How do stocks react to the announcement of green bond issuances?

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Dissertation written under the supervision of professor Zoë Venter

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My thesis explores the impact of the announcement of green bond issuances on stock prices in Europe. The study is structured around two main research questions. First, I investigate the influence of the announcements of corporate green bond issuances on stock market movements compared to traditional bonds, and second, I identify firm and bond characteristics that affect the market response. The empirical analysis employs an event study, multivariate linear regression and difference-in-differences analysis. Results indicate a positive and significant cumulative abnormal return of 0.179% over a 21-day event window around the green bond announcements, conversely with a negative return of 0.391% for traditional bond announcements over an 11-day event window. I identify a positive significant relationship between the green characteristic of a bond and its cumulative abnormal return over a 21-day event window in a multivariate linear regression. In conducting a difference-in-difference analysis, I find no evidence of a positive relationship between CAR and green characteristic. Overall, my results suggest that investors value firms' commitment to green investments.

Keywords: Green finance; Green bonds; Corporate social responsibility; Event study; Abnormal return

Como as ações reagem ao anúncio de emissões de títulos verdes?

Ádám György Orémusz

A presente tese explora o impacto do anúncio de emissões de obrigações verdes nos preços das ações na Europa. O estudo encontra-se estruturado em torno de duas questões principais. Primeiro, estuda a influência dos anúncios de emissões de obrigações verdes nos movimentos do mercado de ações, em comparação com os de obrigações tradicionais. De seguida, identifica as características das empresas e obrigações que afetam a resposta do mercado. A metodologia utilizada na análise empírica recorre ao estudo de eventos, a uma regressão linear múltipla, e à análise de diferença-das-diferenças. Os resultados indicam um retorno anormal cumulativo (CAR) positivo e significativo de 0,179% ao longo de uma janela de evento de 21 dias em torno dos anúncios de emissão de obrigações verdes, contrastando um retorno negativo de 0,391% para os anúncios de obrigações tradicionais ao longo de uma janela de 11 dias. Utilizando uma regressão linear múltipla, identifico uma relação positiva e significativa entre a característica "verde" de obrigações e o seu CAR. Ao realizar uma análise de diferença-das-diferenças, não foram encontradas evidências de uma relação positiva entre o retorno anormal cumulativo e a característica "verde". No geral, os meus resultados sugerem que os investidores valorizam o compromisso das empresas com investimentos sustentáveis.

Palavras-chave: Finanças verdes; Títulos verdes; Responsabilidade social corporativa; Estudo de eventos; Retorno anormal

Table of contents

1. Introduction

Today's modern societies are striving for continuous economic growth and the maintenance of prosperity. However, achieving these goals is accompanied with one of the most pressing problems of our time: environmental pollution along with the overuse and over-exploitation of natural resources. Hove and Tursoy (2019) argued that the economic Kuznets curve supports this connection, and suggests that in societies where economic growth appears to be in its early stages, the expansion of production and the increase in wealth will lead to major environmental problems. In subsequent stages, once a given level of income is exceeded, the negative impact on the environment is mitigated as always present causing serious issues. It would be essential to achieve sustainability and environmental protection, alongside the growth of production and wealth.

The financial sector, including green finance, has an important role to play in climate and sustainability efforts. Green finance is an expanding financial segment supporting the achievement of environmental goals, as evidenced by the growing demand for green financial instruments. Green financial instruments are a tangible sign of environmental protection, as their profound purpose is to finance projects aimed to pose a positive environmental impact. Green bonds have paved the way for the creation and development of many other green financial products as a result of which the market for financial instruments to tackle global environmental challenges has been steadily broadening on an international level.

The objective of this paper is to provide an overview of the green bond market and to give an outline of the incentives for companies to issue green bonds. I intend to explore the motivating factors that drive the gradual development of the green bond market, including a new potential incentive, the rise in share prices.

The content of the paper is structured around answering two main research questions in this context. First, I apply an event study to examine the potential impact of announcements of corporate green bond issues on the stock market across issuances in Europe. Then, using multivariate linear regression and a difference in differences analysis, my purpose is to investigate which firm and bond characteristics influence the market response in terms of changes in stock prices.

The essay is structured as follows. Subsequent to the introduction, the second chapter presents the relationship between climate change and the economy in general. In addition to international organisations, the economic participants involved in climate change are also

discussed with special attention to the most relevant companies in the field. In the third chapter the green bond market and the projects that can be financed through green bonds and international green bond standards are detailed. In chapter four, a summary of previous research on the topic is provided, mentioning complementary papers as well. In the fifth chapter, the methodology of the event analysis is presented, with all the essential parts of the calculations described, then the two hypothesises to be tested are defined. In chapter six, the steps of acquiring all the necessary data required to conduct my research and a summary statistic are provided. Chapter seven includes the results for the event analysis, while chapter eight stands for the methodology and the result of the regression analysis. In the ninth chapter, the summary of the research can be found with all the results and a potential further development is proposed regarding relevant studies in the future.

2. Climate change and the economy

The problems caused by climate change have an impact not only on the environment, but on the global economy as well. As a result, there has been an increasing need for properly coordinated actions by all participants of the global economy to create a sustainable world. To set up the remaining sections of the study, now the relationship between climate change and the world economy is introduced.

Since the late 20th century, addressing climate change has been acknowledged as a critical global challenge. The 169 signatory countries of the Kyoto Protocol, which was started in 1992 and went into effect in 2005, represented an early effort to reduce greenhouse gas emissions. With 195 signatories, the Paris Climate Agreement came into force in 2016 with the goal of keeping the rise in global temperatures in between 1.5 and 2°C. Furthermore, beginning in 2023, member states are to schedule thorough evaluations every five year to monitor development (European Council, 2016). What is more, there is a legal commitment provided by the EU to reach climate neutrality by 2050 and a 55% reduction in greenhouse gas emissions by 2030 in its member states.

Doubtless to say, that financial institutions are essential participants to achieve climate protection and sustainability objectives. Not only is significant investment needed from both the EU and the public, the private sector is also considered to be indispensable to realise a climate-neutral economy by 2050. The European Parliament (2021) argued that an additional investment of €260 billion per year would be required to reduce EU greenhouse gas emissions by 40% by 2030. The targets can be reached through a framework – designed by the European

Commission in 2020 – that encourages public and private investment in the transition to a climate-neutral economy.

Economic participants, including financial institutions and central banks, play a crucial role in maintaining economic equilibrium amid climate change risks. The identified climate risks can be categorized as follows. Firstly, not only should physical risks, such as extreme weather conditions be taken into consideration when it comes to impacting the economy, but transition risks, reflecting the challenges and costs associated with shifting to a sustainable economy and liability-linked risks with economic operators seeking to transfer losses to insurance companies are also to be taken into account. According to Dikau and Volz (2018), addressing these risks is an imperative for ensuring financial stability, with the excerpt underscoring the urgency of adapting to a sustainable economy, complying with environmental regulations, whilst preparing for potential economic consequences arising from climate-related events.

It is also essential to draw attention to the companies among the economic participants that are essential to this research. Environmental, Social, and Governance (ESG) principles build upon the foundation of Corporate Social Responsibility (CSR) and aim to redefine long-term societal challenges. ESG was introduced to enhance the tracking and comparison of companies' CSR performance by broadening and standardizing measurement criteria.

The United Nations Environment Program Financial Initiative (UNEP FI) has advocated for ESG integration in financial institutions' decision-making processes since 1992. Over time, ESG has gained prominence as a metric for assessing the sustainable growth of businesses. Notably, the European Commission in March 2018 revealed plans to enhance ESG transparency in benchmark techniques and propose low-carbon benchmark guidelines for the EU. ESG is being increasingly recognized globally, especially in Europe and America, as an efficient decision-making tool for investors. It offers an insight into opportunities and risks related to the environment, society, and governance as well. By incorporating ESG factors into their decision-making, investors can achieve sustainable returns comparable to traditional investment strategies. These strategies greatly help shield investors from short-term market volatility while ensuring long-term success. Incorporating ESG disclosure brings multiple benefits to corporations, including lower information asymmetry costs, improved corporate image, and enhanced relationships with stakeholders.

3. Green bonds

The financial sector has a major role to play in tackling climate change. Green financial instruments, including green bonds, are becoming a valuable instrument in the transition to a sustainable economy. In this chapter, I describe green bonds with high potential, their issuer standards, the uses to which they can be put, and the types of issuers relevant to this thesis. I also describe the possible incentives and incentives for issuing green bonds.

3.1. What are green bonds?

Green bonds are a specific type of fixed-income financial instrument that differ from their conventional counterparts in a way that the use of the funds is earmarked. The funds can only be used to finance or refinance green activities that contribute to the environmental goals, climate change and sustainability objectives. These objectives can be considered as activities adopted in accordance with international standards and their criteria. The earmarking of resources requires transparent documentation, with the projects to be financed being presented and recorded in advance. Transparent documentation and compliance with the criteria are facilitated by the three green bond Schemes established by international organisations and the European Union:

The Green Bond Principles (GBP) established by the International Capital Market Association (ICMA) in 2014 serve as a guide for green bond issuers, emphasizing transparency and information availability for investors. The four main components of the GBP include defining green project categories, outlining the decision-making process and criteria, describing the use and management of funds upon bond issuance, and mandating ex-post reporting on environmental impact. Independent external certifiers review bond issues to verify compliance with these criteria.

The Climate Bonds Standard (CBS), developed by the Climate Bonds Initiative (CBI), is a more limited set of principles compared to GBP. While green bonds under CBS are also considered compliant with GBP, the reverse is not necessarily true. CBS criteria encompass defining project categories, specifying fund use and allocation, requiring reporting and third-party certification, and employing a certification process for the green label based on specific criteria. Additionally, projects must align with categories defined by a scientific framework.

The European Union's Green Bond Standard (GBS), outlined in 2019 with formal adoption pending, introduces more stringent criteria compared to ICMA's GBP and CBS.

Similarly, GBS emphasizes defining green objectives, project categories, selection processes, resource management, and environmental impact reporting. Notably, independent certifiers must be registered or accredited, and the criteria for green projects and sustainability activities are more rigorously defined.

3.2. Green bond market

Published in 2007, the European Investment Bank (EIB) issued the first green bond, named "climate awareness bond." In addition to increasing in total issue amount, the global green bond market has experienced growth on a geographical basis. From 2010 onwards, a succession of issuers included corporates, municipalities, and banks, but the big boom came in 2014 – the publication of GBP. The range of issuers widened fully in 2016, when sovereigns entered the market. After the Paris Climate Agreement, green bonds as a financial instrument became an increasingly attractive option for governments. Poland became the first country to issue a green sovereign bond in 2016, a green mortgage-backed security (MBS) valued at $24.9 billion USD, which was released by the US government agency Fannie Mae in 2017. The first green Islamic bond in history, known as a "green Sukuk," was introduced by Malaysia in 2017 to support climate-aware development. The types of issuers are noticeably expanding meaningfully, including supranational organizations, development banks, commercial banks, non-bank financial institutions and corporations.

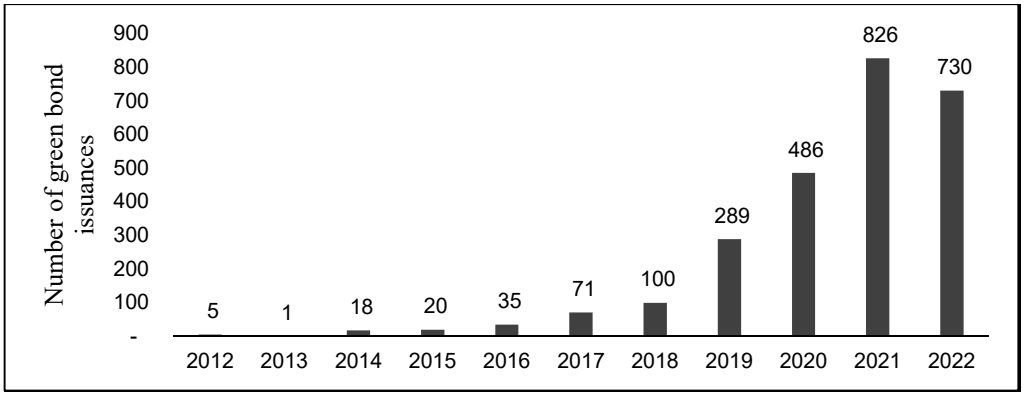

Figure 1: Green bond issuances in Europe (2010-2022). Source: Refinitiv Eikon data.

The steadily increasing trend in annual issuances also shows a positive outlook for the future. Green bond issuances increase the chances of achieving the sustainability goals and companies themselves can further improve their environmental performance. The issuer base has broadened and more diverse base of issuers, including countries, has entered the green bond market.

3.3. Factors and incentives driving issuances

Seeing the dynamic development of the green bond market, it is reasonable to ask why it is worth for companies, banks, municipalities, sovereigns and other financial institutions to issue this financial instrument and also why the growing trend has been going on for years. In this section, my aim is to describe the motivating factors that orient economic agents towards issuance.

Mitigating climate change is considered a global challenge, and the financial sector plays a crucial role in addressing it by influencing investments and managing climate change risks. Green bonds are identified as a potential instrument in this long-term progress, earmarked exclusively for projects contributing to environmental protection, sustainability, and climate change adaptation. Transparency and adherence to international standards in project presentation tend to highly motivate issuers to fund greener projects. Overall, green bonds are seen as contributors to moderating the negative impacts of climate change.

Beyond their environmental influence, green bonds tend to serve as reputational objectives for issuers. Enhanced reputation and market signalling are identified as key drivers for issuing green bonds. Harrison et al. (2020), in a study made for Climate Bonds Initiative, highlighted that reputation enhancement and signalling are major motivations for economic participants issuing green bonds as such instruments are highly likely to make issuers grow more attractive on the international platform thus potentially leading to a reputation boost.

Furthermore, diversification of the investor base is found to be another advantage of green bonds. A well-diversified investor base contributes to market stability and reduces liquidity risk. Investors are attracted to green bonds due to their transparency and alignment with environmental goals. Harrison et al. (2020) indicated that 98% of respondents (issuers) agreed that green bond issuances attracted new investors.

Financial benefits, including the possibility of a green premium, add to the allure of green bonds. The green premium, a negative yield differential, reflects investors' willingness to accept slightly lower returns for environmentally committed investments. While research on the consistent existence of the green premium yields mixed results, it remains a potential financial advantage. Additionally, corporate green bond issuance can positively impact stock prices, especially for companies entering the green bond market.

In conclusion, the benefits of green bonds, encompassing environmental impact, reputation enhancement, investor diversification, and potential financial advantages, contribute

to the dynamic growth of the green bond market amid the pressing global issues of climate change and sustainability.

4. Previous research on the effect of green bonds effect on stock market

In recent years, the existing literature on green bonds has focused mainly on the evidence of the presence of a green premium and on the extent of the green premium. The impact of corporate green bond issuances on stock prices has been analysed by relatively few researchers. In the following, I present the results of these analyses.

Glavas (2018) studied the impact of green bond issuance on stock prices. He proposed two hypotheses: green bonds convey additional information and corporate stock returns respond positively to the announcement of green bond issues. His second hypothesis was that these corporate stock return reactions to announcements were stronger after 2015, as a consequence of the adoption of the Paris Agreement. Both hypotheses were supported by the results of the research. Also using the event analysis methodology, a total of 780 corporate bonds were examined, of which 302 were green and 478 were conventional corporate instruments. The financial instruments originated from 22 countries, with the largest proportion coming from the United States, China and Japan. The data set used in the analysis covered issues between January 2013 and August 2018. The cumulative average abnormal return for green bonds was 0.46% on the date of announcement of bond issues, compared to 0.14% on the date of announcement of conventional bond issues. This resulted in a premium of 0.32% for green bonds.

Baulkaran's (2019) research, published a year later, also contributed to the topic. In this analysis, the author used a similar methodology to the previous one to examine the movements in corporate stock returns at the announcement of corporate green bond issues. The sample observed included 54 companies, mostly based in Europe that issued green corporate bonds. The cumulative average abnormal return on the date of announcement of the issue was -0.17%. The author attributed this low level to the fact that information may have leaked to the market before the announcement date. Therefore, he not only performed the analysis with an event window of [0, 0] on the day of the announcement, but also examined a longer period. When looking at the [-10, 10] interval, the cumulative abnormal return was 1.48%, while the longer [-10, 20] event window yielded a value of 1.46%. In both cases, positive and significant abnormal returns, supporting the fact that shareholders are responding positively to the announcement of the green bond issue.

Zhou and Cui (2019) analysed green bonds issued by Chinese companies. They examined issues between 2016 and 2019 for a total of 80 corporate green bonds. The research was conducted across multiple event windows and no significant results were found for either negative or positive cumulative abnormal returns. Also, an event analysis was conducted on China's green bond market in a study by Wang et al. (2020). They found significant positive stock market responses for corporate green bond issues between January 2016 and June 2019 when examining three event windows.

Tang and Zhang (2020) analysed on the impact of corporate green bond announcements on stock returns. The data set examined included companies from 28 countries. The focus of the research was on green bonds issued between 2007 and 2017, with 132 different companies coming to market with their issues. Using an event analysis methodology, the movements of stock returns around the announcement date of the issues were examined over an event window of 21 days around the announcement date. A cumulative average abnormal return increase (CAAR) of 1.4% was found over the 21-day period. This positive market reaction provides information from a statistical as well as an economic perspective. By increasing stock returns, the firm value increases in the short term. The analysis is based on the assumption that, overall, stock prices are moving upwards and reacting positively to the announcements of green bond issues. As previously Grullon et al. (2004) proved that a firm's visibility matters to stock market investors, thus when a green bond issuer publishes a formal press release announcing that they have successfully classified their bond as a green bond, it sends a positive signal to the market. As a result, the expected market reaction is better for green bonds than for traditional bonds. In other words, labeling a product as "green" means that a third party has validated the company's internal sustainable strategies and green projects, and this label effect has a significant role when firms issue green bonds. This response was stronger and showed a higher increase in returns for companies where the first green bond issuance took place. In addition, not only the cumulative returns but also the number of Google searches increased around the announcement date for the dataset studied, which is sufficient evidence that the market is monitoring and attaching great importance to the development of the green bond market for companies.

Flammer (2021) examined 384 corporate green bonds using an event analysis methodology similar to the previous ones. Her main event window covered the period [-5, 10], where she obtained a cumulative abnormal return of 0.49%. She also performed the analysis for different periods before and after the announcement date of the green bond issue: [-10,-6] and [-20,-10] defined periods before the event, and [11, 20] and [21, 60] periods after the event. In all four cases, negative cumulative abnormal returns were obtained, leading to the conclusion

that there were no other influencing factors that would have shifted stock returns around the announcement date. The research showed that the market reacted positively to the companies' issuances. She found that when a firm issued its first green bond or when a financial instrument was certified by an independent third party, thus the green signal was given, there was a greater positive market reaction and consequently bigger abnormal returns. According to Lyon and Montgomery (2015), signaling theory provides an interpretation for the issue of corporate green bonds as investors frequently lack the knowledge necessary to assess a company's environmental commitment.

Flakkenberg and Baheerathan (2021) conducted their analysis on a dataset of corporate green bonds from the United States and Japan. They used an event study to explore the relationship between stock price movements and announcements of corporate green bond issues. They included 36 US and 31 Japanese corporate green bond announcements in their analysis, with announcements occurring between January 2013 and September 2021. For firms in the US, they found negative cumulative average abnormal return. The returns were examined for several event windows, nine in total, but negative values were obtained in all cases. For Japanese firms, the results were not significant, showing no evidence of a change in stock prices as a result of announcements.

Lebelle et al. (2020) also found negative CARs around the announcement of green bond issuances in developed markets and during the first green bond issuance. The international sample in their study included US, Asian and European corporate green bonds issuances between 2009 and 2018. They demonstrated that investor reactions to green bond announcements are similar to those to conventional bonds, and that the information provided by green bond offerings convey about the companies unfavourable information about the companies issuing them.

To supplement the above-mentioned studies, it is essential to add related research on the subject.

According to Chava (2014), CSR and improved ESG performance are associated with reduced borrowing costs, lower capital costs, higher credit ratings, and better financial performance, which served as a basis for Tang and Zhang (2020). Krüger (2015) investigated stock market reactions to positive and negative events regarding a firm’s CSR activity and provided evidence that CSR news with more robust economic and legal information causes a more noticeable investor response. In addition, Ilhan et al. (2022) found that improved firm-level climate risk disclosure is positively correlated with institutional ownership that is climate-conscious.

In many of the green bond issuances of recent years, a so-called green premium, referred to as "greenium" in the literature, has been identified. This is a negative yield differential that can be measured between green and conventional bonds. Due to the environmental commitment and the transparency and compliance criteria required from issuers, green bond investors are often willing to forego a yield of a few basis points. Harrison (2021) showed that the possibility of a green premium can be beneficial for the issuers in terms of financing costs, as they can earn reduced cost of financing in the green bond issuance, than in a conventional financial instrument.

Several studies have been conducted on the pricing of green bonds, and a large body of empirical research has been published to analyse the existence of greenium. These studies have shown mixed results, so that it cannot be stated with absolute certainty that green bond issuance always yields a negative premium that is favourable to the issuer. The first study to examine the green premium was Preclaw and Bakshi (2015). Their analysis resulted in a negative premium of 0.17% between green and traditional bonds. A later analysis by Zerbib (2019), conducted the analysis on bonds issued between 2013 and 2017. In his study he created pairs of green and traditional bonds with identical issuer and properties. The regression analysis resulted in a green premium of -0.02% basis points. Later on, an analysis from Löffler et al. (2021) also found a pricing difference using two different pairing methods. They found a negative green premium of 0.15%-0.20% in the primary and secondary markets respectively.

Karpf and Mandel (2017) found a green bond premium of 0.08% in comparison to traditional bonds. Conversely, Larcker and Watts (2020) argued that a green bond premium does not exist, showing that there is a bias in the estimation in finding the greenium, as Karpf and Mandel (2017) compared taxable and non-taxable bonds.

As the number of research targeting the green bond premium increased, the results have become more mixed: Kapraun et al. (2021) found no evidence for the existence and significance of a green bond premium, although their results vary substantially. As for the latest results, Salakhova and Pietsch (2022) argued that the existence of green bond premium is still an open question and discovered that the primary factor explaining the greenium is the issuer's or the green bond's credibility.

Findings have often shown a negative yield differential, but always to a different extent. This may be due to the use of inconsistent methodologies, the diversity of databases and their different size. The mixed results of the studies presented above suggest that the presence of a negative premium in each green bond issue is not certain. The possibility exists to earn the greenium, but it is not the most important factor that motivates actors to issue green bonds. As

the green bond market continues to grow, more comprehensive and large sample analyses can be conducted that may provide a more comprehensive picture of the existence and magnitude of the phenomenon in the future.

5. Methodology

In this chapter, I describe the methodological background of the event study conducted.

According to MacKinlay (1997), the methodology consists of several important steps that influence the results. These essential elements to be applied - choosing the length of the event window, defining the sample to be tested, calculating the abnormal return using the appropriate model, defining the estimation window, performing a significance test - are described below.

5.1. Event window

The first essential point in the methodology, beyond the definition of the event, is the identification of the so-called event window. The event considered in this thesis is the date of the announcement of the green bond issue of a company. The event window is the period in which the impact of the announcement on stock prices is examined. The length and choice of the period plays an important role as it can have a significant impact on the final results. The event window is usually defined as a period of several days, with a minimum length of the day of the event and the day after. It is important that the period is neither too short nor too long. The advantage of choosing a long event window is that the impact of the event under investigation is more likely to be identified. On the other hand, it has the disadvantage of violating one of the assumptions of the methodology, the efficient markets theory. In this interpretation, the stock price needs a long time to recognize new information, such as when the event is not immediately incorporated and reflected in prices. A further complicating factor in the case of a long event window may be the exclusion of possible distorting information, other events. The advantage of using a short period is that these distractions, which may affect the final result, can be avoided. Nevertheless, Flakkenberg and Baheerathan (2021) argued that, when using too short an event window, we may omit from our analysis factors that are related to the event under investigation.

To alleviate the concern that a bond issuance has some information linkage, I followed the method of Krüger (2015) by conducting 11-day and 21-day event window and analyse the cumulative abnormal return (CAR) in the given timeframe.

Event windows, each spanning 21 days, were constructed around the bond announcement date. These event windows extended from -10 days to +10 days (-5 days to + 5 days respectively to 11-day event windows) relative to the announcement date. This approach allowed the analysis of stock price movements before and after the announcement of green bonds.

5.2. Abnormal return

A key to measuring the impact and strength of the event under investigation is the determination of abnormal returns over the period of the event window we define. To generate abnormal returns, I used the following formula:

$$\mathrm{AR_i} = \mathrm{r_i} - \mathrm{E(r_i)}.$$

Where $\mathrm{AR_i}$ represents the abnormal return, $\mathrm{r_i}$ is the actual return and $\mathrm{E(r_i)}$ is the expected return. The following step was to come up with expected returns, for which, I used the Capital Asset Pricing Model (CAPM) formula to generate expected returns:

$$E(r_i) = r_f + \beta_i \times (r_m - r_f),$$

where r_f is the risk-free return, β_i is the sensitivity of the stock price movement to the market portfolio return and r_m is the market return. According to MacKinlay (1997) the application of the Capital Asset Pricing Model (introduced by Sharpe (1964)) in event studies was common in the 1970s. The model has four basic assumptions. The first is that all investors are risk averse, i.e. they expect higher expected returns for higher risk. The second assumption is that markets are perfect in several senses: there are no transaction costs and taxes, information is available to all, there is a risk-free interest rate that is the same for all and assets are infinitely allocable. The next assumption of the model is that all market participants have the same investment opportunities. The fourth assumption states that all investors have the same judgements about expected return, dispersion and covariance.

The steps of the calculation are explained in the following section.

5.3. Beta estimation

I used CAPM for evaluating beta, which is an often-used framework in assessing a stock's sensitivity to market movements. The daily risk-free rate was derived from the 10-year German government bond. Concurrently, the daily market return was measured using the Euro

Stoxx 600 index, which provides a thorough representation of market performance across Europe.

I applied an estimation window in this study consistent with Tang and Zhang's (2020) approach, which takes a time frame ranging from 300 trading days to 50 trading days before the bond announcement date. This timeframe has been chosen to capture a sufficiently large historical dataset and at the same time remain relevant to the upcoming financial event.

As a first step, I calculated the risk premium (RP) of the companies one by one, by using the equation:

$$r_i - r_f = RP_i,$$

and the risk premium of the market portfolio for the same analysed time series using the equation:

$$r_m - r_f = RP_m,$$

where r_i is the actual return, r_m is the market return and r_f is the risk-free return.

Afterwards, I calculated the variance and covariance for each stock and the market, and then I determined the beta of the stocks using the following formula:

$$\beta_i = COV(RP_i, RP_m)/VAR(RP_m).$$

Having all the betas generated, I calculated the expected return for each stock for each day in the dataset.

With all the expected returns and actual returns available, I computed the abnormal returns by subtracting the expected actual stock price movements from the actual stock price movement within the event windows for each company.

5.4. Cumulative abnormal return

An essential aspect of measuring the impact of the event under investigation is the aggregation of abnormal returns calculated using the appropriate model. It is important to summarise the abnormal returns over the time horizon selected, both in terms of time and by security. Formally, the cumulative abnormal return (CAR_i) and the cumulative average abnormal return ($CAAR_i$) for the i-th security:

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{it}$$

$$CAAR_i(t_1, t_2) = \frac{1}{N} \sum_{t=t_1}^{t_2} CAR_{it}$$

Where (t_1, t_2) is the time window chosen, N is the number of elements in the sample and AR_{it} is the abnormal return.

After calculating the CAR values as outlined above, the next phase of the analysis involved a comprehensive examination of the drivers influencing these CAR values. This investigation was conducted through the application of a multiple regression analysis. The multiple regression model allowed for the identification and assessment of various factors that may contribute to the observed patterns in CAR values. Additionally, a Difference-in-Differences analysis was employed to further explore and understand the impact of specific interventions or events on the cumulative abnormal returns. These analytical approaches aimed to provide an in-depth understanding of the underlying dynamics influencing the observed CAR values, contributing to a more comprehensive interpretation of the results.

5.5. Testable hypotheses

In this section, I present the hypotheses I want to test, and the results of analyses based on similar research questions and methodologies to my thesis.

The paper seeks to answer two interrelated sets of questions:

1. Question: *Do the announcements of corporate green bond issuances in Europe have an impact on the stock market and, if so, to what extent?*
2. Question: *If there is a stock market reaction because of the announcements, is it related to certain characteristics and features of the company or the green characteristic itself?*

The first question will be addressed by the event study, the background and steps of which is presented in the previous section. The number of published empirical studies on this topic is not very large, but the diversity of results suggests that it is worth exploring the issue in further analyses. Specifically in Europe, no research has yet been conducted on the topic, so I considered it important to conduct this analysis, thus contributing to the literature on green finance. An important question is whether announcements of corporate green bond issues trigger a positive stock market reaction, thus increasing the scope of the benefits of green bond issuance.

The first hypothesis is related to the first question mentioned above:

1. Hypothesis: T*he announcements of corporate green bond issues in Europe have an impact on the stock market, resulting in a positive market reaction*.

Where announcements have an impact on the share prices of the issuing companies, an important question is what the characteristics of the company and the green bond are. The second question seeks to answer what are the characteristics that affect the degree of stock market reaction. To answer the second question, I use a multiple linear regression analysis with the cumulative abnormal stock returns around the announcements in the event study as the outcome variable, and certain corporate and green bond characteristics as explanatory variables to answer the second question, I have assumed the following hypothesis:

2. Hypothesis: *Green indicator, total assets, issued amount, leverage and coupon rate (at issuance) characteristics are associated with cumulative abnormal returns over the event window interval in Europe.*

6. Bond data

This section outlines the data collection and processing steps undertaken in this study to examine the impact of green bond announcements on the stock prices of companies.

Bond data was acquired from Refinitiv Eikon, where using the 'Bond search' page the global bond data becomes filterable, manageable, and downloadable. Bond issuances that occurred between January 1, 2010, and December 31, 2022, were included in the dataset for the markets of European countries. Each bond's issuance date, maturity date, tenor, announcement date, coupon rate (at the issuance date), coupon type, International Securities Identification Number (ISIN), and name of the issuing company were among the information obtained.

A subset of the retrieved bond data was identified as green bonds, indicating bonds issued for environmentally sustainable purposes. Refinitiv Eikon separates green bonds from traditional bonds with a binary indicator (1 = green bond, 0 = non-green bond). These green bonds were separated from the traditional bonds within the dataset. Within traditional (non-green bonds) there was no further classification defined.

After retrieving the mentioned data from Refinitiv Eikon there were 2,581 green bonds and 28,953 traditional bonds included in the data sample. As for this dataset, there are 2,143 green bond issuances, and 24,293 traditional bond issuances by corporations.

My primary source of data was Refinitiv Eikon. Utilizing the 'Bond search' page within Refinitiv Eikon, I was able to access, filter, manage, and download global bond data.

The dataset encompasses bond issuances spanning from January 1, 2010, to December 31, 2022, focusing on the issuances in European markets. Each bond's crucial information, including issuance date, maturity date, tenor, announcement date, coupon rate at the issuance

date, coupon type, International Securities Identification Number (ISIN), and the issuing company's name were collected.

A significant subset of the acquired bond data were green bonds, indicating financial instruments issued with a specific focus on environmentally sustainable purposes. Refinitiv Eikon distinguishes green bonds from their traditional counterparts using a binary “Green bond” indicator, where 'Yes' denotes a green bond, and 'No' signifies a non-green bond. This demarcation helped the isolation of green bonds from the broader dataset of traditional bonds. Notably, within the category of traditional bonds, I did not establish further sub-classification.

Following the extraction of data from Refinitiv Eikon, the dataset proved to comprise of 2,581 green bonds and 28,953 traditional bonds. Among these, there were 2,143 green bond issuances and 24,293 traditional bond issuances by corporations. This extensive dataset formed the foundation of this research, providing a steady understanding of the landscape of green and traditional bond issuances within the specified time frame and geographical focus.

Panel A: Characteristics for green bonds				
	Mean	Median	Std.	N
A) Fix coupon				
Coupon (percent)	1.87	1.25	1.87	1,786
Maturity (year)	8.47	7.00	3.51	1,786
Amount (million)	400	130	908	1,786
B) Floater coupon				
Coupon (percent)	4.23	4.83	2.38	663
Maturity (year)	11.59	5	67.1	663
Amount (million)	190	50	786	663
C) Zero coupon				
Coupon (percent)	-	-	-	133
Maturity (year)	8.11	6	6.84	133
Amount (million)	40	4	131	133

Panel B: Characteristics for traditional bonds				
	Mean	Median	Std.	N
A) Fix coupon				
Coupon (percent)	2.51	1.45	3.14	17,421
Maturity (year)	9.84	8	7.51	17,421
Amount (million)	293	30	1,573	17,421
B) Floater coupon				
Coupon (percent)	4.30	3.91	4.11	8,788
Maturity (year)	9.53	9	9.02	8,788
Amount (million)	115	25	707	8,788
C) Zero coupon				
Coupon (percent)	-	-	-	2,744
Maturity (year)	8.14	6	7.30	2,744
Amount (million)	45	11	184	2,744

Table 1: Bond characteristics

In addition, the bond issuances were further separated into first-time issuances and subsequent issuances, as subsequent issuances generally contain information that was already disclosed in the first issuances. As a result, only the first issuances were considered for analysis. The methodology of examining the first time issuances was used by Tang and Zhang (2020).

The next phase of the data collection involved acquiring stock market data for all the companies that had issued the green and traditional bonds – in the examined timeframe - identified in the previous steps. To establish a link between bond issuers and their publicly traded counterparts, I used Wharton Research Data Services (WRDS). As for the availability of global company data, Compustat – Capital IQ is accessible through WRDS, where global (non-US and non-Canadian) company data can be found and downloaded. To begin the matching procedure, all the data available was retrieved from Compustat from January 1, 2009, until January 31, 2023. The data obtained from WRDS included the Global Company Key, ISIN of the publicly traded stock, stock price, company name and company fundamentals such as total assets, total debt and leverage. The data retrieved included daily closing stock prices.

With all the data obtained, the following step included the merging of the two datasets; Utilizing Excel's fuzzy matching method, with a similarity threshold set at 0.85, matching company names from Refinitiv Eikon and company names from Compustat. Company names were matched to create correspondences. By avoiding inaccurate data entry, this approach attempted to match corporations with their corresponding bond issuances. Any inaccurate matches were removed from the dataset manually.

After data matching, there were found 243 green bond issuances and 784 traditional bond issuances by publicly traded corporations. The calculations showed that there were 11-day and 21-day event windows for 1,027 stocks. This allowed the assessment of the impact of green bond announcements on stock prices.

Panel A: Firm characteristics for green bond issuers				
	Mean	Median	Std.	N
Total Assets (Ln)	13.23	12.71	2.96	243
EBITDA to Revenue	0.35	0.29	0.30	243
Debt to Equity	5.52	2.60	5.60	243
Leverage	0.65	0.72	0.54	243

Panel B: Firm characteristics for traditional bond issuers				
	Mean	Median	Std.	N
Total Assets (Ln)	12.57	12.21	2.83	784
EBITDA to Revenue	0.23	0.18	0.30	784
Debt to Equity	3.39	1.70	4.00	784
Leverage	0.67	0.68	0.24	784

Table 2: Firm characteristics for the 1,027 firms

7. Results

In this chapter I present the results of my own empirical analysis. First, I describe the impact of the announcement of a corporate green bond issue in Europe on the stock market through an example, which I also compare with the impact of a conventional bond issue.

Panel A: CAAR values around the announcement of green bond issuances									
		Mean	Median	Std.	Min	Max	Skew	Kurtosis	N
CAAR 21 days		0.179%*	0.067%	1.669%	-10.237%	8.516%	-0.13	13.2	243
	p-value	(0.094)							
	t-stat	1.68							
CAAR 11 days		0.098%	0.020%	1.424%	-10.536%	7.252%	-0.81	20.4	243
	p-value	(0.283)							
	t-stat	1.08							

Panel B: CAAR values around the announcement of traditional bond issuances									
		Mean	Median	Std.	Min	Max	Skew	Kurtosis	N
CAAR 21 days		-0.320%	0.128%	5.905%	-40.461%	43.746%	-0.99	14.0	784
	p-value	(0.129)							
	t-stat	-1.52							
CAAR 11 days		-0.391%**	0.061%	4.370%	-32.855%	22.652%	-1.65	12.2	784
	p-value	(0.012)							
	t-stat	-2.51							

Table 3: CAAR values (p-values in parenthesis: *** p < .01, ** p < .05, * p < .1.)

As illustrated in the provided table, the p-values associated with the Cumulative Abnormal Average Returns (CAAR) for green bond issuances are 0.094 and 0.283 for 21- and 11-day event windows, respectively. Interpretation at a 5% significance level indicates that we do not reject the null hypothesis (Hypothesis 1), that the 11- and 21-day CAAR values are not significantly different from zero. However, when considering a 10% significance level, we reject that the 21-day CAAR values for companies issuing green bonds are not significantly different from zero, as the 0.179% return corresponds to a p-value of 0.094.

Turning to the impact of issuing traditional bonds, the table reveals negative results with -0.320% and -0.391% for 21- and 11-day Cumulative Abnormal Returns (CAR) values. Furthermore, for the 11-day event window, we reject the null hypothesis at a 5% significance level, that the CAR values are not significantly different from zero in this context.

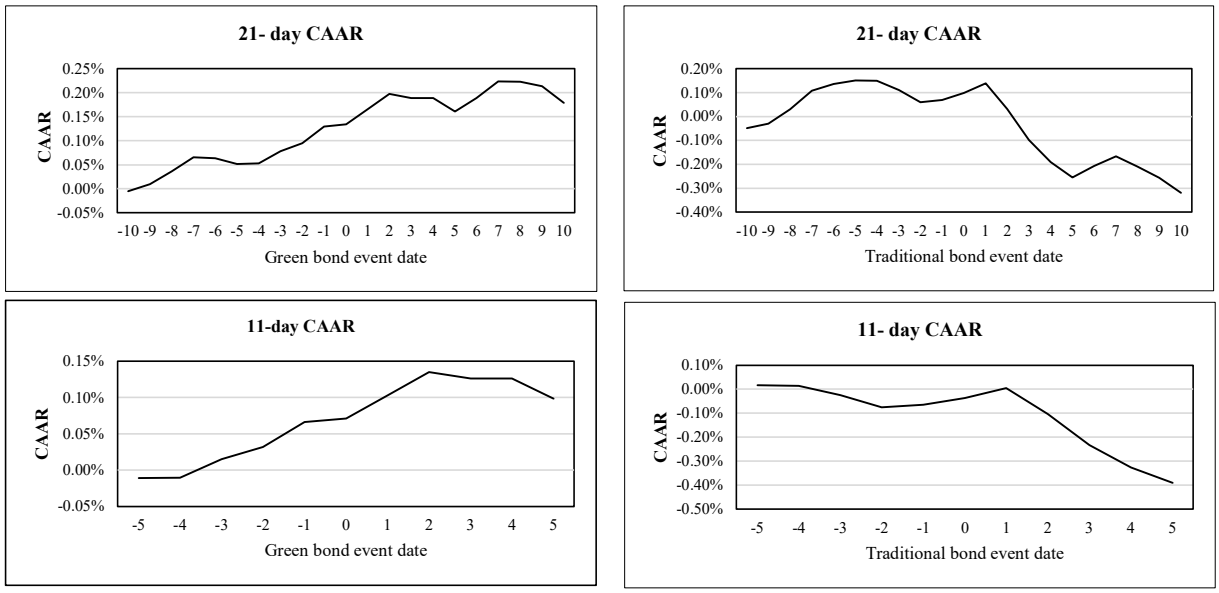

Figure 2: CAAR around the event dates

The CAAR values are positive on the left side of the Figure 2 presented above, while the CAAR values on the right are negative for traditional bond issuances. My results are in line with Glavas (2018), Baulkaran (2019) and Tang and Zhang (2020) showing a positive cumulative abnormal return for green bonds. Results regarding the negative cumulative abnormal return for the announcement of conventional bonds are in line with Elian and Taft (2014), who reported mixed results, including significant negative abnormal returns as well.

Notably, firms who decided to issue green bonds exhibited lower volatility and outlier values in their stock price movements compared to those opting for traditional bonds. This tendency can be a sign of the fundamental stability of businesses that follow eco-friendly policies. The commitment to sustainability inherent in green bond issuance might attract more

established and financially robust entities. Therefore, the observed lower volatility in CAR values could be attributed to the overall stability and size of companies opting for green bonds. In addition, the issued amount and the total assets observed in the previous chapter (Table 1 and Table 2) are perceived to be higher for green bond issuers. This finding motivates additional investigation into the possible interactions among stock market movements, financial stability, and corporate environmental responsibility.

8. Regressions

In this section, I seek to answer the second research question in this paper. Since the results from the event study shows that there may be a stock market reaction in the time interval around the announcement of corporate green bond issues, it is worth investigating the factors that may be influencing this abnormal change in returns. According to the second hypothesis, the green indicator, total assets, issued amount, leverage and the coupon rate are characteristics which drive the value of the cumulative abnormal return. To test this hypothesis, I draw on the studies of Glavas (2018) and Flakkenberg and Baheerathan (2021) who set the CAR values as the dependent variable in their regressions. In their studies, they obtained different results, which I attributed to the different number of items in the sample, time span and the inclusion of different variables. Glavas (2018) found that the total assets characteristic is positively related to cumulative abnormal returns, while the higher the coupon of a financial instrument, the more negative the stock market reaction is. He also found that a dummy variable for green and traditional bonds (Green=1, Traditional=0), is positively related to CAR values. Flakkenberg and Baheerathan (2021) also analysed the effect of total assets, however they did not find significant results, although they also found a positive relation between the green dummy and the CAR values. Before presenting the results of my own analysis, I will describe the variables I included in the analysis and the assumptions I made about them. The sample consisted of 243 green corporate bond issuances and 784 traditional bond issuances. In the multivariate linear regression, I defined five explanatory variables, taking care not to overestimate the number of variables to be analysed in relation to the size of the data set.

$$CAR_i = \beta_0 + \beta_1 \times Green_i + \beta_2 \times ln(Total\ assets)_i + \beta_3 \times ln(Amount\ issued)_i + \beta_4 \times Leverage_i + \beta_5 \times Coupon_i + \varepsilon_i$$

The first independent variable used in the regression analysis was the dummy variable related to the type of corporate green bond (Green=1, Traditional=0). Information on the green bond dummy is also available in Refinitiv Eikon. My assumption before conducting the analysis was that a positive relationship is expected between the green dummy and the cumulative abnormal returns. This may be because, in the eyes of investors, a financial instrument that complies with international standards presents a more credible image of a firm's environmental commitment.

As for the second and third independent variables, I took the natural logarithm of the values of total assets and issued amounts. The fourth independent variable was the leverage, and last the coupon rate (at issuance) as the fifth independent variable. I ran progressive regressions with different numbers of independent variables, to follow the effect of the introduction of a new independent variable.

$$(1)\ CAR_i = \beta_0 + \beta_1 \times Green_i + \beta_2 \times ln(Total\ assets)_i + \varepsilon_i$$

$$(2)\ CAR_i = \beta_0 + \beta_1 \times Green_i + \beta_2 \times ln(Total\ assets)_i + \beta_3 \times ln(Amount\ issued)_i + \varepsilon_i$$

$$(3)\ CAR_i = \beta_0 + \beta_1 \times Green_i + \beta_2 \times ln(Total\ assets)_i + \beta_3 \times ln(Amount\ issued)_i + \beta_4 \times Leverage_i + \varepsilon_i$$

$$(4)\ CAR_i = \beta_0 + \beta_1 \times Green_i + \beta_2 \times ln(Total\ assets)_i + \beta_3 \times ln(Amount\ issued)_i + \beta_4 \times Leverage_i + \beta_5 \times Coupon_i + \varepsilon_i$$

Potential drivers of CAR values - regression analysis								
	21-day				11-day			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Intercept	0.0047	0.0069	0.0088*	0.0179	0.0045	0.0227	0.0242	0.0264
	(0.332)	(0.110)	(0.091)	(0.102)	(0.453)	(0.720)	(0.647)	(0.412)
Green dummy	0.0054*	0.0055**	0.0057**	0.0056**	0.0053	0.0065	0.0066	0.0066
	(0.063)	(0.030)	(0.027)	(0.028)	(0.161)	(0.169)	(0.160)	(0.168)
Total Assets	-0.0007*	-0.0007*	-0.0006	-0.0006	-0.0007	-0.0007	-0.0006	-0.0006
	(0.057)	(0.057)	(0.103)	(0.103)	(0.185)	(0.185)	(0.281)	(0.278)
Amount issued		-0.0001	-0.0001	-0.0005		-0.0010	-0.0010	-0.0011
		(0.174)	(0.171)	(0.168)		(0.903)	(0.894)	(0.639)
Leverage			-0.0044	-0.0048			-0.0033	-0.0034
			(0.456)	(0.445)			(0.469)	(0.433)
Coupon rate				-0.0432				-0.0107
				(0.765)				(0.368)
R squared	0.0034	0.0034	0.0039	0.0047	0.0064	0.0082	0.0087	0.0088

Table 4: Regression analysis (p-values in parenthesis: *** p < .01, ** p < .05, * p < .1.)

Table 4 provides a clear and comprehensive view of the potential drivers of CARs. According to the results presented in the Table 4, at 10% significance level, we reject the null hypothesis that there is a statistically significant linear relationship between CAR and the Green dummy over a 21-day event window. Thus, for the Green dummy, a 0.5% increase is expected in CAR compared to the non-Green dummy category, suggesting that there is a positive relationship between the green indicator and the CAR. My results are in line with Glavas (2018), who also found positive significant relationship.

The total assets variable is also significant at a 10% level with a negative value of 0.07% in model (1) and (2), however in model (3) and (4), the p-values are over 10% following the introduction of more variables.

Based on the presented values, I found no evidence of significant values over the 11-day event window.

In conducting a further analysis, I used a difference-in-differences methodology incorporating key variables such as the green indicator, post (time), and the interaction term between green and post indicators.

$$CAR_{i,t} = \beta_0 + \beta_1 \times Green_i \times Post_t + \beta_2 \times Green_i + \beta_3 \times Post_t + Amount\ issued\ FE + Coupon\ rate\ FE + \varepsilon_{i,t}$$

Anticipating the potential positive impact of environmentally sustainable practices, particularly at the announcement of the bond issuances (post), I expect positive values for the beta coefficients associated with both the green*post interaction term and the standalone green indicator. This approach allows the examination of the differential effects of green initiatives over time, providing insights into the positive associations between the implementation of environmentally friendly policies and the observed outcomes. I introduced Amount issued and Coupon rate fixed effects in the regression, as these values are constant throughout the lifespan of a bond.

(1) $CAR_{i,t} = \beta_0 + \beta_1 \times Green_i \times Post_t + \beta_2 \times Green_i + \beta_3 \times Post_t + \varepsilon_{i,t}$

(2) $CAR_{i,t} = \beta_0 + \beta_1 \times Green_i \times Post_t + \beta_2 \times Green_i + \beta_3 \times Post_t + Amount\ issued\ FE + \varepsilon_{i,t}$

(3) $CAR_{i,t} = \beta_0 + \beta_1 \times Green_i \times Post_t + \beta_2 \times Green_i + \beta_3 \times Post_t + Coupon\ rate\ FE + \varepsilon_{i,t}$

Difference in differences analysis						
	21-day			11-day		
	(1)	(2)	(3)	(1)	(2)	(3)
Intercept	0.0007	0.0018	-0.0005	-0.0007	-0.0010	-0.0008
	(0.579)	(0.554)	(0.804)	(0.480)	(0.290)	(0.399)
Green*Post	0.0039	0.0080	0.0052	0.0023	0.0022	0.0022
	(0.287)	(0.156)	(0.259)	(0.197)	(0.437)	(0.438)
Green	0.0005	0.0013	0.0000	0.0014	0.0031	0.0022
	(0.857)	(0.803)	(0.996)	(0.232)	(0.154)	(0.309)
Post	-0.0046**	-0.0109**	-0.0036	-0.0026*	-0.0025*	-0.0025*
	(0.011)	(0.011)	(0.289)	(0.086)	(0.065)	(0.066)
Amount issued FE	NO	YES	NO	NO	YES	NO
Coupon rate FE	NO	NO	YES	NO	NO	YES
R squared	0.0041	0.0065	0.0058	0.0033	0.0028	0.0030

Table 5: Difference-in-differences analysis (p-values in parenthesis: *** p < .01, ** p < .05, * p < .1.)

As presented in Table 5, I only obtained significance regarding the Post variable. Regarding the Green*Post variable, my results indicate a positive relationship with CAR values, in all six cases, however, the p-values are over 10% in all cases. Moreover, with the introduction of fixed effects, the significance levels continue to change through the results. With the introduction of Amount issued fixed effects, almost all p-values moved closer to significance compared to the base model (1). Conversely, with the introduction of Coupon rate fixed effects, the p-values mostly worsen compared to model (1).

To conclude, after running a difference-in-differences regression, to capture the effect of Green*Post and Green dummy characteristics, no significant results were found.

9. Conclusion

The aim of my thesis was to present a comprehensive picture of the green bond market, highlighting corporate green bond issuances across Europe, thus contributing to the literature on green finance. In the paper, I sought to answer two main research questions, for which I put forward two hypotheses. In the first question, I was interested in whether announcements of corporate green bond issuances have an impact on stock price movements compared to traditional bonds. In the second question of the paper, I focused on identifying the firm or bond characteristics that might influence the stock market reaction that occurs.

I have divided my empirical analysis into two parts. To answer the hypotheses, first, I examined the impact of the announcement of green bond issuances on stock prices across Europe through an event study. Using the Capital Asset Pricing Model, I performed the calculation on two event windows with a 250-day estimation window. Using a 21-day event window around the announcement date, I obtained a positive significant cumulative abnormal return of 0.179% for the announcement of green bond issuances. I also measured the effect of the announcement of traditional bond issues, where I obtained a negative cumulative abnormal return of 0.391% over the 11-day event window around the announcement date using the same analysis. My results indicate that the commitment of firms towards green investments is valued by investors.

As a second part, I ran multivariate linear regressions to answer the second research question regarding the drivers of CAR values. I found a positive significant relationship between the green characteristic of a bond and its cumulative abnormal return over a 21-day event window in a multivariate linear regression. Thus, a green label of a bond indicates a 0.5% increase in the expected cumulative abnormal return compared to traditional bonds, suggesting

that there is a positive association between the green indicator and the cumulative abnormal return. In conducting a difference-in-differences analysis, I found a positive, but not significant relationship between CAR and green characteristic, however, after introducing fixed effects, the results moved closer to a significant level.

As corporate green bonds are a relatively new financial products, and as such, the literature on the subject is limited. This made it harder to relate my results to earlier research with a broad range of results, in addition, there are not a huge number of publicly listed green bond issuers in Europe. This leaves a modest number of observations since I was only interested in first-time issuances. Regarding further limitations, I was not able to access some data, which could have been useful in finding significant result. I recommend that future studies include changes in investor profiles and institutional ownership over the event window, because these changes could provide valuable insight regarding the behaviour of investors and returns. Future studies, especially with more data available, could shed additional light on stock market reactions and the significance of a company's credibility when it comes to green investing.

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