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Stock Market Reaction to Green Bond Announcements

An empirical study on firms listed on European stock exchanges

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Abstract

This thesis contributes to the recent academic literature on green bonds, by providing evidence of positive abnormal returns following green bond announcements in the European stock market from November 2013 to October 2019. By applying an event study methodology on a sample of 54 public European companies, we find a cumulative average abnormal return of 0.37% in the two-day event window surrounding the green bond announcements. The results indicate that green bond announcements have a positive effect on the market valuation of public European firms, albeit less positive than the global average found in previous studies.

Further, we find strong evidence of geographical differences within Europe, as green bond announcements lead to higher stock market returns in Northern Europe, with a cumulative average abnormal return of 0.67%. The other regions in Europe exhibit no significant returns, which suggests that Northern Europe is the main driver for the positive stock market reaction in Europe.

When applying the event study methodology, we find significant positive returns for first-time green bond announcements and certified bonds, but no significant results for subsequent announcements or non-certified bonds. However, when controlling for bond and firm-specific characteristics using regression, the results indicate that also subsequent green bond announcements contribute positively to shareholder value. This is in contrast to the existing literature, which only find first-time green bond announcements to be significant for firm value. We therefore contribute to the literature by providing evidence for that firms benefit each time they announce a green bond, and not only the first time.

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List of Abbreviations

AAR	Average abnormal return
AR	Abnormal return
ASAR	Average standardized abnormal return
ASCAR	Average standardized cumulative abnormal return
CAAR	Cumulative average abnormal return
CAGR	Compound annual growth rate
CAR	Cumulative abnormal return
CBI	Climate Bonds Initiative
CMAR	Cumulative median abnormal return
EBIT	Earnings before interest and taxes
ESG	Environmental, Social and Governance
GBP	Green Bond Principles
ICMA	International Capital Markets Association
MAR	Median abnormal return
ROA	Return on assets
SAR	Standardized abnormal return
SCAR	Standardized cumulative abnormal return
SEC	Securities and Exchange Commission
SIC	Standard Industrial Classification

1. Introduction

How to finance the transition to a low-carbon economy in order to achieve the goals of the Paris Agreement, is one of the major issues facing the world economy. In particular taking into consideration the vast amount of financing necessary to shift from rhetoric into action (Gianfrante & Peri, 2019). The financial system will be crucial to support and accelerate investments in the clean energy and technologies needed to decarbonise the economy. In recent years, green bonds have emerged as one of the best candidates to help mobilizing financial resources towards clean and sustainable investments. A green bond is defined by the International Capital Markets Association (ICMA) as “any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible green projects” (ICMA, 2018). Corporate green bonds were first introduced in 2013, and the market has grown rapidly ever since. In the first half of 2019, the global corporate green bond market reached $86bn, with Europe being the biggest market, issuing more than $47bn (Refinitiv, 2019).

The limited existing research on green bonds, combined with the substantial growth of the market and its increased importance in terms of decarbonisation, makes it an appealing subject for an event study. Moreover, there are no studies on the European market exclusively. To the best of our knowledge, all existing literature focus on the green bond announcement effect on the global stock market. With Europe being the largest market for green bonds, it would be interesting to analyse how the market reacts to such announcements. In addition, the substantial differences between the European economies in regards to industries and performance makes it possible to see whether the green bond announcements are of greater value within specific regions.

In this thesis we seek to understand how the stock market reacts to green bond announcements by public European corporations. Do shareholders benefit from issuing green bonds? We attempt to answer this research question by examining all public European corporate green bond announcements in the time period November 2013 to October 2019. To measure the effect of the announcement, we analyse the stock’s cumulative abnormal return (CAR). In order to answer the research question, we use the event study methodology as proposed by MacKinlay (1997). The main event window is [0,1], with 0 being the day of the green bond announcement.

For Europe, we find a cumulative average abnormal return (CAAR) of 0.37%, implying a positive stock market reaction to the green bond announcements. We also compute the CAAR on the announcement day for all conventional bonds of the same issuers in the same period. For conventional bonds we find a CAAR of -0.21%, indicating a green bond premium of 0.58%. The standardized cross-sectional test and Wilcoxon signed-rank test are used as the parametric and non-parametric tests, respectively. The results from these tests confirm that green bonds are perceived as value-enhancing by the market.

Further, we investigate whether there exists geographical differences on stock market reactions within Europe. As previous studies show (Autti & Kokkinen, 2014), countries differ in regards to environmental responsibility and awareness. Therefore, it would be of interest to examine whether the location of the issuer has any effect on the stock market reaction to green bond announcements. We find that companies listed in Northern Europe exhibit a CAAR of 0.67%, which is 0.30% higher than the total average. Conversely, we do not find any evidence of green bond announcements impacting the stock market reaction in other regions in Europe.

In addition, we analyse the difference between first and subsequent green bond announcements. According to Tang & Zhang (2018), when the firm announces its first green bond, it signals a commitment to eco-friendly actions towards the market. Consequently, issuers should not benefit from the green label effect after the first announcement. In line with previous studies (Flammer, 2018; Tang & Zhang, 2018) we find a significant positive stock market return for first-time announcements. The results suggest a CAAR of 0.40% for the first-time green bond announcements in the sample, while we do not find any significant stock market reaction for subsequent announcements using the event study methodology.

Previous studies on the global market have shown that green bonds certified by an independent third party leads to higher stock market returns (Flammer, 2018). Certification raises the administrative costs and compliance burdens of the company. As a result, certified green bonds signify a more reliable commitment towards the environment. We find a CAAR of 0.44% in the main event window for certified companies, suggesting that European companies experience a similar stock market reaction as the global average (Flammer, 2018). Moreover, we find no significant evidence for that non-certified bonds result in any stock market reaction, also in line with the existing literature.

To further strengthen the analysis, we perform a regression where we control for a wide set of variables that may affect the stock market reaction to bond announcements (Godlewski, Turk-Ariss, & Weill, 2013). Based on the CARs estimated from the event study, we compute an OLS regression as a robustness test. The results confirm the findings from the event study in regards to the overall positive stock market reaction to green bond announcements in Europe and the regional differences. However, in contrast to the event study results we find evidence for that also subsequent green bond announcements are perceived as value-enhancing by the market.

We contribute to the existing literature on green bonds in being the first to analyse the European market exclusively. The findings provide significant evidence for that green bond announcements are positively related to shareholder value in the European market. However, the findings imply that the stock market reaction in Europe is less positive than when compared to the global market (Flammer, 2018; Glavas, 2018). There may be multiple reasons for this. First, we include more recent data. Second, European economies are more transparent (Transparency International, 2019), and the market for sustainable investing in Europe is different in regards to investor base and jurisdiction (EU, 2019). Lastly, equity investors may have the impression that European firms are more likely to invest in eco-friendly projects, making the signalling effect of the green bond weaker.

This thesis further adds to the literature by being the first to analyse regional differences within Europe. Interestingly, the findings indicate that Northern Europe exhibits higher returns than the rest of Europe. The CAAR is substantially higher than for the entire continent, implying that green bond announcements are deemed as more valuable in Northern Europe. This is consistent with the notion of the Northern European countries being more environmentally aware (Autti & Kokkinen, 2014). Additionally, the more widespread use of green bonds and interest in sustainable finance may also drive the higher returns (SEB, 2019).

To the best of our knowledge, we are the first to use regression analysis to control for firm and bond-specific characteristics when measuring the effect of first versus subsequent green bond announcements. When applying regression, we find evidence for that subsequent green bond announcements also are perceived as value-enhancing by the market. This is in contrast to previous studies (Flammer, 2018; Tang & Zhang, 2018), which do not find any significant stock market reaction to subsequent announcements.

In summary, we complement the existing literature by documenting that green bond announcements results in a positive stock market reaction in the European market, albeit less positive than the global average. Further, the results suggest that Northern Europe is the main driver for the positive stock market reaction in Europe. Finally, we provide evidence for that subsequent green bond announcements also are perceived as value-enhancing by European equity investors.

The structure of the thesis is as follows. Chapter 2 first contains a brief overview of the green bond market, then we present the relevant literature for this thesis. Further, Chapter 3 presents the data collection process. Chapter 4 presents the methodology applied and the results of the empirical analysis. Lastly, Chapter 5 provides the overall conclusion. Figures and tables displayed in the appendix are denoted with an A or B in their descriptions.

2. Literature Review

In this chapter, we first provide a brief overview of the green bond market. Second, we present the literature on the empirical findings on green bonds, with the main focus being on green bond announcement effects on firm value.

The European Investment Bank (EIB) and the World Bank issued the first green bond in 2007, and initially the green bond market was driven by supranational organizations. It was first when public corporations entered the market in 2013, the growth escalated (Boulle, 2014). The total amount outstanding reached over $521bn in 2018 (Climate Bonds Initiative, 2019). Still, the market is considered to be in its infancy (Baulkaran, 2018), as it constitutes only about 2% of the total bond market (Refinitiv, 2019). However, the market has grown rapidly in recent years and has continued its growth in 2019, totalling $117.8 billion in issuances in the first half of the year. This represents a 48% growth compared to the same period last year (Climate Bonds Initiative, 2019). The largest issuers are found in the US, China, and France, but the geographical spread is increasing. Green bond issuers are found on every continent with a total of 54 different countries (Climate Bonds Initiative, 2019).

Despite the rapid growth of the market, there is still no exact definition of what makes a bond "green", as there are disputes regarding definitions and taxonomy. Primarily there are two "standards", the Green Bond Principles (GBP) and the Climate Bonds Initiative (CBI). GBP is a set of guidelines developed by investment banks[1] in 2014, and is widely accepted by the market. For example, to be labelled as a green bond on Bloomberg the issuer has to align with the GBP. The CBI, on the other hand, includes eligible criteria and a thorough green taxonomy by sector, which enables independent third parties[2] to assess the qualification of a green bond. The CBI database also provides information on whether the green bond has been certified by an independent third-party, which will reduce potential information asymmetry and greenwashing (Bachelet, Beccheti, & Manfredonia, 2019).

In late November 2013 the first European public corporate[3] green bond was announced by Electricite de France (Electricite de France, 2013). This date also marks the starting point of

[1] The banks are Citibank, Bank of America Merrill Lynch, JP Morgan, BNP Paribas and HSBC.
[2] Independent third-party verifiers are organizations such as Cicero and Sustainalaytics.
[3] 27.11.2013.

the analysis, as we intend to only include public corporate issuers in this paper. The growth of corporate green bond issuances has increased every year, and as of October 2019, over €83bn have been issued by public European corporations[4] (Bloomberg L.P., 2019). For an overview of yearly amount issued in Europe since 2013, see Figure 1.

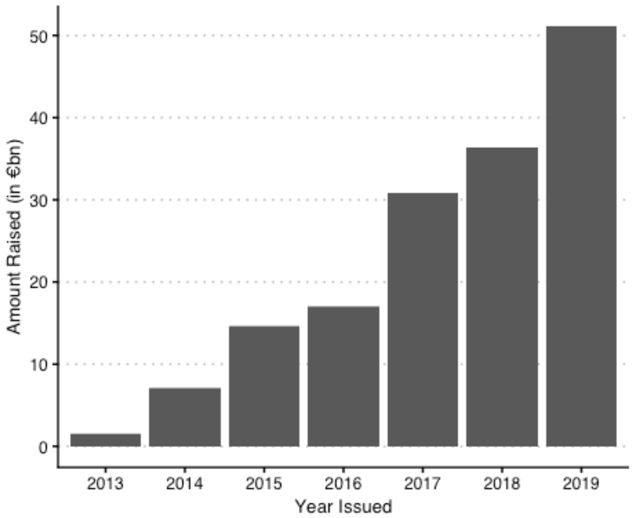

Figure 1 - Growth of corporate green bonds in Europe November 2013-October 2019[5]

From an investor perspective, green bonds could represent an opportunity for diversification, as well as improving their ESG score and satisfying their green mandate (Reboredo, 2018). The investor base mainly consists of large institutional investors[6], and only a small percentage is traded in the secondary markets (Baulkaran, 2018). For the issuers', green bonds can help broaden the investor base and potentially reduce the cost of capital, which studies by Tang & Zhang (2018) and Gianfrante & Peri (2019) show. Conversely, issuing green bonds results in more information disclosure, administrative costs for certification and reputation risk.

The existing literature on green bonds has primarily focused on bond pricing, and the differences in cost of capital when issuing green bonds as opposed to conventional bonds. The majority of studies have investigated whether there exists a green bond market premium, referring to the lower yield of a green bond.

[4] Including direct subsidiaries of public companies.
[5] Data retrieved from Bloomberg Fixed Income Database.
[6] For example pension funds.

Ehlers & Packer (2017) and Hachenberg & Schiereck (2018) find evidence for green bond issuers borrowing at a lower rate than their conventional counterparts. This will lead to cheaper financing for the green bond issuing firms, and might be perceived as value-enhancing by the market. We also find a more favourable stock market reaction to green bond announcements in Europe, than for conventional bond announcements. The cheaper cost of capital for green bonds might be one possible explanation as to why green bond announcements leads to a more positive market reaction.

Zerbib (2017) used a matching method comparing green bonds with similar conventional bonds with identical bond characteristics, and finds an average green bond discount of 0.08%. He finds a lower discount for Europe at only 0.02%, and attributes the negative premium to the excess demand and oversubscription of green bonds in the market. We also find evidence for geographical differences in the equity market reaction to green bonds, in that the European market provides on average a less positive stock market return than the global average.

Hyun, Park, and Tian (2018) initially find no significant evidence of a yield premium for green bonds. However, when the green bonds are certified by a third-party, they find significant evidence for a green bond premium, indicating that developing a universal green bond standard will improve the pricing of green bonds and promote the development of green bond markets. The results of this study on European firms further supports these findings, as we find considerably higher stock market returns for certified green bond issuers.

More recent literature regarding green bonds, and also more related to this thesis, have focused on the green bond announcement effect on market value and firm performance. Since corporate green bonds is a relatively new phenomenon, there are only a few studies investigating the topic. Previous research on green bond announcement effects on firm value only investigate the total green bond market, and do not analyse geographical differences. Therefore, this paper adds to the discussion by being the first to analyse Europe exclusively and segmenting different regions.

Flammer (2018) conducts the first empirical study on green bond announcement effects, with a sample containing all corporate green bond announcements worldwide from 2013-2017. The study shows that green bond announcements yield improvements in short-term equity value and operating performance. In contrast to Flammer (2018), we study the market of corporate green bonds in Europe exclusively. We find a similar positive stock market reaction, albeit less positive. Flammer (2018) finds a CAAR of 0.67%, while we find a CAAR at 0.37% for Europe in the event window [0,1]. Additionally, Flammer (2018) finds that third-party certified green bonds exhibit significantly higher returns than the overall average. We find the same pattern for Europe as well, where the CAAR for certified bonds are 0.07% higher than the CAAR for the full sample. In line with Flammer (2018), we do not find any significant stock market reaction to non-certified green bond announcements.

Tang & Zhang (2018) analyse the global green bond market from 2008-2017, and also find evidence for that stock prices respond positively to green bond announcements. The study does not find evidence of a consistently significant premium, which suggests that the stock returns are not fully driven by the lower cost of debt. In addition, Tang & Zhang (2018) show that stock liquidity improves after green bond announcements as well as leading to an increase in institutional ownership.

Both Flammer (2018) and Tang & Zhang (2018) find that the CAARs for the first green bond announcements are higher than for the total average, and find no evidence for subsequent announcements being significant. The results we find for European announcements are similar in the event study, where we also find that the CAARs are only significant for first-time announcements. This thesis contributes to the literature by being the first to use regression to measure the first-time green bond announcement effect while also controlling for bond and firm-specific characteristics. The regression results confirm that the announcement effect of the first issuance is higher than for subsequent issues. However, the results also indicate that subsequent green bond announcements are perceived as value-enhancing by equity investors.

Glavas (2018) compares equity investors’ reaction to green bond announcements before and after the Paris Agreement, with a sample comprised of all corporate green bonds issued globally from 2013-2018. The results show that the stock price reaction to green bond announcements grew after the Paris Agreement, suggesting a change of equity investor behaviour after said agreement. Furthermore, Glavas (2018) tests whether the debt component or the green label of the bond is responsible for the abnormal returns, using regression analysis to control for other possible drivers of the stock market reaction. We apply the same technique and use similar control variables in this study. The results suggest that green bonds are perceived as value-enhancing by equity markets in Europe as well, confirming that corporations benefit more from issuing green bonds than conventional bonds.

Lastly, this thesis adds to the literature in regards to media attention. Firms announcing green bonds increase their visibility, while also signalling a thorough commitment towards the environment. Grullon et al. (2004) finds that the visibility of a firm has significant impact on the stock market. Empirical studies have also examined the announcement effects of corporate news on environmental issues, where Hamilton (1995) and Dasgrupta et al. (2001) find that negative environmental news results in a negative stock price reaction. This study implies that the opposite is true for positive environmental news. Dowell et al. (2000) show that firms with rigorous environmental standards have higher firm value. The results from this thesis adds to the existing evidence implying a positive relation between firm’s environmental responsibility and firm value (Guenster, Bauer, Derwall, & Koedijk, 2011; Klassen & McLaughlin, 1996).

3. Data

In the following chapter, we describe the data collection process. First, we describe the dataset used in the event study, consisting of bond, stock and index data. Second, we describe the financial data included in the regression. Lastly, we provide descriptive statistics.

3.1 Bonds

Data regarding green bonds are obtained from Bloomberg. We use their fixed income database to extract all European corporate bonds labelled as green. Given the broad coverage of Bloomberg's fixed income database, the resulting dataset is likely to represent all corporate green bonds (Flammer, 2018). A unique feature of Bloomberg is that it also includes the announcement date for each bond issuance, which is vital for the event study analysis. We collect detailed information about each bond, including issuer, country of issuance, amount issued, industry[7], coupon rate, credit rating, maturity, issue date and announcement date. Since the majority of the bonds were issued in euro, we choose euro as currency when extracting the data. All the green bonds in the sample also comply with the GBP[8] (ICMA, 2018).

We collect information regarding certification of the bond from the Climate Bonds Initiative (2019), which is not included in the Bloomberg database. Using the CBI database we find that 91% of the green bonds in the sample have obtained status as a "certified green bond". Among all available data sources, the CBI and Bloomberg are the two most extensive sources and have a similar green bond selection criterion, including the use of proceeds, the selection of projects, eligibility verification, and reporting (Tang & Zhang, 2018).

For the event study, we restrict the sample to green bonds issued only by publicly traded firms, since detailed firm information and stock returns are only available for public firms. Initially, we use the feature of Bloomberg to identify whether the issuer is a public or private company. However, we also include private issuances made by direct subsidiaries of public firms[9], following (Tang & Zhang, 2018). For example the privately listed Iberdrola Finanzas SA issues green bonds, however it is a fully controlled subsidiary of the publicly traded company Iberdrola SA. Since this method is common among large corporations, we include the green

[7] Industries as defined by SIC Code. See appendix A.1.
[8] All green bonds listed on Bloomberg align with the Green Bond Principles.
[9] Parent company has to be listed in Europe.

bond in the sample, and correspond the announcement to the parent company's publicly traded stock. When adding bonds issued by direct subsidiaries, the total number of public European green bonds issuers is 82, corresponding to 291 issuances.

We exclude all green bonds issued by banks or financial institutions, as previously done in studies such as Glavas (2018). Standard corporate green bonds are used to finance the issuers' own projects. In contrast, financial institutions issue green bonds to make loans to other firms and borrowers to finance their projects, and consequently do not use the amount raised to directly invest in eco-friendly projects (Fatica, Panzica, & Rancan, 2019). Therefore, we remove all companies with an SIC code within the interval 6000-6282, which is the code used to identify banks and financial institutions (SEC, 2019). This reduces the sample considerably to 59 companies and 154 issuances, as financial institutions are one of the major issuers of green bonds.

In regards to conventional bonds, we use Bloomberg to extract the same bond-specific data as for their green counterparts. Following Glavas (2018), we classify a conventional bond as issued by the same company, but not labelled as green by the Bloomberg or CBI database. We extract all the conventional bonds issued by the same 59 companies that issued green bonds in the same period, to control for the different firm-specific factors that might affect the stock market reaction to bond announcements.

Finally, we remove all firms that have confounding events within the window of [− 5] to [+ 5] days around the announcement date. In regards to confounding events, we checked for M&As, stock repurchases, earnings announcements and changes in top management or credit rating.

3.2 Stock Prices

We use Datastream to collect the adjusted daily stock prices for all the companies in the sample. The adjusted daily stock price, which accounts for corporate actions such as dividends and stock splits, is used to calculate daily returns. To reduce the potential of thin trading, which can result in the market model's estimates of β to be biased and inconsistent (Brown & Warner, 1985), we remove all stocks with trading in less than 50% in the estimation window. Additionally, stocks with any missing trading days in the event window are also dropped from the sample.

Based on these criteria, the final sample consist of 54 companies and 117 green bonds issuances corresponding to 99 unique announcement dates – as some green bonds are announced on the same day by the same company. See full list of companies in appendix Table A.2.
We then use the same excluding criteria as for green bonds to extract all conventional bonds issued by the same 54 companies. This results in a total of 380 conventional bond issuances corresponding to 299 announcement dates.

3.3 Indices

Data regarding each stock market index is collected from Datastream. We use each country's leading stock market index as a proxy for the market, also done in studies such as Brounen & Derwall (2010). Næs, Skjeltorp, & Ødegaard (2008) argue that the benchmark should reflect the local stock market. Moreover, investors are and have mostly been local (Ivkovich & Weisbrenner, 2003). We therefore argue that the local stock market index for each country is preferable. This results in 13 different indices corresponding to the 13 different countries in the dataset, see the full list in appendix A.2. As a robustness check, we also use the STOXX Europe 600 as a proxy for the overall European market.

3.4 Control Variables

We collect financial data for each company from Datastream, which we use as control variables in the regression analysis. To be able to compare across countries, we convert all the amounts to euro, as previously done with the bond-specific data.

First, we find total assets and total shareholder's equity, which we use to derive equity-to-assets. Second, we retrieve EBIT and interest expense to derive EBIT-to-interest expense. Then, we find each firm's operating cash flow, to calculate cash flow ratio[10]. Lastly, we retrieve each company's net income to calculate the return on assets (ROA). Similar studies use these to control for firm-specific characteristics that potentially impact the stock market reaction to bond announcements (Spiess & Affleck-Graves, 1999; Bradshaw, Richardson, & Sloan, 2006; Godlewski, Turk-Ariss, & Weill, 2013; Baulkaran, 2018).

[10] Cash flow ratio = Operating cash flow / Total assets.

Many companies issue multiple bonds on the same issue date, tranches, which results in different bonds having the same event date. When several tranches are issued by the same company on the same day, we combine them together in one single bond issue and cumulate the amounts, as applied in other studies such as Flammer (2018). This is done so that we do not have identical observations for the regression analysis. Furthermore, we also remove bonds that have no maturity date, or when the maturity date is unknown.

3.5 Descriptive Statistics

In the following section, we provide an overview of the European green bond landscape. We first display the descriptive statistics for the initial sample before adjusting for methodology specific criteria. Thereafter, we provide a table containing bond-specific characteristics used in the empirical analysis. Finally, we present the control variables with corresponding relevant statistics.

3.5.1 Bonds

The initial dataset is comprised of 589 green bond issuances, which is the total of all the corporate green bonds issued in Europe from 27 November 2013 to 4 October 2019, with an average issue size of €273.1m, maturity of 9.91 years and an median credit rating of -A. See Table 1 for descriptive statistics of the European green bond market.

Table 1: Descriptive Statistics of the Green Bond Market in Europe

This table provides the descriptive statistics for all corporate green bonds in column (1) in the sample period November 2013 to October 2019. Column (2) and (3) provide the similar statistics for corporate green bonds issued by private firms and public firms, respectively. *# Green bonds* is the number of green bonds issued. *Amount* is the issuance amount in €m. *Certified* is a dummy variable which is equal to one if the green bond is certified by a third-party. *Maturity* is the maturity of the bond in years. *Fixed-rate bond* is a dummy variable equal to 1 if the bond has fixed coupon payments. *Coupon* is the coupon rate in percentage, while *Credit rating* is the credit rating of the bond. The sample mean is reported for each characteristic, with the standard deviation reported in the parentheses. The only exception is the credit rating, where the median is reported, based on ratings from Moody's and Standard & Poor's.

	All	Private	Public
	(1)	(2)	(3)
# Green bonds	589	432	157
Amount (in €m)	273.1	238.6	367.0
	(361.2)	(352.8)	(368.1)
Certified (1/0)	0.913	0.917	0.905
	(0.281)	(0.277)	(0.295)
Maturity (years)	9.12	7.37	13.95
	(41.47)	(4.83)	(80.01)
Fixed-rate bond (1/0)	0.660	0.678	0.612
	(0.474)	(0.468)	(0.489)
Coupon (for fixed rate)	1.85	1.95	1.58
	(1.90)	(2.06)	(1.34)
Credit rating			
S&P rating (median)	A-	A-	A-
Moody's rating (median)	A3	A3	A3

In column (2) and (3), we separate green bonds issued by private firms (2) and public firms (3). The table shows that there are more private issuers than public issuers in Europe. However, the bonds issued by public firms are considerably larger. Public bonds have longer maturities, largely driven by a bond with a maturity of 1000 years, and they have lower coupon rates.

Table 2 presents the descriptive statistics for all the green and conventional bonds used in this study. The data is manually adjusted for methodology specific criteria such as overlapping event windows, removal of financial institutions, thin trading, late IPOs and stock price history of at least 221 days.

Table 2: Descriptive Statistics of the Conventional and Green Bond Issuances in Sample

Table 2 describes the number of observations, the mean, median, standard deviation, minimum and maximum of the issued bonds in the sample period November 2013 to October 2019. *Amount* is stated in €m. *Maturity* is reported in years, while *Coupon* is reported in percentage. *Certified* is a dummy variable equal to one if the bond is certified by a third-party. Lastly, *Fixed-rate bond* is a dummy variable equal to 1 if the bond has fixed coupon payments.

Variable	N	Mean	Median	Standard deviation	Minimum	Maximum
Conventional bonds						
Amount	380	528.78	429.31	548.66	10	3000
Maturity*	355	12.01	7.49	13.83	0.51	100
Coupon	380	2.23	1.75	1.58	0	7
Fixed-rate bond (1/0)	380	0.65	1	0.48	0	1
Green bonds						
Amount	117	423.05	300	389.15	20.75	1750
Maturity*	112	16.49	6.99	93.83	2	1000
Certified (1/0)	117	0.91	1	0.29	0	1
Coupon	117	1.50	1.25	1.07	0	6.38
Fixed-rate bond (1/0)	117	0.56	1	0.50	0	1

* There were 25 conventional bonds and 5 green bonds with unknown maturity dates.

First, Table 2 shows that there were issued more conventional bonds than green bonds in the time period analysed. Secondly, the average green bond issuance has a lower size than conventional bond issuances. The coupon rate for green bonds is lower than the average coupon rate of the conventional bonds. 91% of the green bonds in the sample are certified by a third-party. The green bonds are also less likely to be fixed-rate bonds than the conventional bonds.

3.5.2 Control Variables

As previously mentioned, we use multiple control variables in the regression analysis. The 497 bond observations from public firms corresponds to 160 unique firm-year observations. Table 3 displays descriptive statistics at the issuer level. The time-period of interest has been defined in section 3.1.

Table 3: Descriptive Statistics at the Issuer Level

The table below presents the descriptive statistics at the issuer level in the sample period November 2013 to October 2019. *Total Assets* is presented in €bn. The rest of the variables are all ratios. *Equity-to-Assets* is the book value of equity divided by assets. *EBIT-to-Interest* is the EBIT divided by interest expenses. *CF Ratio* is the cash flow ratio, which is the cash flow from operations divided by total assets. Lastly, *ROA* is the return on assets calculated as net income divided by total assets.

Variable	N	Mean	Median	1st quartile	3rd quartile	Minimum	Maximum
Total Assets (€bn)	160	67.26	20.33	7.37	70.84	0.77	515.83
Equity-to-Assets	160	0.30	0.30	0.22	0.40	-0.04	0.61
EBIT-to-Interest	160	5.40	3.99	3.16	6.25	-0.78	32.69
CF Ratio	160	0.05	0.05	0.03	0.07	-0.08	0.16
ROA	160	0.04	0.03	0.02	0.06	-0.13	0.14

The median of Total Assets is well below the mean, in addition to the mean being close to the 3rd quartile. This implies that there are a few big firms within the sample, such as Volkswagen, Vodafone and EDF, which account for a relatively large part of the total assets. The Equity-to-Assets are relatively well-distributed, with the CF Ratio and ROA exhibiting the same pattern. Most of the companies in the sample have an EBIT-to-Interest ratio above zero, implying that they are reliable debtors.

4. Empirical Analysis

In this chapter, we first present the applied methodologies before answering the research question on how the stock market reacts to green bond announcements by European firms. First, we present the event study methodology, followed by an analysis of the event study results. Second, we present the regression methodology, before presenting the results from the regression analysis, where we control for firm and bond-specific characteristics.

4.1 Event Study

We begin this section with a brief review of the methodology for the event study. Then, we present the results in section 4.1.2.

4.1.1 Methodology

The purpose of this event study is to examine the impact of green bond announcements by public European firms, by measuring the abnormal returns associated with the announcement. Given the semi-strong form of the efficient market hypothesis, the effects of a green bond announcement should be reflected immediately in the stock price. The announcement date, as opposed to the issuance date, is the relevant date for the event study since it captures the day when the information is provided to the market. In contrast, on the issuance date, no new information is provided (Flammer, 2018).

Based on an estimation period prior to the analysed event, the method estimates what the normal return of the green bond issuers should be at the day of the announcement, as well as several days prior and after the announcement. This is known as the event window. The event window should be short enough to exclude confounding effects, but long enough to capture the true effects of the event (McWilliams & Siegel, 1997). The period preceding the announcement may be of interest, as information might be acquired by the market prior to the firm announcing green bonds. It is also suggested by MacKinlay (1997) to include a period after the event, which will enable us to analyse the continual update of the stock price.

The estimation window should be defined to be short enough to include the most recent movements in price and avoiding changes in systematic risk, while also being long enough to minimize the variance of the daily returns (Strong, 1992). The estimation period ends 21 days prior to the green bond announcement date in order to avoid overlapping between the event window and estimation window. The timeline of the event study is illustrated in Figure 2.

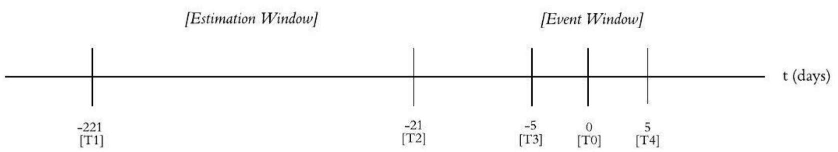

Figure 2 – From MacKinlay (1997) – Estimation Window

The announcement date is represented by T_0 = 0 in the study. T_1, T_2, T_3 and T_4 is set to -221, -21, -5 and 5, respectively. The estimation window is the time period between [T_1, T_2] consisting of 201 days of stock returns. The main period of interest is the event window [0,1]. However, the full event window is the time period between [T_3, T_4], implying 11 days of stock returns [-5,5]. We include 9 additional days of stock returns to ensure robustness.

The benchmark for normal performance is the expected return without conditioning on the event occurring (MacKinlay, 1997). We use the market model to estimate normal performance (Stapleton & Subrahmanyam, 1983). Equation 5.1 expresses the market model.

$$R_{it} = a_i + \beta_i R_{mt} + \varepsilon_{it} \tag{5.1}$$

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

Where R_{it} is the return of security i at time t and R_{mt} is the return of the market portfolio at time t. ε_{it} is the error term, with an expected value of zero and variance of $\sigma^2_{\varepsilon_i}$. a_i and β_i are parameters of the market model. The market model uses OLS regression to estimate $\hat{\alpha}_i$ and $\hat{\beta}_i$. A new estimation of $\hat{\alpha}_i$ and $\hat{\beta}_i$ is required for each green bond announcement, as both company and market characteristics may vary over time and between countries. We use the estimation window [T_1, T_2] consisting of 201 days of stock returns to estimate $\hat{\alpha}_i$ and $\hat{\beta}_i$.

The estimated abnormal return (AR_{it}) for event i at time t is the difference between the realized return and the normal return estimated by the market model. It is expressed in equation 5.2.

$$AR_{it} = R_{it} - (a_i + \beta_i R_{mt}) \tag{5.2}$$

The aggregation of the abnormal returns for security i gives us the cumulative abnormal return $CAR_i(T_3, T_4)$, defined in equation 5.3

$$CAR_i(T_3, T_4) = \sum_{t=T_3}^{T_4} AR_{it} \tag{5.3}$$

The average abnormal returns (AAR_t) are aggregated for all securities i of each t in the event window. We do not consider clustering to be a problem in the model[11]. The AAR_t in a sample with N events is defined in equation 5.4

$$AAR_t = \frac{1}{N} \sum_{i=1}^{N} AR_{it} \tag{5.4}$$

Finally, the sum of the AAR over the t days in the event window is used to find the cumulative average abnormal return ($CAAR$). The $CAAR(T_3, T_4)$ in the event window for a sample with N events is expressed in equation 5.5

$$CAAR(T_3, T_4) = \frac{1}{N} \sum_{T_3}^{T_4} AAR_t \tag{5.5}$$

In order to draw statistical inference from the CAARs estimated from the event study, we need to test for significance. Significance tests used in event studies can be divided into two categories; parametric and non-parametric. Parametric tests are usually complemented by non-parametric tests in order to ensure robustness[12]. The analysis will therefore be based on a parametric test, the standardized cross-sectional test proposed by Boehmer, Musucemi & Poulsen (1991), which considers the change in variance close to the day of the event. The Wilcoxon signed-rank test is included as a non-parametric test to ensure robustness (Wilcoxon, 1945).

The standardized cross-sectional test is a combination of the Patell (1976) test and the traditional cross-sectional test. It is more robust than the traditional test, as it considers information from both the estimation and event window, and accounts for event-induced

[11] Brown & Warner (1985) found that market model estimation did not cause misspecification. In addition, the standardized cross-sectional test is not affected by time clustering (Boehmer et al., 1991). As we use the market model to estimate normal performance and the standardized cross-sectional test for significance, we consider time clustering as a limited problem in this thesis.
[12] The difference between parametric tests and non-parametric tests, is that the parametric tests assume that the abnormal returns are normally distributed (MacKinlay, 1997).

volatility and serial correlation (Kolari & Pynnönen, 2010). This is useful when a change in volatility is a potential issue. While non-clustered events are sufficient according to MacKinlay (1997), the standardized cross-sectional test requires uncorrelated cross-sectional residuals (Boehmer, Masumeci, & Poulsen, 1991).

In the standardized cross-sectional test, the standardized AR_{it} ($SAR_{i,t}$) and CAR_i ($SCAR_i$) is aggregated through events. The test statistics for AR_{it} and CAR_i is defined in equation 5.6 and 5.7, separately.

$$Z_{1,t} = \sqrt{N} \times \frac{ASAR_t}{\sqrt{Var(ASAR_t)}} \tag{5.6}$$

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

$ASAR_t$ is the average SAR_t at time t, $SAR_{i,t}$ is the standardized abnormal return for event i at time t, while $Var(ASAR_t)$ is the variance of $ASAR$ at time t and N is the number of events.

$$Z_1 = \sqrt{N} \times \frac{ASCAR}{\sqrt{Var(ASCAR)}} \tag{5.7}$$

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

$ASCAR$ is the average $SCAR$, $SCAR_i$ is the standardized cumulative abnormal return for event i, while $Var(ASCAR)$ is the variance of $ASCAR$ and N is the number of events.

In the following section, we apply the outlined methodology to investigate the stock market reaction to green bond announcements, using the sample derived in Chapter 3.

4.1.2 Results

In this part of the thesis, we present the results from the event study. First, we look at the main sample, comparing green bonds to their conventional counterpart. Second, we analyse geographical differences within Europe. Third, we examine whether there are differences between first and subsequent green bond announcements. Lastly, third-party certified green bonds are compared to non-certified green bonds.

The Stock Market Reaction to Green Bond Announcements

Table 4 presents the CAARs and CMARs surrounding the green and conventional bond announcements in the sample, with the AARs being graphically illustrated in Figure 3. The results show that green bond announcements on average have a significant positive effect on the market valuation of European firms. We find a CAAR of 0.37% in the main event window [0,1] surrounding green bond announcements. Additionally, we find a CAAR of -0.21% for the conventional bonds, which suggests a green bond premium of 0.58%.

Table 4: CAAR and CMAR Surrounding Bond Announcements

The sample consists of 99 green bond announcements, and 299 conventional bond announcements in the period November 2013 to October 2019. *EV* is the event window. The standardized cross-sectional test (Z_1) is used as the parametric test to test if the cumulative average abnormal returns (*CAARs*) are significantly different from zero, while the Wilcoxon signed-rank test (Z_2) is used as the non-parametric test to test if the cumulative median abnormal returns (*CMARs*) are significantly different from zero. The alternative event windows (EV) are included as a robustness check regarding the choice of event window. Skewness and kurtosis are included to measure symmetry and extremeness in the data, respectively.

	Green bonds					Conventional bonds				
EV	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]
CAAR	0.30	0.20	0.10	0.37**	0.00	-0.12	-0.15	-0.04	-0.21**	0.09
Z_1	(1.09)	(1.30)	(0.62)	(2.48)	(0.32)	(1.13)	(1.13)	(0.47)	(2.03)	(0.04)
CMAR	0.29	0.16	0.09	0.35**	-0.23	-0.22*	-0.07	0.02	-0.11	-0.09
Z_2	(1.08)	(1.50)	(0.53)	(2.16)	(0.07)	(1.66)	(0.77)	(0.26)	(1.22)	(0.08)
Skewness	(0.29)	(-0.59)	(-0.22)	(0.21)	(-0.98)	(0.87)	(-0.31)	(0.19)	(-0.61)	(0.99)
Kurtosis	(1.44)	(2.01)	(1.21)	(0.03)	(4.67)	(4.68)	(2.09)	(3.00)	(3.04)	(4.60)
Obs.	99	99	99	99	99	299	299	299	299	299

*** Significance for a 2-tailed test at the 1% level

** Significance for a 2-tailed test at the 5% level

* Significance for a 2-tailed test at the 10% level

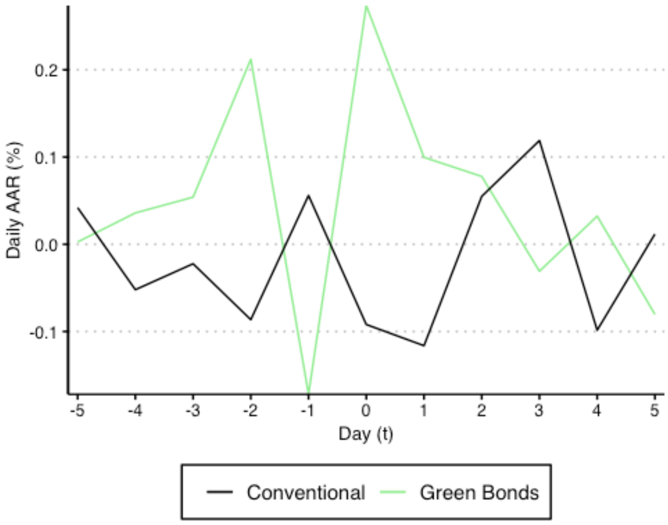

Figure 3 – ARs Surrounding the Bond Announcement

In order to test for statistical significance, we use the standardized cross-sectional test derived in subsection in 4.1.1. We use several alternative event windows and the Wilcoxon signed-rank test in order to ensure robustness. The computed CARs are aggregated across securities and events, which yields the CAAR and the cumulative median abnormal return (CMAR) in Table 4.

We report the CMAR to mitigate the issue that the results might be driven by a small number of stocks with extreme price reactions (Flammer, 2018). The CMAR of 0.35% compared to the CAAR of 0.37% indicates that there is no such issue in the sample. Furthermore, the Wilcoxon signed-rank test rejects the null hypothesis of CMAR equal to zero at the 5% level. This is an implication of the results being robust. The skewness in the main event window suggests that the data is fairly symmetrical, while the kurtosis suggests thin tails and few outliers in the dataset.

None of the alternative event windows are significant, indicating that the results are not driven by unrelated trends around the event date. The positive market reaction confirms that green bonds are regarded as value-enhancing. As a final robustness check, we re-ran the event study using the STOXX Europe 600 index as an alternative benchmark. The results are similar to what we computed when using the country-specific indices, see appendix B.1 for the results.

Leakage of information does not seem to be an issue in the sample, as the AAR on the day prior to the announcement is not statistically significant, see appendix B.2 for the AARs of the main sample. It appears that the announcements of green bonds in the sample were mostly announced before the stock exchange closed on the announcement day. Thus, the information in regards to the announcement is likely incorporated into the stock price on the announcement date. This is in accordance with the semi-strong form of the efficient market hypothesis.

The results are consistent with prior studies, which document a positive market reaction when companies announce eco-friendly actions (Klassen & McLaughlin, 1996; Krüeger, 2015). The reason for the positive stock market reaction is debated, as the literature propose different explanations (Tang & Zhang, 2018; Flammer, 2018). One proposed theory argues that green bond announcements attract investors' attention and improves market visibility, as well as enlarging the investor base. The rationale behind the theory is that investors initially do not pay attention to corporate announcements (Ben-Rephael, Da, & Israelsen, 2017), i.e. conventional bond issues, but that the visibility of a company matters to equity investors (Grullon, Kanatas, & Weston, 2004). Furthermore, green bonds attract investors seeking to improve their ESG scores and satisfy their green mandate (Reboredo, 2018). This increases demand and leads to an increase in stock price. Announcements related to green bond issuances are usually accompanied by a formal press release, in which the company declares their eco-friendly projects. Thus, media attention increases, while the firm also signals its green profile to the market, which will attract new investors (Klassen & McLaughlin, 1996; Krüeger, 2015).

An alternate explanation, labelled the "fundamental channel" by Tang & Zhang (2018), suggests that green bond announcements reduce information asymmetry, as they contain information about future investment opportunities, leading to the positive announcement effect (Myers & Majluf, 1984; Kang & Stulz, 1997). Green bond issuers explicitly state their use of proceeds in the bond prospectus and report their ongoing or future environmental activities. When firms issue conventional bonds, the same information is not disclosed. Consequently, equity investors will benefit from the additional information revealed when firms issue green bonds, resulting in the positive stock market reaction.

We show that European firms experience a positive stock market reaction following green bond announcements, which is line with the existing literature (Flammer, 2018; Glavas, 2018). However, we find that European firms experience on average lower abnormal returns than the global average (Flammer, 2018; Glavas, 2018). There may be multiple reasons for this. The Global Sustainable Investment Alliance (2019) found in their 2018 review that the CAGR[13] of sustainable investing assets in Europe was 6% in the period 2014-2018, which is lower than the United States (16%), Japan (308%), Canada (21%) and Australia/New Zealand (50%). This suggests that the European market for sustainable investing is more mature than the rest of the world, which could lead to investors reacting less positively to news regarding green bond issuances.

Another possible explanation for this deviation, is related to theories regarding asymmetric information. The European countries in the sample are regarded as economies with a high degree of transparency (Transparency International, 2019). Information is easily accessible, which in turn will reduce the information asymmetry by easing the pre-announcement uncertainty of investors. The lower CAAR may also be related to the high requirements for a bond to be labelled as green, as opposed to other regions. For example, Chinese financial institutions provided at least $1 billion in green financing to coal-related projects in the first half of 2019 (Reuters, 2019), which would not be labelled as green financing in Europe (Climate Bonds Initiative, 2019).

In addition, European companies have to follow EU guidelines in regards to non-financial reporting[14], which require large companies to disclose information regarding their impact on society and the environment (EU, 2019). These guidelines further incentivise the utilization of green finance, as evident by Europe being the biggest market for green bonds (SEB, 2019). It is required that European firms disclose information about how their company affects the environment. Therefore, investors might expect European firms to invest in eco-friendly projects regardless, which in turn might reduce the green bond announcement effect.

To sum up, there may be multiple reasons as to why European firms experience lower returns than the global average found in other studies (Flammer, 2018; Glavas, 2018; Tang & Zhang, 2018). First, we use a different time period. Second, European economies are more transparent, which reduces the effect of the new information provided by the green bond announcement. Third, the market for sustainable finance in Europe is different in regards to investor base and

[13] Compound Annual Growth Rate.
[14] The EU Non-Financial Reporting Directive.

jurisdiction. Finally, equity investors' may have the impression that European firms are more likely to invest in eco-friendly projects, making the signalling effect of the green bond weaker. However, these guidelines are relatively new[15], and do not explain the lower returns for the entire period, as the first European public green bond was issued in 2013. Furthermore, the aforementioned green signalling effect does not hold if one apply Tang and Zhang's (2018) "fundamental channel" as the main driver for the positive stock market return.

Regional Differences

In this section, we investigate the existence of any regional differences within Europe. There are no prior studies that are directly comparable, as this is the first paper studying green bond announcement effects in Europe exclusively. A previous study examining green bond pricing in Europe deemed the market too small for subsamples (Gianfrante & Peri, 2019). However, their study did not include data from 2018-2019, which is a period where the market has experienced tremendous growth[16]. The market is still not large enough to analyse all the four main regions separately[17]. This is largely because of the relatively small size of the overall market, but also due to the large geographical spread of green bonds issuers within Europe. We find that the majority of issuances are from Northern Europe, while the rest are located in either Western or Southern Europe. There are no issuances in Eastern Europe[18].

Since the issuances of green bonds are more widespread in some regions than others, we are only able to conduct statistical analysis in areas where we have enough data. Therefore, we analyse the region where green bond issuances are most prevalent, Northern Europe[19]. 41 out of 99 announcements are from this region, which is considered to be large enough to draw statistical inference (Kish, 1965). None of the other regions have large enough samples on their own, we therefore combine them as "Rest of Europe".

[15] Came into force in 2018 (EU, 2019).
[16] See Chapter 2 for further discussion.
[17] Regions as defined by the United Nations Statistics Division (2019) - North, South, East and West.
[18] See appendix A.4. Industry and Country splits.
[19] Northern Europe is defined by the UN as Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden and the United Kingdom (UN, 2008).

Table 5: CAAR and CMAR for Northern Europe versus Rest of Europe

The sample consists of 41 green bond announcements in Northern Europe and 58 green bond announcements in the rest of Europe in the period November 2013 to October 2019. *EV* is the event window. The standardized cross-sectional test (Z_1) is used as the parametric test to test if the cumulative average abnormal returns (*CAARs*) are significantly different from zero, while the Wilcoxon signed-rank test (Z_2) is used as the non-parametric test to test if the cumulative median abnormal returns (*CMARs*) are significantly different from zero. The alternative event windows are included as a robustness check regarding the choice of event window. Skewness and kurtosis are included to measure symmetry and extremeness in the data, respectively.

	Northern Europe					Rest of Europe				
EV	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]
CAAR	-0.02	0.70***	0.43*	0.67***	-0.08	0.53	-0.15	-0.13	0.16	0.06
Z_1	(0.02)	(2.92)	(1.88)	(2.77)	(0.16)	(1.41)	(0.75)	(1.05)	(0.78)	(0.67)
CMAR	0.22	0.74***	0.40	0.64**	-0.25	0.45	-0.16	-0.23	0.04	-0.09
Z_2	(0.04)	(2.70)	(1.59)	(2.42)	(0.24)	(1.47)	(0.43)	(0.84)	(0.66)	(0.13)
Skewness	(0.16)	(0.05)	(-0.15)	(0.05)	(-1.54)	(0.58)	(-0.94)	(-0.51)	(0.23)	(0.31)
Kurtosis	(1.55)	(0.01)	(-0.26)	(-0.21)	(4.93)	(0.61)	(2.47)	(2.73)	(0.03)	(0.20)
Obs.	41	41	41	41	41	58	58	58	58	58

*** Significance for a 2-tailed test at the 1% level
** Significance for a 2-tailed test at the 5% level
* Significance for a 2-tailed test at the 10% level

In Table 5, we compare the stock market reaction of Northern Europe to the rest of Europe. The CAAR of countries from Northern Europe is 0.67%, and statistically significant at the 1% level. Rest of Europe has a CAAR of 0.16%, but is not statistically significant. Furthermore, the CMAR of 0.64% is statistically significant at the 5% level, indicating robust results. It is worth noticing that the CAAR for Northern Europe exclusively at 0.67% is substantially higher than for Europe combined at 0.37% for the main event window.

The results show that equity investors react more positively to green bond announcements in Northern Europe. On the contrary, when excluding the Northern European countries, we find no significant reaction to the announcements. Put differently, we find that the main driver of the positive stock market reaction is the Northern European countries. One of the reasons may be that investors in Northern Europe are more invested in green finance, and that the demand for eco-friendly stocks is larger (SEB, 2019). For example, green bonds account for 21% of total bonds issued in Sweden in 2019[20], compared to less than 4% of total bond issuance in most major currencies (SEB, 2019). Furthermore, a study conducted by Autti and Kokkinen

[20] As of October, 2019.

(2014) ranks Sweden, Finland, Denmark and Norway amongst the 8 most environmentally aware countries in the world[21]. With these countries making up the majority of the subsample, it seems reasonable that shareholders in these countries are more likely to invest in companies announcing eco-friendly projects.

First versus Subsequent Green Bond Announcements

In the following section, we analyse how the stock market reacts to the first green bond announcement versus subsequent announcements, see Table 6 for the results. It is worth noting that only 14 firms issue more than one green bond, so the dataset does not include subsequent issues for the majority of the sample.

Table 6: CAAR and CMAR for First versus Subsequent Green Bond Announcements

The sample consists of 54 first-time announcements and 45 subsequent announcements in the period November 2013 to October 2019. *EV* is the event window. The standardized cross-sectional test (Z_1) is used as the parametric test to test if the cumulative average abnormal return (*CAARs*) are significantly different from zero, while the Wilcoxon signed-rank test (Z_2) is used as the non-parametric test to test if the cumulative median abnormal returns (*CMARs*) are significantly different from zero. The alternative event windows are included as robustness regarding the choice of event window. Skewness and kurtosis are included to measure symmetry and extremeness in the data, respectively.

	First Announcements					Subsequent Announcements				
EV	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]
CAAR	0.23	0.28	0.29	0.40**	-0.29	0.39	0.11	-0.13	0.34	0.34
Z_1	(0.43)	(1.24)	(1.35)	(2.01)	(0.78)	(1.20)	(0.60)	(0.66)	(1.47)	(0.99)
CMAR	0.23	0.31*	0.26	0.50*	-0.35	0.38	-0.13	-0.26	-0.04	-0.02
Z_2	(0.44)	(1.65)	(1.35)	(2.02)	(0.92)	(1.08)	(0.48)	(0.85)	(1.04)	(1.10)
Skewness	(0.34)	(-0.44)	(-0.14)	(-0.05)	(-0.31)	(0.19)	(-0.65)	(-0.47)	(0.55)	(-1.46)
Kurtosis	(1.47)	(0.25)	(-0.14)	(0.19)	(-0.08)	(-0.48)	(2.67)	(3.25)	(-0.38)	(6.36)
Obs.	54	54	54	54	54	45	45	45	45	45

*** Significance for a 2-tailed test at the 1% level

** Significance for a 2-tailed test at the 5% level

* Significance for a 2-tailed test at the 10% level

The CAAR is 0.40% for first-time issuers, implying that the first green bond announcement yields a short term gain in firm value. The increased equity value is significant the 5% level for the CAAR, and for the CMAR at the 10% level. For subsequent announcements the CAAR is 0.34%, but not statistically significant. Hence, the results indicate that subsequent issues do not have any impact on stock returns upon announcement.

[21] United Kingdom is ranked as the 18th most environmentally aware country in the world, in a list consisting of 57 countries.

In regards to investor attention, the issuers should not benefit from the green label effect after the first announcement, at least not to the same extent. When the firm announces its first green bond, it signals a commitment to eco-friendly actions towards the market. After the first announcement, it is reasonable to assume that the market has learned about the firms' commitment to environmental projects, which leads to the information content of subsequent issues being more like a conventional bond issue (Eckbo, Masulis, & Norli, 2007). Therefore, we should not expect to find any positive effect for subsequent green bond announcements.

In contrast, the "fundamental channel" theory (Tang & Zhang, 2018) suggests that every green bond announcement will contain investment opportunities and valuable information, and presumably the stock market will react in every case. The theory implies that every green bond announcement, first and subsequent, should result in a similar stock market reaction. However, we do not find evidence for this theory in the event study, as the CAAR for the subsequent issues are not statistically significant. Thus, the "fundamental channel" is likely not the main driver of the positive stock market reaction.

Moreover, the findings are also consistent with the existing literature on the topic. Flammer (2018) examines all public green bond announcements globally, and find that first-time announcements are both positive and statically significant, while subsequent announcements are also positive but not significant. Similar results were also found by Thang & Zang (2018) in their study of green bond announcement effects. Consistent with Flammer (2018), we also find the CAAR to be higher for first-time announcements than the total sample.

Certification

In line with previous research, we also examine the potential signalling effect following third-party certification of the issuer. Table 7 reports the difference in stock market reaction between green bonds certified by a third party and non-certified green bonds.

Table 7: CAAR and CMAR for Certified Green Bonds versus Non-Certified Green Bonds

The sample consists of 91 third-party certified green bonds and 8 non-certified green bonds in the period November 2013 to October 2019. *EV* is the event window. The standardized cross-sectional test (Z_1) is used as the parametric test to test if the cumulative average abnormal returns (*CAARs*) are significantly different from zero, while the Wilcoxon signed-rank test (Z_2) is used as the non-parametric test to test if the cumulative median abnormal returns (*CMARs*) are significantly different from zero. The alternative event windows are included as robustness regarding the choice of event window. Skewness and kurtosis are included to measure symmetry and extremeness in the data, respectively.

	Certified					Non-Certified				
EV	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]
CAAR	0.30	0.25	0.16	0.44***	-0.05	0.39	-0.33	-0.51	-0.38	0.50
Z_1	(0.99)	(1.48)	(1.01)	(2.74)	(0.05)	(0.58)	(0.63)	(1.43)	(0.30)	(1.03)
CMAR	0.29	0.21*	0.10	0.35**	-0.26	0.15	0.00	-0.46	-0.02	0.148
Z_2	(0.96)	(1.69)	(0.85)	(2.34)	(0.14)	(0.33)	(0.20)	(1.30)	(0.20)	(0.47)
Skewness	(0.29)	(-0.62)	(-0.28)	(0.37)	(-1.01)	(0.25)	(-0.94)	(0.02)	(-0.49)	(-0.58)
Kurtosis	(1.31)	(1.98)	(1.27)	(-0.12)	(5.11)	(-1.24)	(-0.11)	(-1.70)	(-1.56)	(-0.64)
Obs.	91	91	91	91	91	8	8	8	8	8

*** Significance for a 2-tailed test at the 1% level

** Significance for a 2-tailed test at the 5% level

* Significance for a 2-tailed test at the 10% level

The CAAR of the certified green bonds in the main event window is 0.44% and statistically significant at the 1% level. Furthermore, the CAAR of the certified bonds is 0.07% higher than for the full sample of green bonds. The CMAR is also statistically significant at the 5% level, indicating robust results. The sample of non-certified bonds is too small to make any valid inference, however it is worth noticing that the CAAR is negative at -0.38%.

In the literature, the signalling effect of the certification has been pointed out as a major reason for the increase in firm value (Park, Hyun, & Tian, 2018; Gianfrante & Peri, 2019). In order for the bond to be certified as green, the firm has to establish that the proceeds are funding projects that generate environmental benefits (Climate Bonds Standard, 2019). This will in turn raise the administrative costs and compliance burdens of the company. As a result, certified green bonds signify a more reliable commitment towards eco-friendly projects, which could explain the stronger market reaction (Flammer, 2018). Previous studies on the certification effect of green bonds also underline this, as Flammer (2018) finds significantly higher returns for the certified green bonds than the non-certified.

4.2 Regression

We include this section as a robustness for the event study, where we use regression analysis to control for an array of variables that potentially affect the stock market reaction to green bond announcements. Before we present the results from the regressions in section 4.2.2, we provide an overview of the methodology and variables included.

4.2.1 Methodology

Previous research on debt issuance link to equity markets show that several bond and firm characteristics may affect the stock market reaction to bond announcements (Spiess & Affleck-Graves, 1999; Bradshaw, Richardson, & Sloan, 2006; Godlewski, Turk-Ariss, & Weill, 2013). Therefore, as robustness for the event study, we perform a regression analysis on the CARs to detect whether or not the green label still has an effect on the stock market return, after controlling for other relevant variables. Based on the literature, we select the following control variables for the regression.

The first element we control for is firm size, as it is considered to be a potential driver of stock market reaction to bond announcements (Spiess & Affleck-Graves, 1999; Bradshaw, Richardson, & Sloan, 2006). We compute firm size as the natural logarithm of total assets, done in studies such as Godlewski et al. (2013). Second, we need to control for risk-related factors that might affect the equity investor reaction. To account for this, we choose EBIT-to-interest expense, equity-to-assets and cash flow ratio as control variables (Baulkaran, 2018; Goh & Ederington, 1993). Third, a company's financial performance is also expected to affect the stock market reaction. Following Godlewski et al. (2013) we choose ROA to control for financial performance.

Following Glavas (2018), we lag all of the aforementioned firm-specific control variables, using the fiscal year financial data prior to the bond announcement date. We only apply full-year accounting data, as it is the most reliable source. Full-year accounting data undergoes a thorough auditing process, which is not necessarily the case for other financial data, such as quarterly reports.

Specific bond characteristics may also affect the perception of firm value by equity investors. In particular, maturity, coupon rate, and issue size have been applied in previous studies

(Godlewski, Turk-Ariss, & Weill, 2013; Glavas, 2018). Accordingly, we also control for these aspects in the regression to further strengthen the analysis. We compute maturity in years, coupon rate as percentage and bond size as the natural logarithm of the amount issued.

Lastly, since the sample is comprised of multiple countries across different industries and years, we also control for country, firm, industry and year fixed effects. Thus, we test the following OLS regression, largely based on the works of Godlewski et al. (2013) and Glavas (2018):

$$CAR_{ij} = a_i + \beta_{ij} \times Green + Controls_{ij} + \varepsilon_{ij} \tag{5.8}$$

The OLS is used to estimate the parameters of the model above, where CAR_{ij} is the dependent variable using the window [0,1], corresponding to the main event window. $Green$ is a dummy variable equal to one if the bond is green, and zero if otherwise. $Controls_{ij}$ represents the list of the control variables described above for firm i on announcement j and ε_{ij} is the error term with an expected value of zero and a variance of $\sigma^2_{\varepsilon_i}$. The OLS model assumes homoscedastic error terms, however this assumption is often violated (MacKinlay, 1997). Therefore, we apply robust standard errors drawn from using the approach of White (1980).

The main element of interest in the regression is the β_{ij}-coefficient. A significant positive (or negative) sign would suggest that the green label of the bond has a an effect on the stock return. If we find a significant positive β_{ij}-coefficient, it would imply that equity investors consider green bond announcements to contain information of positive value. In contrast, if the β_{ij}-coefficient is not statistically significant, it would imply that equity investors do not consider the green label to have any value-relevant information.

Finally, when interpreting the results from a regression in an event study setting, there are certain aspects that should be considered. The abnormal returns for the event date could be connected to firm characteristics through both the valuation effect and anticipation effect of the event, which involves firm characteristics being used to predict the probability of an event occurring (MacKinlay, 1997). For example, companies with well-known environmentally friendly profiles could be anticipated to issue green bonds in the future. Hence, the observed valuation effect from the event study could deviate from the true effect (MacKinlay, 1997). Still, Prabhala (1997) claims that the coefficients derived from a regression analysis are proportional to the true parameters, arguing that the corresponding t-statistics can be interpreted as a lower bound of the true significance level.

4.2.2 Results

This part of the thesis presents the results from the regression analysis, provided as robustness for the event study. We perform regression analyses on the same set of subsamples as for the event study[22].

Green versus Conventional

We use the CAR from the event window [0,1] as the dependent variable, since it is the main variable of interest from the event study and statistically significant for green bond announcements. The independent control variables are the bond and firm-specific characteristics derived above. We present the results from the regression analysis in Table 8.

[22] We exclude Certification as we deem the subsample of non-certified bonds too small.

Table 8: Regression results – Green Bonds versus Conventional Bonds

The regression results, with robust Huber-White standard errors, are displayed below. The sample period is November 2013 to October 2019. The dependent variable is the cumulative abnormal return (*CAR*) for all the regressions. In model (1), we follow Godlewski et al. (2013) and Glavas (2018). The independent variable of interest *Green* is equal to 1 when the bond is labelled as green, 0 otherwise. Then, we add the control variables. *Size* is equal to the natural logarithm of total assets, *Equity-to-Assets* is the shareholders' equity divided by the total assets, *EBIT-to-Interest* is equal to the company's EBIT divided by the interest expense, *CF Ratio* is the cash flow ratio of the company, calculated as operating cash flow divided by total assets. *ROA* is the net income divided by the total assets, *Coupon* is the coupon rate of the bond in percentage, while *Maturity* is the bond's maturity expressed in years. Model (2) is the same model with industry, year and country fixed effects. Model (3) uses the same variables as model (1), however, we also add *Bond Size* as the natural logarithm of the amount issued and firm and year fixed effects.

	(1)	(2)	(3)
Variables	CAR	CAR	CAR
Green	0.612***	0.589**	0.680***
	(0.194)	(0.233)	(0.246)
Size	0.119	0.069	0.520
	(0.078)	(0.130)	(0.507)
Equity-to-Assets	-0.018	1.079	3.959
	(0.710)	(1.126)	(4.340)
EBIT-to-Interest	-0.034	-0.065*	0.066
	(0.023)	(0.036)	(0.074)
CF Ratio	0.348	6.192	0.847
	(2.930)	(4.576)	(7.991)
ROA	2.717	3.440	1.800
	(3.247)	(3.873)	(4.502)
Coupon	0.121	-3.766	-2.123
	(8.524)	(9.842)	(11.235)
Maturity	-0.013	-0.007	-0.009
	(0.009)	(0.010)	(0.013)
Bond Size			-0.079
			(0.096)
Constant	-2.738	-6.016**	-11.176
	(1.978)	(2.997)	(12.456)
Observations	367	367	367
R^2	0.04	0.11	0.22
Firm FE	No	No	Yes
Industry FE	No	Yes	No
Year FE	No	Yes	Yes
Country FE	No	Yes	No

Huber-White standard errors in parentheses

*** Significance for a 2-tailed test at the 1% level

** Significance for a 2-tailed test at the 5% level

* Significance for a 2-tailed test at the 10% level

In the first regression (1) we show the results including all control variables except bond size, which is not considered to have a large impact on stock market reaction Glavas (2018). The following regressions (2) and (3) show the results with additional fixed effects and time variant controls. All the results are presented with Huber-White robust standard errors.

The main finding is that the variable $Green$ is positive and statistically significant in all the estimations, thus confirming the notion of a significant positive stock market reaction to green bond announcements. After controlling for potential biases, we measure a 0.68% increase of the CAR resulting from the green label of the bond.

In regression (2), we find EBIT-to-interest to be statistically significant at the 10% level. This is in contrast to Glavas (2018), who finds multiple control variables to be significant. However, we do not use the same bond market or the same time period in this study, which might explain why the results differ. Moreover, the literature on whether specific firm and bond characteristics affects the stock market reaction is mixed (Spiess & Affleck-Graves, 1999; Baulkaran, 2018). For instance, Godlweski et al. (2013) used similar variables as in this study, and did not find any of the control variables to be statistically significant.

Omitted variable bias and simultaneity bias are two repeatedly mentioned sources of endogeneity (Roberts & Whited, 2013). In this study, simultaneity bias does not seem to be a risk for practical reasons. Once the green bond is announced, the issuer cannot control the stock price reaction which is due to investors' evaluation of the new information regarding firm value (Glavas, 2018). Consequently, we do not anticipate simultaneity bias to be of major concern for the regression estimates.

However, there might be some variables that both impact the dependent and independent variables, which can result in omitted variable bias. To prevent this, we include a number of control variables, as explained above. In addition, we also include firm, industry and country fixed effects and time effects in the model. The firm, industry and country fixed effects allows us to control for time-invariant omitted variables, such as firm or country-specific characteristics. Time fixed effects are represented by Year FE in the model, and controls for omitted macroeconomic variables. The use of these two controls does not impact the results, and the label green is still statistically significant at 1% when controlling for these potential biases. Lastly, we use the generalized variance-inflation factors and a correlation matrix to check for multicollinearity. Multicollinearity does not seem to be an issue in the regression[23].

[23] See appendix B.4 - B.6.

Regional Differences

We perform a regression analysis controlling for the same variables as outlined in section 4.2.1, as a robustness check for regional differences. We add two dummy variables for the two regions of interest, $Northern\ Europe$ and $Rest\ of\ Europe$. Then, we combine them with the dummy variable $Green$, to test the effect of a bond being announced in a specific region while also being green. The regression results measure to what extent the green label of the bond affects the stock price in Northern Europe and the Rest of Europe. In Table 9, we present the regression results.

Table 9: Regression results – Northern Europe versus Rest of Europe

The regression results, with Huber-White robust standard errors, are displayed below. The sample period is November 2013 to October 2019. The dependent variable is the cumulative abnormal return (*CAR*) for all the regressions. In model (1), we follow Godlewski et al. (2013) and Glavas (2018). The independent variable of interest *Green*Nordics* is equal to 1 when the bond is Northern European and labelled as green, 0 otherwise. *Green*Rest of Europe* is 1 when the bond is not from Northern Europe and labelled as green, 0 otherwise. *Northern Europe* is equal to 1 if the bond is announced in Northern Europe and labelled as conventional, 0 otherwise. Then, we add the control variables. *Size* is equal to the natural logarithm of total assets, *Equity-to-Assets* is the shareholders' equity divided by total assets, *EBIT-to-Interest* is equal to the company's EBIT divided by the interest expense, *CF Ratio* is the cash flow ratio of the company, calculated as operating cash flow divided by total assets. *ROA* is the net income divided by total assets, *Coupon* is the coupon rate of the bond in percentage, while *Maturity* is the bond's maturity expressed in years. Model (2) is the same model with industry, year and country fixed effects. Model (3) uses the same variables as model (1), however, we also add *Bond Size* as the natural logarithm of the amount issued and firm and year fixed effects.

Variables	(1) CAR	(2) CAR	(3) CAR
Green*Northern Europe	1.008***	0.981***	1.188***
	(0.302)	(0.331)	(0.416)
Green*Rest of Europe	0.287	0.370	0.339
	(0.273)	(0.280)	(0.272)
Northern Europe	-0.135	-0.275	-0.212
	(0.229)	(0.328)	(1.470)
Size	0.125	0.144	0.532
	(0.077)	(0.125)	(0.512)
Equity-to-Assets	-0.115	0.135	3.636
	(0.824)	(1.216)	(4.409)
EBIT-to-Interest	-0.037	-0.043	0.062
	(0.025)	(0.030)	(0.075)
CF Ratio	-0.141	2.244	0.646
	(2.915)	(3.623)	(8.041)
ROA	1.443	0.711	1.593
	(3.459)	(4.078)	(4.594)
Coupon	-2.199	-1.412	-4.092
	(8.688)	(9.922)	(11.594)
Maturity	-0.013	-0.011	-0.009
	(0.011)	(0.010)	(0.013)
Bond Size			-0.079
			(0.096)
Constant	-2.674	-3.818	-11.197
	(1.915)	(2.968)	(12.566)
Observations	367	367	367
R^2	0.04	0.11	0.22
Firm FE	No	No	Yes
Industry FE	No	Yes	No
Year FE	No	Yes	Yes
Country FE	No	No	No

Huber-White standard errors in parentheses

*** Significance for a 2-tailed test at the 1% level

** Significance for a 2-tailed test at the 5% level

* Significance for a 2-tailed test at the 10% level

The main finding is that the variable of interest, $Green * Northern\ Europe$, is significant at the 1% level in all the regressions. Further, the variable $Green * Rest\ of\ Europe$ is not significant in any of the regressions, indicating that there is no significant reaction to a green bond announcement in the other European regions. Moreover, we do not find the coefficient $Northern\ Europe$ to be statistically significant, providing further evidence for that it is not the region Northern Europe itself that is the driver for the abnormal returns. This suggests that the positive stock market reaction is only present when the bond is labelled green and issued in Northern Europe.

After controlling for firm and bond-specific characteristics we measure a 1.19% increase of the CAR, resulting from the green label of the bond in the Northern European countries, which is higher than the increase of 0.68% that we found for all the European countries in the sample. This confirms the findings of the event study, as it further underlines that equity investors react more positively to green bond announcements in Northern Europe, than in the rest of Europe. Additionally, it is consistent with the Northern European countries being the main driver for the positive stock market reaction to green bond announcements.

First versus Subsequent Green Bond Announcements

To ensure robustness, we measure the effect of first and subsequent green bond announcements, by performing a similar regression analysis as described above. We add the dummy variables $First * Green$ and $Subsequent * Green$, representing all the first green bond announcements and all the subsequent green bond announcements, respectively. In Table 10, we present the regression results.

Table 10: Regression results – First versus Subsequent Green Bond Announcements

The regression results, with Huber-White robust standard errors, are displayed below. The sample period is November 2013 to October 2019. The dependent variable is the cumulative abnormal return (*CAR*) for all the regressions. In model (1), we follow Godlewski et al. (2013) and Glavas (2018). The independent variable of interest *First*Green* is equal to 1 when the bond is the first green bond announced by a corporation, 0 otherwise. *Subsequent*Green* is equal to 1 when the bond is a subsequent green bond announced by a corporation. Then, we add the control variables. *Size* is equal to the natural logarithm of total assets, *Equity-to-Assets* is the shareholders' equity divided by total assets, *EBIT-to-Interest* is equal to the company's EBIT divided by the interest expense, *CF Ratio* is the cash flow ratio of the company, calculated as operating cash flow divided by total assets. *ROA* is the net income divided by total assets, *Coupon* is the coupon rate of the bond in percentage, while *Maturity* is the bond's maturity expressed in years. Model (2) is the same model with industry, year and country fixed effects. Model (3) uses the same variables as model (1), however, we also add *Bond Size* as the natural logarithm of the amount issued and firm and year fixed effects.

	(1)	(2)	(3)
Variables	CAR	CAR	CAR
First*Green	0.746***	0.783***	0.740***
	(0.238)	(0.262)	(0.277)
Subsequent*Green	0.578**	0.520	0.698*
	(0.277)	(0.320)	(0.367)
Size	0.130*	0.097	0.526
	(0.078)	(0.131)	(0.507)
Equity-to-Assets	0.036	1.223	3.984
	(0.721)	(1.133)	(4.326)
EBIT-to-Interest	-0.036	-0.066*	0.063
	(0.023)	(0.036)	(0.074)
CF Ratio	0.286	6.033	1.116
	(2.923)	(4.527)	(8.005)
ROA	2.973	3.400	1.849
	(3.210)	(3.816)	(4.483)
Coupon	-0.212	-4.002	-1.986
	(8.510)	(9.785)	(11.264)
Maturity	-0.013	-0.007	-0.009
	(0.009)	(0.010)	(0.013)
Bond Size			-0.081
			(0.096)
Constant	-3.043	-7.041**	-11.313
	(2.023)	(3.087)	(12.428)
Observations	367	367	367
R^2	0.04	0.11	0.22
Firm FE	No	No	Yes
Industry FE	No	Yes	No
Year FE	No	Yes	Yes
Country FE	No	Yes	No

Huber-White standard errors in parentheses

*** Significance for a 2-tailed test at the 1% level

** Significance for a 2-tailed test at the 5% level

* Significance for a 2-tailed test at the 10% level

We find the main variable of interest, $First * Green$, to be significant at the 1% level for all the regressions, after controlling for potential biases. Consequently, providing further evidence for that the initial signalling effect of the increased environmental responsibility is perceived as value-enhancing by equity investors. The results are also consistent with the findings from the event study. Compared to the regression examining the green bond effect for the total sample[24], we find $First * Green$ to exhibit higher returns, which is also consistent with the event study.

In contrast to the event study, we find $Subsequent * Green$ to be significant at the 5% level in regression (1) and at the 10% level in regression (3), implying that also subsequent green bond announcements are perceived as value-enhancing by the market. This deviates from the results found in the event study, where we find no evidence for subsequent announcements providing a positive stock market reaction. Using regression analysis to control for potential factors when measuring the effect of first and subsequent green bond announcements has not been done in previous studies, to the best of our knowledge. Flammer (2018) and Tang & Zhang (2018) analyse the first and subsequent announcement effects only by applying the event study methodology, and do not find any significant results for subsequent announcements.

Therefore, this paper adds to the discussion by providing evidence for that when controlling for firm and bond-specific characteristics, subsequent green bond announcements may also be beneficial to equity holders. The information about future investments revealed in the green bond announcements reduces information asymmetry, which could explain the increased stock price. Since we find a significant stock market reaction after subsequent announcements, the "fundamental channel" may be part of the explanation for the positive reaction (Tang & Zhang, 2018). The regression analysis provide evidence for the "fundamental channel", as we find a significant stock market reaction to every green bond announcement, not only the first.

[24] See Table 8.

5. Conclusion

This thesis examines how the stock market reacts to green bond announcements by firms listed on European stock exchanges from November 2013 to October 2019. By applying the event study methodology on public European companies, we find evidence of green bond announcements having a positive impact on firm value.

In the main event window [0,1] surrounding the green bond announcement date, we find a CAAR of 0.37%. Conventional bond announcements yield a CAAR of -0.21% in the same event window, suggesting a green bond premium of 0.58%. The results are in line with previous studies, albeit we find a less positive stock market return than the global average (Flammer, 2018; Glavas, 2018). There are multiple potential reasons for this deviation. First, the time period is different, as we include more recent data. Second, the European market is different in regards to transparency, investor base, and jurisdiction. Last, the signalling effect of green bonds is potentially weaker in Europe, due to investor expectations and EU guidelines.

Next, we investigate whether there exists regional differences within Europe. We find a CAAR of 0.67% for firms listed in Northern Europe. Conversely, we do not find any significant stock market reaction to green bond announcements in other European regions. Thus, the Northern European companies seem to be the main drivers for the positive stock market reaction in Europe. We regard this as an interesting finding, as it is consistent with the notion of Northern European countries being more environmentally aware (Autti & Kokkinen, 2014). Additionally, investors in Northern Europe are more invested in green finance (SEB, 2019), potentially leading to the stock market reaction of green bonds being more positive.

In the event study, we find a significant CAAR of 0.40% upon announcement for first-time issuers. Consistent with the existing literature (Flammer, 2018; Tang & Zhang, 2018), we find no significant results for subsequent announcements, indicating that the market has learned about the firm’s commitment to green projects after the first issue (Eckbo, Masulis, & Norli, 2007). Further, we find that third-party certified issuers exhibits a CAAR of 0.44% upon announcement, while we find no significant reaction for non-certified bonds. The findings are in line with previous research (Flammer, 2018), implying that third-party certification signifies a stronger commitment to the environment, which could explain the stronger market reaction.

As an additional robustness check, we conduct a regression analysis controlling for an array of variables that might affect the stock market reaction to bond announcements. From the regression analysis we find that the green label of the bond has a significant positive impact on firm value for the companies in the sample, thus confirming the findings from the event study. Furthermore, we investigate whether the regional differences and first-time announcement effects are robust when controlling for bond and firm-specific characteristics. The regression results further confirms that Northern Europe exhibits higher returns than the rest of Europe. In contrast to the event study results, the regression analysis provide evidence for that also subsequent announcements lead to a positive stock market reaction.

We contribute to the existing literature on green bonds in being the first to analyse the European market exclusively, while also being the first to include data from both 2018 and 2019, a period where the green bond market has experienced tremendous growth (Refinitiv, 2019). The findings suggest that green bond announcements are positively related to equity value in the European market. Furthermore, we contribute to the literature by providing evidence of regional differences within the continent. The results imply that Northern Europe is the main driver of the positive stock market reaction in Europe. This finding is especially interesting, as it indicates that even though green bonds are more widespread and has many repeat issuers in Northern Europe, it is still considered as more value-enhancing in this region than the rest of Europe.

Previous studies (Flammer, 2018; Tang & Zhang, 2018) have only used event study methodology to examine whether subsequent green bond announcements has an effect on firm value. We therefore contribute to the literature by measuring the impact of subsequent green bond announcements, while controlling for bond and firm-specific characteristics. By applying regression analysis, we show that the "fundamental channel" is a potential driver for the positive stock market reaction. Therefore, we add to the discussion of green bonds by providing evidence for that shareholders benefit each time a green bond is announced, and not only the first time.

Lastly, this study further adds to the understanding of how financial markets can play a role in the fight against climate change. In order to reach the Paris Agreement goals and prevent global warming, companies have to reduce their environmental footprint. The findings of this study imply that green bonds can represent a method for companies to invest in eco-friendly projects, without reducing shareholder value. In fact, we provide evidence of green bond announcements resulting in a positive stock market reaction for European firms, suggesting that green bonds can help combat climate change while also increasing shareholder value.

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Appendix A: Data

Appendix A.1: SIC Codes

Table A.1: SIC Divisions

This table contains a shortlist of the Standard Industrial Classification (SIC) codes, as defined by the SEC (2019).

Range of SIC Codes	Division
0100-0999	A: Agriculture, Forestry and Fishing
1000-1499	B: Mining
1500-1799	C: Construction
2000-3999	D: Manufacturing
4000-4999	E: Transportation, Communications, Electric, Gas and Sanitary service
5000-5199	F: Wholesale Trade
5200-5999	G: Retail Trade
6000-6799	H: Finance, Insurance and Real Estate
7000-8999	I: Services
9100-9729	J: Public Administration
9900-9999	K: Not classified

Appendix A.2: Companies in Sample

Table A.2: Companies in Sample

The following table presents every company utilized in the event study in the time period November 2013 to October 2019. *N* denotes in which order the company issued the bond. *Company* corresponds to the name of the company. *Country* is the country of origin. Finally, *Index* is the stock market index used for said company in the analysis.

N	Company	Country	Index
1	Electricite de France	France	CAC 40
2	Unibail-Rodamco-Westfield	France	CAC 40
3	Iberdrola	Spain	IBEX 35
4	Engie	France	CAC 40
5	Hera	Italy	FTSE MIB
6	Abengoa Greenfield	Spain	IBEX 35
7	Vestas Wind Systems	Denmark	OMX C20
8	Schneider Electric	France	CAC 40
9	Nordex	Germany	DAX
10	Covivio	France	CAC 40
11	Entra	Norway	OBX
12	Castellum	Sweden	OMX S30
13	Enel	Italy	FTSE MIB
14	Atrium Ljungberg	Sweden	OMX S30
15	Fabege	Sweden	OMX S30
16	Senvion	Germany	DAX
17	Volvo	Sweden	OMX S30
18	SSE	Britain	FTSE 100
19	Icade	France	CAC 40
20	Innogy	Germany	DAX
21	Scatec Solar	Norway	OBX
22	Naturgy Energy Group	Spain	IBEX 35
23	Ørsted	Denmark	OMX C20
24	Kungsleden	Sweden	OMX S30
25	Volkswagen	Germany	DAX
26	Verbund	Austria	ATX
27	Klovern	Sweden	OMX S30
28	Actividades de Constructión y Servicios	Spain	IBEX 35
29	Skanska	Sweden	OMX S30
30	Terna Rete Elettrica Nazionale	Italy	FTSE MIB
31	Encavis	Germany	DAX
32	Iren	Italy	FTSE MIB
33	ALD	France	CAC 40
34	Getlink	France	CAC 40
35	FastPartner	Sweden	OMX S30
36	Energias de Portugal	Portugal	PSI 20
37	Sammhaldsbyggnadsbolaget i Norden	Sweden	OMX S30

38	Nobina	Sweden	OMX S30
39	Stora Enso	Finland	OMX H25
40	Electrolux	Sweden	OMX S30
41	ERG	Italy	FTSE MIB
42	Koninklijke Phillips	Netherlands	AEX
43	Wallenstam	Sweden	OMX S30
44	Vodafone	Britain	FTSE 100
45	Acciona	Spain	IBEX 35
46	Fastighets AB Balder	Sweden	OMX S30
47	BayWa	Germany	DAX
48	A2A	Italy	FTSE MIB
49	E. ON	Germany	DAX
50	Zug Estates Holding	Switzerland	SMI
51	Covivio	France	CAC 40
52	PostNL	Netherlands	AEX
53	Azzicurazioni Generali	Italy	FTSE MIB
54	NCC	Sweden	OMX S30

Appendix A.3: Thin Trading

Thinly traded stocks is a potential problem in an event study, as the estimated β could be artificially low. Thus, thin trading may lead to stocks appearing less risky. This will in turn lower the expected returns and consequently increase abnormal returns. Brown & Warner (1985) found evidence towards the OLS estimated β of the marked model being inconsistent and biased. In order to correct for thin trading, all green bond observations which traded in less than 50% of the estimation window are excluded. Additionally, events without trading in [-1], [0], and [-1] are excluded, due to the proximity of the announcement date.

Appendix A.4: Industry and Country Splits

Table A.4 presents the industry and country splits of bond announcements in the sample.

Table A.4: Industry and Country Split of Bond Announcements in Sample

The table below presents the split of bond announcements per industry and per country. The industry split is based on the Standard Industrial Classification (SIC) code, while the country split is based on International Standards Organization (ISO) country code. Both are extracted from Datastream. *Variable* is an indicator of what industry and country the firm operates in. *N* is the number of observations. *Frequency* is the frequency of the observation. *Unique Firms* is the number of unique firms in the sample.

Variable	N	Frequency	Unique Firms
Industry			
Construction	1	0.2%	1
Industrial Other	7	1.4%	4
Insurance	6	1.2%	1
Manufacturing	89	17.5%	5
Real Estate	174	35.4%	14
Services	52	10.5%	1
Transportation & Public Utilities	151	30.4%	23
Wholesale Trade	17	3.4%	5
Country			
Austria	1	0.2%	1
Britain	53	10.7%	2
Denmark	6	1.2%	2
Finland	6	1.2%	1
France	115	23.1%	8
Germany	34	6.8%	7
Italy	31	6.2%	7
Netherlands	6	1.2%	2
Norway	13	2.6%	2
Portugal	15	3.0%	1
Spain	62	12.5%	6
Sweden	153	30.8%	14
Switzerland	2	0.4%	1

The most common industries for the issuers are real estate, transportation & public utilities and manufacturing. This is consistent with the notion that the real estate industry's commitment to sustainability has grown significantly in the last 10 years (GRESB, 2019). Moreover, the primary issuers in the transportation & public utilities industry are utilities that fund renewable projects. The manufacturing sector mainly consist of issuers who fund projects that are energy efficient. Given that the renewable project suppliers and retailers are classified under this category as well, it seems reasonable that manufacturing is one of the biggest industries for green bonds. Lastly, the countries with the most announcements are Sweden, France and Spain.

Appendix B: Empirical Analysis

Appendix B.1: Robustness Test Using STOXX Europe 600

Table B.1: CAAR and CMAR for Green Bond Announcements Including STOXX Europe 600

This table contains the CAAR and CMAR of the different event windows with both country-specific indices and the STOXX Europe 600 index in the period November 2013 to October 2019. *EV* are the event windows utilised. The standardized cross-sectional test (Z_1) is used as the parametric test to test if the cumulative average abnormal returns (*CAARs*) are significantly different from zero, while the Wilcoxon signed-rank test (Z_2) is used as the non-parametric test to test if the cumulative median abnormal returns (*CMARs*) are significantly different from zero. The alternative event windows are included as a robustness check regarding the choice of event window. Skewness and kurtosis are included to measure symmetry and extremeness in the data, respectively.

	Country-Specific Indices					STOXX Europe 600				
EV	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]	[-5,-2]	[-1,1]	[-1,0]	[0,1]	[2,5]
CAAR	0.30	0.20	0.10	0.37**	0.00	0.21	0.22	0.09	0.40**	-0.16
Z_1	(1.09)	(1.30)	(0.62)	(2.48)	(0.32)	(0.81)	(1.48)	(0.71)	(2.61)	(0.38)
CMAR	0.29	0.16	0.09	0.35**	-0.23	0.30	0.21	-0.03	0.42**	-0.21
Z_2	(1.08)	(1.50)	(0.53)	(2.16)	(0.07)	(0.79)	(1.43)	(0.50)	(2.21)	(0.33)
Skewness	(0.29)	(-0.59)	(-0.22)	(0.21)	(-0.98)	(0.21)	(-0.36)	(-0.47)	(0.21)	(-0.88)
Kurtosis	(1.44)	(2.01)	(1.21)	(0.03)	(4.67)	(1.10)	(1.13)	(1.76)	(-0.12)	(2.74)
Obs.	99	99	99	99	99	99	99	99	99	99

The STOXX Europe 600 exhibits largely the same pattern as the country-specific indices, in regards to abnormal returns. The differences are negligible, and most importantly, the main event window is significantly different from zero, while also being positive.

Appendix B.2: AAR and MAR of Main Sample

Table B.2: AAR and MAR Surrounding Green Bond Announcements

The sample consists of 99 green bond announcements excluding financial firms, and 299 conventional bonds excluding financial firms in the period November 2013 to October 2019. *Event Window* is the event windows utilised, where [0] is the day of the event. The standardized cross-sectional test (Z_1) is used as the parametric test to test if the average abnormal returns (*AARs*) are statistically different from zero, while the Wilcoxon signed-rank test (Z_2) is used as the non-parametric test to test if the median abnormal returns (*MARs*) are statistically different from zero. The alternative event windows are included as a robustness check regarding the choice of event window. Skewness and kurtosis are included to measure symmetry and extremeness in the data, respectively.

	Green Bonds			Conventional bonds		
Event Window	[-1]	[0]	[1]	[-1]	[0]	[1]
AAR	-0.17	0.27**	0.10	0.06	-0.09	-0.12
Z_1	(1.43)	(2.10)	(1.14)	(0.79)	(1.53)	(1.46)
MAR	-0.10	0.30**	0.24	0.06	-0.05	-0.01
Z_2	(1.59)	(2.10)	(0.99)	(0.42)	(1.03)	(0.87)
Skewness	(-0.77)	(1.01)	(0.05)	(1.05)	(-0.23)	(-0.83)
Kurtosis	(4.46)	(3.18)	(0.32)	(7.51)	(4.83)	(1.81)
Obs.	99	99	99	299	299	299

*** Significance for a 2-tailed test at the 1% level

** Significance for a 2-tailed test at the 5% level

* Significance for a 2-tailed test at the 10% level

The AAR is significantly different from zero on the announcement day at the 5% level for all green bond issues. When looking at the conventional bonds, one can see that the AAR is not statistically significant on the announcement day, while also being negative. This implies that green bond announcements by European firms on average have a significant effect on the value of a company on the announcement day, exhibiting a green bond premium of 0.36% when comparing all announcements in the sample.

Appendix B.3: AARs and MARs for Subsamples

Table B.3: AARs and MARs Surrounding Green Bond Announcements for Subsamples

The sample consists of 99 green bond announcements excluding financial firms, divided into subsamples in the period November 2013 to October 2019. *Event Window* is the event windows utilised, where [0] is the day of the event. The standardized cross-sectional test (Z_1) is used as the parametric test to test if the average abnormal returns (*AARs*) are statistically different from zero, while the Wilcoxon signed-rank test (Z_2) is used as the non-parametric test to test if the median abnormal returns (*MARs*) are statistically different from zero. The alternative event windows are included as a robustness check regarding the choice of event window.

Panel A: First Green Bond Announcements vs. Subsequent Green Bond Announcements

	First Announcement			Subsequent Announcements		
Event Window	[-1]	[0]	[1]	[-1]	[0]	[1]
AAR	-0.12	0.41**	-0.01	-0.23	0.11	0.23
Z_1	(0.90)	(2.49)	(0.06)	(1.11)	(0.31)	(1.64)
MAR	-0.07	0.44**	0.09	-0.10	0.09	0.32
Z_2	(1.13)	(2.51)	(0.16)	(0.42)	(0.16)	(1.39)
Obs.	54	54	54	45	45	45

Panel B: Northern Europe vs. Rest of Europe

	Northern Europe			Rest of Europe		
Event Window	[-1]	[0]	[1]	[-1]	[0]	[1]
AAR	0.03	0.40*	0.27*	-0.31**	0.19	-0.02
Z_1	(0.43)	(1.81)	(1.76)	(2.19)	(1.11)	(0.07)
MAR	0.09	0.35	0.32	-0.33**	0.24	0.06
Z_2	(0.41)	(1.43)	(1.59)	(2.45)	(1.55)	(0.10)
Obs.	41	41	41	58	58	58

Panel C: Certified Green Bonds vs. Non-Certified Green Bonds

	Certified			Non-Certified		
Event Window	[-1]	[0]	[1]	[-1]	[0]	[1]
AAR	-0.19	0.35***	0.09	0.06	-0.56	0.18
Z_1	(1.37)	(2.64)	(1.02)	(0.35)	(1.05)	(0.48)
MAR	-0.10	0.34**	0.24	-0.10	-0.28	-0.22
Z_2	(1.55)	(2.54)	(1.05)	(0.47)	(0.87)	(0.00)
Obs.	91	91	91	8	8	8

*** Significance for a 2-tailed test at the 1% level

** Significance for a 2-tailed test at the 5% level

* Significance for a 2-tailed test at the 10% level

Appendix B.4: Generalized Variance-Inflation Factors

Table B.4: Generalized Variance-Inflation Factors

Table B.4 displays the generalized variance-inflation factors. *Variable* is the regression variable in question, with *GVIF* displaying the corresponding generalized variance-inflation factor. *Degrees of Freedom* displays the degrees of freedom. $GVIF^{\frac{1}{2\times df}}$ is the generalized variance-inflation factor adjusted for degrees of freedom.

Variable	$GVIF$	$Degrees\ of\ Freedom$	$GVIF^{\frac{1}{2\times df}}$
Green	1.83	1	1.35
Size	139.5	1	11.81
Equity-to-assets	41.5	1	6.44
EBIT-to-interest	1.09	1	3.30
CF-ratio	1.19	1	3.46
ROA	4.16	1	2.04
Coupon	2.92	1	1.71
Maturity	2.62	1	1.62
Bond size	2.73	1	1.65
FE Year	1.00	6	1.21
FE Firm	$1.69e+07$	53	1.17

In Table B.4, the generalized variance-inflation factors are displayed. The GVIF suggests that there are issues with multicollinearity. GVIF values above 5 or 10 is cause for concern. However, this is a result of including factors representing firm-specific effects. These effects explain most of the same variance as both size and equity-to-assets, causing their variance to inflate. Furthermore, the variable of interest $Green$ does not exhibit a high GVIF value. When removing the fixed effects from the model, all of the GVIF values are below 1.8. Thus, we do not regard multicollinearity as a problem in the regression analysis.

Appendix B.5: Correlation Matrix – Control Variables

As there is a large number of independent variables, Table B.5 only shows the variables from regression (3) in Table 8 with a correlation above |0.4|.

Table B.5: Correlation Matrix

Table B.5 displays a correlation matrix to check for problems related to multicollinearity in the regression. Both *Variable 1* and *variable 2* display the different control variables applied in the regression. *Correlation* is a column of numbers, displaying the correlation between *Variable 1* and V*ariable 2.*

Variable 1	Variable 2	Correlation
Coupon	Maturity	0.534
Amount Issued	Total Assets	0.465
Total Assets	ROA	-0.462
Total Assets	Assicurazioni Generali	0.508
Total Assets	Volkswagen	0.524
EBIT-to-Interest	Volvo	0.452
CF Ratio	Telefónica	0.463
Equity-to-Assets	Vodafone Group	0.437
A2A	2013	0.466

Naturally, the control variables Coupon and Maturity are correlated. Bonds with longer maturity are riskier, as the value of the bond could be impacted by changes in interest rate prior to maturity. Hence, bonds issued with long maturities tend to have higher coupon rates to compensate investors. Second, Amount Issued is correlated with Total Assets. Intuitively, bigger corporations are able to issue larger bonds.

Appendix B.6: Correlation Matrix – Green

Multicollinearity is a potential problem when explanatory variables are highly correlated. According to Allison (2012), the model may not give valid results about the true significance and independent variables' coefficients. Still, when the variables are used as controls in a regression model and the coefficients are not meant to be interpreted, it is sufficient for the variable of interest to not display collinearity (O'Brien, 2016). Additionally, the dummy variables applied all represent more than three categories (Allison, 2012).

Table B.6: Correlation Matrix

Table B.6 displays a correlation matrix to check for problems related to multicollinearity in the regression. *Variable 1* is a column of *Green*, while *variable 2* displays the different control variables applied in the regression. *Correlation* is a column of numbers, displaying the correlation between *Green* and the other variables.

Variable 1	Variable 2	Correlation
Green	Amount Issued	-0.071
Green	Total Assets	-0.043
Green	EBIT-to-interest	0.081
Green	CF Ratio	-0.085
Green	Coupon	-0.135
Green	ROA	0.077
Green	Equity-to-Assets	-0.018

Table B.6 presents the variables applied in the regression, and their correlation with the main variable of interest. No variables in the regression have a correlation with $Green$ above the threshold of |0.6| (Dormann, Elith, & Bacher, 2013). Consequently, multicollinearity does not seem to be an issue.