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Investors' Value Perception of Green and Brown Bond Issuances

An event study on green and brown bonds announcement effect on stock price returns before and after the EU taxonomy

by

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ABSTRACT

The purpose of this study is to investigate if the equity markets react more positively to the issuance announcement of a green bond compared to the issuance announcement of a brown bond and if the introduction of the EU taxonomy has had an effect on the announcement effects. The study contributes to the existing literature by using an updated sample of 511 bonds from 61 issuers stemming from countries within the EU and testing if investor behavior regarding the announcement effect has changed after introducing the EU taxonomy. The study uses an event-study methodology and regression analysis for robustness. It contributes to the existing literature as the results do not show any positive significant announcement effect on the stock price regarding the issuance of a green bond, but instead a significant negative effect after the announcement of brown bond issuance. Furthermore, the results suggest investors' value perception in regards to the announcement of green and brown bonds has changed after the announcement of the EU taxonomy.

Keywords: Green bonds, EU-taxonomy, Event study, Cumulative Abnormal Returns

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1. Introduction

In December 2015, the parties of the United Nations confirmed their ambition to hold the global average temperature well below 2 degrees and strive to limit it to 1.5 degrees by signing the Paris Agreement (OECD, 2017). In order to reach the targets, the European Commission underlined the need to transition financial and capital flows to green investments (European Commission, 2019). The financial market's response to the directives has been an increase in capital allocation towards more sustainable use of proceeds with green bond issuances of 500 billion USD in 2021 (Climate Bond Initiative (CBI), 2022), a 50% growth in comparison to 2020. Observing **Figure 1**, CBI estimates that green bond issuance will exponentially increase over time.

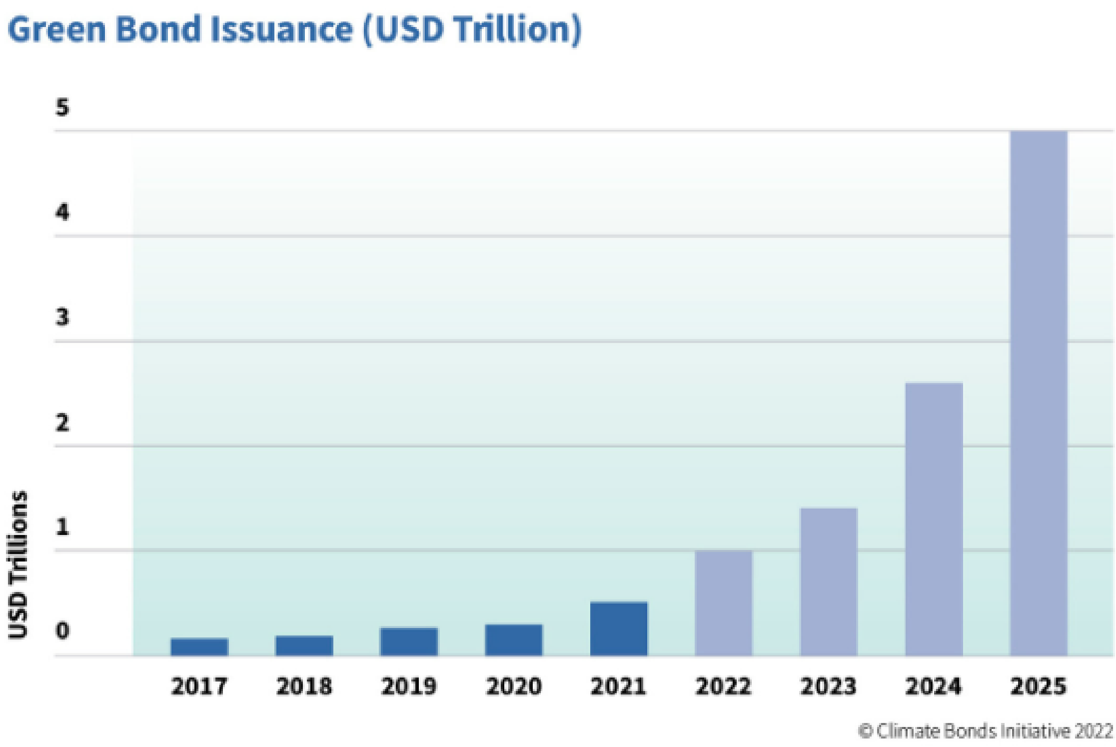


Figure 1. Green bond issuance in USD Trillion (CBI, 2021). The estimated increase in the issuance of green bonds issuance volume over time.

In March 2018, the European Commission announced a new action plan for sustainable growth (European Commission, 2019). Announced on the 22nd of June in 2020, the result was a taxonomy with the purpose of creating a classification system for environmentally sustainable economic activities (European Commission, n.d.). The benefits of the taxonomy are proposed to help translate the commitments to the Paris Agreement and the Sustainable Development Goals and reward the firms that pursue environmentally sustainable activities (TEG, 2020).

A green bond is defined as “any type of bond instrument where the proceeds or an equivalent amount will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible Green Projects” (ICMA, 2021, pp. 3). Following the Technical Expert Group’s (TEG) recommendation (European Commission, 2021), we use this definition as the “green” in green bonds. Bonds that do not fit into the definition will henceforth be called brown bonds. Besides the definition of green itself, there are other prerequisites that separate a green bond from a brown bond.

As sustainable investments and green bonds have increased in popularity over the years, empirical research on green bonds has followed the same trend. Many studies have been conducted in the field of yield discrepancies between green bonds and conventional bonds (Zerbib, 2020; Löffler, Petreski & Stephan, 2021; MacAskill, Roca, Liu, Stewart & Sahin, 2021), although only a few on equity investors’ value perception of green bond issuance announcement. Of those, the majority of studies have been conducted on a global market, while only two studies, conducted by Nylén (2021) and Pedersen & Thun (2019), have studied the green bond issuance announcement effect on the stock price on the European market. Nylén's (2021) and Pedersen & Thun’s (2019) results have been contradictory in terms of both positive and negative bond issuance announcement effects on the stock price.

We find reasons to follow Nylén (2021) and Pedersen & Thun (2019) and investigate the European market solely instead of a global market. To elaborate, there are regional differences in market maturity, as Europe’s compounded annual growth rate (CAGR) is 1% in sustainable investments, whereas the United States is 17% and Asia and Australia is 36% Global Sustainable Investment Alliance (2021). Thus, investors’ value perception of green bond issuances can be different between regions. Furthermore, the degree of transparency is higher in European economies in relation to the global average (Transparency International, 2022), making the signal less valuable in terms of information. On that note, the European market is more appropriate to investigate due to the EU taxonomy forcing firms to follow the same non-financial reporting requirements regarding environmental operations (TEG, 2020).

Hence, by analyzing investors' value perception of a bond's "green" flag, we can expect every issuer to have similar information for every bond issuer.

Therefore, we will contribute with further studies of the relationship between the value perception of bond issuance announcements. We will estimate if there is a difference in the value perception between the green and the brown bond issuance announcement effect on the stock price. In addition, we will investigate if the introduction of the EU taxonomy has influenced investors' value perception of the "green" flag of bonds. Therefore, we will provide a comparison between bonds announced before and after the EU taxonomy was announced. To estimate investors' value perception of bond issuances, we utilize MacKinlay's (1997) event study methodology to estimate the relationship between the green bond issuance announcement effect on the stock price and regression analysis to confirm the relationship further.

To conduct our event study methodology, we construct our sample of all publicly listed corporate bonds, excluding financial issuers, issued in the EU between 2015-12-13 and 2022-04-25 with the Bloomberg database as our data source. Thus, a final sample of 511 bonds was issued by 61 firms, out of which 356 bonds are classified as brown and 155 as green. Subsequently, we collect each firm's stock returns and the corresponding market returns from Factset. After the collection of returns, we conduct the event study methodology where the bond issuance announcement date serve as our event for samples consisting of solely green bonds, solely brown bonds, solely bonds announced before the taxonomy announcement (henceforth, pre-taxonomy), and solely bonds after the taxonomy announcement (henceforth, post-taxonomy). Furthermore, we use the t-test and Boehmer, Musumeci & Poulsen's (1991) standardized cross-sectional test to verify the significance of our results.

The results from the event study showed insignificant Cumulative Abnormal Average Returns (henceforth, CAAR) for green bond issuance announcements and a significant CAAR for the event window [-10, 10] of -1.073% for the brown issuance announcements. Furthermore, we found a significant negative CAAR of -2.265% for brown bonds after the EU taxonomy was announced. Hence, we found a similar relationship between the green and brown issuance announcement effect on the stock price as in previous studies, but where investors view brown bonds as value-diminishing instead of green bonds as value-enhancing.

A result partially aligning with previous results found in this field of study while contradicting some. Hence, our study contributes to the field of study with new results, suggesting a change in investors' value perception of green bond issuances and the value-perception of brown bond issuances. Indicating a shift from rewarding firms’ that pursue sustainable operations to punishing firms that do not.

The remainder of the study is organized as follows; in section 2, we provide an overview of the current literature on green bonds and outline our hypotheses. In section 3, we present the data utilized in our study and its descriptive statistics. In section 4, we explain our methodologies and their respective results. In section 5, we conduct a discussion of our results. Lastly, in section 6, we conclude our study.

2. Literature Review and Hypotheses

Corporate social responsibility (CSR) and its effect on firm value have been an increasingly popular subject. Events such as the 2015 Paris agreement and the introduction of the EU taxonomy in 2020 signal policymakers' increasing focus on environmental issues. Chava (2014) shows a connection between the environmental profile of a company and its cost of capital and further suggests that the company’s environmental concerns are taken into account by both investors and lenders. Ratajczak & Mikołajewicz (2021) finds that the long-term cost of debt decreases for firms engaging in environmental CSR. Similarly, El Ghoul, Guedhami, Kwok & Mishra (2011) find that environmental policies are one of the CSR dimensions that decreases a firm's cost of equity. Given this background, this paper contributes to the literature by comparing the green and brown bond markets with an updated sample and investigating if the introduction of the EU taxonomy has had any effect on the market reaction to green bond issuance.

Much of the previous literature regarding green bonds has focused on whether green bonds are quoted with a premium compared to brown bonds. Zerbib (2020) finds that the yield of green bonds, on average, was two basis points lower than that of a brown bond. Löffler, Petreski & Stephan (2021) also find a lower yield for green bonds, both on the primary and secondary market, which would suggest a green bond premium. In MacAskill et al.’s (2020) literature review on the green premium in the bond markets, they conclude that there is not a consensus regarding the premium. Their review found that 56% of studies find a green premium on the primary market, and 70% find a green premium on the secondary market.

The research conducted on the stock price reaction after the issuance of a green bond has mostly agreed that there is a positive stock price reaction in connection to the issuance of a green bond. Tang & Zhang (2020) researched the stock price reaction after a green bond announcement. Analyzing a global sample of solely green bonds issued by public issuers, their findings were a positive green bond issuance announcement CAAR of 1.4% in the event window [-10, 10].

Analyzing a global sample of public, non-financial, issuers between 2013 and 2018, Glavas (2020) showed a significant positive stock price reaction to the announcements of green bond issuances compared to brown bond’s. The green CAAR ranged between 0.46% and 0.57%, whereas the brown CAAR was estimated to 0.14%, in the event windows [0, 1] and [0, 0]. The positive reaction was larger after the Paris agreement, suggesting that investors anticipate future regulations and value green investments higher.

Flammer (2021) analyzed a global sample of public issuers, between 2013 and 2018 with findings of a significant positive stock price reaction to the announcement of green bond issuances. The CAAR was estimated to 0.49% with an event window of [-5, 10]. In the paper, Flammer states that this is consistent with the signaling argument and that the firm actually improves its environmental performance after the issuance.

Lebelle, Lajili & Sassi (2020) also used a global sample to investigate the announcement effect between 2009 and 2018. In contrast to previous studies, they found a significant negative effect on the stock price for green bond announcements with CAARs ranging from -0.5% to -0,2% with the event windows [0, 1], [-1, 1] and [-20, 20].

Pedersen & Thun (2019) contributed to the field of bond issuance announcement effect on the stock price with the first European-based sample. The sample constructs of green and brown bonds issued by publicly listed firms, excluding financials, announced between 2013 and 2019. Moreover, they found a significant CAAR of 0.37% for green bonds in the event window [0, 1].

Nylén (2021) contributed to the field of study with an extensive study on the bond issuance announcement effect on the stock price. Investigating a European sample consisting of publicly listed, non-financial green bonds between 2013 and 2020, she found a controversial result with both significant negative and positive bond issuance announcement effects on the stock price. The lowest negative CAAR of -0.195% was computed with the event window [-1, 1], and the positive CAAR was computed with the event window [-5, 5]. In other words, a short-term negative effect and a long-term positive effect.

With the exception of Tang & Zhang (2020), the common ground for the named studies' in the field of green bond issuance announcement effect on stock price is the use of regression analysis to isolate the "green" flag's effect. More specifically, previous studies include CAR of each event as the dependent variable and bond-specific characteristics, firm-specific characteristics, and a dummy variable for the “green” flag in bonds as explanatory variables. The regression then provides the explanatory power of the bond’s “green” flag in each event.

Observing **Table 1** below, there is no unanimous conclusion regarding the green bond issuance announcement’s effect on the stock price. Studies have found both significant negative and positive announcement effects on the stock price. However, most studies have varied significances in their results, which in turn is estimated with different event windows. Moreover, the difference in each study’s sample construction is sometimes large. One reason can be found in the exponentially growing green bond market, where the delimitation of each study becomes more sensitive for the final sample, as it is expected that more bonds will be existent for studies conducted on a more recent market than before. In addition, there are mainly three bond inclusion criterions creating differences in each study’s sample; the time frame of investigation, a globally based sample or a European-based, and exclusion of financial firms or not. The general findings have been a positive green bond issuance announcement effect on the stock price for studies conducted on a global market between 2009 and 2018, although Lebelle, Lajili & Sassi (2020) found contradicting results in the most recent global sample. Furthermore, the studies conducted with European-based samples are the most recent samples, investigating a sample until 2020, and have found ambiguous results with similar delimitations. Hence, we believe there is reason to further investigate the relationship between the bond issuance announcement and the stock price with the most recent sample of the European market. To increase the comparability of our results, we follow similar bond inclusion criteria as Pedersen & Thun (2020) and Nylén (2021). In addition, we follow Glavas (2020) and Pedersen & Thun (2020) and provide a comparison between the green and the brown announcement effect on the stock price. Lastly, we investigate whether the difference between the green and brown bond issuance announcement effect on the stock price has changed after the announcement of the EU taxonomy introduction.

Table 1 Overview of previous studies in the field of green bond issuance announcement effect on stock price

Author	Event windows with significance	Data	Time frame	Green bond results
Tang & Zhang (2020)	[-10, 10]	Global sample of solely green bonds issued by public issuers. 132 individual issuers.	2010 - 2017	Positive announcement effect **CAAR: 1.4%**
Glavas (2020)	[0, 1] [0, 0]	Global sample of both green and brown bonds, issued by publicly listed non-financial issuers. 74 individual issuers.	2013 - 2018	Positive announcement effect **CAAR: 0.46% – 0.57%**
Flammer (2021)	[-5, 10]	Global sample of solely green bonds, issued by public listed firms and non-corporate issuers. 400 individual issuers.	2013 - 2018	Positive announcement effect **CAAR: 0.49%**
Lebelle, Lajili & Sassi (2020)	[0, 1] [-1, 1] [-20, 20]	Global sample of solely green bonds, issued by publicly listed firms and non-corporate issuers. 145 individual issuers.	2009 - 2018	Negative announcement effect **CAAR: -0.5% – -0.2%**
Pedersen & Thun (2019)	[0, 1]	European sample of both green and brown bonds, issued by publicly listed non-financial issuers. 54 individual issuers.	2013 - 2019	Positive announcement effect **CAAR: 0.37%**
Nylén (2021)	[0, 1] [-1, 1] [-5, 5]	European sample of solely green bonds, issued by publicly listed non-financial issuers. 61 individual issuers.	2013 - 2020	Positive and negative announcement effect **CAAR: -0.195% – 0.333%**

Given the previous literature regarding the stock price reaction to the announcement of green bonds, we will investigate whether the announcement effect is still present in the market. This, combined with the increasing focus from policymakers on environmental issues, leads us to believe that the announcement of green bonds will have a more positive effect than that of brown bonds. Therefore, the following hypotheses are formulated:

H1: There is a positive announcement effect on the stock price after a firm announces the issuance of a green bond.

H2: The bond issuance announcement effect is positively larger for green bond announcements than for brown bond issuance announcements.

As previously stated, Glavas (2020) investigated if there was a difference in the stock price reaction at green bond announcements before and after the Paris agreement. As his results suggest that the effect has been stronger after the Paris agreement, it could be that other, environmentally important events could have the same effect on the announcement effect. As the EU taxonomy system helps to classify sustainable investments, it could help to mitigate issues such as greenwashing (European Commission, 2019). By introducing this clearer classification of sustainable financing, investors with a preference for green investments should be able to more easily identify their desired investment opportunities and have increased certainty that the investment is, in fact, sustainable. Given this, the following hypothesis is formulated:

H3: The announcement effect is positively larger for green bond issuance announcements than for brown bond issuance announcement after the EU taxonomy was introduced

3. Data Collection

3.1 Sample construction

Constructing our sample, we use Bloomberg as our source for data collection. The reason is mainly that Bloomberg's definition of a green bond is close to identical to International Capital Market Association's (henceforth, ICMA) definition for which the use of "proceeds are exclusively toward new and existing green projects, defined as projects and activities that promote climate or other environmental sustainability purposes" (Tang & Zhang, 2020). Moreover, we investigate the stock market reaction for firms affected by the introduction of the EU taxonomy. Therefore we choose to limit the sample to bonds issued by publicly listed firms within the EU between 2015-12-13 and 2022-04-25. The choice of the time frame is derived from Glavas' (2020) identification of change in investors' value perception of green bond announcements after the Paris Agreement in 2015. Hence, we choose to no collect data before the introduction of the Paris Agreement, 2015-12-13, in order to solely include investors with similar value perception. In similarity to Glavas (2020), Pedersen & Thun (2019), and Nylén (2021), we choose to exclude financial firms since the nature of their bond issuances can differ from the rest of the industries. Furthermore, we use Bloomberg's filtering function in order to exclude bonds missing data on either the coupon, the maturity date, the "green" flag, the control variables used in the regression (outlined in section 4.3), and the bond issuance announcement date. This resulted in a sample consisting of 2849 bonds issued by 662 firms, whereof 2532 bonds are brown, and 317 are green. Ultimately, we exclude all bonds from issuers who solely had issued brown bonds or green bonds, in line with Glavas (2020) and Pedersen & Thun (2019). This reduces the sample to 619 bonds issued by 70 firms, whereof 441 bonds are brown, and 178 are green.

The market index prices were collected from Factset, similar to Lebelle, Lajili & Sassi (2020), as well as the stock prices for all firms and firm characteristics. Following Pedersen & Thun (2019), we compute our market returns from each country's leading market index. This is, for example, OMX-30 for Swedish firms, the DAX index for German firms, and the CAC-40 for French firms.

In order to conduct an event study on investors' value perception of the "green" flag in issuers' bond announcements properly, we exclude bonds for which one bond's event window overlaps with another from the same issuer (further explanation of the methodology and alleviation of clustering problems is provided in section 3.3). This results in a final sample consisting of 511 bonds issued by 61 firms, where 356 bonds are brown, and 155 are green.

Lastly, in the case when a firm issues several tranches of a bond on the same event day, we choose to follow Nylén (2021) and merge those issuances into one event. Hence, our sample comprised 380 events, of which 257 are brown, and 123 are green.

3.2 Descriptive statistics

Our final sample study consists of green and brown bonds from publicly listed, non-financial issuers based in EU member states. As shown in **Table 2**, Sweden, Germany, and France are the most frequent issuers as they constitute more than two-thirds of the total sample. A similar trend can be found when analyzing green bonds, where Sweden, Germany, and France constitute the most frequent non-financial green bond issuers.

As discussed in the Literature Review (section 2), the samples differ between each study. The studies investigating a global sample (Tang & Zhang, 2020; Flammer, 2021; Lebelle, Lajili & Sassi, 2020; Glavas, 2020) most frequent issuers are in general China, the United States, and France, whereas the studies investigating a European sample (Nylén, 2021; and Pedersen & Thun, 2019) most frequent issuers were France, Spain, and Germany, and Sweden, France, and Spain, respectively.

Table 2. A geographical overview of event distribution in the EU.

Country	Green event Frequency	Green event Percent	Total event Frequency	Total event Percent
Austria	5	4.1%	13	3.4%
Belgium	6	4.9%	26	6.8%
Czech Republic	3	2.4%	14	3.7%
Germany	15	12.2%	67	17.6%
Denmark	1	0.8%	4	1.1%
Spain	3	2.4%	5	1.3%
Finland	5	4.1%	10	2.6%
France	19	15.4%	80	21.1%
Italy	12	9.8%	31	8.2%
Netherlands	2	1.6%	6	1.6%
Poland	3	2.4%	9	2.4%
Portugal	5	4.1%	6	1.6%
Sweden	44	35.8%	109	28.7%
Total	123		380	

Analyzing **Table 3**, we observe a slight difference in *Amount issued* between green and brown bonds. A contradictory finding, as Glavas (2020) explains that green bonds' use of proceeds are more specific and, therefore, lower in relation to brown bonds. Thus, an indication of a potential change in green bond's use of proceeds. Furthermore, we observe a similar mean coupon rate. The mean maturity differs by close to two and a half years, while the other descriptive statistics are similar. An indication of a larger proportion of green bonds with longer maturity than brown. Moreover, the difference in mean maturity could explain the large difference between the maximum amount issued on a green bond in relation to a brown bond. In other words, one could argue a bond with longer maturity is more likely to be issued with a larger amount than a bond with shorter maturity.

Table 3. Summary of descriptive statistics for green and brown bonds.

Summary of descriptive statistics over green and brown bonds between 2015 - 2022. Amount issued is denominated in million USD, Maturity is computed in years, and Coupon is in whole percent.

Variable	N	Mean	Median	Standard deviation	Minimum	Maximum
Green bonds						
Amount issued	155	468.6	507.11	496.5	0.5	3358.6
Maturity	155	11.2	7.02	14.7	2.0	61.3
Coupon	155	1.4%	1.0%	1.0%	0.0%	5.0%
Brown bonds						
Amount issued	356	417.2	253.3	446.3	0.2	2000.0
Maturity	356	8.6	7.0	7.9	2.0	61.0
Coupon	356	1.5%	1.3%	1.3%	-0.2%	7.7%

4. Stock price Reaction to Bond Issuance Announcement

To estimate the effect a bond issuance announcement has on the stock price, we will use an event study methodology. The purpose of the event study is to investigate whether there is a relationship between bond announcements and stock price movement for green and brown bonds. Subsequently, we conduct an OLS regression analysis with the purpose of isolating the "green" announcement effect on the stock price from firm-specific and bond-specific effects.

4.1 Event study

To estimate investors' value perception of the "green" flag in issuers' bond announcements, we choose to conduct MacKinlay's (1997) short-term event study methodology with the influence of Boehmer, Masumeci, and Poulsen's (1991). The purpose of an event study is to measure the effect a certain event has on the value of a firm (MacKinlay, 1997). In our case, the event in interest is the bond issuance announcement date on the stock price and not the bond issuance date. This is due to the nature of the stock market, for which the stock price reaction from a bond issuance is expected to be incorporated in the stock price after the bond announces its issuance and not when the bond is issued (MacKinlay, 1997). Hence, to capture the effect of bond issuance, we observe the abnormal returns around the bond issuance announcement date. In addition, the methodology aligns with the theory of (semi-strong) efficient markets, since it is expected that the new information is incorporated into the stock price immediately after its announcement.

The format of our event study is an estimation window of 250 trading days, as suggested by MacKinlay (1997), and several event windows with the longest spanning ten days before and after the bond issuance announcement date, as suggested by Tang & Zhang (2020). Similar to the entire field of study, our choice of event window is to account for the risk of information leakage before the bond issuance announcement and for the risk of a delayed market reaction to the bond issuance announcement.

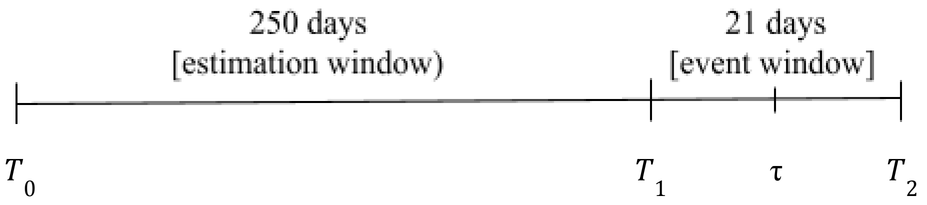


Figure 2. Overview of the event study format (MacKinlay, 2019).

In **Figure 2** we visualize the structure of the event study, where the estimation window is $L_1 = T_1 - T_0$ = 250 days and the event date is $\tau = 0$ with an interval of [-10, 10] days, meaning the event window is $L_2 = T_2 - T_1$ = 7 in total.

To estimate the Abnormal Return (henceforth, AR), we use the market model, in line with MacKinlay (1997), Glavas (2020), Nylén (2021), Lebelle, Lajili & Sassi (2020) and Pedersen & Thun (2019). Hence, we collect the total stock return and each country's market returns from Factset. Subsequently, we estimate the AR as:

$$AR_{it} = R_{it} - \left(\widehat{\alpha}_i + \widehat{\beta}_i R_{mt}\right), \tag{1}$$

where AR_{it} is the Abnormal Return for security *i* on day *t*, R_{it} is the return on security *i* on day *t*, $\widehat{\alpha}_i$ and $\widehat{\beta}_i$ parameters estimated by an ordinary least square regression of R_{it} and R_{mt}, where R_{mt} is the market return for index *i* on day *t*.

Furthermore, we compute the Cumulative Abnormal Return (henceforth, CAR) by summing up the AR's between T_1 and T_2, and the CAAR by dividing the CAR with the number of event studies, N:

$$CAR_i(T_1, T_2) = \Sigma_{t=T_1}^{T_2} AR_{it} \ , \tag{2}$$

$$CAAR(T_1, T_2) = \frac{1}{N}\Sigma_{i=1}^{N} CAR_i \tag{3}$$

To ensure the AR's and CAR's statistical significance, we need to account for the issues arising when conducting an event study methodology. The first issue is raised by MacKinlay (1997), where the assumption of cross-sectional independence between events can lead to statistical misspecifications. More specifically, if clustering of event dates is present in the sample there is a possibility of cross-sectional correlation between the firms' AR's. On a firm-specific level, we account for this by removing bonds that are announced within [-10, 10] days of each other. However, we believe this to be a limited problem for our entire sample due to the nature of bond issuances is not cyclical. This assumption is in line with Glavas (2020). In addition, we will account for the potential clustering problems by conducting Boehmer, Masumeci, and Poulsen's (1991) standardized cross-sectional test. The test will be presented later in this section.

Another issue Boehmer, Masumeci, and Poulsen (1991) raises is the increased variance around the event date. Thus, inappropriate rejection rates for the null hypothesis become present, since the critical value from the t-test is computed solely using the estimation window. Hence, they propose the standardized cross-sectional test, where the test statistic accounts for the increased variance in the event window. Together with the standard t-test, this will construct our parametric tests. To conduct Boehmer, Masumeci, and Poulsen's (1991) standardized cross-sectional test, we compute the variance of the CARs by:

$$S^2_{CAR_i} = S^2_{AR_i}\left[L_i + \frac{L_i^2}{M_i} + \frac{(\Sigma_{t=T_1+1}^{T_2}(R_{m,t} - \bar{R}_m))^2}{\Sigma_{t=T_0}^{T_1}(R_{m,t} - \bar{R}_m)^2}\right], \text{ where} \tag{4}$$

$$S^2_{AR_i} = \frac{1}{M_i - 2}\Sigma_{t=T_0}^{T_1}(AR_i)^2 \tag{5}$$

where $S^2_{AR_i}$ is the variance for AR for event i, L_i denote the number of AR's in the event-window for event i, M_i denotes the number of AR's in the estimation window for event i, and $\bar{R}_m$ is the average market return in the estimation window. Subsequently, we standardize each CAR_i by dividing it by its respective S_{CAR_i}, in order to compute the variance of the standardized average CAR as:

$$S^2_{\overline{SCAR}} = \frac{1}{N-1}\Sigma_{i=1}^{N}(SCAR_i - \overline{SCAR})^2 \tag{6}$$

$$\overline{SCAR} = \frac{1}{N}\Sigma_{i=1}^{N} SCAR_i \qquad (7)$$

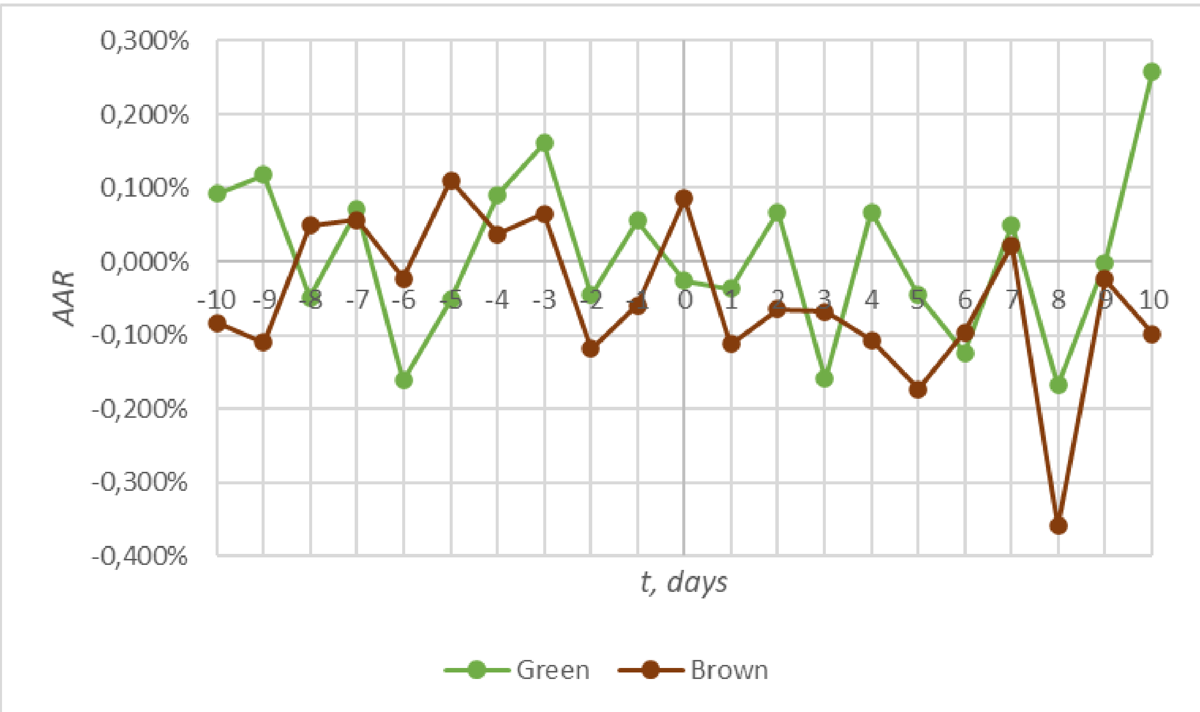
$$Z_{BMP} = \sqrt{N}\,\frac{\overline{SCAR}}{S_{\overline{SCAR}}} \qquad (8)$$

where $S^2_{\overline{SCAR}}$ denote the variance of the standardized average CAR, *N* denotes the number of events, $SCAR_i$ denote the standardized CAR for event *i*, $\overline{SCAR}$ denote the average standardized CAR, and Z_{BMP} is the test statistic. The Z_{BMP} follows a standard normal distribution.

4.2 Results from event study

In **Figure 3**, we give a visual representation of the AARs for green and brown bonds announcement effect on the stock price ten days before and after the announcement date. Although due to insignificance for our overall findings, we refer to **Appendix 1a and 1b** for tests, calculations, and results for the green and brown daily AARs**.**

Figure 3. Average abnormal returns for the event window [-10, 10] for green and brown bonds



In **Table 4** we observe the CAARs of the entire green and brown sample for six different event windows with both a t-test and BMP-test. The event windows span from [-10, 10] to [0, 0] around the bond issuance announcement date. The green bond sample show an insignificant relationship between green bond issuance announcement and the stock price for every event window and for both tests. In the brown sample's event window [-10, 10], we find a CAAR of -1.073% on a 5%-significance level. Thus, we observe a significant difference in stock price reaction between green bond issuance announcements and brown bond issuance announcements. Therefore, the results suggest that the **H1 hypothesis** is not valid, as the green bond issuance announcement effect on the stock price is not significantly different from zero. On the other hand, as the brown bond issuance announcement effect on the stock price is significantly negative, the results suggest a valid **H2 hypothesis**.

In **Table 5** below, green bonds are divided into samples of pre- and post-announcement of the EU taxonomy. Identical to **Table 4**, we show CAARs computed on event windows between [-10, 10] and [0, 0] tested with the t-test and BMP-test. Observing the results, we find no significant CAAR in any event window. Therefore, we find no suggestion to a change in investors' value perception of green bond issuance announcements on the stock price before and after the EU taxonomy was announced.

Furthermore, **Table 6** shows the results for brown bonds pre- and post the announcement of the EU taxonomy. For the event window [-10,10], the results compute to a negative CAAR of 2.265% significant at the 1% level for both the t-test and BMP-test on the post taxonomy announcement subsample. For the same event window on the subsample of pre taxonomy announcement, the CAAR is not significantly different from zero. In the post taxonomy announcement subsample, the CAAR for the event window of [-5,5] is negative 0.859% and significant at the 10% level while the pre taxonomy announcement subsample is not significantly different from zero. These results indicate that investors' value-perception has changed after the announcement of the taxonomy by reacting significantly negatively to brown bond issuance announcements. Hence, the results suggest a valid **H3 hypothesis**, as investors' value perception of green bond issuance announcements, in comparison to brown bond issuance announcements, has changed after the announcement of the EU taxonomy.

Table 4. The entire sample's Cumulative Average Abnormal Returns around the bond issuance announcement date

*The table shows the Cumulative Average Abnormal Returns for green and brown bonds around the bond issuance announcement date between 2015 - 2022. We have six different event windows. The event windows range from three to zero days before and after the announcement date. We also show the number of events in each computation of CAAR for each type of bond. The CAAR is presented in percent. Subsequently, we show the performed test statistics for the CAARs and their significance level with p-values in parenthesis. The tests are the t-test and Boehmer, Masumeci, and Poulsen's (1991) standardized cross-sectional test. Details of the tests are elaborated in section 4.1. Significance levels of 1%, 5% and 10% are denoted with *, ** ,and ***, respectively.*

Event Window	**Type of announcement**	**Number of events**	**CAAR**	**t-stat (p-value in %)**	**BMP Z-stat (p-value in %)**
[-10, 10]	Green bond	123	0.158%	0.233 (0.816)	0.007 (0.994)
	Brown bond	257	-1.073%	-2.131** (0.034)	-1.664* (0.096)
[-5, 5]	Green bond	123	0.075%	0.163 (0.871)	0.559 (0.576)
	Brown bond	257	-0.405%	-1.374 (0,171)	-0.852 (0.394)
[-3, 3]	Green bond	123	0.014%	0.042 (0.967)	0.400 (0.689)
	Brown bond	257	-0.272%	-1.110 (0.268)	-0.719 (0.472)
[-1, 1]	Green bond	123	-0.008%	-0.035 (0.972)	-0.074 (0.941)
	Brown bond	257	-0.086%	-0.433 (0.655)	-0.381 (0.703)
[0, 1]	Green bond	123	-0.064%	-0.302 (0.763)	-0.184 (0.854)
	Brown bond	257	0.027%	0.166 (0.868)	-0.264 (0.792)
[0, 0]	Green bond	123	-0.027%	-0.161 (0.873)	0.008 (0.994)
	Brown bond	257	0.085%	0.788 (0.441)	0.553 (0.580)

Table 5. Green bonds, Pre and Post-taxonomy sample. Cumulative Average Abnormal Returns around the bond issuance announcement date for the green bond sample.

*The table shows the Cumulative Average Abnormal Returns for green bonds around the bond issuance announcement date for pre- and post-taxonomy announcements. The results are shown with six different event windows. The event windows range from three to zero days before and after the announcement date. We also show the number of events in each computation of CAAR for each type of bond. The CAAR is presented in percent. Subsequently, we show the performed test statistics for the CAARs and their significance level. Details of the tests are elaborated in section 4.1. Significance levels of 1%, 5% and 10% are denoted with *, ** ,and ***, respectively.*

Event Window	Pre/Post taxonomy	Number of events	CAAR	t-stat (p-value in %)	BMP Z test (p-value in %)
[-10, 10]	Pre-taxonomy	50	-0.471%	-0.430 (0.688)	-0.398 (0.691)
	Post-taxonomy	73	0.649%	0.765 (0.446)	0.556 (0.578)
[-5, 5]	Pre-taxonomy	50	-0.152%	-0.284 (0.777)	0.252 (0.801)
	Post-taxonomy	73	0.251%	0.357 (0.722)	0.518 (0.604)
[-3, 3]	Pre-taxonomy	50	-0.116%	-0.294 (0.769)	0.189 (0.850)
	Post-taxonomy	73	0.116%	0.219 (0.827)	0.361 (0.718)
[-1, 1]	Pre-taxonomy	50	-0.437%	-1.414 (0.160)	-1.241 (0.215)
	Post-taxonomy	73	0.326%	0.918 (0.360)	1.026 (0.305)
[0, 1]	Pre-taxonomy	50	-0.406%	-1.492 (0.138)	-1.094 (0.274)
	Post-taxonomy	73	0.202%	0.654 (0.514)	0.715 (0.475)
[0, 0]	Pre-taxonomy	50	-0.191%	-1.417 (0159)	-1.133 (0.257)
	Post-taxonomy	73	0.101%	0.371 (0.712)	0.611 (0.541)

Table 6. Brown bonds, Pre and Post-taxonomy sample. Cumulative Average Abnormal Returns around the bond issuance announcement date for the green bond sample.

*The table shows the Cumulative Average Abnormal Returns for green bonds around the bond issuance announcement date for pre- and post-taxonomy announcements. The results are shown with six different event windows. The event windows range from three to zero days before and after the announcement date. We also show the number of events in each computation of CAAR for each type of bond. The CAAR is presented in percent. Subsequently, we show the performed test statistics for the CAARs and their significance level. Details of the tests are elaborated in section 4.1. Significance levels of 1%, 5% and 10% are denoted with *, ** ,and ***, respectively.*

Event Window	Pre/Post taxonomy	Number of events	CAAR	t-stat (p-value in %)	BMP Z test (p-value in %)
[-10, 10]	Pre-taxonomy	192	-0.713%	-1.197 (0.233)	-0.659 (0.510)
	Post-taxonomy	65	-2.265%	-2.537*** (0.012)	-2.762*** (0.006)
[-5, 5]	Pre-taxonomy	192	-0.268%	-0.760 (0.448)	-0.263 (0.814)
	Post-taxonomy	65	-0.859%	-1.703* (0.090)	-1.715* (0.086)
[-3, 3]	Pre-taxonomy	192	-0.213%	-0.735 (0.463)	-0.313 (0.754)
	Post-taxonomy	65	-0.467%	-1.057 (0.292)	-1.058 (0.290)
[-1, 1]	Pre-taxonomy	192	0.004%	0.016 (0.987)	0.066 (0.947)
	Post-taxonomy	65	-0.383%	-1.015 (0.311)	-1.023 (0.306)
[0, 1]	Pre-taxonomy	192	-0.055%	-0.289 (0.773)	-0.459 (0.646)
	Post-taxonomy	165	0.066%	0.221 (0.826)	0.346 (1.270)
[0, 0]	Pre-taxonomy	192	0.033%	0.263 (0.793)	0.057 (0.955)
	Post-taxonomy	65	0.257%	1.252 (0.212)	1.064 (0.287)

4.3 Regression analysis

As mentioned in the section Literature review and hypotheses, Glavas (2020), Flammer (2021), Lebelle, Lajili & Sassi (2020), Pedersen & Thun (2020) and Nylén (2021) chose to perform regression analysis including firm-specific and bond-specific characteristics in order to isolate the "green" flag's effect in the announcement effect on the stock price. The choice of firm-specific and bond-specific variables is based on what is believed to have an impact on the CARs, as well as what previous studies have chosen. The purpose of the regression analysis is to observe to which extent investors' value the label of a bond in relation to the firm-specific and bond-specific characteristics of the issuance. The firm-specific variables used are from the fiscal year prior to the announcement of the bond issuance. This is chosen over quarterly reporting, given that full-year fiscal reporting undergoes an auditing process (Glavas, 2020).

For our firm-specific variables, we collect *Total assets* (Glavas, 2020; Flammer, 2021; Nylén, 2021; Lebelle, Lajili & Sassi , 2020, Pedersen & Thun, 2020), *Debt-to-Asset-ratio* (Flammer, 2021; Nylén, 2021; Lebelle, Lajili & Sassi , 2020, Pedersen & Thun, 2020), *Interest coverage-ratio* (Glavas, 2020), *Return on assets* (Glavas, 2020; Flammer, 2021; Nylén, 2021; Lebelle, Lajili & Sassi , 2020, Pedersen & Thun, 2020) and *Operating margin* (Glavas, 2020). For our bond-specific variables, we follow Glavas (2020) and collect *Maturity*, *Coupon,* and *Bond Size*. Lastly, as our sample covers several countries and years, fixed effects will be added for these in accordance with Glavas (2020) and Pedersen & Thun (2019). As our dependent variable, we will use CAR [-10, 10] as it was the main event window of significance in our event study. The following model is derived from Glavas (2020):

$$CAR_{ij}(T_1, T_2) = \alpha_i + \beta_{ij} * Green_i + Controls_{ij} + \varepsilon_{ij} \quad (9)$$

where $Green_i$ denotes a dummy variable equal to one for the event's where green bonds and zero for brown bonds, $Controls_{ij}$ is the list of firm-specific, bond-specific and fixed effects control variables used for event *i* on firm j, ε_{ij} is the error term. The variable of interest in the OLS regression will be the dummy variable $Green_i$ as a significant result would suggest that a bond labeled as "green" generates a different reaction from the stock market compared to a brown bond announcement. In accordance with Pedersen & Thun (2020), Glavas (2020), and Lebelle, Lajili & Sassi (2020), robust standard errors are used.

4.4 Results from regression analysis

The main variable of interest in the regressions is the dummy variable for the "green" flag. As shown in **Table 7**, the variable is shown to be significant at the 10%-level, accounting for country and year fixed-effects. Given that the CAAR in our event study was significantly larger for green bond issuance announcements compared to brown bond issuance announcements, i.e. green bond issuance announcements were not significantly different from zero while brown bond issuance announcements were significantly smaller than zero, the results from the regression analysis is in line with the results from the event study. However, since the regression is only significant when taking the fixed effects into account, it can be assumed that the positive coefficient of the Green variable is either affected by geographical or time-varying effects. This will be further discussed in the following regression of the sub-samples of pre- and post EU taxonomy.

Table 8 shows the regression analysis from the sub-sample post taxonomy. The variable of interest, *Green,* is significant at the 10%-level when country and year fixed effects are excluded and significant at the 5%-level when the fixed effects variables are included. This result is also in line with the event study results, as the CAAR for green bond issuance announcements in the period was not significantly different from zero and the CAAR from brown bond issuance announcements was significantly negative.

In **Table 9**, we show the regression results for the subsample of pre taxonomy. The results indicate that the *Green* variable is not significant. This result does not change when country and year fixed effects are included in the regression. Thus, the results from the regression analysis is in line with the results from the event study, given that neither the CAAR for green or brown bond issuance announcements were significantly different from zero.

In contrast to the regression in **Table 7**, the regression results for the *Green* in **Table 8** are significant even when the country and year fixed effects are excluded. In **Table 9**, the green variables are not significant with or without the country and year fixed effects. Given that the sub-samples of pre- and post taxonomy are divided by based on their bond issuance announcement date, it suggests that investors' value perception of bond issuances has changed over time.

The control variables *Coupon* in **Table 8**, *Maturity* in **Table 9,** and *Operating margin* in **Table 9** are found to be significant, but these will not be further commented on given that they are not this study's variables of interest and there is no consistency in which control variables are significant between the three regressions. Additionally, Pedersen & Thun (2020), Glavas (2020), and Nylén (2021) show no clear consistency in significance among control variables.

Table 7. OLS regression results for the entire sample

*Below are the regression results for the period 2015-12-13 to 2022-04-25 with Huber-White standard errors in parenthesis. The dependent variable is CAR [-10,10] for all regressions. The independent variable Green is a dummy variable given the value 1 if the bond was labeled as green by Bloomberg, and 0 otherwise. The firm specific variables are Size which is the natural logarithm of total assets, Leverage which is the firm's total debt divided by its total assets, EBIT-to-interest which is the firm's EBIT divided by its interest expense, ROA which is the firm's operating income divided by its total assets and Operating Margin which is operating income divided by revenue. In addition to the firm-specific control variables, also bond-specific variables are included. These are the bond's coupon, the natural logarithm of the amount issued, and the maturity is expressed in years. The last two variables are fixed effects variables for country and year. Significance levels of 1%, 5% and 10% are denoted with *, ** ,and ***, respectively.*

Variables	**CAAR [-10,10] (Standard errors)**	**CAAR [-10,10] (Standard errors)**
Green	0.0105	0.0147*
	(0.0076)	(0.0083)
Size	0.0006	-0.0027
	(0.0035)	(0.0041)
Leverage	-0.0305	-0.0024
	(0.0258)	(0.0295)
EBIT-to-interest	0.0000	-0.0004
	(0.0005)	(0.0006)
ROA	-0.1335	-0.2379
	(0.1575)	(0.1926)
Operating Margin	0.0282	0.0358
	(0.0186)	(0.0227)
Coupon	-0.1945	-0.3559
	(0.4369)	(0.4141)
Amount issued	-0.0002	-0.0007
	(0.0019)	(0.0023)
Maturity (in years)	0.0002	0.0004
	(0.0003)	(0.0004)
Intercept	0.0006	0.0366
	(0.0384)	(0.0464)
Country fixed	No	Yes
Year fixed	No	Yes
R-squared	0,0248	0,1034
Observations	380	380

Table 8. OLS regression results for the post taxonomy sample

*Below are the regression results for the period 2020-06-23 to 2022-04-25 with Huber-White standard errors in parenthesis. The dependent variable is CAR [-10,10] for all regressions. The independent variable Green is a dummy variable given the value 1 if the bond was labeled as green by Bloomberg, and 0 otherwise. The firm specific variables are Size which is the natural logarithm of total assets, Leverage which is the firm's total debt divided by its total assets, EBIT-to-interest which is the firm's EBIT divided by its interest expense, ROA which is the firm's operating income divided by its total assets and Operating Margin which is operating income divided by revenue. In addition to the firm-specific control variables, also bond-specific variables are included. These are the bond's coupon, the natural logarithm of the amount issued, and the maturity is expressed in years. The last two variables are fixed effects variables for country and year. Significance levels of 1%, 5% and 10% are denoted with *, ** ,and ***, respectively.*

Variables	**CAAR [-10,10] (Standard errors)**	**CAAR [-10,10] (Standard errors)**
Green	0.0208*	0.0274**
	(0.0117)	(0.0122)
Size	0.0013	-0.0030
	(0.0050)	(0.0059)
Leverage	-0.0577	-0.0405
	(0.0386)	(0.0437)
EBIT-to-interest	-0.0006	-0.0011
	(0.0013)	(0.0013)
ROA	-0.1015	-0.1573
	(0.1309)	(0.1730)
Operating Margin	0.0215	-0.0234
	(0.0318)	(0.0372)
Coupon	1.1112*	0.9529
	(0.5919)	(0.6231)
Amount issued	-0.0012	0.0016
	(0.0034)	(0.0038)
Maturity (in years)	-0.0004	-0.0008
	(0.0004)	(0.0006)
Intercept	-0.0071	0.0700
	(0.0567)	(0.0686)
Country fixed	No	Yes
Year fixed	No	Yes
R-squared	0.0798	0.2088
Observations	138	138

Table 9. OLS regression results for the pre taxonomy sample

*Below are the regression results for the period 2015-12-13 to 2020-06-22 with Huber-White standard errors in parenthesis. The dependent variable is CAR [-10,10] for all regressions. The independent variable Green is a dummy variable given the value 1 if the bond was labeled as green by Bloomberg, and 0 otherwise. The firm specific variables are Size which is the natural logarithm of total assets, Leverage which is the firm's total debt divided by its total assets, EBIT-to-interest which is the firm's EBIT divided by its interest expense, ROA which is the firm's operating income divided by its total assets and Operating Margin which is operating income divided by revenue. In addition to the firm-specific control variables, also bond-specific variables are included. These are the bond's, the natural logarithm of the amount issued, and the maturity is expressed in years. The last two variables are fixed effects variables for country and year. Significance levels of 1%, 5% and 10% are denoted with *, ** ,and ***, respectively.*

Variables	**CAAR [-10,10] (Standard errors)**	**CAAR [-10,10] (Standard errors)**
Green	-0.0034 (0.0090)	-0.0069 (0.0113)
Size	0.0012 (0.0051)	-0.0026 (0.0051)
Leverage	-0.0243 (0.0349)	-0.0097 (0.0379)
EBIT-to-interest	-0.0000 (0.0007)	-0.0001 (0.0007)
ROA	-0.1810 (0.3107)	-0.3804 (0.3654)
Operating Margin	0.0310 (0.0284)	0.0654* (0.0371)
Coupon	-0.9278 (0.5920)	-0.7718 (0.5718)
Amount issued	-0.0004 (0.0023)	-0.0025 (0.0029)
Maturity (in years)	0.0008** (0.0004)	0.0010 (0.0004)
Intercept	0.0072 (0.0569)	0.0376 (0.0619)
Country fixed	No	Yes
Year fixed	No	Yes
R-squared	0.0585	0.2242
Observations	242	242

5. Discussion of Results

The results from the event study indicate that investors view the value perception of green bond issuances as insignificant and brown bond issuances as value-diminishing. The findings from previous studies are divided, where Tang & Zhang (2020), Glavas (2020), Flammer (2021), and Pedersen & Thun (2020) found a positive significant green bond issuance announcement effect on the stock price, Nylén (2021) and Lebelle, Lajili & Sassi (2020) found a negative significant green bond issuance announcement effect on the stock price. Hence, in terms of the green bond issuance announcement effect on the stock price, we contribute with a contradicting result to previous studies.

A possible explanation for our findings, in relation to the studies investigating a global sample (Tang & Zhang, 2020; Flammer, 2021; Glavas, 2020) and found a positive green bond issuance effect on the stock price, can be derived from the differences between the global and European market in terms of maturity. To elaborate, The Global Sustainable Investment Alliance (2020) showed that the CAGR in sustainable investments between 2014 and 2020 in Europe was 1%, in comparison to 17% in the United States and 36% in Asia and Australia. This suggests that the European market is more mature in comparison to the global market. Thus, investors' reactions toward green bond issuance announcements may be different on a global market in relation to a European. Furthermore, as China and the United States is two of the most frequent issuer on the global market, a potential explanation for the positive green bond issuance announcement effect on the stock price can be driven by China and the United States, as we do not find any on the European market.

Furthermore, our results contradict Flammer's (2021) signaling argument, where the stock market will react positively to the issuance of a green bond as a signal of their commitment toward environmentally sustainable operations. An explanation for our results could be derived from the transparent European market, where European economies' degree of transparency is higher in relation to the global average (Transparency International, 2022), as well as the EU taxonomy forcing firms to report their environmental operations in identical manner (TEG, 2020). Hence, investors may not find the green bond issuance as a significant signal of firms' environmental operations, as firms' transparency already decreases the investors' information asymmetry. In other words, the information a green bond is supposed to signal is abundant. Additionally, it would explain why the previous studies investigating a global market found a significant positive green bond issuance effect on the stock price.

Although our results contradict Flammer's (2021) signaling argument regarding environmental operations, it does not necessarily contradict the signaling argument itself. Similar to Pedersen & Thun (2019), our results instead suggest that firms not issuing green bonds, but brown bonds, signal their inability to pursue environmentally sustainable operations, and therefore, investors react negatively.

When comparing the subsamples of pre- and post-announcement of the EU taxonomy, the results indicate no change in investors' value perception of green bond issuances. Instead, their value perception of brown bond issuances went from insignificant to significantly negative. These results suggest that after the announcement of the EU taxonomy, investors value issuances of brown bonds as value-diminishing in relation to green bonds, where investors' value perception was insignificant. This is in line with the results of Glavas (2020), who found that environmentally significant policies, the Paris agreement, change investors' value perception of green bond issuances compared to brown bond issuances. The introduction of the EU taxonomy could help facilitate investors' ability to differentiate between sustainable and non-sustainable investments. After environmentally significant events, such as the announcement of the EU taxonomy, investors might fear incoming regulations for non-sustainable investments, which could be an explanation for the negative brown bond issuance announcement effect on the stock price after the announcement of the EU taxonomy.

What should be noted, however, is that Glavas' (2020) results suggest that the Paris agreement led to a positive green bond issuance announcement, while our results instead suggest a negative announcement effect for brown bonds after the announcement of the EU taxonomy. As mentioned before, a possible explanation for this could be the choice to investigate a global market. Pedersen & Thun (2020), who constructed a sample of European issuers similarly to this study, also found a significantly negative announcement effect of brown bonds. As previously mentioned, the European market can be argued to be more mature than the global market. Therefore, the new "normal" might be firms pursuing environmentally sustainable operations and not the opposite, as investors' do not reward the green issuers but punish the brown.

Lastly, Nylén (2021) and Pedersen & Thun (2019) investigated a European sample and arrived in different findings. Pedersen & Thun (2019) found a smaller green bond issuance announcement effect on the stock price in relation to studies investigating global markets, when investigating a sample between 2013 and 2019. On the other hand, Nylén (2021) found a negative green bond issuance announcement effect on the stock price, investigating a sample between 2013 and 2020. As we found an insignificant relationship between green bond issuance announcements and the stock price, investigating a sample between 2015 and 2022, we differentiate from previous studies conducted with a European sample. Pedersen & Thun (2019) explains that different time samples can be a reason for the decrease in the green bond issuance announcement effect. As we investigate a more updated sample, an explanation could be that the green bond issuance announcement effect is sensitive to which time frame the study investigates.

6. Conclusion

In 2015, the parties of the United Nations confirmed their ambitions to hold the global average temperature well below 2 degrees (OECD, 2017). Thus, the European Commission underlined the need to transition capital flows to green investments (European Commission, 2019), and as a result, the EU taxonomy was introduced (TEG, 2020). As green bond issuance has increased, and few studies in the field of investors' value perception of green bond issuances have been conducted, we find it an appropriate field to study.

Our study contributes to the field of green bond issuance announcement effect on the stock price with a study on a sample of non-financial listed issuers in the EU between 2015-12-13 and 2022-04-25. Applying the event study methodology, we find insignificant CAARs for green bond issuance announcements and a negative CAAR of -1.073% in the event window [-10, 10] for brown bond issuance announcements. To investigate the effect of the introduction of the EU taxonomy, we divide bonds into samples of bonds announced before and after the EU taxonomy was announced. Analyzing the change in investors' value perception, we still find insignificant CAARs for green bond issuance announcements and brown bonds announced before the taxonomy announcement. Although in the event window [-10, 10] of brown bonds announced after the taxonomy, we find a significant CAAR of -2.265%. Thus, our results contradict the findings of previous studies, as investors' do not deem green bonds to be value-enhancing but rather brown bonds to be value-diminishing. Controlling the bond issuance announcement effect for bond-specific and firm-specific effects with regression analysis, we further confirm the results from the event study.

This field of study calls for future research. As the green bond market is constantly growing, it would be interesting to estimate investors' value perception of green bond issuances in smaller markets when the data allows for it. Furthermore, as green bonds no longer are a value-enhancing signal for investors, studies on other investors' value perception of other environmental measures could be contributing to this field of study.

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Appendix

Appendix 1a - Calculations of the Average Abnormal Return (AAR) and the t-test:

To test significance with a t-test you compute Average Abnormal Return for time *t* and its respective variance. Divide the AAR with the variance of AAR and multiply the quota with the square-root of the number of events *N*. The t-statistic follow a t-distribution.

$$AAR_t(T_1, T_2) = \frac{1}{N}\Sigma_{i=1}^{N} AR_{it}$$

$$S^2_{AAR_t} = \frac{1}{N-1}\Sigma_{i=1}^{N}(AR_{it} - AAR_t)^2$$

$$t_{AAR_t} = \sqrt{N}\,\frac{AAR_t}{S^2_{AAR_t}}$$

Appendix 1b - Table over average abnormal returns for [-10, 10] for the entire sample of both green and brown bonds

*This table present the average abnormal returns for green and brown bonds around each bond's issuance announcement date (0). The p-value is presented for the null hypothesis where the E(AAR)=0. The significance level at 1%, 5% and 10% is denoted with *, **, and ***, respectively.*

	AAR	**t-stat**	**P-value**	**AAR**	**t-stat**	**P-value**
	Green bonds			*Brown bonds*		
AAR(-10)	0.092%	0.599	0.550	-0.084%	-0.811	0.418
AAR(-9)	0.118%	0.739	0.461	-0.110%	-1.105	0.271
AAR(-8)	-0.049%	-0.322	0.748	0.049%	0.475	0.635
AAR(-7)	0.070%	0.429	0.669	0.056%	0.527	0.599
AAR(-6)	-0.161%	-1.036	0.302	-0.023%	-0.214	0.831
AAR(-5)	-0.052%	-0.368	0.713	0.110%	1.166	0.245
AAR(-4)	0.091%	0.685	0.495	0.038%	0.332	0.740
AAR(-3)	0.161%	1.324	0.188	0.065%	0.603	0.547
AAR(-2)	-0.046%	-0.320	0.749	-0.119%	-1.307	0.192
AAR(-1)	0.056%	0.374	0.709	-0.059%	-0.550	0.583
AAR(0)	-0.027%	-0.160	0.873	0.085%	0.785	0.434
AAR(1)	-0.038%	-0.281	0.779	-0.112%	-1.109	0.269
AAR(2)	0.068%	0.466	0.642	-0.065%	-0.660	0.510
AAR(3)	-0.160%	-1.188	0.237	-0.068%	-0.604	0.547
AAR(4)	0.068%	0.478	0.633	-0.107%	-1.189	0.236
AAR(5)	-0.046%	-0.274	0.784	-0.174%	-1.706	0.089*
AAR(6)	-0.124%	-1.014	0.313	-0.096%	-0.999	0.319
AAR(7)	0.050%	0.454	0.651	0.022%	0.214	0.831
AAR(8)	-0.169%	-1.001	0.319	-0.360%	-2.581	0.010***
AAR(9)	-0.001%	-0.009	0.993	-0.025%	-0.231	0.817
AAR(10)	0.258%	1.747	0.083*	-0.098%	-0.879	0.380

Appendix 1c - Table over average abnormal returns for [-10, 10] for green bonds before and after the EU taxonomy was announced

*This table present the average abnormal returns for green bonds before and after the taxonomy was announced around each bond's issuance announcement date (0). The p-value is presented for the null hypothesis where the E(AAR)=0. The significance level at 1%, 5% and 10% is denoted with *, **, and ***, respectively.*

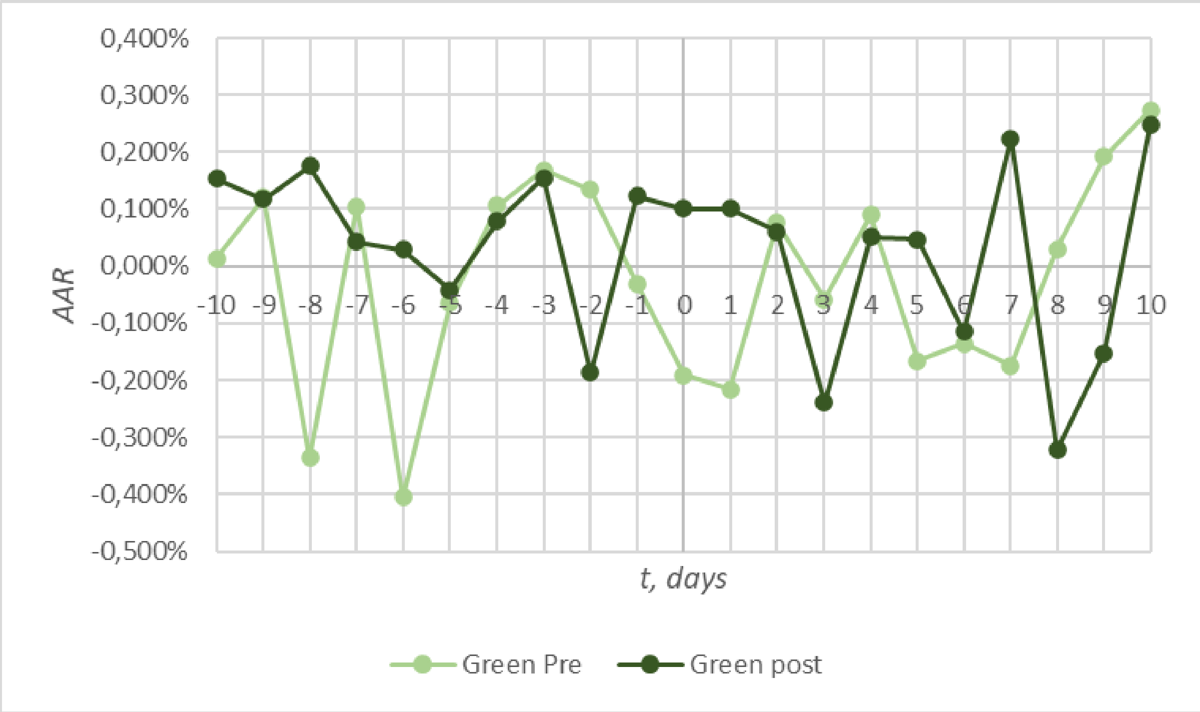
	AAR	t-stats	p-values	AAR	t-stats	p-values
	Pre taxonomy			*Post taxonomy*		
AAR(-10)	0.014%	0.068	0.946	0.153%	0.683	0.497
AAR(-9)	0.119%	0.474	0.638	0.117%	0.566	0.574
AAR(-8)	-0.337%	-1.462	0.150	0.175%	0.868	0.388
AAR(-7)	0.105%	0.462	0.646	0.042%	0.184	0.855
AAR(-6)	-0.405%	-1.548	0.128	0.029%	0.153	0.879
AAR(-5)	-0.065%	-0.378	0.707	-0.041%	-0.195	0.846
AAR(-4)	0.106%	0.530	0.598	0.079%	0.443	0.659
AAR(-3)	0.169%	0.980	0.331	0.155%	0.907	0.368
AAR(-2)	0.134%	0.851	0.399	-0.186%	-0.837	0.406
AAR(-1)	-0.031%	-0.127	0.900	0.123%	0.668	0.506
AAR(0)	-0.191%	-1.403	0.166	0.101%	0.368	0.714
AAR(1)	-0.215%	-1.071	0.289	0.101%	0.566	0.573
AAR(2)	0.076%	0.417	0.678	0.061%	0.282	0.779
AAR(3)	-0.058%	-0.334	0.740	-0.240%	-1.206	0.232
AAR(4)	0.089%	0.468	0.642	0.051%	0.249	0.805
AAR(5)	-0.166%	-0.826	0.412	0.047%	0.184	0.855
AAR(6)	-0.136%	-0.662	0.511	-0.115%	-0.771	0.443
AAR(7)	-0.174%	-1.095	0.278	0.224%	1.525	0.132
AAR(8)	0.030%	0.164	0.870	-0.323%	-1.220	0.227
AAR(9)	0.192%	1.227	0.225	-0.152%	-0.630	0.531
AAR(10)	0.273%	1.081	0.284	0.247%	1.398	0.167

Appendix 1d - Table over average abnormal returns for [-10, 10] for brown bonds before and after the EU taxonomy was announced

*This table present the average abnormal returns for brown bonds before and after the taxonomy was announced around each bond's issuance announcement date (0). The p-value is presented for the null hypothesis where the E(AAR)=0. The significance level at 1%, 5% and 10% is denoted with *, **, and ***, respectively.*

	AAR	**t-stats**	**p-values**	**AAR**	**t-stats**	**p-values**
	Pre taxonomy			*Post taxonomy*		
AAR(-10)	0.157%	0.830	0.411	-0.156%	-1.299	0.196
AAR(-9)	0.029%	0.140	0.889	-0.152%	-1.344	0.181
AAR(-8)	0.087%	0.409	0.684	0.037%	0.319	0.750
AAR(-7)	-0.242%	-1.200	0.236	0.146%	1.188	0.237
AAR(-6)	0.174%	0.963	0.340	-0.083%	-0.641	0.523
AAR(-5)	0.202%	0.909	0.368	0.083%	0.761	0.448
AAR(-4)	-0.050%	-0.187	0.852	0.064%	0.520	0.604
AAR(-3)	-0.017%	-0.086	0.932	0.090%	0.709	0.479
AAR(-2)	-0.018%	-0.102	0.919	-0.149%	-1.423	0.157
AAR(-1)	-0.449%	-1.593	0.117	0.059%	0.531	0.596
AAR(0)	0.257%	1.240	0.220	0.033%	0.262	0.794
AAR(1)	-0.191%	-0.802	0.426	-0.088%	-0.802	0.424
AAR(2)	-0.192%	-1.015	0.315	-0.026%	-0.230	0.818
AAR(3)	0.143%	0.775	0.442	-0.132%	-0.978	0.330
AAR(4)	-0.394%	-2.135	0.037**	-0.020%	-0.193	0.847
AAR(5)	-0.150%	-0.693	0.491	-0.181%	-1.572	0.118
AAR(6)	-0.409%	-1.925	0.060	-0.002%	-0.017	0.986
AAR(7)	-0.216%	-1.218	0.229	0.095%	0.756	0.451
AAR(8)	-0.306%	-1.360	0.180	-0.376%	-2.241	0.026**
AAR(9)	-0.037%	-0.180	0.858	-0.021%	-0.169	0.866
AAR(10)	-0.643%	-1.834	0.072	0.067%	0.700	0.485

Appendix 2a - Table over average abnormal returns for [-10, 10] for green bonds before and after the EU taxnonomy was announced



Appendix 2b - Table over average abnormal returns for [-10, 10] for brown bonds before and after the EU taxnonomy was announced