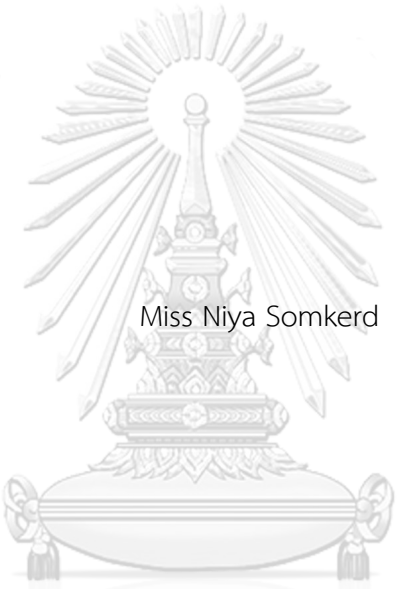
Is greener really better? Stock market reaction to green bond announcements, Evidence from Europe

Miss Niya Somkerd



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การตอบสนองของราคาหลักทรัพย์ต่อการประกาศการออกตราสารหนี้สีเขียวของบริษัทจดทะเบียนในตลาดหลักทรัพย์ในทวีปยุโรป

น.ส.นิยา สมเกิด

สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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Field of Study	Finance
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นิยา สมเกิด : การตอบสนองของราคาหลักทรัพย์ต่อการประกาศการออกตราสารหนี้สีเขียวของบริษัทจดทะเบียนในตลาดหลักทรัพย์ในทวีปยุโรป. (Is greener really better? Stock market reaction to green bond announcements, Evidence from Europe) อ.ที่ปรึกษาหลัก : ดร.ธนวิต แซ่ซือ

งานวิจัยนี้ศึกษาผลกระทบของการออกตราสารหนี้สีเขียว โดยบริษัทจดทะเบียนในตลาดหลักทรัพย์ที่ไม่ถูกจัดอยู่ในกลุ่มธุรกิจการเงินในทวีปยุโรป ต่อราคาหุ้นของผู้ออกตราสาร ระหว่างเดือนมกราคม ปี ค.ศ. 2013 ถึง เดือนกันยายน ปี ค.ศ. 2022 ผู้วิจัยพบว่า มีผลตอบแทนเชิงลบที่ผิดปกติจากการออกตราสารหนี้สีเขียวโดยเฉลี่ย 0.28% ระหว่างวันที่มีการประกาศออกตราสารหนี้ดังกล่าวและหนึ่งวันถัดจากนั้น นอกจากนี้ ผู้วิจัยยังพบว่า นักลงทุนในตลาดหุ้นตอบสนองต่อการประกาศออกตราสารหนี้สีเขียวเช่นเดียวกันกับการประกาศออกตราสารหนี้ปกติ ผู้วิจัยยังศึกษาถึงความสัมพันธ์ของดัชนีความไม่แน่นอนของนโยบายด้านสภาพภูมิอากาศ ซึ่งจัดทำโดย Gavriilidis (2021) ต่อการตอบสนองของตลาดหุ้นดังกล่าว โดยพบว่า ดัชนีดังกล่าวมีความสัมพันธ์เชิงบวกต่อการตอบสนองของตลาดหุ้นในช่วงเวลาก่อนเกิดการแพร่ระบาดของเชื้อไวรัสโคโรนา 2019 เท่านั้น

สาขาวิชา	การเงิน	ลายมือชื่อนิสิต .....
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Niya Somkerd : Is greener really better? Stock market reaction to green bond announcements, Evidence from Europe. Advisor: TANAWIT SAE SUE, Ph.D.

Employing an event-study approach, we examine how the stock market responded to the offering of green bonds by non-financial companies listed on the European stock market from January 2013 to September 2022. We observed a drop, on average about 0.28%, in the company stock prices on the day they announced these offerings and the day after. Moreover, we found that investors react in the same manner for green bond announcements as for conventional bond announcements. We also studied if the Gavriilidis (2021)'s climate policy uncertainty index has any relationship with the market reactions. Our findings suggest that the index is positively related to the market's reaction to green bond offerings only before the COVID-19 pandemic hit.

Field of Study:	Finance	Student's Signature .....
Academic Year:	2022	Advisor's Signature .....

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Niya Somkerd

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1 Introduction

Green bonds, though seemingly appear to be not different from conventional bonds, have specific features, including the commitment by the issuers to allocate the funds raised to support environmentally friendly or climate-related projects. As the demand for sustainable investments increases and the climate change continues to gain attention in public policy debates (Fatica & Panzica, 2021), more firms are turning to green bonds as a way to raise capital for environmentally friendly projects. Although the total amount issued remains relatively small in comparison to traditional bonds, corporate green bonds have been rapidly growing in numbers. There are new corporate green bonds worth USD 58.64 billion (excluding financials industry and governments) issued in 2022 alone[1].

Our aim is to examine the effects of publicly listed European firms' green bond issuance announcements on the issuer's stock price from January 2013 to September 2022 using the event study method. We select the European market as the sample since it is the largest green bond market[2]. Additionally, Europe is known as the leader in promoting sustainable investment with a strong green bond regulation. However, only a few studies in this topic focused on the European market, while prior studies have focused on either global market (Flammer, 2021; Glavas, 2018; Lebelle et al., 2020; Tang & Zhang, 2020) or the Chinese market (Wang et al., 2020).

Apart from firm and bond characteristics which are previously explored as the determinants of abnormal returns from green bond offerings in the literature (e.g., Autio, 2022; Glavas, 2018; Lebelle et al., 2020; Nylén, 2021), we add to the previous studies by examining the relationship between the climate policy uncertainty and the excess announcement returns. In our study, we employ the newly developed Gavriilidis (2021)'s Climate Policy Uncertainty index to measure and represent the level of uncertainty surrounding climate policies. Despite its importance, there is no research conducted on this topic.

The climate policy uncertainty, as mentioned above, can be an important factor to consider when we analyze the market response to the offering of green bonds. This factor can

[1] Calculated using data from Bloomberg as of Dec 31, 2022.

[2] The Climate Bonds Initiative. (Retrieved February 2, 2023). The Climate Bonds Interactive Data Platform. [Online]. Available: https://www.climatebonds.net/market/data

have a direct impact on a firm's operation, which in turn affects the firm's performance. Additionally, previous literatures have presented the importance of accounting for climate policy uncertainty in firms' valuation and asset pricing (e.g., Azimli, 2023; Chan & Malik, 2022). Therefore, considering this factor may contribute to a more comprehensive explanation of the excess announcement returns.

In light of the fact that the announcement of green bond offerings can potentially influence the stock market, corporate managers may choose to consider alternative types of financing to provide the maximum benefit to shareholders, including preventing a negative impact to the stock price, making firms become more environmentally conscious which benefits investors and society. Furthermore, the findings of our research could provide valuable insights for investors seeking to understand the stock price reactions of publicly traded European firms in response to the announcement of their green bond offerings. This can facilitate more prudent decisions with regards to portfolio optimization around the announcements. Moreover, it may assist investors in comprehending how the climate policy uncertainty index relates to the stock market response surrounding the announcement of green bonds, and whether, when the level of uncertainty increases, the issuance of green bonds might help alleviate the impact of such uncertainty on the stock market.

We organized this study into six distinct sections. The subsequent section provides a comprehensive literature review that examines the impact of green bond issuance announcements on issuer stock prices and explores the relationship between Gavriilidis (2021)'s climate policy uncertainty and asset pricing and firm valuation. Furthermore, this section develops the hypotheses for the study. In the third section, we provide detailed insights into the data collection process, including the sources of data utilized in the study. The fourth section focuses on the event study methodology and regression techniques employed in the analysis. This section outlines the statistical techniques and models used to investigate the research questions. The results of the analysis will be presented and discussed in the fifth section. This section will provide a comprehensive analysis and interpretation of the results. The final section of the study summarizes the findings, discusses the limitations of the study, and provides recommendations for future studies.

2 Literature review and hypothesis development

2.1. Relevant research

2.1.1. Stock market reaction to the announcement of green bond issuances

Glavas (2018) observed a favorable stock market response to the issuance of green bonds using data from 22 countries between 2013 and 2018. The researcher noted that the stock market reaction to green bond announcements became increasingly positive and significant following the Paris Agreement since investors altered their behavior in response to the signing of the agreement. Similarly, Flammer (2021) conducted an event study that revealed a positive market response to the announcement of all corporate green bond issuances from 2013 to 2018. The market response was particularly strong for first-time issuances and green bonds with independent third parties' certification.

Furthermore, Tang and Zhang (2020) discovered that green bonds had a beneficial impact on stock prices after examining green bond offerings across 28 countries from 2007 to 2017. The study also found the announcement returns present a greater magnitude for firms issuing green bonds for the first time compared to those who have done so previously. In addition, financial firms issuing green bonds do not experience a significant reaction in the stock market. Moreover, Wang et al. (2020) found a positive market response to the announcement of corporate green bond issuances in the Chinese market between January 2016 and June 2019.

In contrast, Lebelle et al. (2020) found the stock market had a negative response to green bond announcements, especially for first-time issuances and those issued by firms in developed countries. The study analyzed global green bonds issued between 2009 and 2018, utilizing several models to estimate an abnormal return.

Additionally, Anders Pedersen (2019) examined the market reactions to green bond announcements in the European stock market from November 2013 to October 2019. The findings of their research provide evidence of positive abnormal returns following these announcements. Importantly, the results demonstrate that firms continue to benefit each time they announce a green bond, and not just during the initial announcement. Nylén (2021) employed an event study methodology to analyze the impact of green bond issuance by non-

financial corporations in Europe between 2013 and 2020. The study reveals mixed results, with both positive and negative reactions to the announcement of green bonds on different event windows. Similarly, Autio (2022) also conducted the event study focusing the same region and period as Nylén (2021) and observed a significant abnormal return, particularly for first-time green bond announcements. The study identified the first-time announcement of a green bond and maturity as statistically significant determinants of the abnormal returns from corporate green bond announcements.

2.1.2. The effect of Gavriilidis (2021)'s climate policy uncertainty on asset pricing and firms' valuation.

Previous research has demonstrated that climate policy uncertainty can have an impact on a firm's value and stock price. For example, Azimli (2023) has shown that an increase in the climate policy uncertainty has a negative effect on US firm values, as measured by Tobin's Q ratio. Equally importantly, increased engagement in corporate social responsibility can play an important role in mitigating the adverse effect of the climate-related policy uncertainty on a firm's valuation. Moreover, Chan and Malik (2022) has presented that when there is an increase in the climate policy uncertainty, investors are willing to pay a premium for stocks that offer protection against this uncertainty, particularly those that have lower exposure to it.

The climate policy uncertainty can also be a factor of bond pricing. For example, Silva et al. (2022) has shown that bond portfolio performance is affected by the climate policy uncertainty. The researcher compared the performance of a green bond portfolio to that of a conventional bond portfolio and found that the green bond portfolio underperformed when concerns about climate risks were low, but outperformed when concerns were high, which they proxy the concerns with the climate policy uncertainty constructed by Gavriilidis (2021). In addition, according to Tian et al. (2022), an increase in the climate policy uncertainty has been found to have a negative impact on green bond prices in all three regions examined - the US, Europe, and China. Specifically, the effect of the climate policy uncertainty on green bond prices is more pronounced in Europe compared to the US and China. This could be attributed to Europe's longstanding commitment to global climate change cooperation, reflected in its large carbon trading market and a green bond market that is more responsive to changes in climate-related policy.

2.2. Hypothesis development

Prior research has shown a mixed result regarding stock market reactions to the green bond offering announcement, with both positive and negative reactions observed (e.g., Flammer, 2021; Glavas, 2018; Lebelle et al., 2020; Tang & Zhang, 2020; Wang et al., 2020).

In the context of positive effects, an involving literature has focused on signaling theory. Asymmetric information between corporate managers and investors creates transaction costs, as managers possess better information about their firm compared to investors (Akerlof, 1970). By sending credible signals that cannot be mimicked by other firms, managers can communicate valuable information to investors, which can reduce the transaction costs and increase firm values (Riley, 1979; Spence, 1973).

Flammer (2021) argues that firm's environmentally friendly behavior is one of the valuable information that investors may lack; however, it is used for investment decisions. We can imply that when issuing green bonds, firms may provide valuable information to investors which is a credible signal of a firm's dedication to environmental causes. Additionally, it is costly signal since green bond issuers must invest a significant amount of money in environmentally friendly projects and their bonds frequently obtain independent third-party certification to ensure that the proceeds are used in compliance with the objectives of the green bond. This makes it easier for investors to distinguish between firms that are environmentally friendly and those that are not, resulting in a decrease in the transaction costs from a reduction in asymmetric information. Hence, we may expect that the stock market may respond positively to the announcement of green bond issuances.

On the other hand, the stock market may respond negatively to the green bond offering announcement for a variety of reasons. Firstly, the absence of a global standard for defining and evaluating green projects may cause green bonds to be viewed as a tool of greenwashing, which, in this case, refers to the activities when firms issue green bonds just to appear to be environmentally friendly while making false claims (Flammer, 2021). Given environmental factors are considered by investors, the value of the firm will be reassessed due to an increase in concerns regarding the greenwashing practices, resulting in a decrease in the issuer's stock price. This concept aligns with Lebelle et al. (2020).

Secondly, the offering of green bonds can result in a significantly increased expense for firms. Although the consideration of environmental factors in investment decisions has become increasingly prevalent among investors, financial outcomes are still one of the crucial factors. Lebelle et al. (2020) suggest that commitments to environmental causes through green bond issuance can incur substantial costs for firms. For example, if firms want to avoid the devaluation on the stock price caused by investor's concern on greenwashing, firms may have to obtain third-party verifications for their green bonds, which leads to additional costs. A rise in costs may cause uncertainty in investors as to the firm's ability to maintain its level of profitability; therefore, they might reassess the firm's profitability. As a result, the stock market generally reacts negatively to the green bond offering.

For Europe, given the reputation as a global leader in the green transition[3], with a strong emphasis on environmental policy, and stricter regulations than other regions, it is likely that the stock market will respond positively to their efforts. In other words, their reputation may amplify the signal being conveyed to investors. Furthermore, concerns about greenwashing are less prevalent in Europe due to the stringent regulations surrounding green bonds. Therefore, we expect that there will be positive stock market reaction to the announcement of green bond issuance. The hypothesis 1 is as follows:

***Hypothesis 1*:** In the European market, the issuer's stock price reacts positively to the announcement of green bond issuance by publicly listed firms.

To the best of our knowledge, only firm and bond specific variables have been used for explaining the cumulative abnormal returns from the announcement of green bond issuance (defined in Section 4.3.2.). However, we argue that the changing direction of global climate policies, especially when there is overwhelming uncertainty, could potentially be an important determinant of the cumulative abnormal returns. In an attempt to measure that, we use the Gavriilidis (2021)'s climate policy uncertainty (CPU) index as a proxy. The CPU index has been used in several previous studies and was documented to be a relevant factor in asset price (e.g., Azimli, 2023; Chan & Malik, 2022; Silva et al., 2022; Tian et al., 2022).

[3] European Commission. (November 21, 2022). "EU agrees to COP27 compromise to keep Paris Agreement alive." Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7064

On the one hand, during high climate policy uncertainty and growing sustainability trends, Chan and Malik (2022) indicate that the CPU has significant and negative effect on the cross section of individual stocks. It is likely that the climate policies will become stricter, resulting in higher costs for firms, e.g., the expenses incurred for increased disclosure of environmental impact on investments because of the adoption of the EU's Taxonomy Regulation. Investors may expect a worse financial performance. Moreover, if a firm issues a green bond which is considered as a corporate bond, during the period of increased concern on climate policy uncertainty, this could also increase the default risk, causing investors to have a lower perception of the firm's value. This is related to the negative stock market reactions.

On the other hand, during periods of heighten climate policy uncertainty and increasing focus on sustainability, investors might turn to green stocks, which have lower exposure to the uncertainty. Chan and Malik (2022) suggest that investors are willing to pay premium for them because these stocks could help them maintain their portfolio's value. The findings of Pástor et al. (2021) support the idea that during times of increased concern for the climate uncertainty, green stocks in the US outperformed their less environmentally friendly counterparts, or "brown stocks." According to Flammer (2021), previous studies have demonstrated that the stock market has a positive reaction to firms' environmentally friendly behavior (e.g., Flammer, 2013; Klassen & McLaughlin, 1996; Krüger, 2015). In addition, Azimli (2023) also suggests that firms with increased engagement in corporate social responsibility can counteract the negative impact of climate policy uncertainty on their valuation. Hence, if green bond offerings could be seen as credible signal by firms to entail less climate-related risk by investing in green projects. This would increase the demand for the issuers' stock, resulting in abnormal returns in the stock market around the announcement.

According to Europe's reputation as having the largest green bond market globally, a prolonged history of green bond issuances, and a stringent regulatory environment, investors may appreciate the value of green bond offerings and support the move towards a more sustainable economy. They may not be affected by the costs incurred during the transition process. Hence, the second hypothesis can be stated as:

Hypothesis 2: There is a positive relationship between the climate policy uncertainty and the cumulative abnormal returns in the European stock market due to the announcement of green bond issuance by public listed firms.

3 Data

For the purpose of this study, we have limited our sample of green bond issuances to those made by publicly listed European firms between January 2013 and September 2022. We obtained the dataset from Bloomberg fixed income database as it provides comprehensive coverage of corporate green bond data (Flammer, 2021). Additionally, many previous studies have utilized this source to gather green bond data, i.e., Glavas (2018), Nylén (2021). Since there are various interpretations of what constitutes a green bond, the data we used rely on the "Green" flagged by Bloomberg which defines a bond as a "Green" bond based on the criteria set forth in the "Green Bond Principles" issued by the International Capital Market Association (ICMA). These principles dictate that all proceeds from the bond issuance must be directed towards environmentally sustainable projects.

The data for all firm and bond characteristics is obtained from the Bloomberg Terminal, including announcement date, issuance date, coupon, maturity, issue size, maturity type for bond characteristics and Bloomberg ticker, the Bloomberg Industry Classification Standard (BICS), country of domicile, firm size, ROA, leverage, market-to-book ratio for firm characteristics. The total return issuer's stock price[4], their corporate action announcements[5], and the total return stock market index prices for each country are also collected from the same source for event study purposes. Afterward, we apply an additional filter by removing bond observations with missing information and outliers. Additionally, to create the final sample, we combined and counted multiple tranches of green bonds as a single issuance. This approach allows us to avoid double-counting and provides a more accurate representation of the market reaction to each unique green bond offering.

In this study, we will employ the Climate Policy Uncertainty index developed by Gavriilidis in 2021, and we have extracted monthly data for the index from the website www.policyuncertainty.com. The obtained CPU index is constructed by following the

[4] We have utilized the Bloomberg variable "Total Return Index (Gross Dividends)" which considers the reinvestment of dividends and provides a time series that accurately reflects the total returns of an investment. Moreover, the prices obtained from this variable have been adjusted to account for major capital changes. This adjustment ensures that any significant events, such as stock splits or corporate actions, are appropriately incorporated into the price data analysis.

[5] The information regarding earnings announcements was retrieved from Bloomberg using the EVT (Earnings Event) function, while data on other corporate actions was obtained from Bloomberg using the CACT (Corporate Actions) function.

methodology outlined by Baker et al. (2016), who established the economic policy-related uncertainty index has become a gold standard in measuring economic policy uncertainty in the literature in recent years (Chan & Malik, 2022). According to Gavriilidis (2021), he employed a set of specific search phrases which aims to capture climate policy-related uncertainty in 8 US newspapers[6] covering global issues. For each newspaper, the number of articles of interest per month is divided by the count of all articles published in that month. Afterward, he standardizes each newspaper-level series to have a unit standard deviation and computes the average across the eight newspapers by month. Subsequently, he normalized the resulting series of the eight newspapers such that they have a mean of 100 for the entire period.

As designed, a high value of the CPU index is intended to represent an increase in the level of uncertainty regarding policies related to climate. Consequently, we shall observe that notable spikes in the CPU index correspond to important events that contribute to climate policy uncertainty. For instance, the CPU index exceeded a value of 400 in November 2021, since there is the United Nations Climate Action Summit in this month, highlighting the link between important climate policy events and heightened uncertainty, as anticipated.

Our study is consistent with previous literature (Autio, 2022; Glavas, 2018; Nylén, 2021) in that we focus on non-financial firms mainly due to the different purposes of green bonds released by financial and non-financial firms. Non-financial firms issued green bonds to invest in their own environmentally sustainable projects, whereas financial firms may utilize the funds to provide green loans or invest in environmentally friendly initiatives of other firms. They only disclose general criteria for selecting green projects. Such criteria are not clearly defined like corporate green bonds (Tang & Zhang, 2020). If that is the case then, we could imply that any reduction in information asymmetry effect provided by green bond issuance announcements by financial firms' indirect investments might be less than, if there is any at all, non-financial corporate green bond issuance announcements. Thus, we might not observe abnormal returns from such an announcement from financial firms. Including such firms in this study may cause deviation from accurate results. Additionally, the same rationale is also explained and observed in other literature. Previous studies such as Tang and Zhang (2020) find that there is no market benefit for financial institutions after issuing green bonds. Therefore, the initial sample was

[6] See Gavriilidis (2021).

narrowed down by excluding green bonds issued by the "Financials" industry, identified by the Bloomberg Industry Classification System (BICS).

As suggested by previous studies (e.g., Brown & Warner, 1985; Cannella Jr & Hambrick, 1993; McConnell & Nantell, 1985; Morck & Yeung, 1992), in order to avoid the influence of other events such as merger and acquisition activities, joint venture, stock split, and earnings announcements on the market reaction, such confounding events have to be controlled for. In this study, we will exclude any confounding events of the issuer during the 5-day window surrounding an event date. This will allow us to obtain a more precise result of the event study.

4 Methodology

4.1. Event-study methodology

This study focuses on investigating green bond issuer stock price behavior around an announcement of green bond issuance in Europe. To conduct our analysis, we utilize an event study, a widely and appropriately used for examining the market reaction to specific events (MacKinlay, 1997). Previous literatures, e.g., Glavas (2018), Tang and Zhang (2020), Lebelle et al. (2020), Wang et al. (2020), and Flammer (2021), have also employed this methodology to examine the effects of green bond announcements on various stock markets.

In this study, we adopt the announcement date of green bond offerings as the event date, instead of the bond issuance dates, as it is the day when new information is disclosed to the public. In cases where the announcement date does not coincide with a trading day, the date of the announcement is shifted to the next available trading day.

In terms of the event window, we consider multiple event windows in this study including trading days before and after an event date. The rationale for this approach is based on Fama (1970)'s efficient market hypothesis, which suggests that stock prices reflect all newly available information completely and immediately. However, in the real world, this might not be the case, there could be the information leakage and the market underreaction to such announcements (Glavas, 2018). We then expand the period of interest to multiple trading days

before and after the event date. In accordance with prior literatures such as Tang and Zhang (2020) and Flammer (2021) that examine the longer windows following Krüger (2015), the green bond announcement could affect stock price up to 21-day around the announcement, encompassing ten days before and ten days after the event date. Therefore, we particularly consider the following event windows: [-1, 0], [-3, 0], [-5, 0], [-7, 0], [-10, 0], [0, +1], [0, +3], [0, +5], [0, +7], [0, +10], [-1, +1], [-3, +3], [-5, +5], [-7, +7], and [-10, +10].

In order to calculate the abnormal return, which is the deviation between the actual return observed in the stock market and the expected return, we need to determine the latter. The expected return represents the return that is not affected by any specific events of interest. Our choice for estimating the expected return is the market model, which assumes a steady linear relationship between the returns of the stock and those of the market. This is due to the following reasons. Firstly, the model is widespread used in previous literature. Also, the majority of studies on the stock market reaction to the announcement of green bond issuances use the market model to estimate the expected stock returns. Secondly, the market model is more efficient than the constant mean return model as it minimizes the variance of abnormal returns, thereby enhancing the capacity to identify the event effect (MacKinlay, 1997).

Although there are other alternative models such as multifactor models, the market model remains the preferred choice for event studies. MacKinlay (1997) argues that the use of the multifactor models in event study may not result in significant improvements since the added factors to the market model only provide minimal explanatory power which only marginally reduces the variance of abnormal returns. Furthermore, given that the date of events in this study were not clustered as the issuance of green bonds can occur at any time throughout the year (Glavas, 2018), Binder (1998) stated that, under this circumstance, the estimators from the market model is unbiased and efficient.

The calendar effect, which refers to the regular patterns that occur in stock markets due to the calendar, is not included in our model as its impact is reflected in the overall stock market and can therefore be accounted for in our market model.

Given the diverse composition of the European stock market, spanning across multiple countries, we conducted the analysis using multi-country event study methodology. In order to capture the stock market dynamics accurately, we utilize country-specific stock market indices as valid representations of each respective stock market (Glavas, 2018). For each issuer's stock we estimate the intercept coefficient (α_i) and slope coefficient (β_i) of the market model through the application of the Ordinary Least Squares (OLS) regression method during the specified estimation window as:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

Where R_{it} represents the daily stock return of firm i on day t, R_{mt} represents the daily stock market return on day t and ε_{it} represents the residual term for firm i on day t.

To determine the estimation window, we follow Peterson (1989) who presents that the estimation window is typically set within a range of 100 to 300 days. Therefore, 120 trading days with 50 trading days preceding the event date are chosen as the estimation window, after considering the non-overlapping aspect between the estimation window and the event window as pointed out by MacKinlay (1997).

Then we can estimate the expected stock return of firm i on day t in the event window as:

$$\hat{R}_{it} = \hat{\alpha}_i + \hat{\beta}_i \times R_{mt} \quad (2)$$

Where $\hat{R}_{it}$ is the expected stock return of firm i for day t.

After that, we can calculate the abnormal return (AR) of firm i on day t from the difference between the estimated return and the actual return as:

$$AR_{it} = R_{it} - \hat{R}_{it} \quad (3)$$

Where AR_{it} is the abnormal return of firm i on day t and R_{it} is the actual return that can be observed in the stock market.

Next, to compute the cumulative abnormal return (CAR), we sum the abnormal returns within an event window. For example, if we consider the CAR for the [-5, 5] interval, we will add the abnormal returns of the five days prior to and following the event date.

$$CAR_{i\,(a_1,a_2)} = \sum_{t=a_1}^{a_2} AR_{it} \tag{4}$$

Where $CAR_{i\,(a_1,a_2)}$ is the cumulative abnormal return of firm i from period a_1 to a_2. The event window is defined such that $a_1 \leq a_2$.

Lastly, the cumulative average abnormal return (CAAR) is calculated as follows:

$$CAAR_{(a_1,a_2)} = \frac{1}{N}\sum_{i=1}^{N} CAR_{i\,(a_1,a_2)} \tag{5}$$

Where $CAAR_{(a_1,a_2)}$ is the cumulative average abnormal return during the event period for a sample of N events.

4.2. Significance test

In order to test the first hypothesis whether the cumulative average abnormal return is statistically positive or not, we employ a one-sided test. The null and alternative hypothesis are formulated as follows:

$$H_0: CAAR_{(a_1,a_2)} = 0$$
$$H_1: CAAR_{(a_1,a_2)} > 0 \quad (6)$$

If the null hypothesis is not rejected, the conclusion would be that the announcement of green bond issuances does not have an impact on the European stock market. On the other hand, a rejection of the null hypothesis would provide evidence that there is a significant positive abnormal return around the green bond offerings.

The t-statistic used to deduce the hypothesis is conducted at 1%, 5%, and 10% levels of significance by the following formula:

$$t = \sqrt{N}\frac{CAAR_{(a_1,a_2)}}{\hat{\sigma}_{CAAR_{(a_1,a_2)}}} \quad (7)$$

Where $\hat{\sigma}_{CAAR_{(a_1,a_2)}}$ is the standard deviation for the cumulative average abnormal returns over our event window and N is the number of observations in the sample.

4.3. Regression

To investigate drivers of abnormal returns of green bond issuance events, we employ cross-sectional regression analysis. The selected variables have been considered as potential determinants of cumulative abnormal return in prior literature can be categorized into two groups: 1) firm characteristics, 2) bond characteristics. We determine both characteristics as control variables. Other control variables that we include in this study are the dummy variable to account for the crisis period, as well as dummy variables that capture country-specific and sector-specific effects. Any data from the financial statement is from the fiscal year before an announcement date. Moreover, we address the climate policy uncertainty, which is one of potential determinants of the abnormal returns as described earlier, as an independent variable.

4.3.1. Independent variables

CPU index is defined as the natural logarithm of the climate policy uncertainty index from Gavriilidis (2021) of the previous month before an announcement date, included as an independent variable.

4.3.2. Control variables

4.3.2.1. Firm-specific determinants of abnormal returns

Firm size is defined as the natural logarithm of the total assets owned by the firm. Investors seeking sustainable investment opportunities often prefer larger firms due to their history of stable returns and strong performance. The issuance of green bonds by larger firms is more likely to attract investors, leading to a greater positive stock price reaction to the announcement compared to small firms. This variable is included in Glavas (2018)'s study as prior research on bond issuance and its relationship with equity markets (e.g., Bradshaw et al., 2006; Spiess & Affleck-Graves, 1999) has shown that it plays a significant role in affecting stock market reaction.

The Return on Assets (ROA) ratio is a measurement of a firm's profitability, calculated as the issuer's net income divided by its assets. High ROA values generally correspond to more positive abnormal stock returns. This variable is widely used as a control variable in previous literatures.

Leverage is the issuer's debt to book value of total assets, more leverage can be implied that the firm is taking more risk, which would negatively impact the stock abnormal return. Prior literatures such as Lebelle et al. (2020) also include this variable.

Market-to-book ratio is calculated as the quotient of the difference between the book value of total assets and the book value of equity added to the market value of equity divided by the book value of total assets. Lebelle et al. (2020) found that it has positive relationship with the abnormal returns.

4.3.2.2. Bond-specific determinants of abnormal returns

The amount of bond issued is defined as the natural logarithm of bond size. This variable also used by Glavas (2018), larger amount issued should have more negative impact on the stock's

abnormal return. We expected a similar result because higher debt could lead to higher default risk.

Maturity is defined as the natural logarithm of the length of time until the principal amount of the bond is repaid to bondholders. The variable is expressed in years. Autio (2022) found that the maturity of green bonds has a notable positive effect on abnormal returns following their announcement.

Dummy for callable bond is equal to 1 if this is a callable bond; 0 otherwise. According to the signaling argument that a green bond offering signals the firm's dedication to the environmental causes. Glavas (2018) and Nylén (2021) use this variable in the regression. However, only Nylén (2021) that found the positive relationship between Dummy for callable bond and the abnormal returns. Since firms have the option to redeem the bond before its maturity date, it is considered as favorable feature for firms. Thus, we anticipate that green bonds with a callable feature may experience higher positive abnormal returns.

4.3.2.3. Other control variables

To account for the impact of the COVID-19 pandemic crisis, which caused an economic downturn and significant decline in global stock market indices, we incorporated a dummy variable representing the crisis period in our analysis. The dummy variable takes a value of 1 if the green bonds were issued during the crisis period and 0 otherwise.

Dummy for Country-specific effect is equal to 1 if green bonds issued by firms based in France; 0 otherwise. The consideration of country-level factors is widely acknowledged as crucial when investigating the determinants of cumulative abnormal returns. However, due to limited observations in our study, we only incorporated controls for announcements made by French companies, which constitute most of our dataset, to avoid overfitting in the regression model.

Furthermore, we consider the importance of sector differences since it may cause potential differential reactions to green bond issuance announcements in the European stock market. To account for this, we introduced a dummy variable for the power generation sector, which constitutes the majority of our sample. The dummy variable is equal to 1 if green bonds issued by firms in power generation sector; 0 otherwise. This allows us to capture any distinct effects that may arise from issuers' operating within this sector.

4.3.3. The Model

The model for an OLS regression analysis is as follows:

$$\begin{aligned} CAR_{i,(a_1,a_2)} = {} & \alpha + \beta_1 cpu_i + \beta_2 firmSize_i + \beta_3 roa_i \\ & + \beta_4 leverage_i + \beta_5 marketToBook_i \\ & + \beta_6 amountIssued_i + \beta_7 maturity_i \\ & + \beta_8 dCallable_i + \beta_9 dPostCrisis_i \\ & + \beta_{10} dCountry\_France_i \\ & + \beta_{11} dSector\_Power\_Generation_i + \varepsilon_i \end{aligned} \quad (8)$$

$CAR_{i,(a_1,a_2)}$ is the cumulative abnormal return of the event window before and after an event date, the independent variable, cpu_i, is defined in Section 4.3.1., other control variables are described in section 4.3.2., and ε_i is the error term.

To determine if there is a relationship between the CPU index and cumulative abnormal return, we set the significance levels of the t-test at 1%, 5%, and 10%.

5 Results and discussion

5.1. Event study results

5.1.1. Main results

To conclude the event study analysis, we conducted a test to determine whether the cumulative abnormal returns from the announcement of green bonds around the event day are statistically significantly positive.

Table 1 shows the event study results for different event windows. No significant positive window was observed, meaning that the stock prices of green bond issuers did not react positively to the green bond issuance announcements. Therefore, we reject hypothesis 1.

Contrary to the majority of previous studies that have examined the stock market reaction to green bond announcements, particularly within the European stock market using event study methodology, our findings reveal a distinct outcome. Instead of observing a positive response. Our results indicate a lack of positive reaction in the European stock market following the announcement of green bond issuances.

One key distinction between our study and previous ones lies in the length of the analysis period. This indicates that, over time, the initially observed positive effect of green bond issuance announcements by firms in the European stock market may become distorted.

5.1.2. Additional Findings

Since most of cumulative average abnormal returns within the event windows are negative, to explore the potential negative impact, we conducted an additional analysis that involved testing the significance of the negative cumulative abnormal returns associated with green bond announcements in the European stock market.

In Table 1, we observe negative cumulative average abnormal returns across various event windows. Specifically, our analysis reveals that only the cumulative abnormal return of approximately -0.28% over the two-day event window [0, +1] is statistically significantly negative at the 10% level. This result suggests that investors response negatively after the announcement of the green bond issuances.

In contrast to most of the previous literature exploring the European stock market reaction to the green bond announcement, our study presents a negative response from the stock market in relation to such announcements. However, the result supports the finding of Lebelle et al. (2020), which observed a negative effect of green bond announcements on the global stock market, particularly with developed countries' stock markets experiencing more pronounced negative abnormal returns. Considering that most of our sample consists of green bond offerings by firms in developed countries in Europe, our findings provide further support to the existing literature on these markets.

Regarding the length of the event window, the [0, +1] window is consistent with the pattern observed during green bond issuance announcements as found by Autio (2022) and Anders Pedersen (2019), who likewise focused on green bond announcements within the European stock market. Also, it's worth noting that Tang and Zhang (2020), pointed out researchers normally use a short window surrounding the event date when investigating bond issuances.

Table 1 Cumulative Abnormal Returns Surrounding the Announcement Period of Green Bond Issuances in the Event Windows.

	Mean	T-Statistic	Observations
CAR[−1,0]	0.0000	-0.0050	116
CAR[−3,0]	-0.0003	-0.1021	116
CAR[−5,0]	-0.0005	-0.1692	116
CAR[−7,0]	-0.0018	-0.5311	116
CAR[−10,0]	-0.0037	-0.7936	116
CAR[0,+1]	-0.0028*	-1.3008	116
CAR[0,+3]	-0.0019	-0.6328	116
CAR[0,+5]	-0.0021	-0.5170	116
CAR[0,+7]	-0.0055	-1.1286	116
CAR[0,+10]	-0.0042	-0.6203	116
CAR[−1,+1]	-0.0009	-0.4061	116
CAR[−3,+3]	-0.0003	-0.0869	116
CAR[−5,+5]	-0.0008	-0.1466	116
CAR[−7,+7]	-0.0055	-0.8507	116
CAR[−10,+10]	-0.0061	-0.7087	116

Notes: this table presents the results of a one-tailed t-test analysis for the cumulative abnormal returns. The means of cumulative abnormal returns over the evaluated event windows and the t-statistic are shown in columns 2 and 3. The last column reports the number of observations. The abnormal returns are calculated using the market model. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

To obtain more comprehensive results, we conducted a test to determine whether the cumulative abnormal returns from the announcement of conventional bonds, which were collected within the group of companies that issued green bonds, are statistically significantly negative. These conventional bonds serve as a control group in our analysis.

In Table 2, our observations show that the results of conventional bonds indicate a greater number of event windows displaying a significant negative reaction in the European stock market to bond announcements compared to green bonds. The significant event windows are the [0, +7], [−7, +7], [−10, +10], and [0, +10] windows with statistical significance at the 5%, 5%, 5%, and 10% level, respectively.

This result is consistent with the body of literature concerning conventional bond issuance announcements. For instance, Eckbo (1986) found that the stock market reaction to conventional bond issuances tends to be slightly negative within a short timeframe.

However, when we further conducted the two-sample t-test for unpaired data for testing differences between means of the cumulative abnormal returns for green and conventional bond issuance announcements. The result in Table 3 indicates that there is no statistically significant difference in the cumulative average abnormal returns between green and conventional bonds over the event windows.

Our study did not agree with any of previous studies, e.g., Wang et al. (2020), that compared the abnormal returns for green and conventional bond announcements and found that issuing green bonds generates significantly higher abnormal returns for firms compared to issuing conventional bonds.

Overall, the result implies that firms issuing green bonds did not experience greater abnormal returns compared to those issuing conventional bonds. It suggests that investors may react to the announcement of green bonds in a manner similar to conventional bonds, indicating a lack of distinctive abnormal return patterns for green bond issuances.

Table 2 Cumulative Abnormal Returns Surrounding the Announcement Period of Conventional Bond Issuances in the Event Windows.

	Mean	T-Statistic	Observations
CAR[−1,0]	0.0004	0.4691	362
CAR[−3,0]	0.0000	0.0251	362
CAR[−5,0]	-0.0006	-0.4034	362
CAR[−7,0]	-0.0018	-1.0983	362
CAR[−10,0]	-0.0018	-0.9032	362
CAR[0,+1]	-0.0006	-0.6422	362
CAR[0,+3]	-0.0007	-0.6530	362
CAR[0,+5]	-0.0015	-0.9980	362
CAR[0,+7]	-0.0033**	-1.8840	362
CAR[0,+10]	-0.0036*	-1.6044	362
CAR[−1,+1]	-0.0003	-0.2672	362
CAR[−3,+3]	-0.0009	-0.5728	362
CAR[−5,+5]	-0.0022	-1.1218	362
CAR[−7,+7]	-0.0052**	-2.1373	362
CAR[−10,+10]	-0.0055**	-1.7376	362

Notes: this table provides the results of our one-tailed t-test analysis for the cumulative abnormal returns. In columns 2 and 3, you can find the average cumulative abnormal returns across the event windows, along with the corresponding t-statistic. The last column indicates the number of observations included in our analysis. The abnormal returns were calculated using the market model. Significance levels are denoted by ***, **, and *, representing 1%, 5%, and 10% significance, respectively.

Table 3 Comparative Analysis of Cumulative Abnormal Returns for Green and Conventional Bond Announcements

	Mean		p-value		
	Green bonds	Conventional bonds	two-tailed	one-tailed: negative side	one-tailed: positive side
CAR[−1,0]	0.0000	0.0004	0.8477	0.4239	0.5761
CAR[−3,0]	-0.0003	0.0000	0.9174	0.4587	0.5413
CAR[−5,0]	-0.0005	-0.0006	0.9820	0.5090	0.4910
CAR[−7,0]	-0.0018	-0.0018	0.9986	0.4993	0.5007
CAR[−10,0]	-0.0037	-0.0018	0.7161	0.3581	0.6419
CAR[0,+1]	-0.0028	-0.0006	0.3470	0.1735	0.8265
CAR[0,+3]	-0.0019	-0.0007	0.7209	0.3604	0.6396
CAR[0,+5]	-0.0021	-0.0015	0.8778	0.4389	0.5611
CAR[0,+7]	-0.0055	-0.0033	0.6665	0.3332	0.6668
CAR[0,+10]	-0.0042	-0.0036	0.9260	0.4630	0.5370
CAR[−1,+1]	-0.0009	-0.0003	0.8048	0.4024	0.5976
CAR[−3,+3]	-0.0003	-0.0009	0.8941	0.5529	0.4471
CAR[−5,+5]	-0.0008	-0.0022	0.8066	0.5967	0.4033
CAR[−7,+7]	-0.0055	-0.0052	0.9726	0.4863	0.5137
CAR[−10,+10]	-0.0061	-0.0055	0.9548	0.4774	0.5226

Notes: this table displays the mean values of cumulative abnormal returns over the evaluated event windows for green and conventional bond announcements in columns 2 and 3. The p-values from the two-sample *t*-test for unpaired data assessing the null hypothesis, which examines whether the mean difference between cumulative abnormal returns for green and conventional bond announcements is equal to zero, whether the mean of cumulative abnormal returns for green bond announcements is greater than that for conventional bond announcements, and whether the mean of cumulative abnormal returns for green bond announcements is less than that for conventional bond announcements, are reported in columns 4, 5, and 6, respectively. The rows of the table capture the different pre-event windows and post-event windows. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

5.2. The regression results

5.2.1. Main results

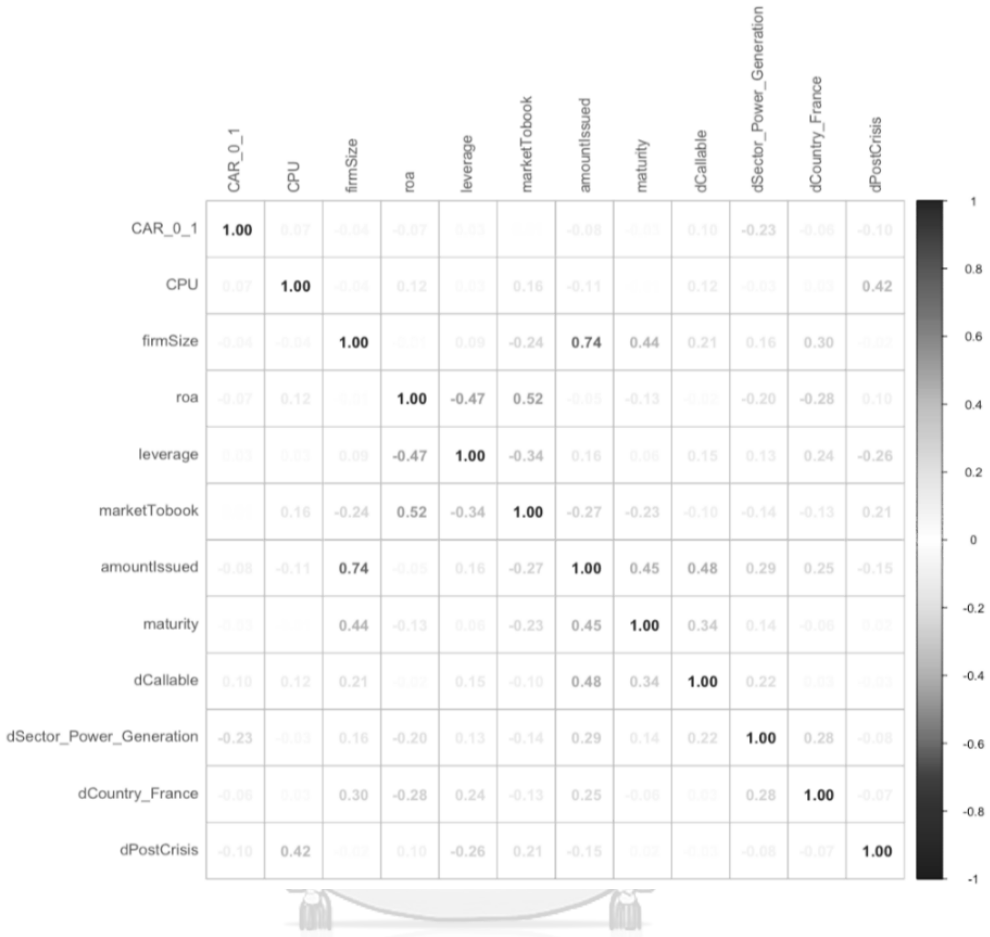
In addition to analyzing cumulative abnormal returns, we investigated the relationship between the cumulative abnormal returns and specific characteristics within our sample using regression analysis. We utilize the CAR [0, +1] as the dependent variable, as only this event window has shown significance in our event study findings. The independent variable and control variables are presented earlier in Section 4.3.

Before conducting the regression analysis, it is essential to assess the presence of multicollinearity, which occurs when there is a substantial linear correlation between the independent variables within the regression model. We have adopted the widely accepted rule of thumb, considering a correlation coefficient of 0.8 or higher as indicative of multicollinearity. Based on the data presented in figure 1, we determined that there is no multicollinearity in our regression models.

Furthermore, maintaining the assumption of constant variance for the error terms, referred to as homoscedasticity, is crucial for reliable analysis. Violation of this assumption can result in misleading standard errors of the variables and incorrect conclusions. To detect the presence of heteroscedasticity, the Breusch-Pagan test is commonly used. The null hypothesis of the test suggests homoscedasticity, while the alternative hypothesis suggests the presence of heteroscedasticity.

Table 4 displays the test results with insignificant p-values (i.e., p-value < 0.05), suggesting that the error terms in the model exhibit constant variance across the observations, known as homoscedasticity. This indicates that the original regression models are appropriate for the analysis.

Figure 1 Correlation coefficients.



Notes: this figure illustrates the correlation coefficients between the independent and control variables employed in this study.

Table 4 Breusch–Pagan heteroskedasticity test.

Model	p-value
Model (1)	0.7919
Model (2)	0.5859
Model (3)	0.1146
Model (4)	0.2129
Model (5)	0.1733

In the regression analysis, we construct the regression model (see Section 4.3.). By including the same variables in Model (1) and considering other factors that could influence the regression result, which are the period of crisis, country-specific effect, and sector-specific effect, using the dummy variables *dPostCrisis, dCountry_France,* and *dSector_Power_Generation*, respectively, in Models (2) and (3), we address the issue of omitted variable bias and uncover the significance of these determinant groups in explaining abnormal announcement returns.

As presented in Table 5, we found that cumulative abnormal returns are influenced by *dCallable, roa*, *dSector_Power_Generation*, and *dPostCrisis*. However, we did not gain a statistically significant relationship between the climate policy uncertainty and the cumulative abnormal return. Therefore, hypothesis 2, which is stated that there is a positive relationship between climate policy uncertainty and cumulative abnormal returns in the European stock market following the announcement of green bond issuance by publicly listed firms, is rejected.

As for the control variables, the estimated coefficient for *dCallable* is positive and statistically significant across all three models. This result suggests that companies issuing green bonds with callable features have experienced higher cumulative abnormal returns across the event window. This consequential finding aligns with the insightful findings put forth by Nylén (2021), who, in their study, also identified a positive relationship between the dummy variable for callable bonds and the observed patterns of cumulative abnormal returns. Since the callable feature allows firms to re-borrow at more advantageous interest rates before the bond's maturity, making it a favorable characteristic for firms, investors in the stock market may respond positively, resulting in an increase in the abnormal return.

Moreover, *roa* is found to be significant and negative for the Model (3). Although the negative impact of ROA on the cumulative abnormal return when a firm issues a green bond may seem contrary to common sense expectations, there is a potential explanation for this result. Firms with higher ROA are often regarded as successful firms with higher market expectations. The announcement of a new green bond offering is found by Lebelle et al. (2020) that could be perceived as a forthcoming shift in operational and capital expenditures or a departure from their established successful practices. Consequently, in light of these circumstances and factors, investors, who are concerned that the returns they desire may fall below their lofty expectations, may respond with a pessimistic sentiment, thereby triggering a downward trajectory in the abnormal return and, hence, causing it to decline.

While the *dCountry_France*, representing country-specific differences, did not show a significant impact on excess announcement returns, we observed significantly negative coefficients for the *dPostCrisis* and *dSector_Power_Generation* dummy variables. Other control variables are insignificant. These findings imply that country-specific effects, specifically in the case of France, may not have a substantial influence on the cumulative abnormal return from issuing green bonds. However, it appears that green bond issuances during the crisis period may have a more pronounced negative impact on returns compared to non-crisis situations.

Additionally, the sector of the issuer has significant means of determining the magnitude of excess announcement returns, with particular emphasis on the power generation sector. The significance of this sector lies in its important role in facilitating the transition process towards a green economy and the promotion of related environmental concepts. Green bonds issued by power generation firms are often seen as directly contributing to the net zero emissions, such as through financing renewable energy projects. However, it is important to note that power generation firms, especially those heavily focused on fossil fuels, might be perceived as having a risk of carbon lock-in, where their ability to transition to greener technologies is limited. As a result, the announcement of green bond issuances by these firms could potentially lead to negative abnormal returns due to concerns surrounding this perceived risk.

Overall, our findings indicate that the negative reaction observed in response to green bond issuance can be mitigated for issuers utilizing callable green bonds, as this feature provides benefits to the issuing firms. The callable features of green bond were not, however, the only the factor contributing to the lower cumulative excess green bond announcement returns. As discussed previously, ROA also generates a negative effect to these excess returns. Furthermore, our results suggest that if the issuing firms operate within the power generation sector and issue green bonds during a crisis period, it can further deteriorate the abnormal return.

Table 5 The results of the three regression analyses where CAR [0, +1] serves as the dependent variable.

Variables	Dependent variable		
	CAR [0, +1]		
	(1)	(2)	(3)
CPU	0.002	0.002	0.008
	(0.006)	(0.006)	(0.007)
firmSize	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)
roa	-0.066	-0.111	-0.133*
	(0.077)	(0.079)	(0.079)
marketTobook	0.001	0.001	0.002
	(0.003)	(0.003)	(0.003)
leverage	-0.001	-0.001	-0.010
	(0.017)	(0.016)	(0.017)
amountIssued	-0.005	-0.003	-0.004
	(0.003)	(0.003)	(0.003)
maturity	-0.001	-0.002	-0.002
	(0.004)	(0.004)	(0.004)
dCallable	0.009*	0.010*	0.010**
	(0.005)	(0.005)	(0.005)
dPostCrisis			-0.010*
			(0.005)
dCountry_France		-0.002	-0.003
		(0.007)	(0.007)
dSector_Power_Generation		-0.013***	-0.014***
		(0.005)	(0.005)
Constant	0.051	0.023	0.012
	(0.060)	(0.060)	(0.060)
Observations	116	116	116

Notes: the table reports the result for the OLS regression on the dependent variables CAR [0, +1]; two-tailed t-tests. ***, ** and * indicate a significance level of 1%, 5% and 10% respectively.

5.2.2. Additional analysis

As a consequence of our main analysis, we have identified a significant and negative coefficient associated with the crisis dummy variable, suggesting a potential detrimental effect of green bond issuance announcements on stock prices during crisis periods, we examine a subsample analysis. As the crisis period, or COVID-19 pandemic, is clearly defined as starting in early 2020, we narrowed down our dataset to include only observations from the non-crisis period spanning from 2014 to 2019. By doing so, we aim to obtain a clearer understanding of the specific outcomes that are not influenced by the crisis period, thereby providing deeper insights into the relationship between the cumulative abnormal return from green bond announcements and our independent and control variables.

Table 6 reports the result of the pre-crisis period analysis. In this analysis, we re-run the regressions with the same independent variables as in Models (3) using subsample as discussed earlier, but without including the *dPostCrisis* dummy variable, we found that cumulative abnormal returns are primarily influenced by *CPU*, *roa*, and *marketTobook*.

In the additional analysis, we observed the positive and significant for *CPU* at the 1% level for both Model (4) and (5), suggesting that the effect that cumulative abnormal returns increase with rising climate policy uncertainty is confirmed. It is interesting that the CPU index is able to explain the cumulative abnormal return resulting from the announcement of green bond offerings in the pre-crisis period.

Within this context, firms utilize the issuance of green bonds, as an instrumental approach to fostering sustainable practices, effectively signaling their dedication to environmentally friendly activities, particularly during periods of heightened climate policy uncertainty. Market participants may interpret these actions as a form of temporary hedging, aiming to mitigate potential decreases in share prices resulting from the climate policy uncertainty (Chan and Malik (2022); Pástor et al. (2021); Azimli (2023)). As a result, in times of great uncertainty, investors are more likely to place greater value on the announcement of green bonds. As anticipated, the cumulative abnormal returns increase in conjunction with the CPU index.

Table 6 The results for the two regressions with CAR [0, +1] as the dependent variable.

Variables	Dependent variables	
	CAR [0, +1]	
	(4)	(5)
CPU	0.019***	0.020***
	(0.006)	(0.006)
firmSize	0.002	0.004
	(0.003)	(0.003)
roa	-0.235**	-0.376***
	(0.098)	(0.124)
marketTobook	0.013	0.025**
	(0.010)	(0.012)
leverage	-0.020	-0.040
	(0.026)	(0.030)
amountIssued	-0.006	-0.006
	(0.004)	(0.004)
maturity	0.001	-0.003
	(0.005)	(0.005)
dCallable	0.006	0.009
	(0.005)	(0.006)
dCountry_France		-0.013
		(0.008)
dSector_Power_Generation		-0.004
		(0.005)
Constant	-0.010	-0.035
	(0.072)	(0.075)
Observations	34	34

Notes: the table reports the result for the OLS regression on the dependent variables CAR [0, +1]; two-tailed t-tests. ***, ** and * refer to significance at 1%, 5% and 10%, respectively.

In addition, the result from model (4) and (5) indicates that *roa* is negative and significant. This observation reinforces the notion, as discussed in the previous section, that the return on asset serves as an important determinant influencing the cumulative abnormal return. Our results also show a positive relationship between cumulative abnormal returns and firm growth opportunities in Model (5), as indicated by *marketTobook* as represented the market-to-book ratio. This suggests that the announcement of green bond issuance causes a stronger market reaction for firms with greater growth opportunities compared to those with lower growth opportunities. The finding is consistent with Lebelle et al. (2020).

Furthermore, the inclusion of dummy variables aimed at controlling for sector-specific and country-specific effects yields insignificant results. This suggests that during the pre-crisis period, the excess announcement return is not influenced by these variables. In other words, the specific sector in which the firm operates or the country in which it is located does not have a significant impact on the excess announcement return during this timeframe.

6 Conclusions and Future Research

This study aims to investigate the stock market's reaction to the announcement of green bond issuances in the European stock market, using the event study methodology. The results show a negative market reaction to the announcement of a new green bond issuance. Moreover, there is no substantial difference in the cumulative abnormal returns between firms issuing green bonds and those issuing conventional bonds. This suggests that investors respond to the announcement of green bonds in a similar manner to conventional bonds.

The interpretation of this result might be the effects of major events such as the COVID-19 pandemic. This global crisis introduced significant economic uncertainty worldwide, leading to increased risk-aversion among investors and maybe more cautious about new investments. Consequently, an announcement of a green bond offering during such a period of uncertainty may fail to induce the positive stock market reaction seen under more stable economic conditions.

This study also shed light on the factors influencing cumulative abnormal returns from green bond issuance announcements in Europe. We discovered that negative market reactions can be alleviated by issuers employing callable green bonds, providing benefits to the issuing

firms. However, factors such as return on assets, operation within the power generation sector, and issuance during a crisis period can further erode the abnormal return from the green bond issuance announcement. This underlines the importance of considering specific bond features, firm characteristics, sector dynamics, and timing when analysing the impact of green bond issuance on abnormal returns.

In addition, this study incorporates an analysis aiming to understand outcomes not influenced by the crisis period. We found that the CPU index conducted by Gavriilidis (2021) is able to explain the cumulative abnormal return from the announcement of green bond offerings in the pre-crisis period. This suggests that firms send a credible signal to commit towards the environmentally friendly activities to investors by issuing a green bond which will be received as temporary hedging tools for investors during periods of heightened climate policy uncertainty. Investors are more likely to place greater value on the announcement of green bonds, thereby potentially generating an increase in the issuer's share price.

Nevertheless, the results do not provide empirical evidence of the hedge positive effect arising from green bond issuance announcements during the period of the COVID-19 outbreak. This suggests that during this period investors prioritize their concerns about the uncertainty surrounding a firm's value in relation to green bond issuances, such as potential lower profits due to the higher costs associated with issuing these bonds, rather than recognizing the value generated through the commitment to environmental projects, leading to a negative impact following the green bond offering announcements.

Furthermore, the excess announcement return subsequent to green bond offerings can be explained by various firm and bond attributes, including return on assets, market-to-book ratio, and callable features. During the pre-crisis period, the excess announcement return is not significantly impacted by the power generation sector variable or the country of the issuer (represented by France). However, it is important to highlight that amidst periods of the COVID-19 pandemic, the specific sector demonstrates some influence on the abnormal return resulting from green bond issuances.

This study extends previous literature on green bonds, notably revealing the unfavourable market reaction towards green bond offering announcements within the European market and being, to the best of our knowledge, the first to exclusively examine the relationship

between the climate policy uncertainty and cumulative abnormal returns from green bond announcements.

However, this study has some limitations. A small sample size restricts data aggregation based on firm, sector, country, and period classifications, implying that the impact of green bond issuance announcements may vary across these factors. Moreover, future research should address the challenge of incorporating structural changes in samples that span longer time periods.

Appendix

Table A.1. Market Index by Country.

Country	Market Index
Austria	ATX Index
Belgium	BEL20 Index
Denmark	KFX Index
Finland	OMXHB Index
France	CAC Index
Germany	DAX Index
Greece	ASE Index
Italy	FTSEMIB Index
Lithuania	VILSE Index
Luxembourg	LUXXX Index
Netherlands	AEX Index
Norway	OBX Index
Poland	WIG20 Index
Portugal	PSI20 Index
Spain	IBEX Index
Sweden	OMXS30B Index
Switzerland	SMI Index
United Kingdom	UKX Index

Table A.2. Green Bond Issuances by Year.

Year	# of bonds	Amount issued (bn€)
2014	4	3.5000
2017	7	4.0771
2018	5	3.2000
2019	25	9.9564
2020	30	12.1566
2021	36	12.6267
2022	30	10.8770

Notes: this table reports the number and amount in billion euros of green bond issuances by year, converted using the exchange rate at the time of issuance, for green bonds issued by non-financial firms in Europe.

Table A.3. Green Bond Issuances by Country.

Country	# of bonds	Amount issued (bn€)	# of unique issuers
France	25	15.5680	9
Italy	20	9.4000	7
Austria	4	0.7030	3
Norway	12	1.3893	8
Denmark	6	4.0950	1
United Kingdom	6	2.4223	4
Portugal	6	4.5000	1
Finland	11	3.4604	4
Sweden	17	2.3346	9
Spain	5	0.5495	3
Germany	15	9.0585	9
Switzerland	4	0.5630	3
Netherlands	2	0.3650	2
Poland	2	0.7353	2
Greece	1	0.5000	1
Belgium	1	0.7500	1

Notes: this table presents the number and amount in billion euros of green bond issuances by issuer's country of domicile for green bonds issued by non-financial firms in Europe.

Table A.4. Green Bond Issuances by Industry.

BICS Level 1	BICS Level 2	# of bonds	Amount issued (bn€)
Communications	Cable & Satellite	1	0.2353
	Wireless Telecommunications Services	2	0.5717
	Wireline Telecommunications Services	1	0.7500
Consumer Discretionary	Retail – Consumer Discretionary	2	1.0000
	Travel & Lodging	2	1.4000
	Home Improvement	3	0.2837
	Auto Parts Manufacturing	1	0.4215
	Automobiles Manufacturing	1	1.0000
	Homebuilders	2	0.1943
Consumer Staples	Retail – Consumer Staples	1	0.5000
	Food & Beverage	8	1.1313
	Consumer Products	2	0.0870
Energy	Renewable Energy	3	0.1395
	Refining & Marketing	2	1.0000
Health Care	Health Care Facilities & Services	2	0.1203
Industrials	Industrial Other	3	0.6570
	Waste & Environment Services & Equipment	3	0.5000
	Transportation & Logistics	3	0.4316
	Manufactured Goods	2	0.7000
	Electrical Equipment Manufacturing	3	0.0764
	Machinery Manufacturing	2	0.1873
Materials	Forest & Paper Products Manufacturing	11	3.0979
	Chemicals	5	2.7328
	Metals & Mining	2	0.1837
Utilities	Power Generation	43	24.3929
	Utilities	27	14.5997

Notes: this table presents the number and amount in billion euros of green bond issuances by issuer's industry according to Bloomberg Industry Classification System (BICS) for green bonds issued by non-financial firms in Europe.

Table A.5. Green Bond Characteristics.

	Max	Min	Mean	Std.
Coupon (percent)	9.3500	0.0000	2.2785	1.7814
Maturity (year)	61.2904	1.6247	10.7881	13.5691
Amount (m€)	1,300.0000	2.0000	411.6342	306.4342

Table A.6. Green Bond Issuers' Characteristics.

	Max	Min	Mean	Std.
Total Asset (m€)	302.4380	0.0443	29.6176	50.4732
ROA (percent)	16.4751	-6.1384	3.4416	0.0365
Leverage ratio	0.9711	0.1516	0.6533	0.1549
Market to book ratio	5.9179	0.7982	1.4834	0.8451

Table A.7. Conventional Bond Characteristics.

	Max	Min	Mean	Std.
Coupon (percent)	8.0400	0.0000	1.8287	1.5019
Maturity (year)	61.0411	0.0274	7.4900	10.7619
Amount (m€)	1,500.0000	8.0000	283.0737	295.0630

Figure A.1. Histogram of Summary Statistics for Green and Conventional Bonds.

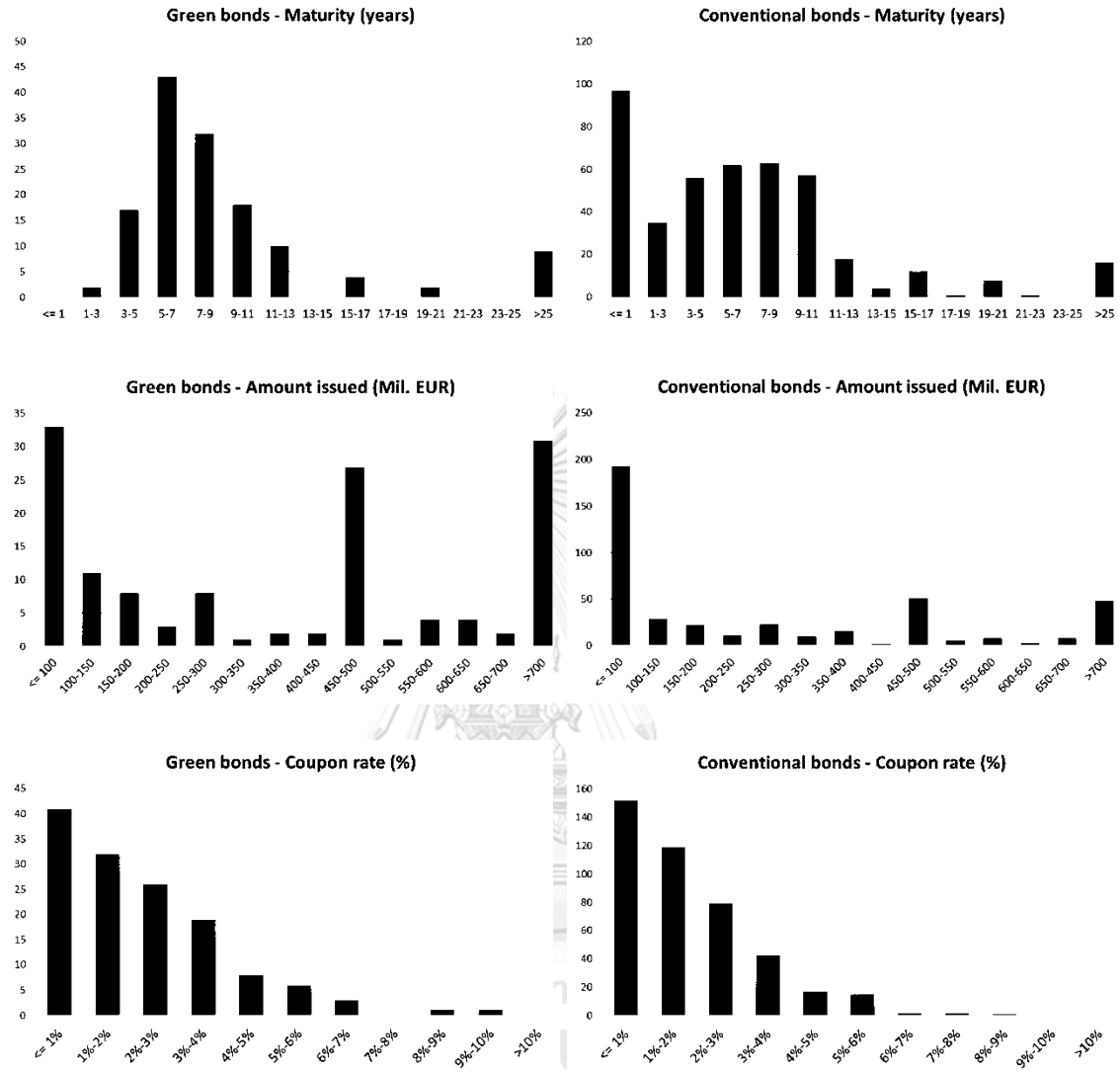


Figure A.2. Cumulative Average Abnormal Returns in Event Windows for Green Bond Issuance Announcements.

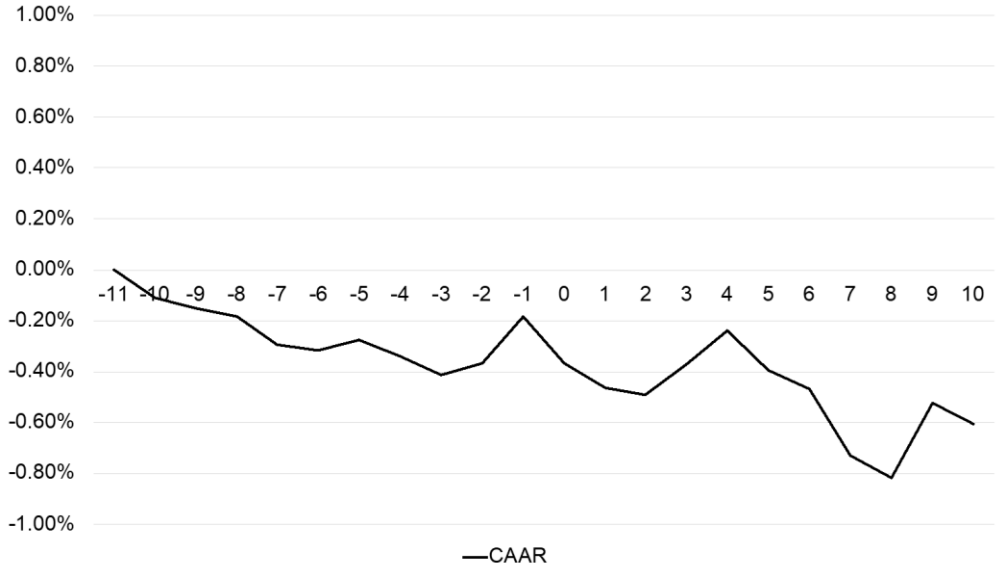
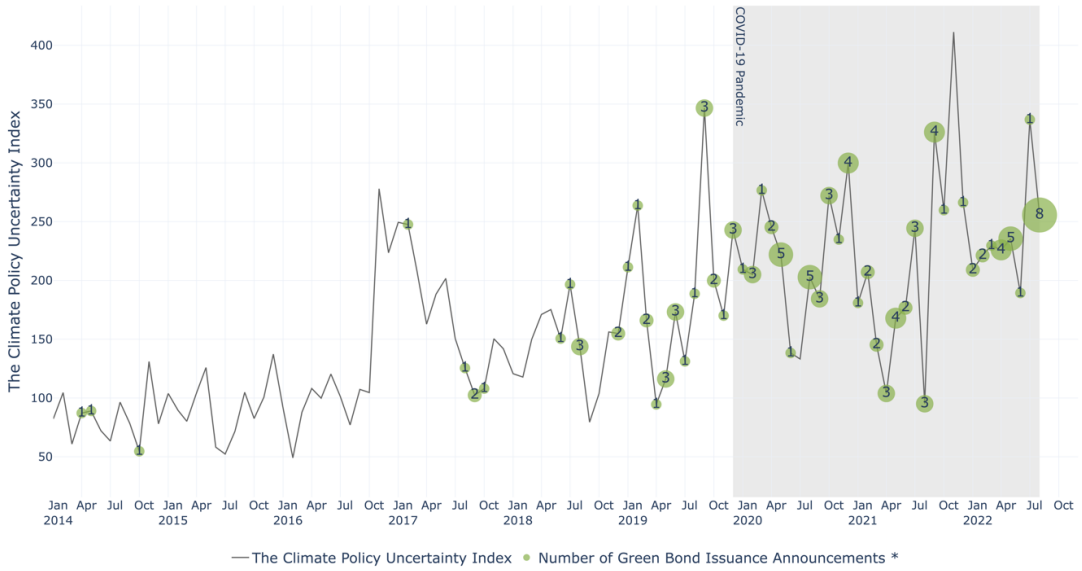


Figure A.3. The Climate Policy Uncertainty Index and Green Bond Issuance Announcements.



Notes: this figure illustrates the monthly time series sampled from January 2014 to August 2022, showcasing the dynamic fluctuations of the Climate Policy Uncertainty Index of Gavriilidis (2021). The figure includes the monthly count of green bond issuance announcements, where multiple tranches of green bonds are combined and counted as a single issuance. It's important to note that, in our regression analysis the index from the previous month is utilized. Therefore, the number of bond issuance announcements depicted in the figure corresponds to the subsequent month.

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