. We examined each day within a range from day -10 to day 10, with day 0 being the focal point representing the exact date of the bond announcement. However, the main event window of this study is [0,1]. Our findings revealed that the introduction of a green bond issuance resulted in a positive Cumulative Average Abnormal Return (CAAR) of 0.54% during the main event window, exhibiting statistical significance at the 1% level. Conversely, the announcement of a conventional bond issuance led to a positive CAAR of 0.22%. Notably, this study highlighted a previously unmeasured premium of 0.32% associated with green bond issuance announcements in comparison to announcements regarding conventional bond issuances. Additionally, we analysed the difference between initial and subsequent green bond issuances. In line with the findings of Flammer's (2021) study, our analysis revealed a significant upward movement in stock market performance following first announcements. Our findings show that the CAAR for initial green bond announcements in the dataset is 0.77%. Nevertheless, although we observed a positive CAAR of 0.34%, we did not detect any substantial influence on the stock market for further announcements of green bonds.

Based on the outcomes of the event study, we conducted regression analyses with the Cumulative Abnormal Return (CAR) as the dependent variable. In these regressions, we employed dummy variables to distinguish between green bonds from conventional ones, as well as between initial green bonds and subsequent green bonds. Additionally, we included a set of control variables as independent factors in the regression models. The outcomes validate the conclusions made in the event study regarding the positive response of the European stock market to green bond announcements. Moreover, it also verifies that this reaction is particularly stronger during the initial green bond issuance.

We make two forecasts regarding our analysis findings. The initial prediction suggests that the announcement of issuing green bonds holds valuable information leading to a significant and positive stock market reaction compared to the announcement of conventional bond issuances. Our second forecast anticipates that the market's response to the inaugural green bond of a company will be more significant than subsequent ones, indicating that subsequent green bonds may not elicit such a positive market reaction. As per our results, both predictions accurately capture how equity investors responded to the announcement of a green bond issuance.

Our research aligns with prior studies (Flammer, 2021; Glavas, 2018), affirming a positive market response to green bond issuances. Our contribution to the existing literature lies in our exclusive focus on the European market. Furthermore, we conduct a comparative analysis between green and conventional bonds, and we also examine both companies' inaugural and subsequent green bond releases. Furthermore, our sample encompasses a significantly wider range of time compared to previous studies in this subject.

The rest of the thesis is structured as follows: chapter 1 encompasses a comprehensive literature review. It begins by defining green bonds, proceeds with a concise summary of the green bond market, and culminates in an exploration of existing literature concerning the market's response to green bonds. The second chapter outlines the utilized data, while in chapter 3 we describe the methodology. The results from our event study and regression analysis are detailed in chapter 4. Lastly, chapter 5 delves into a discussion of the study's results.

CHAPTER 1

1. Literature Review

This section will delve into academic research on Green Bonds. Let us begin with a concise introduction of Green Finance. Next, we shift our focus to the financial instrument central to this subject: Green Bonds. Subsequently, we provide a brief overview of the Green Bond market. Finally, we examine the current body of research about the market's response to the issuance of green bonds.

1.1. Green Finance

The concept of green finance is gaining momentum at both the public and private sector levels. Governments worldwide are crafting policies and regulations that promote sustainable financial practices, such as mandating greater transparency on climate-related risks and incentivizing green investments. Green finance encompasses a range of financial instruments, services, and strategies that support the financing of initiatives and endeavours aimed at mitigating the effects of climate change, preserving natural resources, and promoting sustainable development.

In their study, Höhne et al. (2012) provided a concise explanation of the idea of green finance. They defined it as the allocation of financial resources towards projects and initiatives that promote sustainable development, environmental products, and policies aimed at fostering a more sustainable economy. Green finance encompasses climate funding but is not restricted just to it. The term also encompasses a broader set of environmental goals, such as the regulation of industrial pollution, the improvement of water sanitation, and the preservation of biodiversity (Höhne et al., 2012).

Green finance primarily involves a wide array of financial tools that direct funds towards activities that are environmentally sustainable. Green bonds are a significant element of green financing.

Green money is crucial for promoting the United Nations Sustainable Development Goals (SDGs) since it offers a way to tackle various global concerns concurrently, such as climate change mitigation, renewable energy adoption, poverty alleviation, and the development of sustainable urban areas.

The growing popularity of green finance can be attributed to two key factors (Nylén, 2021). First, more people understand the connection between climate change and financial risks. Companies and investors now have a greater understanding of the risks associated with climate change and how these risks can impact their businesses. The second factor, which happened in 2015, refers to the Paris Agreement. When companies demonstrate their commitment to climate action, they encourage investors to support green finance in developed and emerging economies (Banga, 2019).

In summary, green finance serves as a catalyst for building a more resilient, equitable, and environmentally conscious global economy. This represents a transformative approach to finance that holds the potential to drive positive environmental change while generating economic growth.

1.2. Green Bonds

1.2.1. Definition

Green bonds are financial instruments that are issued by firms, governments, or other entities in order to raise funds for projects or activities that have a beneficial effect on the environment, such as decreasing CO2 emissions and preventing pollution (Tang & Zhang, 2020). These are a category of financial instruments that are part of the green finance sector. The Organization for Economic Cooperation and Development (OECD) has not yet furnished a precise delineation for green bonds. However, it has formulated explicit definitions for "green infrastructure" and "green investments" in its undertakings. In addition, the OECD has established a quantitative framework for evaluating infrastructure systems in order to ascertain the degree to which they are "low-carbon and climate-resilient."

Like conventional bonds, green bonds also possess a predetermined duration and interest rate. They are offered to investors who supply funds to the issuer in return for periodic interest payments and the repayment of the initial investment upon the bond's maturity. A fundamental distinction between a green bond and a conventional vanilla bond is in the need that the funds raised from a green bond must be exclusively allocated towards environmentally sustainable initiatives (Bachelet et al., 2019). Consequently, investors can have assurance that their funds are being utilized to endorse projects that are in accordance with their principles. Green bonds are frequently employed to fund projects such as renewable energy, environmentally friendly transportation, sustainable building, and responsible water resource management. A green bond is a financial instrument that enables organizations to raise funding for environmentally beneficial initiatives, while providing investors with the opportunity to support these projects through their investments.

The GBP categorizes green bonds as four distinct kinds (International Capital Market Association [ICMA], 2022):

(i) Standard Green Use of Proceeds Bond: aligned with the GBP and has similar characteristics to vanilla bonds in terms of recourse rights.

(ii) Green Revenue Bond: a non-recourse-to-the-issuer debt obligation that follows the Green Bond Principles (GBP). The credit exposure of the bond is determined by the cash flows that are pledged from different sources such as revenue streams, fees, taxes, etc. These cash flows are used for Green Project(s), whether they are connected or unrelated.

(iii) Green Project bond: a bond specifically designed for financing one or more Green Projects. By investing in these bonds, the investor assumes direct exposure to the risks associated with the project(s), either with or without the possibility of seeking compensation from the issuer, and that is aligned with the GBP.

(iv) Secured Green Bond: The funds raised from issuing this bond will be exclusively utilized to finance or refinance either: 1) The Green Project(s) exclusively securing the particular bond, or 2) The Green Project(s) of the issuer, originator, or sponsor, which may or may not fully or partially secure the individual bond.

The level of exposure can differ between the project's risk or the company's risk, depending on the specific bond chosen by the investor.

In recent years, there has been a significant increase in the use of green bonds to raise capital, coinciding with the growing awareness and concern about climate change and the urgent need to reduce greenhouse gas emissions. Green bonds offer a financial solution that aligns with the goal of achieving a more sustainable future.

The significance of Green Bonds was further emphasized following the implementation of the Paris agreement. This Agreement acknowledges the necessity of substantial investment in low-carbon and climate-resilient infrastructure, and green bonds offer a method of funding these expenditures.

As Zerbib (2017) said, the expansion of the green bond market has been essential in encouraging institutional investors to effectively diversify their portfolios by redirecting their attention towards sustainable investment initiatives.

1.2.2. Taxonomies

In the past, there has been a lack of agreement on the definition and environmental impact of green finance. Investors could face a disadvantage due to the issuer's discretion in determining what qualifies as green. Consequently, concerns have been raised about *greenwashing*[1], as issuers may label a bond green to improve its environmental reputation, even if it has minimal impact on tackling climate change (Ehlers & Packer, 2017).

The development of green bond taxonomies has become vital due to the growth of the green bond market. These taxonomies function as classification systems that aid in the identification and assessment of the environmental sustainability of economic and financial operations. The purpose of green bond taxonomy is to assist investors, governments, and bond-issuers in identifying environmentally sustainable assets and activities by providing explicit guidelines (Ma et al., 2016). Furthermore, they offer instructions on how to integrate sustainability criteria into investment decision-making processes. Adopting a standardized strategy is crucial for promoting transparency and confidence in the green finance industry. It helps to reduce the deceptive practice of *greenwashing* and encourages investment efforts that have a true environmental benefit.

Moreover, Martin and Moser (2016) highlight the importance of disseminating information, specifically in relation to the societal advantages of investments. The evidence they offer is persuasive and suggests that investors place greater importance on these disclosures compared to just knowing the expenses. This highlights the notion that the transparency and communication of the beneficial effects of investments are crucial in garnering investor attention and endorsement.

The Green Bond Principles (GBP) were established in 2014 as a set of voluntary recommendations by a consortium of investment institutions. These principles constitute a collection of optional suggestions. Following that, the International Capital Market Association (ICMA) created an independent secretariat with the task of overseeing the ongoing monitoring and progress of the recommendations. The main goal of the GBP is to support issuers in obtaining finance for initiatives that advance environmental sustainability, contribute to achieving a net-zero emissions economy, and protect the natural environment (ICMA, 2022).

A green bond, as defined by the ICMA, refers to a bond that is used solely to finance or refinance new and/or existing eligible Green Projects. These projects must align with the four core components of the Green Bond Principles (ICMA, 2022). The four fundamental elements for achieving alignment with the GBP are:

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[1] *Greenwashing* is a deceptive practice used by companies or organizations to create a false impression of environmentally friendly actions or policies. It involves deceptively advertising the ecological aspects of a company's product, service, or practices to appear more environmentally responsible than it actually is.

(i) Use of Proceeds: allocation of the funds obtained from the bond towards qualifying Green Projects aimed at tackling significant environmental issues.
(ii) Process for Project Evaluation and Selection: aiming to inform investors about the environmental sustainability objectives, detailing the process involved in selecting projects and providing further information on how the issuer identifies and addresses potential social and environmental risks related to the respective project(s).
(iii) Management of Proceeds: the net revenues from the Green Bond, or an equivalent amount, must be allocated exclusively to green projects.
(iv) Reporting: the submission of annual reports with the description of the projects, their expected and/or achieved impact, and the amounts allocated.

Another relevant taxonomy is the Climate Bonds Standard (CBS) elaborated by the CBI. The CBS ensures bonds are aligned with the challenge of climate change and consistent with the goals of the Paris Climate Agreement. This certification confirms alignment with the ICMA Green Bond Principles (CBI, 2019). CBS has established a comprehensive set of criteria to clearly define assets and projects that align with climate objectives. By doing so, CBS determines what qualifies as "green" for investors and ensures that issuers are genuinely making a meaningful impact on addressing climate change. The CBS certification process involves validating both before and after the bond issuance to ensure compliance with the established standards. An independent third-party assurance provider or auditor, who is approved by the CBS, ensure that the green bond meets the requirements set by the Green Bond Standard (GBS). This ensures the credibility and reliability of the certification process.

The European Commission, in 2020, introduced another significant taxonomy, called the EU Green Bond Standard (EU-GBS). The EU-GBS aims to establish a set of fundamental elements for EU Green Bonds, with the goal of improving transparency, integrity, consistency, and comparability among such bonds. By doing so, the EU GBS seeks to facilitate greater financing for green and sustainable projects (European Commission, 2021). A green bond issuance that aligns with the EU-GBS should allocate all the funds exclusively to projects that adhere to the EU taxonomy. The Taxonomy Regulation establishes six climate and environmental objectives: “i) climate change mitigation, ii) climate change adaptation, iii) sustainable use and protection of water and marine resources, iv) transition to a circular economy, v) pollution prevention and control, and vi) protection and restoration of biodiversity and ecosystems “(European Union Technical Expert Group, 2019).

1.3. Green Bond Market

1.3.1. Evolution

The European Investment Bank (EIB), in 2007, took a pioneering step by introducing the concept of allocating bond proceeds specifically for environmentally friendly projects. The EIB issued a EUR 600 million Climate Awareness Bond to fund projects related to renewable energy and energy efficiency. The World Bank issued in 2008 the inaugural green bond officially designated as such (World Bank, 2019). During the first few years, the Green Bond Market was characterized by a relatively small number of bond issuances each year. Moreover, these issuances were primarily limited to development banks with AAA ratings.

In November 2013, the Électricité de France issued the first public corporate green bond. Since then, the number of Green Bond issuances, issuers, and investors has been increasing year after year. In the first 13 years since the market was established, the average annual growth rate is approximately 95%.

The issuance of green bonds has experienced a remarkable surge in growth. This can be attributed to traditional investors becoming more conscious of the advantages of green investments and recognizing the potential effects of climate change on financial assets (Caldecott, 2017).

In 2014, the worldwide issue value was about USD 37 billion. However, by 2021, the annual issue value exceeded the half trillion mark. In that year, Europe maintained its position as the region with the highest total value of issued securities, with the value amounting to USD 288 billion out of a total of 305 issuers (CBI, 2023).

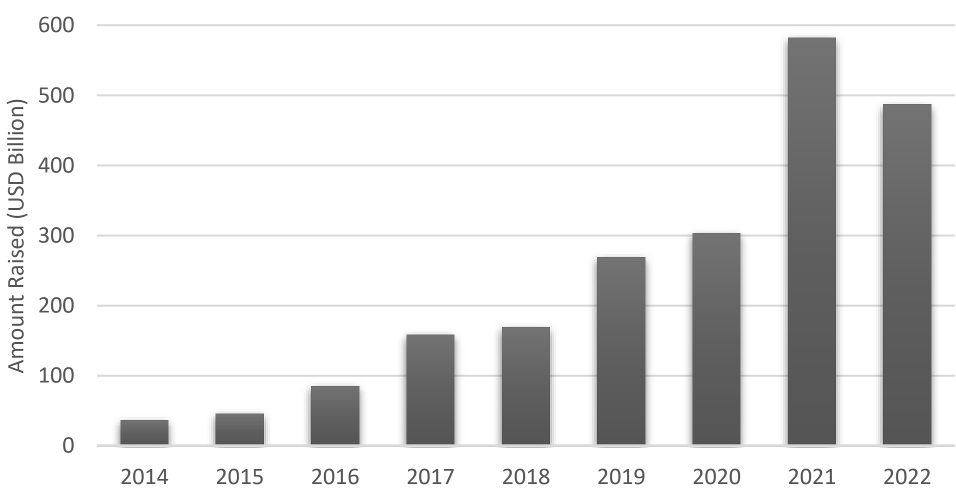

Figure 1.1: Green Bond Annual Issuance (2014-2022).

Source: CBI

1.3.2. Drivers of Market Growth

As mentioned earlier, the green bond market has shown significant expansion over the past decade, despite encountering many hurdles and issues. Several causes can account for this substantial growth.

The ICMA's publication of the Green Bond Principles in January 2014 was essential in stimulating the growth of the market (Ehlers & Packer, 2017). The aforementioned concepts have served as the basis for numerous current green labels (ICMA, 2022). As a result of this progress, the market for labelled green bonds has experienced a substantial expansion, reaching, in cumulative issuance, the USD 100 billion mark in 2015, the USD 500 billion mark in 2018 and the USD 1 trillion mark in 2020 (CBI, 2023).

Another important catalyst for the advancement of the green bond market has been the growing certification of these bonds by third parties (Ehlers & Packer, 2017). This certification offers reassurance that the funds raised through the bonds will be used in alignment with the goals specified in the Paris Agreement.

Deschryver and de Mariz (2020) elucidated that green bonds are increasingly being utilized as a strategic marketing tool in response to the mounting interest in sustainable assets and the investigation of how climate risk impact investment returns. Financial institutions are actively promoting the expansion green bonds, and issuers are facing pressure from stakeholders to join the market for marketing, commitment, and investor relations.

Flammer (2021) justified the expansion of the green bond market with the role in preventing greenwashing, potentially reducing financing expenses for companies when investors prioritize societal and environmental benefits and serving as a prominent symbol of a company's dedication to environmental causes.

Finally, the growth of the green bond market can be linked to the aftermath of the 2008 financial crisis and the unconventional measures implemented by major central banks. These actions led to consistently low interest rates, which left investors in advanced economies searching for better returns (King, 2017). This search for better returns put pressure on institutional investors like pension funds and insurance companies to make their savings products more attractive and reduce pension costs due to low interest rates (King, 2017). Institutional investors are increasingly recognizing green bonds as a strategic means to diversify their investment portfolios, driven by the growing awareness of climate issues and the prevailing low-interest rate environment in most developed nations (Banga, 2019).

1.3.3. Challenges

Substantial challenges and potential risks persist in the ongoing utilization and expansion of the green bond market.

First, green bonds are typically designed to adhere to the Green Bond Principles guidelines. However, as compliance with these principles is not mandatory, companies might not consistently allocate the funds acquired from these bonds toward environmentally friendly projects (Fernandez, 2023), practicing greenwashing. There are multiple ways to tackle the issue of greenwashing. An alternative strategy entails obtaining impact reports that evaluate the consequences of resources acquired through a green or social bond. Verifying the rise in expenditure for a particular environmentally friendly initiative is straightforward. However, accurately evaluating its actual influence, whether beneficial or not, necessitates unambiguous and open evaluations. However, corporations can use these impact reports as a way to differentiate themselves in the eyes of investors (Fernandez, 2023).

Second, assessing the actual impact presents a considerable challenge. To assess the ecological impact of a project financed by a green bond, it is necessary to establish and quantify the indicators that accurately represent environmental progress. Conducting thorough assessments requires a significant amount of time and financial investment, and the results may not be realized or accessible until the bonds reach their maturity date.

Third, the transaction costs associated with the issuance of green bonds are significantly high. These costs involve obtaining a "green level certification" from an independent agency and the requirement to provide comprehensive reports that describe the use of green bond funds over the entire duration of a project (Fernandez, 2023). Facilitating the involvement of smaller enterprises in the Green Bond Market is of utmost importance. This involves minimizing expenses related to certification, standardization, and evaluations, while simultaneously promoting the use of certification and third-party assessments.

Fourth, the focus should be on enhancing the institutional capability within the green bonds market. The issuance of sovereign themed bonds encompasses multiple stages, including project identification, implementation, monitoring, and evaluation. Therefore, it is important to ensure coordination among various entities and organizations within a government. Additionally, technical expertise is crucial, especially in emerging markets where it is frequently deficient (Fernandez, 2023).

To summarize, the primary challenge in the Green Bond market is balancing supply and demand. The promotion of green bond investments necessitates the continuous creation of worldwide norms and standards. This development aims to tackle challenges such as the scarcity of historical data and the potential risk of greenwashing (Sartzetakis, 2020). In order to optimize the efficacy of these criteria, it is crucial to effectively distribute information, hence augmenting awareness and engagement in green bond investments.

1.3.4. Current Overview

In 2022, the total issuance volume of green bonds experienced a decline in line with the broader bond market. The combined volumes of Green, Social, Sustainability, Sustainability-linked, and transition bonds (GSS+) amounted to USD 863.4 billion (CBI, 2023). This marked the first annual decrease in volumes in the past ten years, mostly attributed to difficult macroeconomic circumstances impacting global bond issuance. This was a result of market volatility, inflation concerns, increasing interest rates, and geopolitical uncertainties. These factors collectively led to higher borrowing costs, dampened investor enthusiasm, and impacted the overall bond market (Wu et al., 2023). However, there was a resurgence in the growth trend during the first half of 2023, with green bonds reaching a total of USD 278.8 billion. This marked a 33% rise from the USD 209 billion documented in the second half of 2022 (Harrisson, 2023). Nevertheless, despite the overall decline of 2022, GSS+ volumes maintained their 5% share of the global bond market. It is noteworthy that green bond issuances constituted more than 50% of the total volume among the GSS+ bonds.

Europe has continually held the top spot in terms of emission volume throughout 2022, accounting for 47% of the total global emissions. Developed markets were the source of approximately two-thirds (67%) of the green bond volume in 2022, while emerging markets accounted for 23%, and Supranational issuers contributed 9% to the total volume. China produced the largest volume of green bonds (USD 85.4 bn), followed by the United States (USD 64.4bn) and Germany (USD 61.2bn) (CBI, 2023).

Similar to the global market, the European market, which nearly reached the $300 billion mark in 2021, has been experiencing exponential growth, except for the year 2022 due to the reasons mentioned earlier. Germany has emerged as the leading European country in issuing green bonds, with France and the Netherlands following suit. Both Germany and France achieved a milestone in 2022, both issuing over USD 200 billion (CBI, 2023).

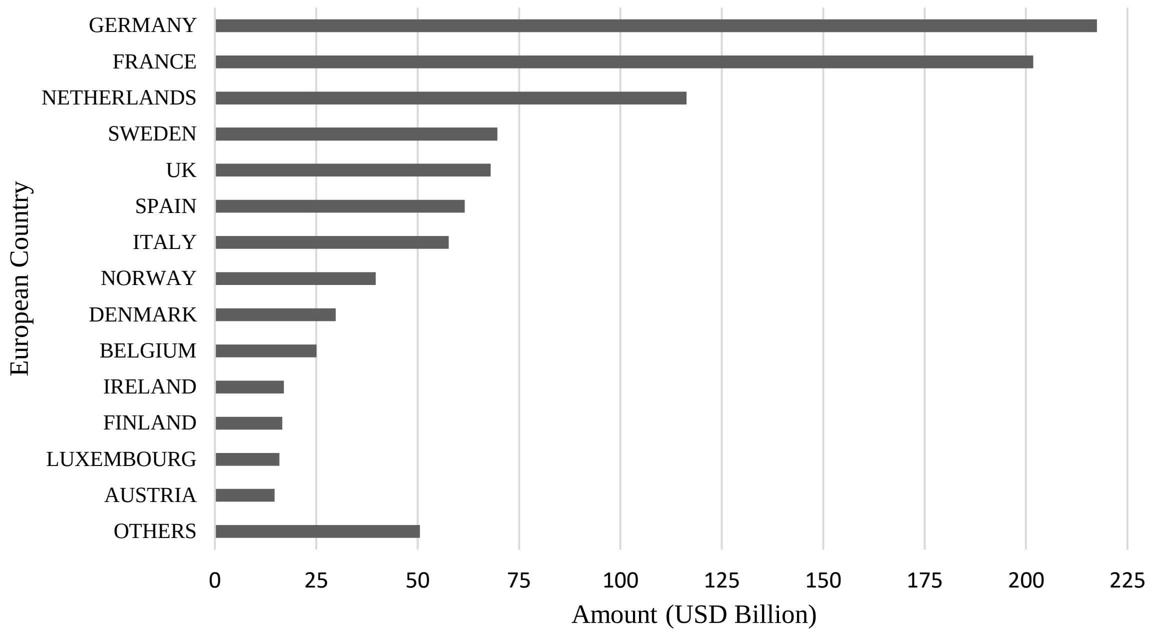

Figure 1.2: Green Bonds Total Amount Issued by each European Country until 2022.
Source: CBI

Regarding the type of issuer, in 2022, financial corporates issued the highest volume globally (29%), out of a total of 702 issuers, followed by non-financial corporates (25%) with 306 issuers.

Energy, Buildings, and Transport are the three dominant categories in terms of the Use of Proceeds (UoP), accounting for a combined 77% of the overall green debt volume. Nevertheless, there has been a decline from 2021's 81% and the record-high 85% in 2020. This decline can be attributed to smaller categories gaining traction, as a growing number of issuers, including significant sovereign entities, have sought financing for a wider array of projects.

In 2022, 79% of green bonds were issued in strong, stable currencies. The Chinese Yuan (CNY), the Canadian Dollar (CAD) and the New Zealand Dollar (NZD) were the only currencies that saw growth, with a 21%, 10% and 153% increase, respectively. The increase in the total amount of green bonds issued in Chinese currency can be attributed to the ongoing expansion of the green bond market in China over the past few years. Canada and New Zealand experienced this increase as a result of both launching their first-ever government-backed green bonds. The Euro (EUR) remained the leading currency for green bonds for the fifth consecutive year. Europe stood out as the region with the most extensive environmental policies and a substantial number of investment commitments expressly dedicated to green projects, making it the primary driver of green bond issuances (CBI, 2023).

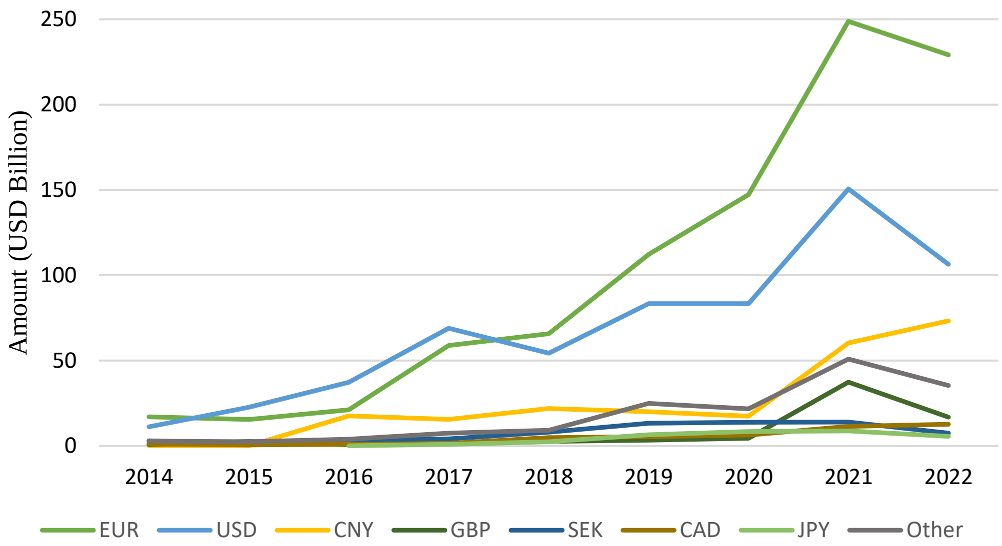

Figure 1.3: Green Bond Annual Issuance by Currency (2014-2022).
Source: CBI

1.4. Previous studies

Works done over the years show that markets react positively to environmentally friendly conduct and to the integration of environmental, social, and governance (ESG) criteria (e.g., Flammer, 2013; Guenster et al., 2011; Krüger, 2015). Companies that publicly announce their plan to issue green bonds enhance their visibility and, simultaneously, showcase a firm commitment to environmental sustainability.

Flammer (2013) investigated whether shareholders showed a response to a company's environmental impact. To do this, she conducted an event study that covered corporate environmental news announcements for all publicly traded US companies from 1980 to 2009. Her event study revealed that the announcement of environmentally friendly activities by corporations resulted in a favourable response from shareholders, leading to a rise in stock prices. On the other hand, when companies disclosed ecologically detrimental practices, it resulted in negative abnormal returns for shareholders. Furthermore, Dasgupta, et al. (2001) conducted a study on the effects of corporate environmental news announcements. They found that when unfavourable environmental news is released, it might lead to a decline in stock prices.

When it comes to research on green bonds, the primary emphasis is typically placed on one of three key areas. Firstly, there is a focus on the green bond market premium, which refers to the variance in yield between a green bond and a traditional bond. Secondly, studies delve into the performance of bond portfolios that adhere to environmental criteria. Lastly, the focus is on examining the market's reaction to the issuance of green bonds, as well as the possible financial advantages for the company issuing them.

1.4.1. The Green Bond Premium

The green bond premium, or *greenium*, refers to a difference in yield between green bonds and other non-green bonds that have similar characteristics, including the issuer, maturity, payment rank, and currency. Several recent studies (Bakshi & Preclaw, 2015; Fatica et al., 2021; Zerbib, 2017) have established the presence of a *greenium*. However, in contrast, there are additional studies that do not consistently find a significant advantage in the issuance of green bonds (Tang & Zhang, 2020). Furthermore, certain studies demonstrate a positive market response overall, but this response does not extend to green bonds with higher coupon rates (Baulkaran, 2019).

Bakshi and Preclaw (2015) discovered evidence indicating that there is a Green Bond premium of approximately -20 bps in the secondary market. To explain why this premium exists in the Green Bond Market, the researchers put forward several potential explanations. Firstly, the presence of a *greenium* suggests an increasing demand for these items that is not sufficiently satisfied by the current supply of green bonds. Secondly, they considered the possibility that Green Bonds could be less risky or volatile than other types of bonds, making them attractive to investors. Thirdly, this spread can simply be attributed to investor preferences. Investors may be inclined towards this choice due to the additional benefits they obtain, which offset the reduced cash flow often associated with green bonds. Finally, investors accept the lower yield provided by green bonds because they recognize the positive externalities associated with these investments. By supporting environmental initiatives, green bonds help mitigate climate-related risks, which creates additional value beyond financial returns.

Zerbib (2017) conducted an analysis of the green bond premium by examining 135 investment grade senior bullet fixed-rate green bonds, issued globally. The study reveals that bondholders experience an average green premium of 8 basis points in the secondary market, which is statistically significant. According to the researcher, this disparity in market microstructure can be attributed to two phenomena that are not mutually exclusive. Firstly, there is an excess of investment demand driven by the unique characteristics of green bonds. Secondly, there is an inadequate supply of green bonds being issued, resulting in a shortfall in meeting the investor demand.

Fatica et al. (2021) conducted a study that examines how the green label affects the pricing of bonds in the primary market. They analysed a wide range of bonds issued globally between

2007 and 2018 to understand the factors influencing the yield of new bond issuances. Their findings indicate that green bonds do not consistently command higher prices than regular bonds, but rather exhibit varying patterns depending on the issuer. They observed a Green Bond premium associated to supranational and corporate issuers, whereas there is no discernible impact on financial issuers. Furthermore, they find that return Green Bond issuers enjoy an extra premium, indicating a reputation effect within the green bond market, particularly for non-financial corporations.

1.4.2. Stock market reaction to green bonds

In recent years, several studies have focused on investigating the influence of green bond announcements on the issuer's stock price.

Glavas (2018) conducted a study on this subject, examining a dataset of 780 announcements for corporate bond issuances across 22 countries from January 2013 to August 2018. The study utilized an event study methodology to independently examine the effects of announcements on green bonds and conventional bonds. The results indicated that the declaration of a green bond offering led to a favourable Cumulative Average Abnormal Return (CAAR) of 0.46% on the day of the announcement. Conversely, an announcement of a traditional bond issue resulted in a positive CAAR of 0.14%, indicating a 0.32% premium linked to the issuance of green bonds. In addition, he assessed the influence of the Paris Agreement by contrasting the consequences prior to and after its enactment. The study revealed that after the Paris Agreement, the Cumulative Abnormal Return (CAR) values experienced a significant increase. This was explained by the change in investors behaviour after the year of the Paris Agreement towards a greater appreciation of the “green” flag associated with bond issuances, reflecting a heightened appreciation for environmentally sustainable investments following the agreement's inception.

Tang and Zang (2020) conducted an empirical analysis to explore the benefits of green bonds for shareholders. They examined a dataset of 132 publicly traded companies and observed a positive stock market response of approximately 1.39% around the time of the green bond announcement.

They explore three potential factors for the observed positive reaction during the announcement of green bonds: i) The financing cost factor, where socially responsible funds or investors with a green mandate may choose to hold green bonds to improve their ESG scores. Consequently, these investors can push up the price of green bonds, leading to a lower cost of debt for the issuers. This, in turn, results in a positive reaction from the stock market. ii) the investor attention factor, when companies label their bonds as green, it attracts media attention and increases the visibility of the issuing firms. This heightened visibility can draw investors' attention and generate more demand for the shares of the company. iii) The firm fundamental factor, that is, by investing in such projects, the company demonstrates its dedication to environmental responsibility, which can be valuable in the long run. This commitment to sustainability can contribute to the overall resilience of the firm, helping them navigate adverse situations and garnering a positive reaction from the stock market (Tang & Zhang, 2020).

Lebelle et al. (2020) undertook an extensive global study to evaluate the influence of corporate green bond issuance on stock prices. Their study covered a range of asset pricing models and varying lengths of time for event windows. The study compiled data from 475 corporate green bonds issued by 145 distinct firms globally, comprising both financial and non-financial publicly listed companies. The study employed the announcement date as the event date and utilized the CAPM model to compute market model parameters for each firm.

In contrast to what was anticipated, the results indicated a detrimental market response to the disclosure of green bond offerings. More precisely, the findings showed that the stock market reacted negatively on both the day the green bond was announced and the following day. The CAR exhibited a range of -0.5% to -0.2%, with variations based on the specific asset pricing model utilized, such as the CAPM, the 3-factor Fama and French models, and the 4-factor Carhart models. These results indicate that investors responded in an identical way to green bonds as they would to conventional or convertible bonds.

Flammer (2021) carried out a research that aimed to explore various aspects, including the market's reaction to the announcement of corporate green bond issuances. Using a dataset of 384 Green Bond issuances, mostly from Europe, US, and China, she observed a favourable reaction in the stock market, resulting in a cumulative abnormal return (CAR) of 0.49%. She also concluded that this reaction is more pronounced for green bonds that have been certified by independent third parties. Additionally, her findings indicate that green bond issuers enhance their environmental performance after the issuance takes place. Specifically, she observed two notable trends: first, the improvement in the company's environmental rating, and second, a reduction in CO_2 emissions (Flammer, 2021).

CHAPTER 2

2. Data

In this chapter, we describe the data selection procedure. Initially, we present details about the dataset employed for the event study, encompassing information on issuers, bonds, stocks, and indices. Then, we elucidate the financial data incorporated in the regression analysis, and lastly, the descriptive statistics for reference will be provided.

2.1. Bonds data

The majority of those involved in the Green Bond market have established their individual databases for Green Bonds. For instance, institutional investors who have a significant interest in Green Bonds maintain their distinct sets of data related to these bonds. Similarly, major commercial banks that engage in issuing green bonds, often as underwriters, typically maintain their separate records of Green Bonds, owing to their influential roles in the primary bond market (Lebelle et al., 2020).

At the outset, a selection was made comprising 67 European non-financial corporations, all issuers of green bonds. Information pertaining to both green and conventional bonds issued by these companies was acquired from diverse sources including the *Cbonds* database, the companies' official websites, and the online platforms of the Euronext, Frankfurt Stock Exchange, and the Luxembourg Stock Exchange.

In this research, all the bonds under consideration were released within the timeframe spanning from November 2013 to December 2022. Notably, when focusing specifically on green bonds, most of them were issued during the more recent years. All green bonds included in this study are in line with the GBP and/or CBS.

Upon acquisition of the International Securities Identification Number (ISIN) codes, a compilation of data was gathered from the mentioned online platforms for each bond. This encompassed details such as the announcement date, issuance date, issued amount, currency, coupon rate, maturity, credit rating, issuance country, and industry sector.

For each issuer a maximum of four green bonds were used (though most did not issue the full four during that timeframe) and up to two conventional bonds.

Stock and index prices were sourced from *Yahoo Finance* and *Investing* websites.

2.2. Data limitations

In this event study, the sample is limited to cover only securities that were issued by public firms, since that company information and stock returns are accessible exclusively to publicly listed companies. However, there are some exceptions where private issuances are made by direct subsidiaries of public companies. In these scenarios, these bonds were incorporated into the analysis, and the stock prices of the parent public company were utilized for the research objectives.

Green Bonds issued by banks or financial institutions were also excluded, as these entities issue such bonds with the intention of using the proceeds for green loans rather than allocating the funds towards their own environmental initiatives.

Finally, the dataset utilized in this study exclusively comprises bonds issued by European companies, aligning with the study's specific focus on the European context.

Regarding the stock prices of each company, it was verified that there existed enough data encompassing the study event period. This ensured the availability of an estimation window of 271 trading days before the announcement date, as specified in this study.

Furthermore, a thorough examination was conducted for all companies to identify any significant events within the ten-day period preceding and succeeding the announcement date. These significant events can be mergers and acquisitions, stock repurchases, lawsuits and changes in top management or credit rating. Additionally, bonds with announcement dates that coincided with market-disrupting events, like market crashes, were deliberately excluded from the study. For instance, the time frame between February and April 2020, characterized by the COVID-19 lockdowns, was excluded from consideration.

If a company happens to announce multiple green bonds on the same day, the study treats them as a single bond, typically selecting the one with the highest value for analysis. Conversely, when a conventional bond coincided with the announcement of a green bond on the same day, the conventional bond was omitted from the study.

Every stock price and market index data are collected in the native currency of the corresponding country, and the calculation of returns for each company and market index is based on simple returns:

$$R_{it} = \left(\frac{P_{t+1}}{P_t}\right) - 1 \tag{2.1}$$

Here, P_t represents the stock price on day t, while $P_{t+1}$is stock price on the subsequent day, t+1.

2.3. Control Variables in Regression Model

To perform the regression analysis, we compiled a set of control variables concerning the resources and financial indicators of the companies issuing the securities. These control variables were then integrated with the key variables directly linked to the securities themselves, such as Coupon and Maturity, which had been previously obtained. This financial information was obtained from the websites *finbox.com* and *macrotrends.net*.

Comparable research has incorporated similar company-specific variables that could potentially influence how the stock market responds to announcements regarding securities (Baulkaran, 2019; Glavas, 2018; Godlewski et al., 2013). Considering this background, three specific variables were chosen for this study: the company's size (measured by total assets), the return on assets, and the debt-to-equity ratio.

The data pertaining to each of these variables was collected from the firm's financial records, specifically at the conclusion of the year just before the bond was issued.

In brief, for every bond, we gathered the following information: issuer's name, announcement and issuance date, currency, issuance amount, coupon rate, and maturity date. And for each issuer, we acquired the following details: the country of origin, industry, credit rating, total assets, return on assets, and debt-to-equity ratio.

2.4. Descriptive Statistics

Following the resolution of data constraints, a dataset was assembled, consisting of 211 bonds. Among these, 141 are classified as green bonds and the remaining 70 are classified as conventional bonds. In this dataset containing 67 different entities, all of them introduced their first-ever green bond issuance. Conversely, only 46 of these entities had conventional bonds included in the sample. The mean issuance size stands at 583 million euros, coupled with an average maturity of 8.9 years.

Table 2.1 provides an overview of the statistical characteristics of the sample. The initial row displays the count of bonds. The subsequent row indicates the mean issued amount, in millions of euros, followed by the average bond maturity in the third row. The fourth row features a binary variable with a value of one denoting a fixed coupon and zero signifying a variable rate. The fifth row presents the mean coupon rate for fixed-rate bonds, and lastly, the sixth row showcases the median credit rating derived from Standard & Poor's ratings.

Table 2.1: Descriptive Statistics of dataset.

	All	Green	Conventional
# Bonds	211	141	70
Amount (in mn€)	583	566	612
Maturity (Years)	8.9	8.8	9.0
Fixed-rate bond (1/0)	0.958	0.943	0.986
Coupon (for fixed rate)	1.60%	1.78%	1.24%
S&P rating (median)	BBB+	BBB+	BBB+

Source: Own Elaboration

The research focuses on the European market, and the ultimate collection of data comprises bonds originating from 16 different countries. Excluding the UK and Norway all the other countries involved in the study are part of the European Union. The majority of the bonds within the sample were issued in either Italy (43), Germany (39), or France (39), representing almost 60% of emissions. The subsequent table provides insight into the quantity of bonds from each country included in the sample, along with the total value of issuances.

Table 2.2: Number of Bonds and Amount Issued by Country present in the sample.

Country	Number	Percentage	Amount (mn€)	Percentage
Austria	2	0.9%	1000	0.8%
Belgium	7	3.3%	1375	1.1%
Denmark	7	3.3%	3700	3.0%
Finland	5	2.4%	1390	1.1%
France	39	18.5%	27800	22.6%
Germany	39	18.5%	26750	21.7%
Greece	1	0.5%	600	0.5%
Italy	43	20.4%	25300	20.6%
Lithuania	1	0.5%	20	0.02%
Netherlands	8	3.8%	4300	3.7%
Norway	5	2.4%	665	0.5%
Poland	1	0.5%	37	0.03%
Portugal	6	2.8%	4700	3.4%
Spain	26	12.3%	17075	13.9%
Sweden	10	4.7%	3000	2.4%
United Kingdom	11	5.2%	5600	4.6%
Total	**211**	**100.0%**	**123062**	**100.0%**

Source: Own elaboration

Regarding the sector of issuers, the Utilities industry takes prominence with 75 bonds within this sample. A significant portion of these issuers within the utilities sector are companies focused on Electric Utilities, particularly in the context of green bond offerings where funds are directed towards the energy sector. The combined sectors of utilities, industrials, and energy account for over 60% of the bonds within this sample.

Table 2.3: Number of Bonds and Amount Issued by Industry present in the sample.

Industry	Number	Percentage	Amount (mn€)	Percentage
Communication Services	8	3.8%	6537	5.3%
Consumer Discretionary	17	8.1%	10650	8.7%
Consumer Staples	11	5.2%	4745	3.9%
Energy	33	15.6%	22475	18.3%
Health Care	3	1.4%	1600	1.3%
Industrials	24	11.4%	13175	10.7%
Information Technology	5	2.4%	3150	2.6%
Materials	14	6.6%	7510	6.1%
Real State	21	10.0%	6270	5.1%
Utilities	75	35.5%	46950	38.2%
Total	**211**	**100.0%**	**123062**	**100.0%**

Source: Own Elaboration

The statistical summaries for the specified variables within the regression model are presented in Table 2.4. Each variable is accompanied by the count of observations, the average, the median, the standard deviation, the minimum and maximum values, as well as metrics of skewness and kurtosis.

Green is a binary variable, taking a value of 1 if the bond is green, and 0 otherwise. *Amount Issued* represents the overall worth of the bond in millions of euros. Natural logarithms of these values will be used in the model. *Fixed Rate* is a dummy variable, taking the value of 1 if the bond has a fixed interest rate and 0 if it has a variable interest rate. *Coupon* is expressed as a percentage, representing the annual interest rate paid on the bond (considering the first coupon for variable rate bonds). *Maturity* is given in years, signifying the total time between bond issuance and the date when the issuer must repay the bond's face value to the bondholder. *S&P Rating* is a ranking from 1 to 22, where higher values correspond to better ratings (e.g., AAA is 22, AA+ is 21, and the lowest, D, is 1). *Firm Size* represents the value of the company's total assets as of the conclusion of the year just before the bond issuance. Natural logarithms of these values will be employed in the model. *ROA* is presented as a percentage, indicating a company's profitability in relation to its total assets, calculated by dividing net income by total assets. *Debt-*

to-equity (D/E) ratio is used to assess a company's financial leverage, calculated by dividing total liabilities by shareholder equity.

Table 2.4: Descriptive statistics of each variable.

This table describes the number of observations, the mean, median, standard deviation, minimum, maximum, skewness, and kurtosis for each variable of the bonds issued present in the sample.

Variable	**N**	**Mean**	**Median**	**St. Dev**	**Min**	**Max**	**Skewness**	**Kurtosis**
Green	211	0.67	1	0.47	0	1	-0.72	-1.49
Amount Issued (mn€)	211	583	500	345	20	2500	1.30	4.66
Fixed Rate	211	0.96	1	0.18	0	1	-5.25	25.81
Coupon	211	1.67%	1.38%	0.01	0.00%	6.85%	1.46	2.52
Maturity	211	8.85	8	7.60	2	60	5.74	36.32
S&P Rating	194	14.68	15 (BBB+)	1.57	7 (B-)	19 (AA-)	-0.76	4.06
Firm Size (bn€)	211	70.58	28.66	108.88	0.1	611.4	2.97	9.98
ROA	211	3.26%	3.01%	0.04	-9.01%	20.50%	0.69	4.84
Debt-to-Equity	211	1.42	1.19	1.40	0.17	12.3	4.73	30.13

Source: Own Elaboration

CHAPTER 3

3. Methodology

In this chapter, we will outline the methodologies that were employed prior to addressing the research query concerning the stock market's response to announcements of green bonds by European companies. First, we will introduce the event study methodology, followed by the significance tests used in the results of the event study. Subsequently, we will provide a detailed explanation of the regression model.

3.1. Event Study

The event study's primary goal is to investigate how the stock market reacts when European public companies announce their issuance of green bonds. It does so by quantifying the abnormal returns observed in connection with these announcements, shedding light on the market's response to such eco-friendly financial initiatives. Event studies analyse atypical changes in stock prices connected to specific events, like corporate decisions such as dividend increases. These studies rely on two central concepts: the efficient market hypothesis, indicating that stock prices already incorporate all public information (Fama, 1970), and the idea that an asset's price reflects the present value of its future cash flows. Hence, event-related price fluctuations can provide valuable information regarding the event's potential influence on future cash flows (El Ghoul et al., 2022)

The first step in conducting an event study involves defining the specific event under investigation and determining the timeframe during which the stock prices of the relevant firms will be analysed. This period under consideration is referred as the event window (MacKinlay, 1997). In this study, we define the event date “0” as the announcement date since it marks the moment when new information is disclosed to the market. In contrast, when it comes to the issuance date, there is no introduction of new information (Flammer, 2021). The event window, in this context, spans a period of five consecutive trading days preceding and following the announcement date. Apart from establishing the event window, it is equally essential to define the estimation window. For this study, the estimation window will encompass a range of [-270, -21], covering a total time of 250 trading days.

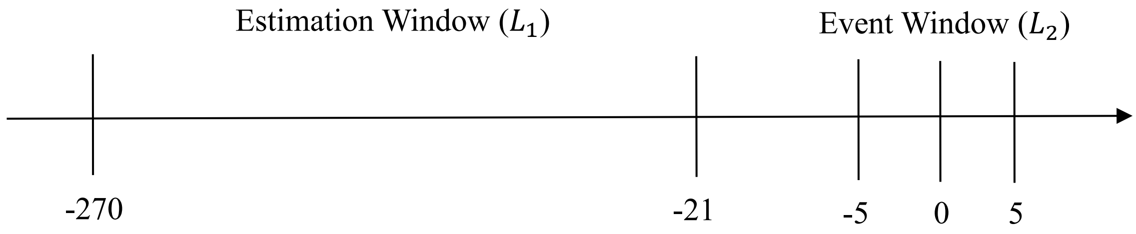

Figure 3.1: Estimation and Event Windows.
Source: Own elaboration

We initiated our analysis by calculating the expected returns through the utilization of the market model. We determined the coefficients α and β through Ordinary Least Squares (OLS) regression, using data from the trading days falling within the estimation window. The following equation expresses de market model.

$$R_{it} = \alpha_i + \beta_i \times R_{mt} + \varepsilon_{it} \tag{3.1}$$

$$E(\varepsilon_{it} = 0) \qquad Var(\varepsilon_{it}) = \sigma^2_{\varepsilon_i}$$

In this context, R_{it} represents the daily return of company *i* stock on day *t*, R_{mt} corresponds to the daily return of the market index in the country where the firm is headquartered. The α_i and β_i are parameters of the market model. The ε_{it} represents the leftover or unexplained portion, known as the residual, with an expected value of zero and variance of $\sigma^2_{\varepsilon_i}$. With every bond announcement, it becomes essential to obtain fresh estimates for $\hat{\alpha}_i$ and $\hat{\beta}_i$. These coefficients are obtained using the market model, which employs an OLS regression approach to get these parameters.

Subsequently, we calculate the estimated daily return of each stock i on day t using the following formula:

$$\hat{R}_{it} = \hat{\alpha}_i + \hat{\beta}_i \times R_{mt} \tag{3.2}$$

Then, we computed the daily abnormal return by taking the realized returns (R_{it}) for each day *t* within the event window and then subtracting the estimated returns ($\hat{R}_{it}$), as illustrated below:

$$AR_{it} = R_{it} - \hat{R}_{it} \tag{3.3}$$

This formula represents how we determine the abnormal return (AR_{it}) for company *i* at time *t*. We apply this calculation for each day *t* in the event window.

According to the null hypothesis, considering the event window market returns, the abnormal returns will collectively follow a normal distribution with a zero conditional mean and a conditional variance $\sigma^2(AR_i)$:

$$\sigma^2(AR_i) = \sigma_{\varepsilon_i}^2 + \frac{1}{L_1}\left[1 + \frac{(R_{m\tau} - \hat{\mu}_m)^2}{\hat{\sigma}_m^2}\right] \tag{3.4}$$

The conditional variance is comprised of two components. One component is the disturbance variance, represented by $\sigma_{\varepsilon_i}^2$ from last equation, and the other component arises from additional variance caused by the sampling error in estimating α_i and β_i. As the length of the estimation window L_1 increases, the second component tends to approach zero as the errors when estimating the parameters diminish (MacKinlay, 1997). In practical terms, the abnormal return's variance is commonly represented as $\sigma_{\varepsilon_i}^2$, since the estimation window is typically large enough that it is reasonable to assume that the second component makes no meaningful contribution to the variance of the abnormal return.

Additionally, to arrive at comprehensive conclusions regarding the event study, it is necessary to aggregate the observations of abnormal returns. Thus, Cumulative Abnormal Returns (CARs) are calculated for the specific event windows chosen in this study. The CAR is obtained by summing the abnormal returns observed during the days of the selected event window, as illustrated by the equation below:

$$CAR_i(T_1, T_2) = \sum_{t=T_1}^{T_2} AR_{it} \tag{3.5}$$

The variance of the CAR is calculated as follows:

$$\sigma_i^2(T_1, T_2) = (T_2 - T_1 + 1)\sigma_{\varepsilon_i}^2 \tag{3.6}$$

The process involves consolidating the average abnormal returns (AAR_t) across the bonds (represented as i) for each time t within the event window. For a sample of N events, the AAR_t is calculated as follows:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \tag{3.7}$$

Its variance is:

$$var(AAR_t) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_{\varepsilon_i}^2 \tag{3.8}$$

Finally, the process involves computing and examining the cumulative average abnormal return (CAAR) for each group of stocks. This CAAR signifies the typical abnormal reaction to the event and provides insight into the combined impact of these abnormal returns (MacKinlay, 1997). Its calculation is demonstrated in the following equation.

$$CAAR(T_1, T_2) = \frac{1}{N}\sum_{i=1}^{N} CAR_i(T_1, T_2) \tag{3.9}$$

Its variance is computed as follows:

$$var\big(CAAR(T_1, T_2)\big) = \sum_{t=T_1}^{T_2} var(AAR_t) \tag{3.10}$$

In the case where the Cumulative Average Abnormal Return (CAAR) during the event window is positive, it indicates that the stock market reacts favourably to the bond announcement. Conversely, if the CAAR is negative, it signifies that the stock market responds negatively to the bond announcement.

We will conduct separate analyses on the sample's green bonds and conventional bonds. Furthermore, an independent analysis will be conducted specifically on the green bonds issued by each company, differentiating between the initial and subsequent green bond issuances. Apart from the main event window of [0, 1], we have incorporated the following time intervals for analysis: [-5, 5], [-3, 3], [-1, 1], [0, 3], [-5, -2] and [2, 5].

To check the robustness of the results, we reran the event study, this time using the STOXX Europe 600 Index, a broader European market index, instead of employing individual country-specific market indices. This index comprises 600 large, medium, and small capitalized companies, across 17 European countries. Furthermore, we compute the median of cumulative abnormal returns (MCAR) and determine the ratio of positive CARs for each sample of bonds.

3.2. Significance tests

Once we've computed the CAAR for the three bond groups across different time intervals, the next step involves conducting three significance tests. In broad terms, significance tests can be categorized as either parametric or nonparametric. Parametric tests operate under the assumption that the abnormal returns of individual firms follow a normal distribution, while nonparametric tests do not depend on any specific distribution assumption. We selected three parametric tests to assess the statistical significance of these findings: the standard T-test, the

Patell's (1976) standardised residual test, and the standardized cross-sectional test proposed by Boehmer, et al. (1991). Both standardized tests are based on the idea that abnormal returns are not correlated at the same time (Kolari & Pynnönen, 2010).

Here are the hypotheses for the significance tests:

H_0: The bond announcement does not influence the stock returns ($CAAR = 0$)

H_1: The bond announcement has an influence on the stock returns ($CAAR \neq 0$)

As per the null hypothesis (H_0), anticipates that CAAR will have a value of zero, whereas the alternative hypothesis (H_1) anticipates CAAR to deviate from zero.

The significance tests are conducted to determine whether the average abnormal returns deviate significantly from zero. One of the underlying assumptions of the t-test is that the sample follows a normal distribution.

The abnormal returns have a variance denoted as $\sigma^2_{\varepsilon_i}$, and as time progresses, the abnormal return observations will become uncorrelated. When considering the null hypothesis, H_0, which suggests that the event has no influence on return behaviour (neither on the mean nor the variance), we can utilize the distributional characteristics of the abnormal returns to make conclusions for any period within the event window (MacKinlay, 1997). Under this null hypothesis (H_0), the distribution of the sample abnormal return for a specific observation within the event window is:

$$AR_{it} \sim N\left(0, \sigma^2(AR_{it})\right)$$

3.2.1. T-test

The traditional t-test calculation is done as follows:

$$t = \frac{CAAR(T_1, T_2)}{\sqrt{var\left(CAAR(T_1, T_2)\right)}} \tag{3.11}$$

3.2.2. Patell Z-test

As Patell (1976) suggests, since the market model incorporates data beyond the event window, abnormal returns encompass forecast errors. Therefore, it is necessary to standardize these abnormal returns. The calculation of Patell Z-Test initiates by standardize each AR_{it}.

$$SAR_{i,t} = \frac{AR_{it}}{S_{AR_{it}}} \tag{3.12}$$

The standardized abnormal returns are determined by dividing the residual during the event period by the standard deviation of the residual during the estimation period, adjusted for the prediction error (Kolari & Pynnönen, 2010):

$$S^2_{AR_{it}} = \sigma^2(AR_i)\left(1 + \frac{1}{M_i} + \frac{\left(R_{m,0} - \bar{R}_m\right)^2}{\sum_{t=-270}^{-21}\left(R_{m,t} - \bar{R}_m\right)^2}\right) \tag{3.13}$$

With:

$$\bar{R}_m = \frac{1}{L_1}\sum_{t=-270}^{t=-21} R_{m,t} \tag{3.14}$$

where $CSAR_i$ denotes the cumulative standardized abnormal return of firm i:

$$CSAR_i(T_1, T_2) = \sum_{t=T_1}^{T_2} SAR_{i,t} \tag{3.15}$$

With variance:

$$S^2_{CSAR_i} = L_2\frac{M_i - 2}{M_i - 4} \tag{3.16}$$

Finally, we compute Z:

$$Z = \frac{1}{\sqrt{N}}\sum_{i=1}^{N}\frac{CSAR_i}{S_{CSAR_i}} \tag{3.17}$$

3.2.3. Standardized Cross-Sectional or BMP Test

The standardized cross-sectional or the Boehmer, Musumeci, and Poulsen (BMP) (1991) test combines elements from the Patell (1976) test and the conventional cross-sectional test, providing greater robustness compared to the traditional method. It incorporates information from both the estimation and event windows, and accounts for event-induced volatility and serial correlation. The test statistics for AAR_t is computed as follows:

$$t = \sqrt{N} \times \frac{ASAR_t}{\sqrt{Var(ASAR_t)}} \tag{3.18}$$

$ASAR_t$ is the average of the standardized abnormal returns at time t and and N number of events. Its variance is calculated as follows:

$$Var(ASAR_t) = \frac{1}{N-1}\sum_{i=1}^{N}\left(SAR_{i,t} - ASAR_t\right)^2 \tag{3.19}$$

The test statistics for $CAAR$ is initiated by calculating the forecast-error-corrected variance:

$$S_{CAR_i}^2 = \sigma_{AR_i}^2 \times \left(L_2 + \frac{L_2}{M_i} + \frac{\sum_{t=T_1}^{T_2} \left(R_{m,t} - \bar{R}_m\right)^2}{\sum_{t=-270}^{-21} \left(R_{m,t} - \bar{R}_m\right)^2} \right) \tag{3.20}$$

Then, we compute the standardized cumulative abnormal return ($SCAR_i$) for event i:

$$SCAR_i = \frac{CAR_i}{S_{CAR_i}} \tag{3.21}$$

Next, we calculate the average standardized cumulative abnormal return ($ASCAR$):

$$ASCAR = \frac{1}{N} \sum_{i=1}^{N} SCAR_i \tag{3.22}$$

And its variance:

$$Var(ASCAR) = \frac{1}{N-1} \sum_{i=1}^{N} (SCAR_i - ASCAR)^2 \tag{3.23}$$

Finally, we calculate t:

$$t = \sqrt{N} \times \frac{ASCAR}{\sqrt{Var(ASCAR)}} \tag{3.24}$$

In the context of this thesis, it's important to mention that all findings with significance levels of 10% or lower will be considered statistically significant. In practical terms, this means that results with t-values equal to or greater than 1.645 will be regarded as statistically significant and play a crucial role in shaping our research's conclusions.

3.3. Regression model

To ensure the event study's reliability, we conducted a regression analysis on the CARs. This analysis aimed to ascertain whether the influence of the green label on stock market returns remains significant even when considering the impact of other variables. We selected the control variables employed in the regression analysis from the existing literature on this topic.

First, certain attributes of bonds can influence how market react and how equity investors perceive a company's overall worth. Previous research (Glavas, 2018; Godlewski et al., 2013) have investigated variables such as maturity, coupon rate, and the size of bond issues in this context. Hence, we incorporated these variables, along with the bond's S&P rating, into our regression analysis. The maturity of a bond is measured in years, coupon rate is expressed as percentage, bond size as the natural logarithm of the amount issued and the bond's rating is rated on a scale ranging from 1 to 22, with 1 representing the lowest rating (D), while a rating of 22 represents the highest rating (AAA) according to the S&P Global Ratings.

Additional control variables are related to the issuer. Firstly, we consider the firm's size, which is determined by taking the natural logarithm of its total assets. Secondly, a control variable is necessary to account for risk-related elements that may impact the response of equity investors. In order to include this, we choose to utilize the debt-to-equity ratio. Thirdly, we introduce a variable that functions as a control for the financial performance of the company. In this case, we have opted for Return on Assets (ROA) as the chosen variable. We implement a time delay to all the firm-specific control variables indicated earlier, using financial data from the fiscal year immediately preceding the day when the bond announcement was made. Specifically, we exclusively utilize full-year accounting data due to its superior reliability.

Finally, considering the diverse array of countries and industries in our sample, we also control for country and industry fixed effects.

Hence, we tested the following OLS regression using an identical model as employed by Godlewski, et al. (2013) and Glavas (2018):

$$CAR_{ij} = \alpha_i + \beta_j \times Green + Controls_{ij} + \varepsilon_j \tag{3.25}$$

where CAR_{ij} is the dependent variable using the main event window [0,1]. $Green$ is a dummy variable that takes the value of one if the bond issued is classified as a green bond, and zero if it is classified as a conventional bond. $Controls_{ij}$ encompasses the comprehensive list of control variables mentioned earlier for firm i on announcement j while $\varepsilon_{ij}$is the error term with an expected value of zero and a variance of $\sigma^2_{\varepsilon_i}$.

The focal point in our regression analysis is the β_j coefficient. A significantly positive or negative coefficient implies that the green label of the bond has a discernible effect on the stock performance. A significant positive (negative) β_j coefficient indicates that equity investors perceive positive (negative) value-related information in the issuance of green bonds. Conversely, if the β_j coefficient is not statistically significant, it indicates that equity investors do not assign any value-related information to the green label of the bond.

Once all control variables were chosen, three distinct regression model were established.

Regression 1:

$$\begin{aligned} CAR_{ij} = \alpha_i + \beta_1 \times Green_i + \beta_2 \times Amount_i + \beta_3 \times Fixed\ Rate_i \\ + \beta_4 \times Coupon_i \ + \beta_5 \times Maturity_i \end{aligned} \tag{3.26}$$

Regression 2:

$$CAR_{ij} = \alpha_i + \beta_1 \times Green_i + \beta_2 \times Amount_i + \beta_3 \times Fixed\ Rate_i + \beta_4 \times Coupon_i + \beta_5 \times Maturity_i + \beta_6 \times Rating_i + \beta_7 \times Firm\ Size_i + \beta_8 \times ROA_i + \beta_9 \times DTE_i \quad (3.27)$$

Regression 3:

$$CAR_{ij} = \alpha_i + \beta_1 \times Green_i + \beta_2 \times Amount_i + \beta_3 \times Fixed\ Rate_i + \beta_4 \times Coupon_i + \beta_5 \times Maturity_i + \beta_6 \times Rating_i + Country\ FE + Industry\ FE \quad (3.28)$$

Additionally, we conducted another regression, removing the *Green* variable from the explanatory variables and adding the variables *First* and *Subsequent*.

$$CAR_{ij} = \alpha_i + \beta_{ij} \times First + \beta_{ij} \times Subsequent + Controls_{ij} + \varepsilon_{ij} \quad (3.29)$$

where $First$ is is a dummy variable equal to one if the green bond issued is the company's inaugural green bond, and zero if otherwise, while the *Subsequent* represents a dummy variable equal to one if it is a green bond but not an inaugural one, and zero otherwise.

In this regression as well, the main element is the coefficient β_{ij}. Its statistical significance, whether positive or negative, points to the influence of the company's first green bond on stock returns. A significant positive (negative) coefficient β_{ij}(of variable *First*) suggests that equity investors view the first green bond issuance as carrying positive (negative) information distinct from subsequent issuances. In contrast, if the coefficient β_{ij} is not statistically significance, it indicates that stock investors do not perceive any differentiating, value-relevant information in the first issuance compared to the subsequent ones.

For every set of bond samples, two OLS regression analyses were conducted. One analysis encompassed all control variables, while the other excluded the S&P Rating and the coupon rate. These variables are excluded because not every bond is assigned a rating, and some of them have a floating rate. By removing these variables, it becomes feasible to encompass a broader range of obligations within the regression analysis.

CHAPTER 4

4. Results

In the upcoming chapter, we present the outcomes of our empirical study. This will commence with a detailed presentation of the event study results, followed by the release of results derived from the multiple regression model, clarifying the main insights of our research.

4.1. Event study results

4.1.1. Green versus Conventional

The event window, as defined, encompasses the temporal span ranging from five days prior to the announcement of the green bond issuance to five days following it. Nevertheless, we also examined shorter event windows. In Table 4.1, we present the CAARs surrounding both green and conventional bond announcements within our sample, examining their effects across different event windows.

The results indicate that, on average, the market valuation of European companies experiences a notable positive impact from green bond announcements. As shown in Table 4.1, this positive CAAR is observed in both the green and conventional bond cases during the [-5,5] event window, however, none of these were statistically significant. The graphic representation in Figure 4.1 illustrates the AARs for the days surrounding the announcements of both green and conventional bonds. Within green bonds, two days exhibit statistically significant AARs and align with the days where positive AARs are detected—specifically, day 0 stands out as statistically significant at a 1% level, along with day 1, statistically significant at a 10% level. As can be seen in Figure 4.1, it is evident that the peak AAR occurs on day 0, which is the day of the green bond announcement. As for the group of conventional bonds, there were no AARs with a statistically significant impact on any of the days.

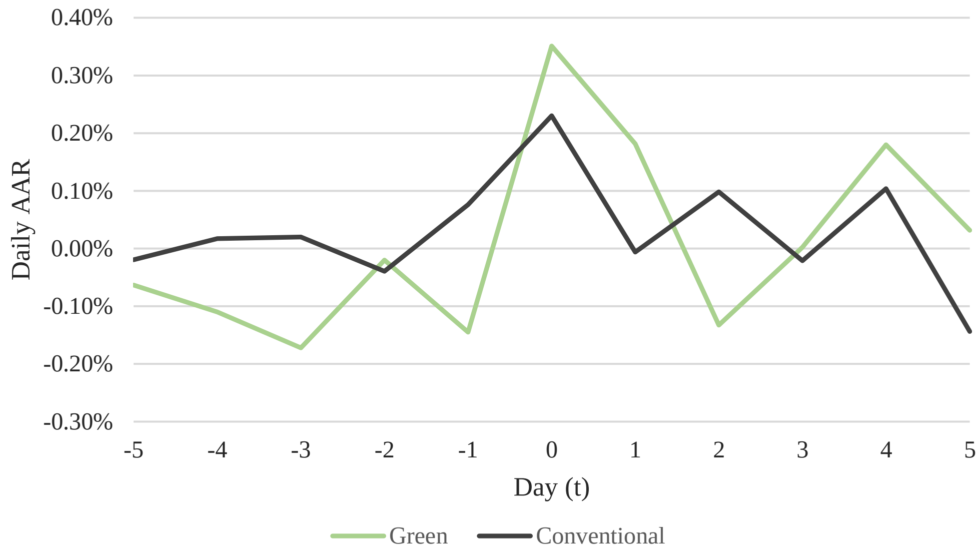

Figure 4.1: Daily AAR for Green and Conventional Bonds from day -5 to day 5.
Source: Own elaboration

Table 4.1: Green and Conventional Bonds results for each Event Window.

Note: This table displays data on 141 green bond announcements and 70 conventional bond announcements covering the period from November 2013 to December 2022. It presents the Cumulative Average Abnormal Returns (CAAR), Median Cumulative Abnormal Return (MCAR), the ratio of positive CARs (number of positive CARs divided by the number of observations), and the CAAR computed using the STOXX Europe 600 Index (CAAR (Europ. I)) across various event windows ([-5,5], [-3,3], [-1,1], [0,0], [0,1], [0,3], [-5, -2], and [2,5]).

	Green					**Conventional**				
EW	N	CAAR (%)	MCAR (%)	Positive ratio	CAAR (Europ. I) (%)	N	CAAR (%)	MCAR (%)	Positive ratio	CAAR (Europ. I) (%)
[-5,5]	141	0.09	0.07	0.50	0.17	70	0.31	0.38	0.54	0.29
[-3,3]	141	0.08	0.15	0.52	0.11	70	0.36	0.44	0.56	0.26
[-1,1]	141	0.39*	0.18	0.52	0.34	70	0.30	0.21	0.53	0.12
[0,0]	141	0.35***	0.41	0.62	0.32**	70	0.23	0.10	0.57	0.20
[0,1]	141	0.54***	0.65	0.60	0.46**	70	0.22	0.14	0.54	0.08
[0,3]	141	0.43	0.35	0.52	0.36	70	0.30	0.01	0.50	0.07
[-5,-2]	141	-0.38	-0.36	0.40	-0.26	70	-0.02	0.04	0.51	0.18
[2,5]	141	0.08	-0.16	0.48	0.08	70	0.04	0.01	0.50	0.00

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.
Source: Own elaboration

When focusing on the subset of green bonds within our sample, it's noteworthy that there is a positive CAAR observed across all the event windows we examined, except for the period [-5, -2]. However, it's important to highlight that statistical significance is only achieved in the event windows of [-1,1], [0,1], and [0,0]. The lack of statistical significance in any of the alternative event windows ([-5, -2] and [2, 5]) suggests that the results are not affected by unrelated factors within the event period. The positive market reaction confirms the notion that green bonds contribute to value enhancement. Within the event window [0,1] encompassing green bond announcements, our analysis reveals a CAAR of 0.54%. Conversely, traditional bonds exhibit a CAAR of 0.22% during the same period. This discrepancy suggests the presence of a green bond premium of 0.32%. The key finding is that, across all statistical tests employed, the CAAR exhibited statistical significance for green bond announcements in the [-1,1], [0,1] and [0,0] event windows. Continuing with Table 4.1, it displays the median values of cumulative abnormal returns (MCAR) for both sets of bonds. The MCAR indicator for green bonds during the event window [0,1] is 0.65%, which is notably higher compared to a much lower value of 0.14% for conventional bonds. Finally, when we look to the results of the event study carried out using only the STOXX Europe 600 index, we observe remarkable similarity and significant findings concerning the CAARs associated with green bonds within the time frames [0,0] and [0,1]. Nevertheless, this level of significance is not apparent in any of the event windows for traditional bonds.

When examining the set of conventional bonds in the sample, it's noted that there is a positive CAAR across all event windows. However, none of these returns exhibit statistical significance at a minimum level of 10%.

The analysis of these findings indicated that announcements regarding the issuance of green bonds generate a favourable response from equity investors. Additionally, the outcomes imply a marginal advantage in terms of stock return reactions upon the issuance of green bonds as opposed to conventional bonds. These initial findings support the perception that green bonds contribute to an increased value proposition.

4.1.2. First versus Subsequent

In this segment, we will showcase and examine how the stock market react to the company's initial green bonds, contrasting it with the market reaction to subsequent green bond announcements.

Table 4.2 reveals that when it comes to new issuers of green bonds, the impact on the market in terms of abnormal returns is quite significant. However, for those issuers who have experience in this field, the effect is far less notable. Specifically, the set of first green bond issuances shows a positive and significant CAARs during certain time frames surrounding the event, such as [-3,3], [-1,1], [0,0], [0,1], and [0,3]. On the other hand, subsequent issuances of these bonds by the same entities do not seem to have much impact on the market, with the CAAR being minimal across all the time frames considered. This finding suggests that the influence of subsequent issuances on the market is significantly diminished. It implies that after the initial bond issue, the market became aware of the company's dedication to environmentally friendly projects. As a result, the subsequent bond issuances may not contain as much new or important information, similar to the market reaction observed in regular bond issuances, which usually do not generate considerable abnormal returns.

The Figure 4.2 displays the AARs during the days before and after the announcements of both initial and subsequent green bond issuances. The graph demonstrates that the initial green bond group consistently displays higher AARs each day within the event window, except for days -5 and 5.

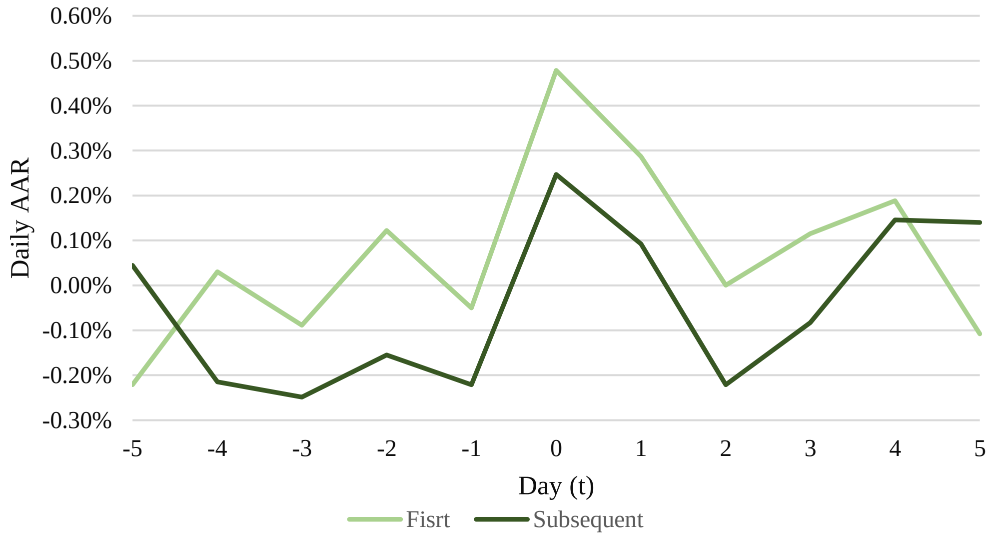

Figure 4.2: Daily AAR for First and Subsequent Green Bonds from day -5 to day 5.
Source: Own elaboration

Table 4.2: First and Subsequent Green Bonds results for each Event Window.

Note: This table displays data on 65 initial green bond announcements and 76 subsequent green bond announcements covering the period from November 2013 to December 2022. It presents the Cumulative Average Abnormal Returns (CAAR), Cumulative Median Abnormal Return (MCAR), the ratio of positive CARs (number of positive CARs divided by the number of observations), and the CAAR computed using the STOXX Europe 600 Index (CAAR (Europ. I)) across various event windows ([-5,5], [-3,3], [-1,1], [0,0], [0,1], [0,3], [-5,-2], and [2,5]).

	First					**Subsequent**				
EW	N	CAAR (%)	MCAR (%)	Positive ratio	CAAR (Europ. I) (%)	N	CAAR (%)	MCAR (%)	Positve ratio	CAAR (Europ. I) (%)
[-5,5]	65	0.75	0.40	0.55	0.70	76	-0.47	-0.40	0.46	-0.29
[-3,3]	65	0.86*	0.82	0.63	0.78	76	-0.59	-0.83	0.42	-0.46

[-1,1]	65	0.71**	0.59	0.62	0.60*	76	0.12	-0.17	0.45	0.12
[0,0]	65	0.48***	0.47	0.69	0.39**	76	0.25	0.11	0.55	0.26
[0,1]	65	0.77***	0.73	0.71	0.65**	76	0.34	0.10	0.51	0.30
[0,3]	65	0.88**	1.04	0.63	0.72*	76	0.04	-0.20	0.43	0.06
[-5,-2]	65	-0.16	-0.32	0.38	0.02	76	-0.57	-0.54	0.42	-0.50
[2,5]	65	0.20	-0.13	0.49	0.07	76	-0.02	-0.27	0.47	0.09

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

Source: Own elaboration

The CAAR during the main event window for the 65 issuers' first green bonds present in the sample stood at 0.77%, signifying an impact at a significance level of 1%. However, within the series of succeeding green bonds, in the same event window, the CAAR was 0.34%, which did not reach statistical significance. Furthermore, during this event window, the MCAR of the firsts green bonds was 0.73%, and 46 out of the 65 initial green bonds (71%) displayed positive CARs. Conversely, in the 76 subsequent green bonds, only 39 (51%) showed positive CARs. Therefore, the findings suggest that subsequent issuances of green bonds do not influence stock returns when they are announced.

The results obtained from the event analysis carried out using the European index corroborate the primary findings of the event study. More precisely, during the periods [0,0] and [0,1], the initial green bonds category, exhibited positive values of 0.39% and 0.65% respectively, both statistically significant at a 5% level. Similarly, in the time intervals [-1,1] and [0,3] the observed values were 0.60% and 0.72% respectively, both statistically significant at 10% level. However, this trend changes in the period [-3,3]. Even though the CAAR remains positive during this period, it fails to reach statistical significance.

These outcomes align with research conclusions suggesting that markets notably respond when a company initially communicates its environmental stance to the market (e.g., Flamer, 2021), in this case, in the moment the first green bond is announced. After the first announcement, it is expected that the market will have become aware of the companies' dedication to environmental initiatives, which subsequently renders the informational content of subsequent issuances similar to that of conventional bond issues.

4.2. Regression results

The purpose of the regression analysis is to comprehend which characteristics at the company level could have an impact on CAR. Hence, a regression is conducted involving multiple explanatory variables. The estimation utilizes an OLS regression model in R Studio, with the

CAR within the main event window [0,1] as the dependent variable. These explanatory variables consist of specific characteristics related to bonds and firms, drawn from earlier literature detailed in chapter 4. Initially, the results of the regression emphasize the *Green* dummy variable, followed by the results of the regression concentrating on the *First* and *Subsequent* dummy variables.

When examining alternative event windows such as [-5, 5], [-3, 3], and [-1, 1] within the three regression models, fewer variables showed significance compared to the [0, 1] event window used as a reference. Nevertheless, the variables that did prove significant in the alternative event windows exhibited identical effects as observed in the studied event window. Additionally, both the R-square and adjusted R-square were lower for the alternative event windows compared to the one utilized in the study.

Table 4.3 displays the outcomes of three regressions. The initial regression (1) encompasses a larger number of observations (211) compared to the remaining regressions, because the variable *Rating* was omitted. As only 194 bonds within the sample possess an assigned rating, the number of observations decreases in regressions (2) and (3). Robust standard errors are applied to all results.

Table 4.3: Regression Results - Green versus Conventional Bonds.

Note: The following outcomes exhibit regressions employing robust standard errors in parentheses. In these models, the Cumulative Abnormal Return (CAR) is the dependent variable. The independent variable (Green) represents a dummy variable set at one for green bond announcements and zero for conventional bond announcements. Control variables are subsequently introduced. In Model 1, the added control variables consist of: Amount, computed as the natural logarithm of the issued amount, Fixed Rate, a dummy variable that equals 1 if the bond has a fixed rate and 0 otherwise, Coupon of the bond issued and Maturity in years. Within Model (2), beyond the control variables featured in Model (1), supplementary variables are incorporated: Rating of the bond, Firm Size, represented as the natural logarithm of total assets, Return on Assets (ROA), calculated as earnings divided by total assets, and Debt-to-Equity (DTE), computed as total liabilities divided by shareholder equity. In Model (3), apart from including the bond rating, industry and country fixed effects are added to the Model (1).

	Dependent variable: CAR [0,1] *OLS*		
	(1)	(2)	(3)
Green	0.005*	0.005*	0.007**
	(0.003)	(0.003)	(0.003)
Amount	-0.001	-0.002	-0.004
	(0.004)	(0.006)	(0.006)
Fixed Rate	-0.015**	-0.013	-0.020
	(0.008)	(0.010)	(0.010)
Coupon	-0.058	-0.032	-0.270*
	(0.114)	(0.136)	(0.146)
Maturity	0.0002	0.0003	0.0003*

	(0.0002)	(0.0002)	(0.0002)
Rating		-0.0001 (0.001)	-0.0001 (0.001)
Firm Size		-0.0004 (0.003)	
ROA		-0.010 (0.041)	
DTE		-0.001 (0.001)	
Constant	0.016 (0.015)	0.021 (0.025)	0.069* (0.034)
Observations	211	194	194
Industry FE	No	No	Yes
Country FE	No	No	Yes
R^2	0.042	0.053	0.205
Adjusted R^2	0.018	0.006	0.064
Residual Std. Error	0.019 (df = 205)	0.019 (df = 184)	0.018 (df = 164)
F Statistic	1.787 (df=5; 205)	1.138 (df = 9; 184)	1.457* (df = 29; 164)
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: R Studio

The primary finding indicates that the variable $Green$ exhibits a positive and statistically significant coefficient in all calculations. The statistical significance is observed at a significance level of 10% for regressions (1) and (2), and at a significance level of 5% for regression (3). Thus, this confirms the notion that there is a significant and favourable market reaction to the announcement of green bonds. The outcomes of these regressions suggest an estimated increase ranging between 0.5% and 0.7% in the CAR due to the green label of the bond. These data corroborate the results of the event study, validating that the green label assigned to bonds has a beneficial effect on the stock market.

In regression (1), one of the control variables, the *Fixed Rate*, demonstrates statistical significance at the 5% level and exhibits a negative effect on the CAR. From model (2), none of the control variables show a significant impact. Additionally, every control variable, except *Maturity*, displays a negative effect on the dependent variable. In model (3), we discovered that both the coupon and maturity variables are statistically significant at a level of 10%. Specifically, the coupon variable demonstrates a negative impact on CAR, whereas maturity exhibits a positive impact.

Table 4.4 displays the outcomes of three regression analyses, which differ from the previous table by including the *First* and *Subsequent* variables and eliminating the variable *Green*.

Table 4.4: Regression Results - First versus Subsequent Green Bonds.

Note: The following results present regressions that employ robust standard errors in parentheses. In these models, the Accumulated Abnormal Return (CAR) is the dependent variable. The independent variable First represents a dummy variable set to one if the green bond issued is the company's inaugural green bond and zero otherwise, while the variable Subsequent represents a dummy variable equal to one if it is a green bond but not an inaugural one, and zero otherwise. Control variables are subsequently introduced. In Model 1, the added control variables consist of: Value, calculated as the natural logarithm of the value issued, Fixed Rate, dummy variable that is equivalent to 1 if the security has a fixed rate and 0 otherwise, Coupon of the security issued and Maturity in years. In Model (2), in addition to the control variables presented in Model (1), complementary variables are incorporated: Security Rating, Company Size, represented as the natural logarithm of total assets, Return on Assets (ROA), calculated as profit divided by total assets, and Debt to Equity (DTE), calculated as total liabilities divided by equity. In Model (3), in addition to including the bond rating, industry and country fixed effects are added to Model (1).

	Dependent variable: CAR [0,1] *OLS*		
	(1)	(2)	(3)
First	0.008**	0.008**	0.009**
	(0.003)	(0.003)	(0.003)
Subsequent	0.003	0.003	0.005
	(0.003)	(0.003)	(0.003)
Amount	-0.003	-0.001	-0.004
	(0.004)	(0.006)	(0.006)
Fixed Rate	-0.014*	-0.011	-0.017
	(0.008)	(0.010)	(0.016)
Coupon	-0.054	-0.024	-0.256*
	(0.114)	(0.135)	(0.146)
Maturity	0.0003	0.0003*	0.0004**
	(0.0002)	(0.0002)	(0.0002)
Rating		-0.00003	-0.001
		(0.001)	(0.001)
Firm Size		-0.0004	
		(0.003)	
ROA		-0.012	
		(0.041)	
DTE		-0.001	
		(0.001)	
Constant	0.014	0.016	0.062*
	(0.015)	(0.025)	(0.034)
Observations	211	194	194
Industry FE	No	No	Yes
Country FE	No	No	Yes
R^2	0.049	0.068	0.211

Adjusted R^2	0.022	0.017	0.066
Residual Std. Error	0.019 (df = 204)	0.019 (df =183)	0.018 (df =163)
F Statistic	1.770 (df =6; 204)	1.325 (df = 10; 183)	1.451* (df = 30; 163)
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: R Studio

Across all three regressions, the variable *First* exhibits a positive impact, at a 5% level of significance. Conversely, the *Subsequent* variable does not demonstrate statistical significance in any of the models, aligning with the event study's conclusions. The event study indicated that solely the initial green bonds possess a positive and statistically significant CAR.

Regarding the control variables, the outcomes closely mirrored those observed in the three preceding regressions. In the first regression, solely the *Fixed Rate* variable exhibited statistical significance, exerting a negative effect on the dependent variable. Within model (2), only the *Maturity* variable, displaying a positive impact at a 10% significance level, stood out as statistically significant. Regression (3) revealed two statistically significant control variables: *Coupon*, demonstrating a negative impact at a 10% significance level, and *Maturity*, exhibiting a positive impact at a 5% significance level.

The significance of the variable labelled *Fixed Rate* arises from the restricted inclusion of variable rate bonds in the sample. The limited availability of this type of bonds could potentially undermine the precision of the estimation. Moreover, most of the variable rate bonds in the sample are issued in a currency other than the Euro and in a country where the circulating currency is not the Euro. This element may have a moderate correlation with the impact on abnormal returns. Regarding the negative impact reported in the third regression regarding the *Coupon* variable, we ascribe it to the higher prevalence of bonds with higher coupon rates issued in 2022. The current year has experienced a significant increase in interest rates, along with a widespread decrease in stock markets. Moreover, a significant proportion of the bonds in our sample that were issued in 2022 can be classified as either subsequent green bonds or conventional bonds.

There could be certain variables that affect both the dependent and independent variables, leading to omitted variable bias. To counteract this, we integrate several control variables, as previously discussed. Additionally, we introduce industry and country fixed effects into the model. These fixed effects enable us to manage unobserved variables that remain constant over time, such as country-specific characteristics. Incorporating these two controls increases the significance of the green label to 5% level even after accounting for these potential biases.

In a classical linear regression model, it is assumed that the residuals follow a normal distribution. Deviation from this normal distribution suggests varying significance of the model across the dependent variable. However, tests conducted on the residuals of each regression show they adhere to normal distribution assumptions (Appendix K).

Another critical assumption in linear regression is homoscedasticity, where residuals exhibit consistent variance across different levels of the predictor variable. The Studentized Breusch-Pagan test was performed on each regression, and in all cases, the null hypothesis was not rejected, indicating the presence of homoscedasticity (Appendix L).

Finally, we utilize generalized variance-inflation factors (Appendix N) and a correlation matrix (Appendix M) to examine multicollinearity. However, there doesn't appear to be any issue of multicollinearity in the regression.

CHAPTER 5

5. Discussion of results

This chapter delves into the discoveries made through the event study and regression analysis. We will compare our findings with those from earlier studies outlined in chapter 1. The scope of our analysis was limited to publicly traded enterprises in Europe. We specifically investigated two assumptions. The main goal of the initial hypothesis was to ascertain whether the announcement of green bond issuance included substantial data that contributes to the generation of market value. The second hypothesis was to evaluate if the initial issuing of green bonds by a corporation has a more significant impact compared to subsequent issuances.

The event study results showed a positive reaction in the stock market both on the day of and the day after the announcement of a green bond issuance. Positive CAAR were recorded in all event windows examined, except for the range [-5, -2], following the announcement of green bonds. Statistically significant results were observed only for the timeframes [-1, 1], [0, 0], and [0, 1], with percentages of 0.39%, 0.35%, and 0.54%, respectively. However, when it comes to traditional bonds, although there's a positive CAAR observed across all analysed event windows, this impact lacks statistical significance in each of these periods. The results indicate a favourable impact on stock prices shortly after the disclosure of green bonds, both on the day of the announcement and on the following day. These findings align with Glavas's (2018) study, which similarly detected a positive CAAR of 0.46% on day 0. The announcement of green bonds leads to a rise in the stock price of the issuing company. This outcome can be seen as validation that the positive impact is directly linked to the announcement itself.

The positive stock market reaction to the issuance of green bonds can be attributed to several factors. Firstly, reputation and perception are improved, that is, companies issuing green bonds are often viewed favourably by investors, as it signals their commitment to environmentally sustainable practices, leading to increased investor confidence and potentially attracting an investor base wider. Secondly, the issuance of green bonds entails allocating funds towards environmentally sustainable initiatives, with the objective of reducing the company's ecological footprint. These endeavours, including energy efficiency, conservation of resources, and sustainable methods, can lead to long-term cost savings. Investors perceive these endeavours as enhancing the company's enduring worth, so elevating its stock price. Another possible cause could be the presence of regulatory and political backing. Certain governments provide incentives or regulatory benefits to corporations that participate in sustainable initiatives, such as issuing green bonds. This support can create a conducive environment for companies to invest in environmentally friendly projects. As a result, it can generate positive market sentiment and contribute to the appreciation of stock prices.

Subsequently, we explore potential distinctions between initial green bond offerings and subsequent ones. Our findings reveal a positive and significant CAAR during various event periods ([-3, 3], [-1, 1], [0, 0], [0, 1], and [0, 3]) following the announcement by first-time issuers. However, when it comes to traditional bonds, the outcomes did not show any statistical significance, and in certain periods, they even displayed negative CAAR values. These results align with prior research (Tang & Zhang, 2020), showing no significant outcomes for subsequent announcements. This suggests that the market gains awareness of a company's dedication to green initiatives primarily after its initial green bond issuance.

During the regression analysis, six models were employed, evaluating the event window [0, 1] as the dependent variable. In the initial set of three models, the explanatory variable *Green* was utilized, while the subsequent trio replaced *Green* with dummy variables *First* and *Subsequent*. Across the first three models, the variable *Green* consistently exhibited a positive and statistically significant coefficient, bolstering the reliability of the event study outcomes. Among the remaining control variables, only three showed notable coefficients—*Fixed Rate* and *Coupon* demonstrated negative effects, while *Maturity* showed a positive effect, each appearing significant only on one occasion.

In the subsequent trio of models, the *First* variable consistently displayed a positive and significant impact, in contrast to the *Subsequent* variable, which despite having a positive coefficient, consistently appeared statistically insignificant. Once again, among the control variables, the same three as in the prior set of models showed a significant influence on the dependent variable. These findings align with the event study, reinforcing the conclusion that only initial green bonds have a noteworthy positive impact on the issuing company's stock price.

Our findings align with earlier research (Flammer, 2021; Glavas, 2018; Tang & Zhang, 2020), indicating that the issuance of green bonds results in net benefits for current shareholders.

Conclusion

Green bonds, a more compelling financial instrument, are continuously growing in both volume and importance. Both companies and investors are progressively seeking out this alternative method of financing or investment as a viable option. This study examines how the European stock market react to the announcement of companies issuing green bonds, which are financial tools aimed at raising funds specifically for projects focused on climate and environmental initiatives. The expected market reaction was forecasted to be positive because of prevailing environmental concerns and the importance that investors attach to them, among other factors. The event study validated this hypothesis, aligning with prior research findings (Flammer, 2021; Glavas, 2018). During specific event periods, there was a positive and statistically significant response observed, particularly on the announcement day (designated as day 0 within the event window). This day exhibited the highest AAR compared to all other event days analysed.

We found that there is a positive and significant impact on stock prices, particularly in the [0, 1] window, when companies issue green bonds for the first time. However, subsequent issuances of green bonds do not seem to affect stock prices. These inaugural green bond offerings are perceived as occasions that enhance value and attractiveness for investors with a focus on environmental activities. The market demonstrates heightened interest in a company's initial announcement of its eco-friendly initiatives, likely because of the potential influence on the company's environmental impact (Cioli et al., 2021).

These findings suggest that the market strongly reacts to a company's debut issuing of green bonds, interpreting it as an indication of the company's commitment to environmental sustainability. Subsequent issuances may not have the same effect, indicating that investors already perceive the company as environmentally friendly after the initial issuance. This results in a positive market reaction largely during the first issue of green bonds.

As an extra method to ensure reliability, we performed a regression analysis while considering various factors that could influence how the stock market responds to bond announcements. The findings from this regression align with those from the event study. Across all regression analyses, the *Green* variable consistently displayed a positive and statistically significant coefficient, as did the *First* variable. Conversely, the *Subsequent* variable did not exhibit statistical significance in any of the regression analyses. This reaffirms that solely the initial issuance of green bonds has a favourable effect on the market.

This research focused solely on the European market and involved studying 67 European public non-financial companies from 16 countries. While this sample doesn't encompass all the European public non-financial companies issuing green bonds over the nearly 10-year period studied, it represents a substantial portion and is considered a highly meaningful sample. As a result, we can infer that there is a noticeable response in the European market to the issuance of green bonds, leading to a positive effect on the stock price of the issuing company, particularly during the firm´s initial green bond offering.

For upcoming studies, we propose expanding the sample size, which is likely to occur as the number of green bond issuances grows in Europe. This expansion would allow for comparative examinations across various European regions (such as Northern and Southern Europe) or different industries (like Energy and Industrial sectors). Furthermore, it would be beneficial to analyse the market impact across various types of bonds included in the GSS+ category.

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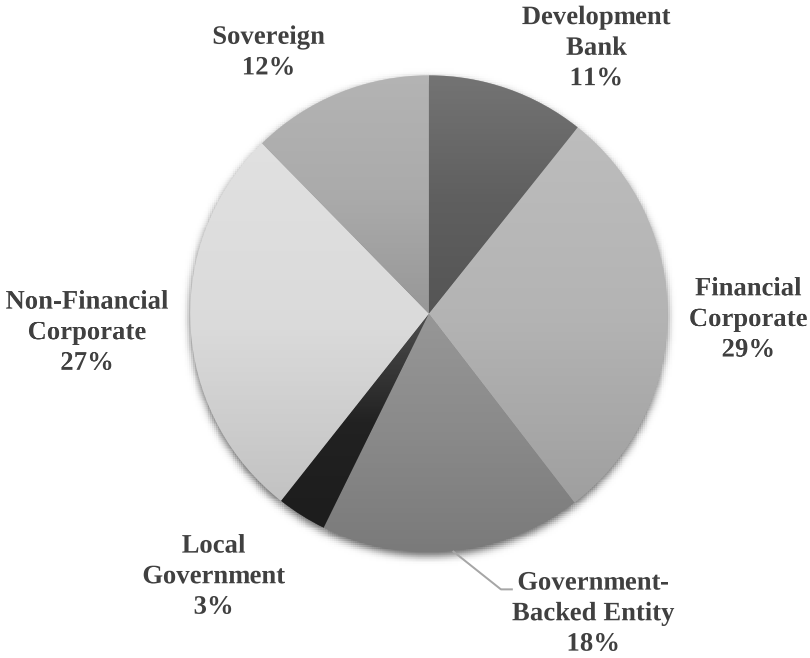
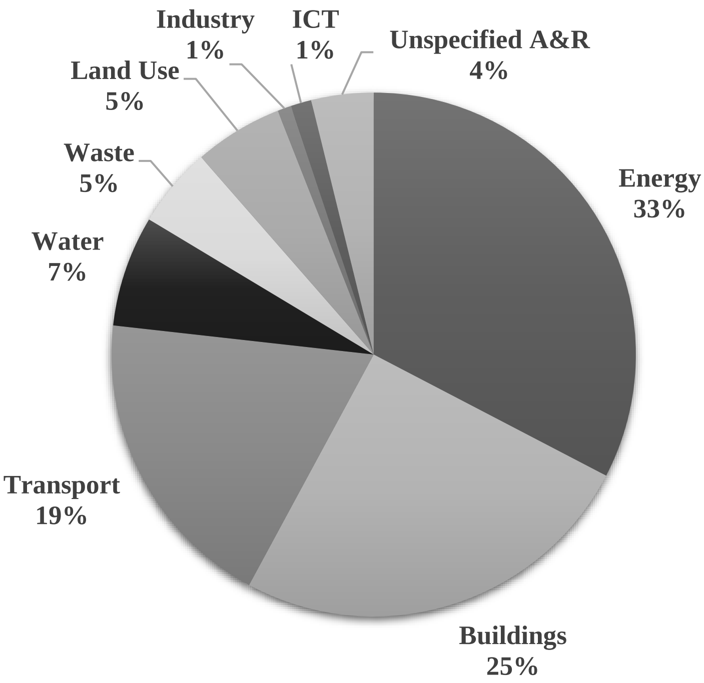
Appendices

Appendix A: Type of Green Bond Issuers until 2022 (% of total amount issued).



Source: CBI (2023)

Appendix B: UoP form Green Bonds issued in 2022 (% of total amount issued).



Source: CBI (2023)

Appendix C: European countries and respective stock market index present in the sample.

Country	Index
Austria	ATX
Belgium	BEL20
Denmark	OMXC20
Finland	OMXH25
France	CAC40
Germany	DAX
Greece	ASE
Italy	FTSE MIB
Lithuania	OMX Vilinius
Netherlands	AEX
Norway	OBX
Poland	WIG30
Portugal	PSI20
Spain	IBEX35
Sweden	OMXS30
United Kingdom	FTSE100

Source: Own elaboration

Appendix D: Issuers, Country, and number of Bond issues in the dataset.

Issuers	Country	Number of Bond issues	Number of Green Bond issues
A. P. Moller-Maersk	Denmark	2	1
A2A SpA	Italy	6	4
Acciona S.A.	Spain	2	2
ACEA SpA	Italy	3	1
Air Liquide S.A.	France	3	1
ALD SA	France	4	2
Alerion Clean Power SpA	Italy	3	3
Arise AB	Sweden	2	2
Arkema SA	France	2	1
ASML Holding NV	Netherlands	2	1
AUGA Group AB	Lithuania	1	1
BASF SE	Germany	4	2
BayWa AG	Germany	1	1
Bonava ab	Sweden	1	1
Carrefour S.A.	France	3	1
Citycon OYJ	Finland	2	2
Cofinimmo SA	Belgium	4	3
Covestro AG	Germany	2	1
Covivio S.A.	France	5	3
CTP N.V.	Netherlands	1	1
Cyfrowy Polsat SA	Poland	1	1
E.ON SE	Germany	6	4
EDP - Energias de Portugal, S.A.	Portugal	6	4
Electricité de France S.A.	France	4	3
Electrolux AB	Sweden	3	2
Ellaktor Value Plc	Greece	1	1
EnBW Energie Baden-Württemberg AG	Germany	5	4
Enel SpA	Italy	5	3
Engie SA	France	6	4
Eni SpA	Italy	2	1
Entra ASA	Norway	3	3
ERG SpA	Italy	3	3
Evonik Industries AG	Germany	3	2
Falck Renewables SpA	Italy	1	1
Getlink SE	France	2	2
Grenergy Renovables	Spain	2	2
Grupo ACS	Spain	2	1
Henkel AG & Co KGaA	Germany	4	3
Hera SpA	Italy	5	3
Iberdrola S.A.	Spain	5	4
Icade S.A.	France	4	2
IMMOBEL SA	Belgium	3	2
Iren SpA	Italy	6	4
Koninklijke Philips N.V.	Netherlands	3	2
Mercedes Benz Group AG	Germany	4	2
MOWI ASA	Norway	2	1
Naturgy Energy Group S.A.	Spain	3	1
Neoen SA	France	1	1
Nordex SE	Germany	1	1
Orsted A/S	Denmark	4	4
PostNL NV	Netherlands	2	1
Red Electrica Corporacion S.A.	Spain	4	2
Renewi PLC	United Kingdom	3	3

Repsol S.A.	Spain	4	2
RWE AG	Germany	4	3
Schneider Electric SE	France	2	1
Snam SpA	Italy	3	2
SSE PLC	United Kingdom	5	4
Stora Enso Oyj	Finland	3	2
Telefonica S.A.	Spain	4	2
Terna SpA	Italy	6	4
Verbund AG	Austria	2	2
Vestas Wind Systems A/S	Denmark	1	1
Vinci SA	France	3	1
Vodafone Group Plc	United Kingdom	3	1
Volkswagen AG	Germany	5	3
Volvo Car Group	Sweden	4	2
Total		**211**	**141**

Source: Own elaboration

Appendix E: Daily AAR from day -10 to +10 (Green versus Conventional).

	Green		Conventional	
Day	**AAR**	**P Value**	**AAR**	**P Value**
-10	-0.01%	0.97	-0.15%	0.34
-9	0.09%	0.51	0.08%	0.60
-8	-0.19%	0.17	-0.01%	0.98
-7	-0.07%	0.62	0.03%	0.85
-6	-0.09%	0.51	0.18%	0.27
-5	-0.08%	0.57	-0.02%	0.90
-4	-0.10%	0.46	0.02%	0.91
-3	-0.18%	0.20	0.02%	0.90
-2	-0.03%	0.84	-0.04%	0.81
-1	-0.14%	0.30	0.08%	0.64
0	**0.35%**	**0.01**	0.23%	0.16
1	0.19%	0.16	-0.01%	0.97
2	-0.12%	0.38	0.10%	0.54
3	0.01%	0.95	-0.02%	0.90
4	0.17%	0.23	0.10%	0.52
5	0.03%	0.85	-0.14%	0.37
6	-0.09%	0.49	0.20%	0.22
7	0.00%	0.97	0.01%	0.93
8	-0.08%	0.54	0.00%	1.00
9	-0.08%	0.57	-0.11%	0.51
10	0.10%	0.45	-0.19%	0.24

Source: Own elaboration

Appendix F: Daily AAR from day -10 to +10 (First versus Subsequent).

	First		Subsequent	
Day	**AAR**	**P Value**	**AAR**	**P Value**
-10	-0.02%	0.90	0.01%	0.96
-9	-0.17%	0.38	0.31%	0.11
-8	-0.04%	0.82	-0.31%	0.11
-7	0.10%	0.62	-0.21%	0.29
-6	-0.06%	0.77	-0.12%	0.54
-5	-0.22%	0.25	0.04%	0.82
-4	0.03%	0.87	-0.21%	0.27
-3	-0.09%	0.64	-0.25%	0.20
-2	0.12%	0.52	-0.15%	0.43
-1	-0.05%	0.79	-0.22%	0.26
0	**0.48%**	**0.01**	0.25%	0.21
1	0.29%	0.14	0.09%	0.64
2	0.00%	1.00	-0.22%	0.26
3	0.11%	0.55	-0.08%	0.67
4	0.19%	0.32	0.15%	0.45
5	-0.11%	0.57	0.14%	0.47
6	-0.04%	0.83	-0.14%	0.47
7	-0.12%	0.54	0.11%	0.57
8	-0.08%	0.69	-0.09%	0.64
9	0.14%	0.47	-0.26%	0.18
10	0.13%	0.50	0.08%	0.67

Source: Own elaboration

Appendix G: CAAR and significance tests of Event Study.

Green							
EW	**N**	**CAAR**	**T-test**	**Patell Z test**	**BMP t-stat**	**MCAR**	**Positive ratio**
[-5,5]	141	0.09%	0.21	-0.20	-0.22	0.07%	0.50
[-3,3]	141	0.08%	0.22	0.01	0.16	0.15%	0.52
[-1,1]	141	**0.39%**	**1.67**	1.59	**1.95**	0.18%	0.52
[0,0]	141	**0.35%**	**2.60**	**2.80**	**3.15**	0.41%	0.62
[0,1]	141	**0.54%**	**2.78**	**2.71**	**2.64**	0.65%	0.60
[0,3]	141	0.43%	1.56	1.28	1.25	0.35%	0.52
[-5,-2]	141	-0.38%	-1.40	-0.77	-1.59	-0.36%	0.40
[2,5]	141	0.08%	0.30	-0.08	0.14	-0.16%	0.48
Conventional							
EW	**N**	**CAAR**	**T-test**	**Patell Z test**	**BMP t-stat**	**MCAR**	**Positive ratio**
[-5,5]	70	0.31%	0.59	0.77	0.71	0.38%	0.54
[-3,3]	70	0.36%	0.84	1.37	1.19	0.44%	0.56
[-1,1]	70	0.30%	1.08	1.34	1.29	0.21%	0.53
[0,0]	70	0.23%	1.43	1.51	1.46	0.10%	0.57
[0,1]	70	0.22%	0.99	1.09	1.17	0.14%	0.54
[0,3]	70	0.30%	0.94	1.20	1.16	0.01%	0.50
[-5,-2]	70	-0.02%	-0.07	0.24	0.06	0.04%	0.51
[2,5]	70	0.04%	0.11	-0.13	-0.18	0.01%	0.50
First							
EW	**N**	**CAAR**	**T-test**	**Patell Z test**	**BMP t-stat**	**MCAR**	**Positive ratio**
[-5,5]	65	0.75%	1.20	0.89	1.07	0.40%	0.55
[-3,3]	65	**0.86%**	**1.72**	1.54	**1.83**	0.82%	0.63
[-1,1]	65	**0.71%**	**2.18**	**2.28**	**2.96**	0.59%	0.62
[0,0]	65	**0.48%**	**2.52**	**2.81**	**4.05**	0.47%	0.69
[0,1]	65	**0.77%**	**2.85**	**2.99**	**3.59**	0.73%	0.71
[0,3]	65	**0.88%**	**2.32**	**2.40**	**2.87**	1.04%	0.63
[-5,-2]	65	-0.16%	-0.41	-0.85	-0.90	-0.32%	0.38
[2,5]	65	0.20%	0.52	0.34	0.53	-0.13%	0.49
Subsequent							
EW	**N**	**CAAR**	**T-test**	**Patell Z test**	**BMP t-stat**	**MCAR**	**Positive ratio**
[-5,5]	76	-0.47%	-0.73	-1.10	-1.10	-0.40%	0.46
[-3,3]	76	-0.59%	-1.15	-1.41	-1.43	-0.83%	0.42
[-1,1]	76	0.12%	0.35	0.06	0.32	-0.17%	0.45
[0,0]	76	0.25%	1.27	1.22	1.19	0.11%	0.55
[0,1]	76	0.34%	1.24	0.93	0.64	0.10%	0.51
[0,3]	76	0.04%	0.09	-0.47	-0.54	-0.20%	0.43
[-5,-2]	76	-0.57%	-1.48	-1.32	-1.31	-0.54%	0.42
[2,5]	76	-0.02%	-0.05	-0.54	0.21	-0.27%	0.47

Source: Own elaboration

Appendix H: CAAR and significance tests for Event Study using the Stoxx Europe 600 Index.

Green							
EW	**N**	**CAAR**	**T-test**	**Patell Z test**	**BMP t-stat**	**MCAR**	**Positive ratio**
[-5,5]	141	0.17%	0.36	0.02	0.02	0.22%	0.52
[-3,3]	141	0.11%	0.29	0.15	0.17	0.07%	0.50
[-1,1]	141	0.34%	1.39	1.28	1.53	0.04%	0.52
[0,0]	141	**0.32%**	**2.25**	**2.31**	**2.55**	0.20%	0.57
[0,1]	141	**0.46%**	**2.30**	**2.18**	**2.46**	0.41%	0.60
[0,3]	141	0.36%	1.28	1.05	1.07	0.22%	0.52
[-5,-2]	141	-0.26%	-0.91	-1.04	-1.08	-0.22%	0.47
[2,5]	141	0.08%	0.29	-0.04	-0.04	-0.06%	0.50

Conventional							
EW	**N**	**CAAR**	**T-test**	**Patell Z test**	**BMP t-stat**	**MCAR**	**Positive ratio**
[-5,5]	70	0.29%	0.53	0.51	0.18	0.29%	0.53
[-3,3]	70	0.26%	0.58	0.85	0.24	0.27%	0.56
[-1,1]	70	0.12%	0.41	0.52	-0.10	0.00%	0.50
[0,0]	70	0.20%	1.18	1.38	1.43	0.01%	0.50
[0,1]	70	0.08%	0.34	0.30	0.13	0.10%	0.51
[0,3]	70	0.07%	0.22	0.20	0.29	-0.11%	0.46
[-5,-2]	70	0.18%	0.52	0.74	0.11	-0.11%	0.50
[2,5]	70	0.00%	0.00	-0.34	0.28	0.10%	0.54

First							
EW	**N**	**CAAR**	**T-test**	**Patell Z test**	**BMP t-stat**	**MCAR**	**Positive ratio**
[-5,5]	65	0.70%	1.06	0.63	0.89	0.38%	0.54
[-3,3]	65	0.78%	1.48	1.17	1.26	0.72%	0.60
[-1,1]	65	**0.60%**	**1.74**	**1.71**	**1.89**	0.41%	0.60
[0,0]	65	**0.39%**	**1.96**	**1.95**	**2.61**	0.35%	0.62
[0,1]	65	**0.65%**	**2.30**	**2.22**	**2.22**	0.54%	0.68
[0,3]	65	**0.72%**	**1.80**	**1.65**	**1.85**	0.62%	0.55
[-5,-2]	65	0.02%	0.06	-0.36	0.04	-0.04%	0.48
[2,5]	65	0.07%	0.19	-0.09	-0.08	0.01%	0.51

Subsequent							
EW	**N**	**CAAR**	**T-test**	**Patell Z-test**	**BMP t-stat**	**MCAR**	**Positive ratio**
[-5,5]	76	-0.29%	-0.44	-0.55	-0.61	-0.11%	0.50
[-3,3]	76	-0.46%	-0.89	-0.88	-1.51	0.96%	0.42
[-1,1]	76	0.12%	0.35	0.16	0.28	-0.17%	0.46
[0,0]	76	0.26%	1.30	1.34	1.31	0.05%	0.53
[0,1]	76	0.30%	1.08	0.92	0.78	0.32%	0.54
[0,3]	76	0.06%	0.15	-0.10	-0.36	-0.14%	0.49
[-5,-2]	76	-0.50%	-1.26	-1.09	-1.29	-0.39%	0.46
[2,5]	76	0.09%	0.23	-0.03	0.22	-0.07%	0.49

Source: Own elaboration

Appendix I: RStudio's outputs of the three regressions (with variable *Green*).

Regression 1:

```
Residuals:
      Min        1Q    Median        3Q       Max 
-0.061217 -0.012213 -0.000198  0.010482  0.056661 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)  0.0163435  0.0147845   1.105   0.2703  
Green        0.0052591  0.0028954   1.816   0.0708 .
Amount      -0.0006066  0.0043310  -0.140   0.8887  
Fixed_Rate  -0.0149102  0.0075320  -1.980   0.0491 *
Coupon      -0.0576178  0.1140169  -0.505   0.6139  
Maturity     0.0002327  0.0001766   1.317   0.1893  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.01929 on 205 degrees of freedom
Multiple R-squared:  0.04177,	Adjusted R-squared:  0.0184 
F-statistic: 1.787 on 5 and 205 DF,  p-value: 0.1168
```

Regression 2:

```
Residuals:
     Min       1Q   Median       3Q      Max 
-0.03796 -0.01326 -0.00014  0.01072  0.05652 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)  2.063e-02  2.483e-02   0.831   0.4073  
Green        5.192e-03  2.904e-03   1.788   0.0755 .
Amount      -1.682e-03  6.013e-03  -0.280   0.7800  
Fixed_Rate  -1.284e-02  9.926e-03  -1.294   0.1973  
Coupon      -3.194e-02  1.355e-01  -0.236   0.8140  
Maturity     2.814e-04  1.730e-04   1.627   0.1055  
Rating      -9.459e-05  1.072e-03  -0.088   0.9298  
Firm_Size   -4.166e-04  3.195e-03  -0.130   0.8964  
ROA         -1.044e-02  4.131e-02  -0.253   0.8008  
DTE         -1.045e-03  9.812e-04  -1.065   0.2881  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.01862 on 184 degrees of freedom
Multiple R-squared:  0.05273,	Adjusted R-squared:  0.006401 
F-statistic: 1.138 on 9 and 184 DF,  p-value: 0.338
```

Regression 3:

```
Residuals:
      Min        1Q    Median        3Q       Max 
-0.042967 -0.011934  0.000000  0.009804  0.049363 

Coefficients:
                            Estimate Std. Error t value Pr(>|t|)  
(Intercept)                0.0688682  0.0338268   2.036   0.0434 *
Green                      0.0066715  0.0028690   2.325   0.0213 *
Amount                    -0.0044884  0.0055948  -0.802   0.4236  
Fixed_Rate                -0.0198899  0.0154357  -1.289   0.1994  
Coupon                    -0.2700192  0.1458063  -1.852   0.0658 .
Maturity                   0.0003427  0.0001789   1.916   0.0571 .
Rating                    -0.0013640  0.0011834  -1.153   0.2507  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.01807 on 164 degrees of freedom
Multiple R-squared:  0.2049,    Adjusted R-squared:  0.06428 
F-statistic: 1.457 on 29 and 164 DF,  p-value: 0.07474
```

Appendix J: RStudio's outputs of the three regressions (with variable *First* and *Subsequent*).

Regression 1:

```
Residuals:
      Min        1Q    Median        3Q       Max 
-0.063296 -0.012367 -0.000566  0.010367  0.054344 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)  0.0140028  0.0148727   0.942   0.3476  
First        0.0075764  0.0034060   2.224   0.0272 *
Subs         0.0033207  0.0032599   1.019   0.3096  
Amount      -0.0003265  0.0043295  -0.075   0.9400  
Fixed_Rate  -0.0135591  0.0075930  -1.786   0.0756 .
Coupon      -0.0537646  0.1138746  -0.472   0.6373  
Maturity     0.0002540  0.0001771   1.434   0.1531  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.01925 on 204 degrees of freedom
Multiple R-squared:  0.04949,	Adjusted R-squared:  0.02153 
F-statistic:  1.77 on 6 and 204 DF,  p-value: 0.1068
```

Regression 2:

```
Residuals:
      Min        1Q    Median        3Q       Max 
-0.037737 -0.011973 -0.001145  0.010666  0.053023 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)  1.605e-02  2.485e-02   0.646   0.5191  
First        8.438e-03  3.461e-03   2.438   0.0157 *
Subs         2.692e-03  3.240e-03   0.831   0.4072  
Amount      -1.133e-03  5.991e-03  -0.189   0.8502  
Fixed_Rate  -1.116e-02  9.924e-03  -1.124   0.2624  
Coupon      -2.388e-02  1.349e-01  -0.177   0.8597  
Maturity     3.081e-04  1.728e-04   1.783   0.0762 .
Rating      -2.967e-05  1.068e-03  -0.028   0.9779  
Firm_Size   -3.831e-04  3.179e-03  -0.121   0.9042  
ROA         -1.224e-02  4.112e-02  -0.298   0.7663  
DTE         -1.009e-03  9.764e-04  -1.034   0.3026  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.01852 on 183 degrees of freedom
Multiple R-squared:  0.06753,	Adjusted R-squared:  0.01657 
F-statistic: 1.325 on 10 and 183 DF,  p-value: 0.2197
```

Regression 3:

```
Residuals:
     Min       1Q   Median       3Q      Max
-0.04082 -0.01128  0.00000  0.01012  0.04728

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)
(Intercept)               0.0624717  0.0342951   1.822   0.0704 .
First                     0.0086536  0.0033811   2.559   0.0114 *
Subs                      0.0048482  0.0033073   1.466   0.1446
Amount                   -0.0039845  0.0056095  -0.710   0.4785
Fixed_Rate               -0.0171783  0.0156189  -1.100   0.2730
Coupon                   -0.2564623  0.1462220  -1.754   0.0813 .
Maturity                  0.0003585  0.0001793   1.999   0.0472 *
Rating                   -0.0013133  0.0011835  -1.110   0.2688
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.01805 on 163 degrees of freedom
Multiple R-squared:  0.2108,    Adjusted R-squared:  0.06555
F-statistic: 1.451 on 30 and 163 DF,  p-value: 0.07463
```

Appendix K: Normality tests for the three regressions.

Normality tests		
Regression 1		
Test	**Statistic**	**p-value**
Shapiro-Wilk	0.9898	0.1412
Kolmogorov-Smirnov	0.055	0.5453
Anderson-Darling	0.5812	0.129
Regression 2		
Test	**Statistic**	**p-value**
Shapiro-Wilk	0.9871	0.0755
Kolmogorov-Smirnov	0.0474	0.7757
Anderson-Darling	0.4108	0.339
Regression 3		
Test	**Statistic**	**p-value**
Shapiro-Wilk	0.9954	0.8164
Kolmogorov-Smirnov	0.0384	0.9369
Anderson-Darling	0.2489	0.7451

Source: R Studio

The Shapiro-Wilk Test, the Kolmogorov-Smirnov test, and the Anderson-Darling test are used to determine whether a sample data come from a normal distribution. In each of these tests, the null hypothesis assumes that the sample is derived from a normal distribution, while the alternative hypothesis suggests otherwise. If the calculated p-value is greater than 0.05, we do not have enough evidence to reject the null hypothesis, suggesting that the data is likely to follow a normal distribution. For all the tests conducted in association for each regression, the null hypothesis was not rejected. Hence, it can be reasonably inferred that the values conform to a normal distribution.

Appendix L: Heteroscedasticity test – Breusch-Pagan test – for the three regressions.

Breusch-Pagan test			
Regression	**BP**	**df**	**p-value**
1	4.5973	5	0.467
2	6.0862	9	0.7313
3	37.862	29	0.1254

Source: R Studio

The Breusch-Pagan test serves to identify the presence of heteroscedasticity within a regression model. This test operates on the premise that the null hypothesis entails homoscedasticity, meaning that the residuals have equal variance. Conversely, the alternative hypothesis posits the presence of heteroscedasticity, indicating that the residuals have uneven variance. If the p-value derived from the test is less than 0.05, we can reject the null hypothesis, which suggests that there is heteroscedasticity in the regression model. In this scenario, none of the three regressions yielded a p-value below 0.05. Consequently, it is inferred that the residuals exhibit equal variance at every level of the predictor variable, confirming the presence of homoscedasticity.

Appendix M: Correlation matrix of explanatory variables.

	1	2	3	4	5	6	7	8	9
1. Green	1								
2. Amount	0.007	1							
3. Maturity	0.024	0.035	1						
4. Fixed Rate	-0.107	0.003	0.064	1					
5. Coupon	0.191	-0.145	0.008	-0.191	1				
6. Rating	-0.111	0.208	0.070	0.109	-0.443	1			
7. Firm Size	-0.125	0.547	0.085	0.216	-0.186	0.427	1		
8. ROA	0.087	-0.201	-0.057	-0.064	0.024	0.078	-0.276	1	
9. DTE	-0.094	-0.026	-0.085	0.040	-0.059	-0.149	-0.130	-0.138	1

Source: R Studio

A correlation matrix is a statistical tool employed to assess the correlation between two variables within a dataset. Within this matrix, a value of -1 indicates a perfect negative correlation, a +1 represents a perfect positive correlation, and a 0 signifies no correlation between the variables. In the present analysis, all the displayed numbers are reasonably close to zero. The most notable association is seen between the *Firm Size* and *Amount* variables. This association is readily understandable as larger companies tend to issue bonds with higher amounts, hence establishing a natural and evident link between these variables.

Appendix N: Multicollinearity test for explanatory variables.

Explanatory variable	VIF
Green	1.075
Amount	1.494
Fixed Rate	1.114
Coupon	1.345
Maturity	1.023
Rating	1.588
Firm Size	1.974
ROA	1.184
DTE	1.095

Source: R Studio

In order to identify multicollinearity within the regression analysis, we computed the variance inflation factor (VIF) for each individual independent variable. All the obtained VIF values were below 2, indicating the absence of multicollinearity among these variables.