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An event study examining the effect of green bond issuance on the stock prices of Norwegian firms

Master's thesis in Financial Economics
Supervisor: Yabin Wang
June 2023

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Preface

This thesis marks the end of our master-program in Financial Economics at the department of economics, NTNU. The process of writing this thesis has provided us with valuable experiences and skills. The work has been challenging at times, but also educational and overall rewarding. The finished result is entirely a product of joint work between the authors.

We would like to thank our supervisor Yabin Wang, for valuable guidance and help with this process. Especially, we want to thank her for her availability and clarifying discussions regarding our questions and concerns. We would also like to thank our friends and family for support and motivation when the process at times have been difficult and stressful.

Abstract

The purpose of this thesis is to investigate if issuance of green bonds has a positive effect on the value of Norwegian firms. The thesis performs an event study attempting to find a statistical coherence between the announcement of green bond issuance and changes in firm stock prices. The result from the study shows a negative and statistically insignificant effect of the announcements across the period of interest. A positive, but insignificant effect is found when the event window following the announcements is isolated to four days. The insignificant results lead to no statistical evidence of green bond issuance increasing firm value in Norway. In addition to the event study, financial reports are examined to investigate the real effect of the announcements on the firms' economic results. It is discovered that a majority of firms experienced an above average growth in total assets, operating income and employee costs in the year following the announcement. The results indicate positive economic development compared to the average. This suggests a positive effect of the announcements but is not enough to alter the overall conclusion due to the lack of a causal relationship. The main findings remain that no significant support of a positive effect of green bond issuance is found, and the thesis concludes that green bond issuance does not increase firm value in Norway.

Sammendrag

Denne masteroppgaven har hatt som mål å undersøke om annonseringen av grønne obligasjoner har en positiv effekt på verdien av norske selskaper. En hendelsesstudie har blitt gjennomført for å undersøke om det finnes en statistisk sammenheng mellom annonseringen av grønne obligasjoner og selskapets aksjeverdi. Resultatene fra studien viser en negativ, og ikke-signifikant effekt av annonseringene for hele interesseperioden. En positiv, men ikke-signifikant effekt blir funnet når hendelsesvinduet gjøres smalere og kun består av fire dager. Mangelen på signifikante resultater gir ingen støtte til problemstillingen om at grønne obligasjoner øker verdien av norske selskaper. I tillegg til hendelsesstudiet har en undersøkelse av selskapenes regnskap blitt gjennomført. Dette ble gjort for å videre undersøke effekten av annonseringene på de ulike firmaenes regnskapstall. Her ble det konstatert en vekst i eiendeler, driftsinntekter og utgifter knyttet til ansatte som er høyere enn gjennomsnittet. Resultatene indikerer en positiv økonomisk utvikling som er høyere enn forventet basert på tidligere år. Dette antyder en positiv effekt av annonseringene, men da ingen kausal effekt kan konstateres, forblir den generelle konklusjonen uendret. Hovedfunnene forblir uendret, og uten signifikant støtte for antagelsen om at grønne obligasjoner har en positiv effekt på verdien av norske selskaper. Masteroppgaven konkluderer dermed med at grønne obligasjoner ikke øker verdien av norske selskaper.

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1. Introduction

1.1 Motivation

In this thesis we want to explore how green bonds affect the financial markets. It is apparent that the world is facing many climate challenges, and that green financial instruments play a key role when the world is trying to reach the goals set in the Paris agreement. This has led to a growing interest in green assets, which includes green bonds. Since this is a relatively new category of financial instruments, the market is somewhat lacking in research. When exploring the segment, it became evident that the research that does exist is mostly conducted on a worldwide basis. Based on this, we wanted to further investigate whether the results from the literature using cross-country data could be applied to the Norwegian market. More precisely, we wanted to explore the possibility of the Norwegian market rewarding companies who contribute to a more sustainable focus in the economy. The results found in “Does shareholders benefit from green bonds” by Tang and Zhang (2020) and “Corporate green bonds” by Flammer (2021) proved to be interesting. This previous research found that the market reacts positively to news of green bond issuance. We want to conduct our own research to see if we can obtain the same result for the Norwegian market. Several Norwegian companies have issued green bonds in recent years, including both corporate and governmental. For the purpose of this thesis, we will solely be focusing on corporate green bonds. The chosen method of measuring the effect of the news is to examine the changes in stock returns. For us, this is the natural choice since we are majoring in finance. We therefore find it interesting to conduct a study to learn more about how the market reacts to different news. We have chosen to conduct an event study as we feel that this will best capture the possible effects of green bond issuance. Our goal when conducting this research is to contribute to an increased focus and understanding of green bonds in the Norwegian market. The thesis therefore aims to answer the following research question:

“Does green bond issuance increase firm value in Norway?”

1.2 Structure of the thesis

This study begins by introducing a theoretical framework to create a foundation of understanding concerning the green bond in a market context. Here, the difference between a bond and a green bond is defined, and the history of green bonds is explained. The theory chapter also explains the framework in which green bonds aim to operate and introduces sustainability-linked bonds. Since the thesis has been conducted based on previous research done on green bonds' effect on firm value, chapter three contains a literature review. This chapter presents the findings of two research papers on which the main research question of the thesis is based. Other relevant research is also included in the chapter to provide a broad perspective. Since the thesis aims to replicate the work of Tang and Zhang (2020) and Flammer (2021), the paper's two hypotheses were constructed based on their findings. Next, the thesis goes on to introduce the methodology and data. The main focus of this chapter is introducing the event study model and the dataset used in the research. Other important concepts are also defined, such as the marked model, abnormal return, and Wilcoxon inference. All concepts introduced in the chapter were used to conduct the event study.

Chapter 5 presents the results from the conducted research. This has been split into two parts. First the results from the baseline model are presented, then the results from the extended augmented model. The chapter also includes a robustness check performed in Excel, offering support for the findings of the event study. In the following chapter, a study of the real effect of the announcement dates on the firms is performed through an examination of financial reports. After all results are presented, the thesis goes on to discuss the findings in light of the results from the previous literature. Here, both potential explanations for the results and potential error sources are presented and discussed as well. Lastly, suggestions for further work are presented and an overall conclusion is drawn.

2. Theoretical Framework

This chapter aims to provide the reader with a fundamental understanding of what a green bond is. It will be used to define and explain different aspects of the green bond market, both worldwide and in Norway. In addition, the specific framework that surrounds the green bonds will be defined, as well as sustainability-linked bonds. Sustainability-linked bonds are included as these are also used to fund environmentally friendly projects.

2.1 Bonds

A bond is a type of financial instrument called a fixed income instrument. When a bond is issued, the issuer borrows money from the investors, and over time the borrower pays either variable or fixed payments to the investor. The literature differs between corporate and governmental bonds, where corporate bonds are issued by companies and governmental are issued by municipalities, states, and sovereign government (Fernando, 2023).

2.2 Green Bonds

In December 2015, the Paris agreement was signed by 196 countries, its aim being to limit global warming to 2, or preferably 1.5, degrees Celsius. The financial system has a critical role in achieving the goal of the agreement and plays a key role when governments and firms need to invest in renewable energy. The market can contribute by raising the funds necessary to expand and develop the technology required to reach the goals set by the agreement (Gianfrate & Peri, 2019, p. 127; United Nations, n.d). One way in which the market can contribute is through the issuance of green bonds. The first green bond was issued as early as 2007 by the World Bank and the European Investment Bank. Since then, the market has slowly been growing but did not kick off properly until 2014. This kick off came as a reaction to the first USD 1 billion bond issuance in 2013 (Climate Bond Initiative, n.d-b). Today the market is larger than ever, and according to The World Bank, a total of USD 182 billion was issued in green, social and sustainability or sustainability-linked bonds in 2021. This is more than thrice as much as in 2020 (Kayaalp, 2022).

However, there are some challenges with the green bond label. One such problem is the lack of an unanimously agreed upon definition of green bonds. Because of this, different sources use different definitions. For example, The World Bank (2021) defines them as “financial instruments that finance green projects and provide investors with regular or fixed income payments". Tang and Zhang (2020), however, explain them as "(…) fixed income securities issued by capital raising entities to fund environmentally friendly projects, such as renewable energy, sustainable water management, pollution prevention, climate change adaptation and so on" (Tang & Zhang, 2020, p. 2). Due to the lack of a clear, unanimous definition, voluntary standards are mainly used when bonds are labeled green. One such standard is "The Green Bond Principles" (GBP). The GBP is a set of voluntary best practice guidelines established in 2014 by a group of investment banks, including Merrill Lynch, JPMorgan Chase, Deutsche Bank et al. Today, the ongoing monitoring and development of the guidelines is performed by the International Capital Market Association (ICMA). The GBP standard does not provide details on which criteria must be fulfilled for a bond to be considered green. They are in place to ensure transparency, accuracy and integrity of the information disclosed and reported by issuers to stakeholders. Since no clear definition of what should be labeled green is included, the decision is left for the issuer to make (Climate Bond Initiative, n.d-c).

This lack of a clear framework dictating which criteria must be fulfilled for a bond to be labeled green, leads to a fear of greenwashing among investors. Greenwashing is a term applied when companies use misleading labels, images, narratives etc. to create an unsubstantiated and misleading claim about their commitment to the environment (Flammer, 2021, p. 503). To avoid greenwashing, companies use third-party verification to show that a neutral party has assessed the bond or the bond framework. This process will be explained in detail in chapter 2.2.1. The CBI offers a list of firms providing third party verification. If the bond is verified by a firm from the list, it receives the Climate Bond Certification. This certification means that the bond or the bond framework are aligned with the Climate Bond Standard which incorporates the GBP and Green Loan Principles. In addition, the Climate Bond Standard is aligned with the guidelines and rules of ASEAN, Japan, India and the proposed new EU Green Bond Standard (Climate Bond Initiative, 2019, p. 4; n.d-a).

2.2.1 Green Bond Framework

The EU Green Bond Standard is a voluntary, collective standard for bonds in the EU, which are currently being developed[1]. This is meant to increase the environmental ambitions of the green bond market, as well as prevent greenwashing by making it easier for investors to

[1] As of May 15th, 2023

assess and compare their investments (Directorate-General for Financial Stability Financial Services and Capital Markets Union, 2021). The EU Green Bonds standard, together with the CBI, GBP and Green Loan Principles, all differ from each other in some respects, but aims to ensure transparency in the green bond frameworks of firms. According to ICMA, the report should consist of four core components: use of proceeds, process for project evaluation and selection, management of proceeds and reporting. This is meant to give an overall understanding of how the green bond is supposed to be used (International Capital Market Association, 2021, p. 4).

Mostly, green bond frameworks aim to describe under which project categories the bond can invest. The framework then proceeds to describe how the issuer is planning to select projects and evaluate these. The reports should include all the projects the bond has funded and plan to fund, unless it is confidential (Kleven, 2022). To ensure credibility, it is common to have an accountant confirm that the money is spent where the firm claims it to be. This is updated at least annually as long as the bond hasn't reached maturity. Next, the green bond reports contain information concerning how relevant numbers will be reported to measure sustainability. This is commonly referred to as impact reporting.

It is recommended that the framework is controlled by an independent third party before acquiring capital. This process is most referred to as a second opinion or an expert evaluation. The third party controls the reports acquired from the respective firms, as well as providing their own report on the firm in question. This document might give the firm an ESG-rating or score, which is usually published for transparency (Kleven, 2022). An example of a third-party verifier is Cicero's Shades of green. Cicero focuses their report on making it visible how “green” the firm's revenue and operating income are. The report aims to make it possible to follow the development of the green income and investment of firms across time. This gives the public an overview of how the company transitions to adjust to the climate changes. By giving the firms a governance score, ranging from excellent to fair, Cicero makes it easier for the investors to compare progress. The assessment also provides a comparison of their framework to the EU Taxonomy (Cicero Shades of Green, n.d)

2.3 Green Bonds in Norway

The focus on a sustainable future has been increasingly more important over the last few years in Norway as well. There has been an influx of green bond issuances on the Norwegian market, and there are only 11 countries that issued more green bonds than Norway during the first six months of 2021 (Saltvedt et al., 2022, p. 70). The first green bond was issued as early as 2010 by Kommunalbanken, and the market continued to grow slowly in the following years. In 2014, Eviny, formerly known as BKK, issued the first corporate green bond (Sonerud, 2014). In the following years, both government and corporate firms have continued to issue green bonds at an increasing rate.

In 2015, Oslo stock exchange, as the first in the world, created a specific list for green bonds (Aase, 2018, p. 162). This signaled an increased market interest for green bonds. Although it seemed like the market was booming, the period 2016 to 2019 displayed a significant drop in green bond issuance (Torvanger et al., 2021, p. 4). In 2021, the interest in the market seemed to increase once again. Today green bonds constitute a small portion of the overall market, even though issuances are increasing yearly.

2.4 Sustainability-linked bonds

Sustainability-Linked Bonds (SLB) are a type of bonds that focuses on sustainability through the ESG perspective. The ESGs are the Environmental, Social and, or, Governance principles used by companies who wish to be more conscious of sustainability (International Capital Market Association, 2020, p. 1). In the Sustainability-Linked Bond Principles, the SLB is defined as "any type of bond instrument for which the financial and/or structural characteristics can vary depending on whether the issuer achieves predefined Sustainability/ ESG objectives» (International Capital Market Association, 2020, p. 2). SLB differs from green bonds in the sense that the loans are not earmarked for green projects. Instead, they are forward-looking performance-based instruments. This means that issuers of these bonds are committing to future improvements in sustainability outcomes within a predefined timeline (International Capital Market Association, 2020, p. 2).

2.5 Summary

This chapter has been used to present the history of the green bond market internationally and in Norway. In addition, some theoretical context has been provided to help the reader understand how a green bond receives the green label and how difficult it can be to find a clear definition. The chapter has also described how a green bond framework can be certified by a third party, and explained why this plays an important role in avoiding greenwashing. Lastly, sustainability-linked bonds have been defined, and their distinction from green bonds has been clarified.

3. Literature review

Through this literature review, the research creating the fundament of the hypotheses used in the thesis will be presented. Previous research on the green bond market has mostly been done using large datasets including several markets and countries of issuance. For example, the effect of green bond issuance was studied in “Do shareholders benefit from green bonds” (Tang & Zhang, 2020) through an event study. A comprehensive dataset was constructed consisting of 132 unique issuers across seven different classes, including development banks, municipalities, commercial banks etc. This dataset uses data from 20 different countries, as well as supranational issuers such as IFC and the World Bank and has a separate category called “others”. The green bonds were issued over a 10 year period, spanning from 2007 to 2017 (Tang & Zhang, 2020, p. 7). The announcement dates of new issuance were used as the event dates, and a 21 day (-10,10) event window was used. The findings in the article show that the stock prices of the issuers increase when a green bond is announced. Specifically, a statistically significant 1.4% cumulative abnormal return (CAR) was found (Tang & Zhang, 2020, p. 2). The paper “Corporate Green Bonds” (Flammer, 2021) conducts a similar event study under different frames. Here, a dataset was constructed using a total of 1189 bonds, where only corporate green bonds were included. The sample covers a time frame spanning from 2013 to 2018. It includes bonds spread across 24 countries, as well as 140 bonds classified as “others”. In total, 18 different industries were represented in the sample, including “others”. The announcement dates were used as event dates here as well, and the event window is 16 days (-5,10). The results showed a positive statistically significant stock market response of 0.49% CAR to the issuance of green bonds (Flammer, 2021, p. 500;507). This is consistent with the research of Klassen and McLaughlin (1996, pp. 2012-2013) who found significant positive abnormal stock returns when positive environmental events were reported, and significant negative returns when negative environmental events were reported. The findings indicate that the market rewarded companies when they received environmental awards and reacted negatively to environmental crises. It is natural to assume that these findings should also apply to the Norwegian market. This leads to the formulation of hypothesis one:

Hypothesis 1: Issuance of green bonds leads to an increase in stock prices for Norwegian firms.

Further on, Tang and Zhang (2020, p. 9) performed the event study on a dataset of 109 subsequent issuers. The results show only an insignificant abnormal return for subsequent issuance of green bonds. Flammer (2021, p. 508) achieved similar results with small and insignificant abnormal returns for second time issuers. Here, a sample of 215 seasoned green bonds are used. A proposed reason for this is that when the second green bond is issued, the market is already aware of the environmental commitment of the firm which leads to a smaller reaction. Again, it is assumed that similar results will be found for the Norwegian market, and the second hypothesis is formed:

Hypothesis 2: First time issuance leads to a higher increase in stock prices than repeat issuers.

4. Methodology and Data

This chapter describes the methods used to perform the analysis. Chapter 4.1 defines and explains how an event study analysis is performed and introduces key concepts used throughout the study. Chapter 4.2 includes how the events and samples were selected, which creates the foundation for the data collection. Lastly, chapter 4.3 introduces descriptive statistics.

4.1 Event Study methodology

"An event study (…) examines the impact of an event on the financial performance of a security" (Hayes, 2022). Most often, this method is used to determine if a specific event has a statistically significant impact on a public company's stock price or value (Hayes, 2022). Conventionally, the null hypothesis (H_0) of the event study is that the event has no effect on the stock returns (MacKinlay, 1997, p. 21). This method was first presented by Fama et al. (1969, p. 20) through a study of stock splits. The findings in the study support the efficient market theory by showing that stock prices adjust very rapidly to new information. Today, the method is considered the standard method of measuring how an announcement or event affects a security price (Binder, 1998, p. 111). When performing an event study, cumulative abnormal returns (CAR) are used to measure how the market reacts to an event. The CAR is calculated by summarizing the abnormal returns (AR) of the security. The AR is the difference between the expected and actual returns of a stock. To estimate the AR, one first needs to calculate the expected return (MacKinlay, 1997, pp. 20-21). There are several models available for this, for example, a form of one-factor models such as CAPM or the market model, or a multifactor model such as APT. It is also possible to calculate the CAR directly in the model through using a dummy variable for the event date. In this case, the expected return is not calculated and compared to the actual return (Binder, 1998, pp. 117; 123-124). Another crucial part of the event study process is to identify the correct event date. The more precise date one can find, the smaller the event window needs to be. For example, if the event date can be determined precisely, the event window can be as small as two days surrounded by longer periods of CAR (Armitage, 1995, p. 34).

4.1.1 Market Model

The market model is considered one of the most popular benchmarks in event studies, and is built on the assumption that the market is the common factor (Bodie et al., 2018, p. 248; Strong, 1992, p. 537). The model differs from other ingle-index models as it makes no assumptions about how equilibrium equity prices are established. The strongest feature of the model is that it leads to smaller variances and smaller correlations across the abnormal returns of the securities. This leads to more powerful statistical tests (Strong, 1992, pp. 537-538). The marked model builds on a general regression model:

$$(4.1) \quad R_{it} = \alpha_i + \beta_i R_{Mt} + e_{it}$$

In the model R_{it} is the expected return of asset *i* at time *t*, and R_{Mt} is the market return at time *t*. Alpha, α_i, is the intercept. The alpha is closely connected to the return of the market. When the excess return of the market is zero, the value of alpha represents how the stock performs compared to the market. Beta, β_i, represents how the stock returns relate to the market index. The beta decides the amount of movement the stock experiences for every one percent movement in the market. β_i therefore represents the slope. Lastly, the residual, e_{it}, is the zero-mean, firm-specific risk for the stock (Bodie et al., 2018, p. 249). When estimating alpha and beta, it is highly important that the input data is separated in time from the event in question. This ensures that the alpha and beta are not affected by any abnormal return that might appear during the event window (Bodie et al., 2018, p. 344; Strong, 1992, p. 537).

The market model differs from the general regression model by assuming that the firm specific risk is diversified. When $E(e_i) = 0$, the market model becomes:

$$(4.2) \quad E(R_{it}) = \alpha_i + \beta_i E(R_{Mt})$$

Equation (4.2) illustrates that the expected return of a security *i,* $E(R_i)$ at time *t*, depends on the expected excess return of the security itself, α_i, as well as the risk premium from the market, $E(R_{Mt})$. The risk premium is considered the reward an investor receives from the market when taking on additional risk. This is found by multiplying the expected return of the market with the beta of the individual security, β_i. Beta is a measure of systematic risk and is 1 on average for all stocks in the economy. This means that a beta higher than 1 represents a stronger stock reaction to changes in the market. The alpha is called a non-market premium and can be both positive and negative. A positive alpha means that the stock has outperformed the market, and a negative alpha means that the performance is lower than that of the market (Bodie et al., 2018, pp. 249-250). One advantage of the market model is that it requires fewer estimates than other models because it only uses one factor. It is, however, important to note that it tends to oversimplify the sources of real-life uncertainty, which is a disadvantage. The model might omit important events. For example, the model might overlook industry specific factors affecting a firm's stock prices when they do not affect the macroeconomy (Bodie et al., 2018, pp. 251-252). An Augmented Market Model (AMM) is commonly used to reduce the downsides of the standard market model. An AMM can be constructed by including more market factors (F_n), such as other indexes. The AMM is also referred to as the multifactor model, and is constructed in the following way:

$$(4.3) \quad R_{it} = E(R_{it}) + \beta_{i1}F_{1t} + \beta_{i2}F_{2t} + \cdots + \beta_{in}F_{nt} + e_{it}$$

The basic assumption of the AMM is that the single-factor model is too simplistic. It assumes that there are indeed other factors that affect the stock prices and therefore the expected returns (Bodie et al., 2018, p. 321). Like the simple market model, this model also has an expected value of zero for firm-specific risk, $E(e_{it}) = 0$, and can easily be expanded through inclusion of more factors.

4.1.2 Abnormal returns

As previously stated, abnormal returns are a crucial part of an event study. "An abnormal return describes the unusually large profits or losses generated by a given investment or portfolio over a specified period" (Barone, 2021). Meaning, the abnormal return expresses how the investments are performing relative to the market or a benchmark. If the abnormal return is positive, the asset has outperformed the overall benchmark. If the abnormal returns are negative, the investment performed worse than the benchmark (Bodie et al., 2018, p. 344).

Using the market model as the benchmark, the abnormal return of a sample is:

$$(4.4) \quad AR_{i\tau} = R_{i\tau} - \alpha_i - \beta_i R_{M\tau}$$

Here $AR_{i\tau}$ denotes the abnormal return of asset *i* at day τ in the event window. $R_{i\tau}$ is the actual return of asset *i* at day τ and $R_{M\tau}$ is the return of the market at event day τ. The variance of $AR_{i\tau}$ is given by:

$$(4.5) \quad \sigma^2(AR_{i\tau}) = \sigma^2_{e_i} + \frac{1}{L_1}\left[1 + \frac{(R_{M\tau} - \mu_M)^2}{\sigma^2_M}\right]$$

L_1 represents the estimation period prior to the event, while μ_M is the mean of the market return. $\sigma^2_{e_i}$, represents the variance of the error term from equation (4.1) and is calculated using formula:

$$(4.6) \quad \sigma^2_{e_i} = \frac{1}{L_1 - 2}\sum(R_{i\tau} - \alpha_i - \beta_i R_{M\tau})^2$$

A commonly used assumption is that when the length of L_1 becomes large the second part of equation (4.5) approaches zero and the variance of AR becomes:

$$(4.7) \quad \sigma^2(AR_{i\tau}) = \sigma^2_{e_i}$$

By squaring equation (4.7) the standard deviation of the abnormal return can be found (MacKinlay, 1997, pp. 19-21).

After obtaining the abnormal return of firm *i* on day τ, it is possible to further estimate the cumulative abnormal return (CAR). The CAR is defined as "(…) the sum of all abnormal returns over the time period of interest. The [CAR] thus captures the total firm-specific stock movement for an entire period when the market might be responding to new information" (Bodie et al., 2018, p. 345). As the CAR is the sum of all the abnormal returns calculated from the market model, the equation is given by:

$$(4.8) \quad CAR_i = \sum(AR_{i\tau})$$

When performing an event study, it is of interest to use CAR to perform inference. The main approach is to estimate an average CAR, often denoted CAAR or $\overline{\text{CAR}}$. Equation (4.9) shows the estimation of CAAR, and equation (4.10) presents the formula for its variance:

$$(4.9)\ CAAR = \frac{1}{N}\sum CAR_i$$

$$(4.10)\ var(CAAR) = \frac{1}{N^2}\sum \sigma_i^2(\tau_1, \tau_n)$$

Here, N represents the number of securities in the sample. Combined, formula (4.9) and (4.10) can be used to test H_0 through the test statistics:

$$(4.11)\ \ \theta_1 = \frac{CAAR}{var(CAAR)^{0.5}} \sim \mathrm{N}(0,1)$$

This can be performed as a t-test where the null hypothesis is rejected when the test statistics $\theta_1 <$ critical value (MacKinlay, 1997, p. 24).

4.1.3 Confidence interval

A confidence interval can be defined as "(…) the probability that a value will fall within the upper and lower bound of a probability distribution " (Akinkunmi, 2019, p. 139). Normally, a 95% confidence interval is used, meaning that one can be 95% sure that the value of a parameter is within the upper and lower limits. For example, if one calculates a confidence interval for a firm's stock return with a lower limit of 0.08% and an upper limit of 1.7%, it can be stated with 95% confidence that the stock return will lie between these values (Akinkunmi, 2019, p. 139). An important assumption for the parametric confidence interval is that the population from which the sample is drawn is normally distributed. However, in some cases, the assumption of normal distribution cannot be justified (Weerahandi, 1995, p. 77). For example, when the number of observations is limited, or the sample size is too small. In such cases, it is not possible to assume that the inference results provide information about the shape of the population (Gibbons & Chakraborti, 2014, p. 978). Under these circumstances, the research must rely on non-parametric or distribution-free methods when constructing the confidence interval. One example of non-parametric inference is the Wilcoxon signed-rank test. This uses the rank of the distributions absolute values and therefore discovers differences in distributions more effectively than similar tests (Weerahandi, 1995, p. 81).

4.1.4 Wilcoxon inference

One type of non-parametric inference is the Wilcoxon signed-rank test, which includes a confidence interval estimate for the median difference of a population. This test is considered the best known distribution-free inference procedure (Gibbons & Chakraborti, 2014, p. 978). The strength of this statistical method is its robustness against the problems often encountered with outliers and non-normative distribution samples. It is also sensitive to the detection of differences between two conditions (Chechile, 2018, p. 1). In this test, the observations are ranked in order of their absolute value, where the smallest rank is given the lowest number, 1, and the largest rank gets assigned the highest number, *n*. The signed rank of the observation is its absolute value attached with a plus or minus sign, based on the positive or negative value of the observation. The total sum of the signed ranks is called the signed-rank sum T, and can be both positive (T^{+}) and negative (T^{-}). The null hypothesis (H_0) is that the median of the population is equal to zero. The signs of the ranks are assumed to be independent and equally likely to be positive and negative. The null hypothesis is rejected if T^{-} is too large and therefore falls above the critical value, or if T^{-} is too low (Pratt & Gibbons, 1981, pp. 147-149). Like with all non-parametric inference approaches, the Wilcoxon approach is still valid when many of the classical inference assumptions are not satisfied (Gibbons & Chakraborti, 2011, p. 978).

4.2 Data

4.2.1 Event Study analysis

This thesis has aimed to follow the method applied by previous articles and has therefore mainly focused on following Flammer (2021). This was done since the study's focus has been on corporate bonds, and since the market model was used to calculate the abnormal returns. This choice was made since Tang and Zhang (2020) includes sovereign and municipal bonds in addition to the corporate bonds in their sample, and as they used CAPM to calculate the abnormal returns. The methods used in the thesis have, however, been adjusted slightly due to limitations in the R-package[2], and restrictions applied to the dataset. For example, Flammer (2021) included banks in the sample. This, together with the limitation of only including

[2] Where Flammer (2021) uses an event window of 21 days (-10,10). This thesis will use an event window of 20 days (-9, 10), this is due to restrictions in the applied R-package. When a 10 day event window is chosen, R sets day 10 as day 0 (event day), meaning that the event window consists of 9 days prior and 10 days past that day.

Norwegian corporate bonds, led to a smaller sample size for this study. Even so, the goal was to investigate if the results found by Flammer (2021), as well as Tang and Zhang (2020), were representative for the Norwegian market. Following Flammer (2021), the announcement dates were used as event dates. This made it possible to study the effect on firm value at the time the investors updated their beliefs about the firm (Krüger, 2015, p. 306). The announcements were chosen instead of the issuance dates as this is the day the market receives the available information. On the day of issuance, the market is already provided with all information (Flammer, 2021, p. 506). By using an event window of 20 days, it was possible to control for potential information leakages before the announcement days. As mentioned, the abnormal returns were calculated using the Market Model, which is the method applied by Flammer (2021, p.506). For robustness, this model was expanded to an Augmented Market model as well. In addition to the green bonds, sustainability-linked bonds were included to strengthen the sample. Flammer (2021) only includes green corporate bonds, but to achieve a big enough sample size, sustainability-linked bonds have been included in this thesis.

4.2.2 Sample selection

To properly answer the research question, it has been essential to impose certain restrictions on the dataset. Generally, two restrictions were mainly applied during the data collecting process. The first restriction was to only consider Norwegian firms who issue or have previously issued green bonds. Second, the firms had to trade stocks on a stock exchange accessible to the public. This was necessary as the thesis used variations in stock prices as a measurement for changes in firm value. When imposing these restrictions, a dataset consisting of 17 Norwegian firms who have issued green or sustainability-linked green bonds from 2015 to 2022 was constructed. A full list of firms and their announcement dates are found in table A.1 in the appendix.

When starting the data collection process, a broad search for Norwegian Green bonds was conducted through open sources. This resulted in a list of active ESG bonds from Euronext. This list was further filtered to only show green bonds issued on Oslo stock exchange. Next, all banks were removed from the list. The banks were excluded since they mostly offer bonds as a third party, meaning that they might not fund their own green projects. This makes it difficult to measure the direct effect of the green project on their stock prices. Next, Nordnet was used to check how many firms left on the Euronext list had publicly accessible stocks. At the end of this process, a total of 9 firms met the requirements.

The next step was to broaden the search to include a larger database in order to find firms with green bonds that were no longer active. Here Eikon(datastream) was used, and as before, the search started broadly and a list of all currently issued bonds was found. This list was then filtered to show bonds that were both active and inactive. At this stage, sustainability-linked bonds were also included to get a larger, more representative sample. To ensure that only the correct bonds were displayed, any bonds that were not green or sustainability-linked were filtered out. In addition, the domicile Norway was chosen. This way, Eikon would only show bonds issued by Norwegian firms but across all stock exchanges. In addition to the traditional bonds list, Eikon provides a separate list for ESG bonds. In this list, all domiciles besides Norway were removed. The list was then used to cross check previous findings. Every bond issued from 2010 to 2022 was checked manually to ensure all corporate green and sustainability-linked bonds were included in the sample. Lastly, Nordnet was again used to make sure all the firms issued stocks. This led to a complete list of 17 firms.

4.2.3 Data collection

After finishing the sample selection, historical data for all firms were collected. The R-package used to estimate the event required specific input and therefore strongly affected the data collection process. In total, three datasets were constructed; one for all event dates, one for all firm returns and lastly, one for the returns on a market index for the same period as the returns. As previously stated, the event dates are the dates when the companies announced that they would be issuing green bonds. Oslo stock exchange News web and Euronext Live were the main sources, but other reliable sources for news on the stock exchange were also used, as well as the companies' home pages. Occasionally, the dates were slightly adjusted as some announcements were published late in the afternoon, after the stock exchange had closed. The announcement date was then pushed to the next day to better capture the reaction of the market. The next step was to collect and calculate all stock returns. The "eventstudies" package in R requires the collection of firm returns to start at the same date, and end at the same date. Furthermore, a period of 300 days prior to the first announcement of the first bond was necessary for the manual calculations of alpha and beta. This means that daily closing prices for the period 02.10.2014 to 5.12.2022 were collected for all firms. The stock returns were then calculated using the following formula in Excel:

$$(4.12)\quad R_{it} = \frac{P_t - P_{t-1}}{P_{t-1}} \cdot 100$$

Where R_{it} is the return on asset i, P_t is the closing price at time t, and P_{t-1} is the closing price from the previous day. Since the Market Model was used to calculate the abnormal returns, the next step was to find a general market index representative for the Norwegian stock market. OSEBX was chosen as this is the main market index from Oslo stock exchange. This index represents the general market of Norway, and consists of 68 firms (Euronext, 2023). Once again, Eikon was used to find the closing prices going back to the earliest green bond announcement in the sample, as well as 300 days prior. The closing prices for OSEBX were collected for the same period as the stock returns. Next, the returns were calculated through formula (4.12). In addition to the market model, an augmented market model was also used in this study. To create the augmented model, historical exchange rates from Norwegian Kroner to Euros were collected from Norges Bank. The exchange rate was included because the Norwegian market is highly affected by changes in this exchange rate, and a majority of the firms in the dataset are exporting and importing goods. Moreover, some of the firms are traded on more than one stock exchange and in other currencies. This means that the stock prices of the firms are affected by the changes in the exchange rate. The historical exchange rates were also collected for the period 02.10.2014 to 5.12.2022 and calculated in Excel using formula (4.12).

4.2.4 Missing data

During the data collection process, some cases of missing data were discovered. For example, three firms were noted on the stock exchange less than 250 days prior to the announcements of green bonds. More specifically, Scatec and Bewi only had a total of 226 and 243 daily closing prices available. Aker Horizon presented a similar issue. This company was listed on the stock exchange just a few days prior to publicly announcing and issuing a green bond. This made the calculation of beta and abnormal returns quite difficult, and it was therefore decided to use the parent company as a proxy in the calculations in Excel. Another concern appeared when it was discovered that some data was missing in the datasets from Eikon. These were mostly single days in the middle of the datasets. To control for this, the database Titlon was used to find the missing closing prices. As all the data from Titlon is provided in NOK, historical exchange rates were used to convert the data into EUR. The returns were then calculated using formula (4.12). Lastly, it was discovered that Yara is noted on both Oslo stock exchange and Nasdaq. Since no restrictions have been imposed concerning which stock exchange a firm uses, a decision was made to use Oslo Stock Exchange because this was the earliest date.

4.3 Descriptive Statistics

The 17 firms in the sample are allocated across 9 sectors, shown in table 1. The biggest sectors are seafood and the industrial sector.

Sectors

Sectors	Number
Real Estate	1
Seafood	4
Utilities	1
Industrial	3
Energy	2
Financials	2
Basic Materials	2
Comsumer Staples	1
Shipping	1

Table 1: Sectors overview

Table 2 shows how many bonds were announced in the period 2015 to 2022. The first column shows the announcements of first time issuance, and the second column shows the announcements of the second time issuance. It is especially interesting to see that the amount of green bonds being issued for the first time increases considerably in 2021.

Year	First	Second
2015	1	0
2016	2	0
2017	0	2
2020	3	0
2021	8	1
2022	3	1

Table 2: Announcements

In the event study analysis, alphas and betas have been calculated using an estimation window of 250 days. This estimation window was calculated for each firm by selecting the 300 days prior to the announcement dates and then omitting the first 50 days. This has been done to avoid bias in the estimation. Table 3 presents the descriptive statistics for the 250 days.

Name	Mean (%)	Var (%)	SD (%)
Entra	0.0477	0.0254	1.5951
Aker Horizons	0.0550	0.1804	4.2473
Aker ASA	0.0939	0.0629	2.5082
Lerøy	0.1900	0.0428	2.0690
Bonheur	0.1042	0.0891	2.9843
Orkla	0.0244	0.0444	2.1077
Tomra Systems	0.0329	0.6870	2.6213
Arendals Fossekompani	0.2467	0.1223	3.4970
Grieg Seafood	-0.0677	0.0740	2.7195
Mowi	0.0396	0.0285	1.6871
Salmar	0.0718	0.0808	2.8429
Scatec	0.3264	0.0743	2.7258
Yara	-0.0434	0.0536	2.2930
Bewi	0.1095	0.0393	1.9824
Norsk Hydro	0.0689	0.0916	3.0264
Wallenius Willhelmsen	0.3604	0.0747	2.7324
Odfjell	0.0623	0.4773	6.9085

Table 3: Descriptive statistics

4.4 Summary

In the methodology and data chapter, the event study method has been defined, and the event window was set to 20 days (-9,10). In addition, key concepts such as abnormal return, confidence interval and Wilcoxon inference have been defined. The concepts were explained to provide the reader with a more in-depth understanding of the components present in an event study analysis. Chapter 4.2.2 and 4.2.3 provides detailed information concerning the data selection process, and how the data was collected and calculated in Excel. This makes it possible for others to replicate the process. The last parts of the chapter discuss missing data and present descriptive statistics for the dataset.

5. Estimation Results from the event study

The focus of this chapter is the results of the event study performed in R. The results will be presented in the form of graphs and tables. The first model presented is the baseline model, which is the simplest model estimated in this study. This includes the market model with only the OSEBX return. The next model includes an Augmented Market Model, where the market model is expanded to also include the return on the exchange rate between NOK and EUR.

5.1 Baseline model

In R, the command "eventstudies" was used to run the analysis. The full code can be found under A.5 in the appendix and will only be briefly explained here. In the "eventstudies" package, all returns for all firms as well as for the OSEBX-index, was uploaded and specified as firm.returns and marked.return in the code. In addition, the list of announcement dates was used to tell R which dates to consider as event dates. This was specified as event.list in the code. The R code also runs with inference as a default, and this was specified to Wilcoxon inference. Wilcoxon was chosen since normal distribution could not be assumed due to the small event window, and since it relies on ranks and not random sampling. Lastly, the event window was specified directly. Since it is defined separately, it is possible to change between different sizes of event windows, and for this study a 20 day event window was used. The study resulted in a 95% confidence interval with a lower limit of 2.5%, an upper limit of 97.5% and a median. The null hypothesis is that the calculated abnormal return estimate is not statistically significant from zero. For the results to be significant, the null hypothesis needs to be rejected and the CAR must lay outside the confidence interval.

Figure 1 shows the baseline plot of the first announcements. The plot includes the median CAR and the upper and lower limits of the confidence interval. The median CAR is shown by the solid blue line, and the confidence interval is illustrated by the stipulated lines. The median CAR is centered around 0, and slightly negative in the days before the event (-9, 0). From day 0 to +1 the median increases but is still negative. At day +2, the CAR median becomes positive and stays positive until day +4, when it decreases. The CAR lies within the confidence interval, which means that the null hypothesis cannot be rejected at a 5% significance level. This results in a positive, but insignificant CAR following the events.

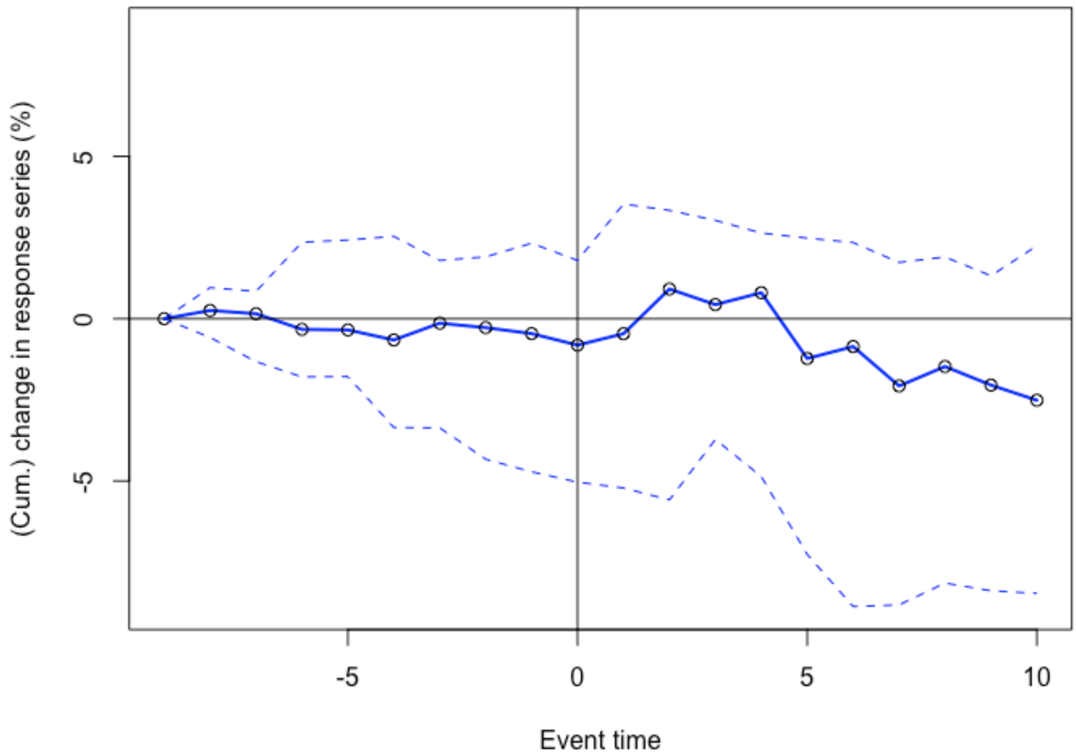

Figure 1: Baseline plot first announcements

In addition to the plots, the event study package provides a detailed confidence interval for the full event window. The complete list of intervals for the baseline models is found under A.2 in the appendix. For the purpose of this thesis, a smaller table was created. Table 4 provides more detailed results than the plot and shows that the CAR median increases from day 0 to day +3. The difference in CAR from day 0 to +1 can be calculated through simple methods, such as finding the difference in the median. This gives an increase in CAR from day 0 to +1 of 0.3517% and a change in CAR of 1.3773% from day +1 to +2, and lastly, a slight decrease of -0.4808% from day +2 to + 3. This indicates that the market might react positively to the announcements, but since the median is within the confidence interval, the null hypothesis of no effect cannot be rejected.

Event day	2.5%	Median	97.5%
- 3	-3.364373	-0.1378001	1.7943905
-2	-4.329506	-0.2754749	1.9059214
-1	-4.718186	- 0.4589928	2.3245407
0	- 5.035374	-0.8137168	1.7951953
+ 1	-5.215616	-0.4620632	3.5343611
+ 2	-5.582875	0.9152106	3.3383004
+ 3	-3.720370	0.4344581	3.0301091

Table 4: Confidence intervals for the first announcements baseline model

Next, the same model was estimated using the second announcements to answer hypothesis two. The plot in figure 2 shows a more fluctuating CAR median and confidence interval. In the period before the announcements (-9, 0) the CAR is mostly negative with the exception of day -4. On the event day, the CAR starts to increase but stays negative until day +4, and almost immediately becomes negative again at day +5. The CAR lies inside the confidence interval of this plot as well, leading to statistically insignificant results.

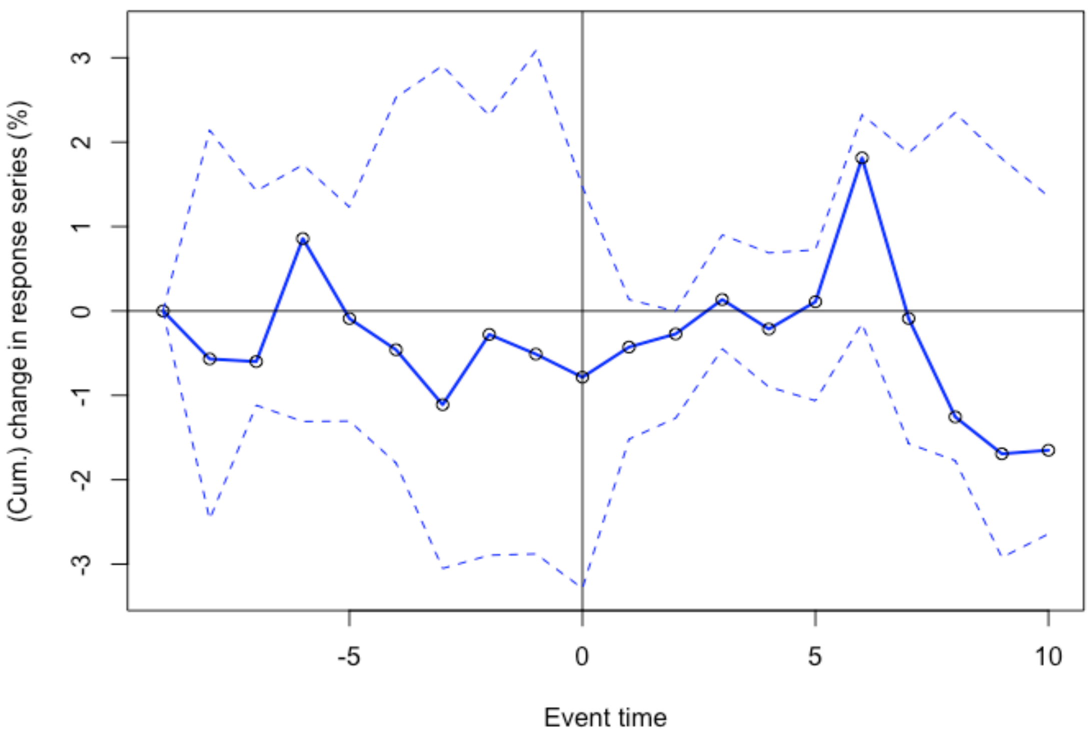

Figure 2: Baseline plot second announcements

Presented in table 5 are the detailed results from the second announcements, presented in a shortened table. Comparing the median of day 0 and +1 shows a slight increase in CAR of 0.3571%. The difference in median from day +1 to +2 is 0.1558%, while day +2 to +3 shows a difference of 0.4073%. Similar to the first announcements, this indicates a positive reaction, but the results are not statistically significant.

Event day	2.5%	Median	97.5%
-3	-3.0512556	-1.1107387	2.9055948
-2	-2.8945781	-0.2783601	2.3130825
-1	-2.8788618	-0.5115420	3.0855256
0	-3.2869180	-0.7852118	1.4728364
+ 1	-1.5188516	-0.4281061	0.1351533
+ 2	-1.2699460	-0.2722627	-0.0039821
+ 3	-0.4491067	0.1350786	0.9014657

Table 5: Confidence intervals for the second announcements baseline model

5.2 Augmented Market Model

After running the baseline models in R, the market model was expanded into an Augmented Marked Model (AMM) to increase robustness. This was done by including the return on the exchange rate between NOK and EUR in addition to the return on OSEBX in the market model. The AM model was incorporated in the R-code by changing "type" from "marketModel" to "lmAMM". This tells R that an AM model is to be used instead of the single factor Market Model. This makes it possible to control for more market effects, and as shown in figure 3, the effect of the event becomes more defined.

The plot in figure 3 follows the same path as the baseline model. The CAR is centered around zero in the period before the announcements (-9, 0). On the day of the event (day 0), the median CAR is negative, but increases and becomes positive at day +1. This differs from the baseline model where the median becomes positive at day +2. Similar to the baseline model, the CAR stays positive until day +4, and then decreases from day +4 to +5. Expanding to the AM model slightly narrowed the confidence interval, but as the plot shows, the median CAR was still not statistically significant at a 5% significance level.

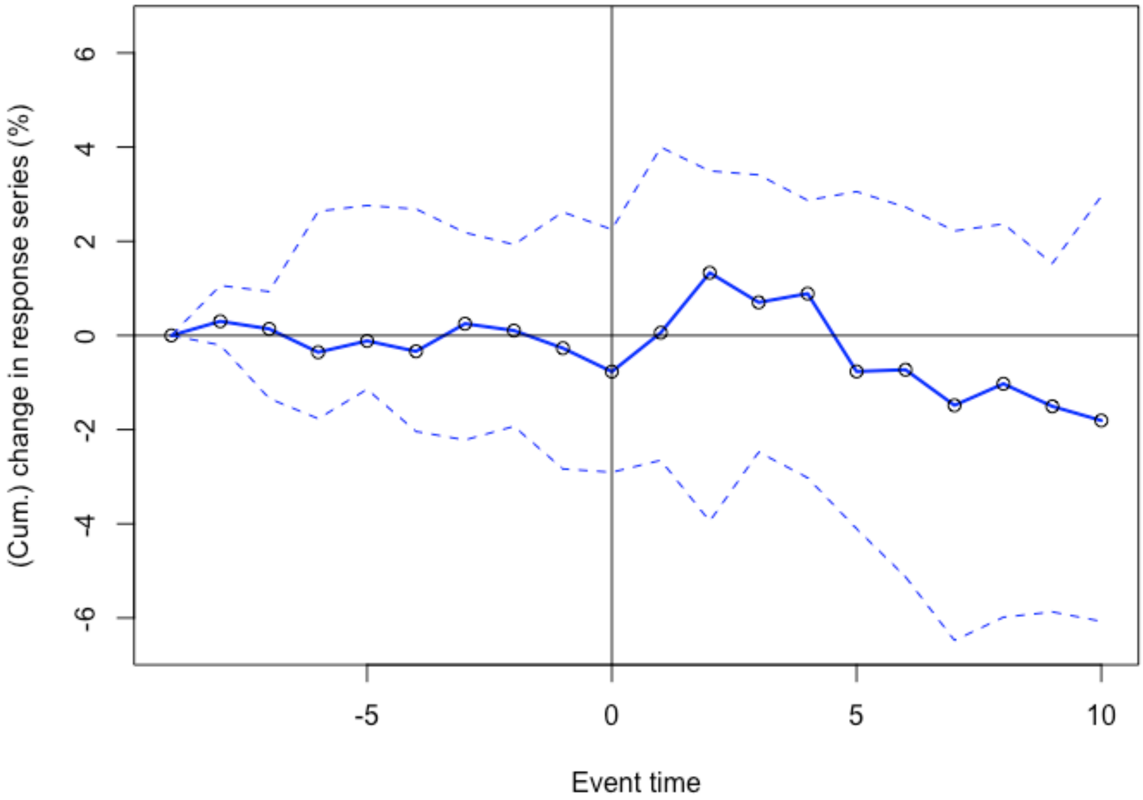

Figure 3: AMM plot first announcements

Table 6 shows the selected, relevant results. The full tables are to be found in A.3 in the appendix. The effect of the event from day 0 to day +1 is shown to be 0.8278%, then the median CAR increases again from day +2 to +3 by 1.2725%. At day +3 CAR is still positive but has decreased slightly compared to day +2. These calculations as well as the results, presented in table 6, show a more defined positive reaction from the market. Comparing the confidence intervals in table 6 to those presented in table 4 shows a narrower confidence interval. For example, in table 4, the confidence intervals for event day 0 have a lower limit of -5.0354% and an upper limit of 1.7952%. Day 0 in table 6 has a lower limit of -2.9051% and an upper limit of 2.2517%. This indicates that the AM model is a more statistically robust model, but as shown by the results, it is still not statistically significant.

Event day	2.5%	Median	97.5%
- 3	-2.2195645	0.2493213	2.1833646
-2	-1.9303612	0.1043598	1.9314452
-1	-2.8339859	-0.2701345	2.6186062
0	-2.9051251	-0.7688870	2.2517291
+ 1	-2.6514202	0.0588812	3.9972392
+ 2	-3.9457173	1.3313814	3.4930367
+ 3	-2.4763888	0.7023041	3.4098167

Table 6: Confidence intervals for the first announcements AM model

Lastly, the augmented model for the second announcements was estimated. Comparing the plot in figure 4 to the one in figure 2 shows a reduction in large fluctuations when including the AMM. As for the baseline model, the period before the announcements (-9, 0) is mostly negative except for day –4. However, the positive outlier is not as prominent as it was in figure 2. At day 0, the CAR is negative, and it stays negative until day +4, where it becomes only slightly positive. At day +5, it again becomes negative and stays negative with the exception of another outlier at day +6. Similar to day -4, this is much smaller than the outlier in figure 2. As with the baseline model, the results here are not statistically significant as the median is still within the confidence interval.

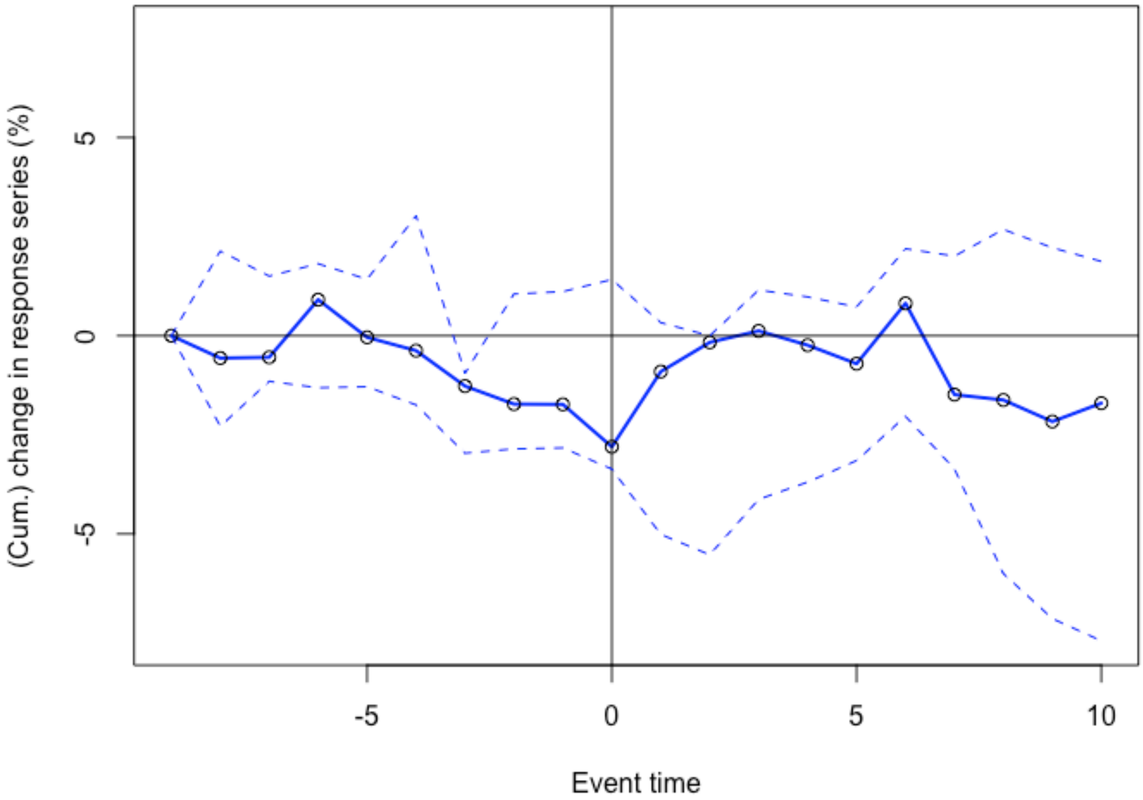

Figure 4: AMM plot second announcements

Table 7 shows the results of the AM model for the second announcements. The effect of the event is positive until day +3, with an increase in CAR of 1.8976% from day 0 to +1, 0.7375% between day +1 and +2, and lastly, an increase of 0.2897 from day +2 to +3. Comparing the confidence intervals of table 7 to those in table 5 shows a decrease in the width of the intervals in the period before the event dates. For example, day 0 in table 5 has a lower limit of –5.0354% and an upper limit of 1.7952%, while the results from the AMM lead to an interval with a lower limit of -3.3662% and an upper limit of 1.2156%. It can be noted that the size of the interval is uneven compared to the intervals of the first announcements.

Event day	2.5%	Median	97.5%
- 3	-2.965182	-1.2714244	-0.9503207
-2	-2.856607	-1.7255111	1.0507558
-1	-2.831408	-1.7338832	1.1118882
0	-3.366170	-2.8040526	1.4155865
+ 1	-5.014028	-0.9064218	0.3293586
+ 2	-5.527585	-0.1689692	-0.0024145
+ 3	-4.129380	0.1207756	1.1511068

Table 7: Confidence intervals for the second announcements AM model

5.3 Robustness check in Excel

The main results from the event study performed in R have been repeated manually using Excel. This has been done to ensure correct and reliable results. Alpha and betas were calculated using the marked model and the AM model in both R and Excel to control for potential errors in the Excel file. The code from R can be found in appendix A.5. Next, the alphas and betas were applied through the formulas presented in chapter 4 to manually calculate CAAR, var(CAAR) and t-value in Excel. This has been done for both the baseline and augmented models for the first and second announcements. The results are presented in tables 8 to 11.

Event window	CAAR	Var (CAAR)	|t-value|
(-9,10)	− 0.8345	9.7066	0.2679
(1,4)	0.4877	1.9413	0.3500

Table 8: Baseline model - Excel results first announcements

Event window	CAAR	Var (CAAR)	|t-value|
(-9,10)	− 0.3270	5.554E+01	0,0439
(1,4)	0.9220	1,111E+01	0.2766

Table 9: Baseline model - Excel results second announcements

Event window	CAAR	Var (CAAR)	|t-value|
(-9,10)	-0.8249	10.0688	0.2600
(1,4)	0.8171	2.0138	0.5758

Table 10: AM model - Excel results first announcements

Event window	CAAR	Var (CAAR)	|t-value|
(-9,10)	− 0.6468	66.812E+01	0.0784
(1,4)	0.7563	1.362E+01	0.2049

Table 11: AM model - Excel results second announcements

The results shown in the tables support the findings in R. For the baseline models, a negative and insignificant CAAR was found for the whole period (-9, 10). A positive, but insignificant CAAR was found for the period directly following the announcements (1,4). For the AM models, the findings were similar with a negative and insignificant CAAR for the period (-9,10), and a positive but insignificant CAAR for (1,4). The results are insignificant since the t-value is lower than 1.69, and H_0 can therefore not be rejected.

5.4 Summary

First, an event study was conducted using a baseline model to evaluate the market reaction to the issuance announcement of a green bond. The results were presented by a confidence interval, revealing how the markets responded during the period surrounding the announcement of a green bond. The findings reveal positive but insignificant results during the four-day period following the event. This indicated that the announcement of a green bond might increase firm value. Nonetheless, due to the lack of statistically significant results, the null hypothesis cannot be rejected. Next, an augmented model was included by introducing the exchange rate as an additional variable. This further reinforced the robustness of the model. Once more, the results were positive but insignificant directly after the announcements. The results from R were replicated manually in Excel in order to verify the findings. Here, a positive but insignificant result was also achieved when isolating a small event window (1,4). When considering the whole period (-9,10), all four models achieved negative and insignificant results.

6. Real effects on firms

A different approach to estimating a firm's value is to study their financial reports. These can give an indication of an increase or decrease in firm value in terms of real financial data. This thesis has therefore applied real data as a measurement to see if the announcements of green bonds were visible through more than just stock prices. For this purpose, three key figures were chosen as they indicate growth across a broad aspect, considering the variety of industries included in the sample. More specifically, changes in total assets, operating income and employee costs. Formula (4.12) has been used to calculate a yearly percentage change for three years prior to the announcements. These percentages were then averaged in order to create a base for comparison. Next, the percentage change from the announcement year to the following year was calculated and compared to the average. A complete table of all data used in the calculations is found under A.4 in the appendix.

6.1 First announcement

All firms have been analyzed using annual reports, as it takes time to see the real effect in the financial reports. However, some firms issued green bonds in 2022, which means that the latest annual reports are not yet published [3]. In addition, Aker ASA and Aker Horizons are part of the same organization, and it was therefore decided to use the financial report for the parent company. In total, 13 firms in the dataset had available annual reports [4].

In table 11, the average changes for the period prior to the announcements are displayed. Table 12 shows the percentage changes from the announcement year to the following year. Comparing the tables show that 10 out of 13 firms experienced an above average increase in total assets, 11 firms in operating income and lastly, 11 displayed a higher than average increase in employee costs. Overall, 8 firms showed an increase in all three categories, only Scatec experienced weaker percentage growth than average, and all the rest displayed growth in at least one key figure.

[3] as of May 15th, 2023.

[4] Tomra Systems, Yara and Norsk Hydro issued late 2022 and therefore no financial reports were available for the required period.

Name	Average total assets	Average Operating income	Average Employee costs
Entra	14 %	38 %	- 6 %
Aker	1 %	13 %	- 35 %
Lerøy	- 13 %	- 28 %	- 11 %
Bonheur	- 13 %	- 9 %	- 12 %
Orkla	10 %	7 %	6 %
Arendals Fossekompani	5 %	- 3 %	- 14 %
Grieg Seafood	14 %	- 10 %	2 %
Mowi	11 %	1 %	6 %
Salmar	3 %	- 29 %	- 21 %
Scatec	22 %	- 1 %	17 %
Bewi	26 %	27 %	22 %
Wallenius Willhelmsen	2 %	1 %	2 %
Odfjell	4 %	7 %	-1 %

Table 12: Change in key figures for first announcements averaged over three years

Name	Total assets	Operating income	Employee costs
Entra	12 %	20 %	14 %
Aker	25 %	188 %	27 %
Lerøy	168 %	18 267 %	2 728 %
Bonheur	- 0.2 %	22 %	4 %
Orkla	14 %	16 %	7 %
Arendal Fossekompani	15 %	9 %	19 %
Grieg Seafood	1 %	6 %	16 %
Mowi	7 %	12 %	2 %
Salmar	174 %	1 664 %	43 %
Scatec	- 33 %	-18 %	- 1 %
Bewi	66 %	40 %	31 %
Wallenius Willhelmsen	8 %	30 %	14 %
Odfjell	-3 %	26 %	-1 %

Table 13: Change in key figures for the year of first announcements to the following year

6.2 Second announcements

For the second time announcers 3 of 4 firms have published annual reports[5]. When comparing the results in table 15 and 16 both Scatec and Bonheur showed an above average increase for all key figures. Next, Entra showed an increase in total assets and operating income, but a decrease in employee costs.

Name	Average Total assets	Average Operating income	Average Employee costs
Entra	12 %	22 %	5 %
Bonheur	- 1 %	5 %	2 %
Scatec	- 5 %	- 15 %	- 5 %

Table 14: Change in key figures for second announcements averaged over three years

Name	Total assets	Operating income	Employee costs
Entra	- 9 %	40 %	2 %
Bonheur	14 %	52 %	91 %
Scatec	28 %	35 %	2 %

Table 15: Change in key figures for the year of second announcements to the following year

6.3 Summary

By introducing real financial data, it was possible to see if the effect of green bonds extends to more than just the stock price. Through comparing the average changes three years prior to the announcement with the change after the announcement, it was possible to see if the firms experienced an effect. For the first time announcements, the results were mainly positive with above average changes in most aspects when comparing annual reports. In total, 8 out of 13 firms improved in all key figures, while 4 firms experienced above average growth in at least one area of interest. For the second announcements, two out of three firms showed an overall abnormal increase for all key figures. The last firm shows an upsurge in one out of three.

[5] Aker ASA announced their second green bond in late 2022, meaning neither annual nor quarterly reports were available following the announcement. Aker ASA was therefore excluded.

Overall, the results suggest an effect of both the first and second announcements. In the event study a small, insignificant effect was found directly after the event day (1,4), but the returns for the full event period (-9,10) was negative. The results from the study of financial firm data support the finding of a positive effect when comparing annual reports but contradicts the overall negative finding. However, some limitations are present when comparing real data. Comparing the percentage changes can indicate a correlation between the announcement and changes in key figures, but is not a measure of causality. For example, other variables and market factors might have caused the effect seen here. This, together with other possible limitations of the study, will be discussed in chapter 7.

7. Discussion

This part of the thesis will provide a discussion centered around how the results contribute to answering the hypotheses. This will be done through discussing the results when considering previous research. In addition, the discussion explores how real financial data compare to the event study results and comments on potential similarities and differences. Lastly, possible sources of error and biases in this study will be debated.

7.1 Hypothesis 1

7.1.1 Results for hypothesis 1

The first hypothesis stated that the issuance of green bonds leads to an increase in stock prices for Norwegian firms. For this hypothesis, the main focus was the first time announcements and whether the firms experienced an increase in stock returns as an effect of the announcements. The results from the baseline model showed a graph and a confidence interval which implied a negative and statistically insignificant CAR for the whole event period (-9,10). The estimates showed a positive but statistically insignificant CAR for the first days after the event (1,4). The robustness check in Excel supported these findings with a CAAR of -0.8345% for (-9,10) with an insignificant t-value of 0.2679. A positive CAAR of 0.4877% was uncovered for the period (1,4). This was also insignificant with a t-value of 0.3500. Next, the model was expanded to an Augmented Market model. In this model, the confidence intervals became slightly narrower, which indicated an increase in robustness. However, the overall results were similar with a negative, insignificant CAAR for the whole period (-9,10) and a positive, but insignificant result for the first days after the announcements (1,4). Once again, the robustness check in Excel supports these findings with a negative, insignificant CAAR of -0.8249 % for (-9,10) with t-value 0.2600. When looking at the narrow event window (1,4), the results show a positive but insignificant CAAR of 0.8171 % with t-value 0.5758.

7.1.2 Deviation from the literature

Hypothesis one was derived based on research by Tang and Zhang (2020) and Flammer (2021). Since the aim of this thesis was to see if their findings could be replicated in the Norwegian market, it was natural to compare the thesis results to the findings from previous research. Tang and Zhang (2020) found a CAR of 1.4% for a period of 21 event days (-10, 10), while Flammer (2021) used a shorter window of (-5, 10) days and found a CAR of 0.49%. The results derived from the AM model will be used in the comparison, as this is the most robust model. When comparing, it becomes evident that this study shows weaker results than previous research. The insignificant CAAR's found through this event study makes it difficult to conclude that the positive responses are due to the announcement of green bonds. The other researchers found both positive and significant CAR's, which indicates that in their samples the positive CAR's are a result of the announcements. The results of this study, as well as those of Tang and Zhang (2020) and Flammer (2021), are summed up in table 17 for comparison:

This thesis	CAAR	Significance
This thesis	-0. 83 % (-9,10)	Not significant
	0.82 % (1,4)	Not significant
Flammer (2021)	0.49 % (-5,10)	Significant
Tang and Zhang (2020)	1.39 % (-10,10)	Significant

Table 16: Comparison of results regarding hypothesis 1

7.1.3 Potential explanations and errors

Several factors can provide a possible explanation for the low CAR. The first potential explanation is that this study uses an event window of 20 days (-9, 10) due to restrictions in the R-package. It was therefore expected that the results would be slightly different from previous findings. Also, Tang and Zhang (2020) used the CAPM model, which includes the risk-free interest rate, while Flammer (2021) used the Market Model. The AM model was therefore closer to the method of Flammer (2021) than to Tang and Zhang (2020). However, this was not likely to be the main explanations since both previous studies found positive and significant CAR, while this thesis found an overall negative and insignificant CAR. If the cause was the length of the event window or the use of the Market Model, one could expect the results from the thesis to be closer to the findings of Flammer (2021). Another possible issue is the small sample size. To compare, Tang and Zhang (2020) used a sample consisting of 132 unique issuers, and Flammer's (2021) sample contained 1189 bonds in total. This made it reasonable to assume that the lack of significance could be due to the small sample, consisting of only 17 firms and therefore 17 bonds. Tanaka (1987) explains the issue of small sample sizes by stating that inference depends on how well the information in the sample represents the information in the population. This will again depend on the size of the sample: "To the extent that samples are large, more information is available and, therefore, more confidence can be expressed for the model as a reflection of the population process" (Tanaka, 1987, p. 134). This supports the assumption that the small sample size might have been the core issue that led to the insignificant results.

There is no denying that the small sample size is a concern, but it might not be the only factor contributing to the weak results. Another potential factor is the low number of Norwegian green bonds issued during the early years. This might have led to a lower interest in the market. For example, when comparing green bonds issued in Norway and Sweden in 2018, a total of 36 green bonds were issued in Sweden and only 11 in Norway. This shows that Norwegian firms issued few green bonds in comparison to Sweden. It is important to note that these numbers include all bonds, both government and corporate, and also include banks, but it still shows that Sweden issued more green bonds earlier. In addition, Sweden was ranked as number 6 on the global green bonds ranking in 2018 , while Norway ranked as number 16 (Filkova & Frandon-Martinez, 2018, p. 3). The larger surge of corporate green bond issuance appeared in Norway in 2021, as shown in table 2. Based on this, the low CAR might be explained by pointing out that Norwegian firms started issuing them late. This might have led to a lower effect, since green bonds were no longer perceived as new and interesting. On the other hand, the green focus has greatly increased in recent years, which might suggest that green bonds should generate a bigger effect than the findings suggest.

An alternative explanation is the liquidity in the market. As shown, the largest part of Norwegian green bonds were issued in the period 2020 to 2022, which is the period most affected by the Covid-19 pandemic. When the restrictions following the pandemic were introduced in 2020, it greatly affected the financial markets worldwide. For example, on 16th of March, the S&P 500 index dropped by 12%, leaving it at the lowest level since 2018 (Imbert, 2020). In Norway, OSEBX fell by 8.77% on March 12th and marked the biggest drop since the financial crisis in 2008 (Ghaderi et al., 2020). These fall points to a potential turmoil in the market and reflect how the distress spread among investors. In addition, the total amount of bank deposits in Norway increased by 8.9% from March to April 2020. This was sizable considering that it was higher than the fluctuation of the whole period of 2016 to 2020. In the following year, from April 2020 to February 2021, the total quantity increased between 8.1% and 10% (Brynestad et al., 2021). When considered in a broader context, the drop in the stock market and the increase in bank deposits could reflect how the priorities likely changed for the average investor. By selling their financial instruments and depositing their funds in savings accounts instead, it is likely that investors sought security in more traditional forms of savings. Combined, this might have led to investors being more reluctant to invest in new green bonds during this time period. Nonetheless, the data from Statistics Norway also shows an increase in private investors investing in stocks during this period (Brynestad et al., 2021). This contradicts the previous statement of a decrease in new investments, due to more uneasiness among investors.

7.1.4 Results from study of real effects in financial data

Since the results from the event study indicated that a positive effect of the event might be present, real financial data was studied to see if this effect was visible through the firm's financial reports. This was done by researching the published reports to find evidence of more employees hired, a higher operating income or an increase in assets. For the first announcements, the study indicated an above average growth. For example, 10 of 13 firms experienced an above average increase in operating income. A majority had an increase in expenses related to employees, which indicated that the workforce expanded. In general, as many as 8 of 13 firms experienced above average results in the year following the announcements. When comparing table 12 and 13, it becomes evident that most firms displayed stronger results following the announcement year, but this is not enough to assume a causal relationship between the growth and the announcements. It can be expected that the inclusion of other key figures, such as expenses and debt, would alter the results. Similarly, inclusion of more firm-specific categories for each industry would likely lead to more fluctuating results. However, the categories chosen are comparable across firms and are therefore more representative for comparison on a general basis. It is also unavoidable that the improvements were due to other factors, such as omitted variable bias. For example, as mentioned, the pandemic likely had a more evident effect on the firm's results than the issuance of green bonds. Some firms displayed major increases from the announcement year to the next. For example, Lerøy Seafood, experienced a growth of 18 267% from 2021 to 2022 due to a significant increase in operating income. It would not be reasonable to argue that this effect was the result of green bond issuance alone, it is highly expected that other factors had an influence. Added up, the results from the study of financial data showed a correlation between the announcements and the increase in company growth. However, this is not proof of causality, meaning that it is not possible to assume that the effect is due to the announcements based on this study of financial data alone. Other factors might have had an undiscovered effect.

7.2 Hypothesis 2

7.2.1 Results for hypothesis 2

The second hypothesis was focused on how the impact of the second announcements differs from the first, and stated that first time issuance leads to a higher increase in stock prices than repeat issuers. To answer the hypothesis, the results from the first announcements were compared to the analysis of the second announcements. When comparing the baseline models, the immediate differences became evident through the plots. The plot in figure 1 appeared to be more steadily centered around 0, while the plot in figure 2 displayed larger fluctuations with some outliers. These differences were also visible in the confidence intervals, where the interval for the first announcements gradually increased, while the interval for the second announcements was more uneven. The result from the second announcements baseline model was an insignificant, negative CAR. The plot indicated a positive response to the announcements when isolating day +1 to +4 (1,4), but this was less evident than for the previous model due to the fluctuating graph. The robustness check in Excel supported the findings with a negative, and statistically insignificant, CAAR of -0.3270% for the period (-9,10), and a positive CAAR for the period (1,4) of 0.9220%. However, they were both statistically insignificant with t-values of 0.0439 and 0.2766, respectively. Similar to the first announcements, an expanded model was used. The AM model showed a plot with smaller outliers than in the baseline model, but was still insignificant. The robustness check in Excel supported the findings with a CAAR of -0.6468% (-9,10) is insignificant with t-value 0.0784, and the isolated (1,4) CAAR of 0.7563% was also insignificant with t-value 0.2049.

7.2.2 Comparison to literature and possible errors

The second hypothesis was also derived based on the research of Tang and Zhang (2020) and Flammer (2021). In both papers an insignificant, small abnormal return was found for the second announcements. Tang and Zhang (2020, p. 9) found an insignificant abnormal return of 0.12% and Flammer (2021, p. 508) found an insignificant abnormal return of 0.246%. The results from this thesis coincided with previous research in the sense that the results were insignificant. The difference is the overall negative CAAR, but the findings indicate an increase in CAAR in a short period after the announcements (1,4). The results from previous research and this study are summarized in table 14:

This thesis	CAAR (event window)	Significance
This thesis	-2.03% (-9,10)	Not significant
	0.48% (1,4)	Not significant
Flammer (2021)	0.12% (-5,10)	Not significant
Tang and Zhang (2020)	0.25% (-10,10)	Not significant

Table 17: Comparison of results regarding hypothesis 2

Under hypothesis one, several possible reasons for the difference in results were discussed. Some are relevant here as well, but the most prominent concern for hypothesis two is the sample size. Under hypothesis one, it was discussed how a small sample is not likely to be representative of the population, and therefore leads to insignificant results. In the case of hypothesis two, there are only four firms in the sample. Based on this, it would be unreasonable to assume that this sample is representative for the population. In addition, when the sample size becomes as small as it was for this model, the chance of biases becomes considerably more evident. Therefore, it is a reasonable argument that the lack of significance was due to the small sample size and not a non-statistical effect of the event itself. It is reasonable to believe that a larger sample would lead to more robust and reliable results.

The statement of the small sample size being the main reason for the weak results finds some support in the study of financial reports. The findings from the reports showed that 2 of the 3 firms studied experienced an above average growth after the announcement. This supports the finding of a small positive CAAR in the (1,4) event window. Nevertheless, the positive growth might be due to other factors, such as those discussed under hypothesis one. In addition, the sample size for the real data study is even smaller than for the event study, due to late announcements and a lack of available reports.

7.3 Potential error sources

As with all research, there is a possibility for errors and biases in this study. Potential sources of error will be presented in this chapter, including uncertainty around exact announcement dates, omitted variables and confirmation bias. In addition, this section will discuss the credibility of the news sources used, as well as potential calculation errors.

7.3.1 Accuracy of announcement dates

The main focus of this thesis has been on the announcements of green bond issuance. It was therefore crucial to get the most exact date possible. An effort was put into conducting research and examine different sources. Even though great care was taken to attempt to find the exact dates, there was always a risk of misinformation. For example, when researching dates on the Oslo Stock Exchange news webpage, there were some differences in how the news of green bond issuance was presented. In some cases, it was announced that a company was contemplating the issuance of green bonds, while in others, it was announced that a green bond was to be issued at an exact date. In a few cases, the headline only stated that a new bond was being issued without specifying it to be a green bond. This especially provided a risk of missing an announcement. As this became apparent, more thorough research was conducted by checking all announcements surrounding the dates of issuance. However, some companies issued several bonds simultaneously, so there is a possibility of announcements being overlooked. In addition, when searching for the announcement date of Yara, another issue was discovered. Yara is traded on both the Oslo Stock Exchange and Nasdaq, and therefore had two announcements on two different dates for the first green bond. It was concluded that the announcement issued at Oslo Stock Exchange was to be used as this was the earliest date.

Another challenge that appeared while searching for exact announcement dates was the lack of news on the official stock news pages. For example, when attempting to find the announcement of Scatec's first green bond, no news of a green bond issuance was found on either Oslo NewsWeb or Euronext. Therefore, the search had to be expanded to include other sources. This search resulted in a source stating that Scatec had successfully issued a green bond the previous week. This made it possible to find an announcement on Oslo NewsWeb about Scatec contemplating a bond issue surrounding this time. It was, however, not specified anywhere that this was a green bond. This created a potential error source as it is possible that the first green bond was announced at a different date. The same issue occurred with the first bond announced by Entra in 2016.

7.3.2 Omitted variables

Given the timeframe and size of this thesis, there are natural limitations considering how broadly the research can be expanded. The baseline model was expanded by the inclusion of the exchange rate and creating the augmented market model. The expansion seemed to affect the CAAR of both the first and second announcements. Since this indicates that some of the abnormal returns were due to the exchange rate, it is reasonable to ask if other factors might have similar effects. Are the CAARs a result of the announcements of green bonds, or are there other, omitted factors affecting them, causing abnormal returns? There are potentially several market specific effects that could impact the stock price, which this thesis has not controlled for. In addition, firm specific events might have happened simultaneously to the announcements. These are all factors the thesis has tried to consider. For example, by using short event windows to minimize the risk of other events having an impact during the same period. The first event window consisted of only 20 days, and was also narrowed to 4 days to see if a clearer effect could be found by isolating the event even more. This makes it unlikely that another event impacted the stock prices in the same period.

7.3.3 Confirmation bias

Throughout this study, efforts have been made to be as neutral as possible and to not let expectations or the results of other studies lead to adjustments of the data. The process of trying to make data and results correspond to already existing beliefs is called confirmation bias. Confirmation bias can be defined as " (...) seeking or interpreting of evidence in ways that are partial to existing beliefs, expectations or a hypothesis in hand " (Nickerson, 1998, p. 175). Avoiding confirmation bias has been a focus point throughout the entire study. For example, the thesis provides detailed descriptions of how the data has been collected and processed as a measure to ensure transparency. However, there is always a risk of subconsciously taking steps to try to make the data resemble already existing results and expectations. For example, as the focus has been to investigate if the results are representative for Norway, the interpretations might have been subconsciously affected. A lot of time and effort has been put into this thesis. It is therefore desirable to find an effect and achieve good results. This might have led to confirmation bias.

A counterargument to the presence of confirmation bias is how the data was collected. The process of collection has relied heavily upon trusted sources and databases such as Eikon (DataStream). In addition, the manipulation of the data has been kept to an absolute minimum. Meaning that only a standard formula has been used to calculate returns, and missing data has only been filled in where no original data was available. When filling in data, the Titlon database was used, as well as the historical exchange rate to ensure a correct stock price. Throughout the process, care was taken not to manipulate the data to gain certain results. The danger of subconsciously manipulating the data was also strongly reduced by the fact that two people were writing this thesis.

7.4 Suggestions to further work

There are several different approaches one could take to further explore the research question of this thesis. For example, an expansion could be to investigate the possibility of a significant difference between self-labeled bonds and bonds that are aligned with green bond guidelines, such as CBI. For instance, one could have tested if investors react differently to self-labeled and CBI-aligned bonds. Is there a significant difference in abnormal returns? Another possible expansion could be to include additional types of green bonds. The dataset used in this thesis consisted of only corporate bonds. It could be interesting to see the inclusion of, for example, government bonds would have made a difference. This would entail finding another method of measuring firm performance, but might overall lead to more significant results. Another way of broadening the sample is to include banks. In this study, banks were excluded, which decreased the size of the sample significantly. If one could find a way to measure the isolated effect of green bonds on the banks' stock prices, it would be interesting to see if this changes the results we concluded within this thesis.

One could also use the date of issuance as a focus point for the event study instead of the announcement dates. Some of the firms had an extended period of time between the first mention of a green bond issuance and the actual date for issuing. Therefore, it is possible that the market reacts more to the "action" of issuance instead of an announcement. This raises the question of when the market reacts, and a different approach to this study could be to look at whether the announcement or the issuance itself has more of an effect on the stock prices.

7.5 Summary

Through chapter 7, the results of the thesis were compared to the results of previous research, specifically Tang and Zhang (2020) and Flammer (2021). Each hypothesis has been discussed separately, and for hypothesis one it was found that the results differ from the literature. This led to a discussion of possible explanations of the differences in results. Potential error sources were presented and discussed, including possible errors with the chosen method, and differences across markets. Some support for the results from the event study was found through the study of real financial data, but no causality can be assumed. For the second hypothesis, the thesis achieved similar results to previous research, but the significance of the results was questioned. In particular, the small sample size was discussed regarding the results being potentially unreliable. The study of real data indicates an effect of the announcements here as well, but only correlation is found. The last part of the chapter was dedicated to a discussion of potential error sources and biases, as well as possible extensions and further research.

8. Conclusion

The goal of this thesis is to contribute to an extensive understanding of the green bond market in Norway. The thesis has built on the results from previous research, which found a positive effect of green bond issuance on stock prices worldwide. It aims to investigate if these findings are representative for the Norwegian market. Two hypotheses have been used to answer the research question: “Does green bond issuance increase firm value in Norway?”.

Hypothesis one stated that issuance of green bonds leads to an increase in firm stock prices. The event study in R found a negative CAR for the whole event window, but a positive CAR directly after the event. Generally, the effect of the events was smaller than for previous research and the findings were insignificant. Hence, H_0 is not rejected at a 5% significance level. Through the study of real financial data, some support was found for the observed positive effect of the announcements. However, the conclusion remains that the findings which indicates a positive, short-term effect of the announcements cannot be representative for the population. The results indicated correlation, but not causation, and is therefore not sufficient to reject H_0.

The second hypothesis states that first time announcements lead to a greater increase in stock prices than repeated announcements. The results showed a negative, insignificant CAR for the whole event window, but a positive, insignificant CAR directly after the event. The insignificant result corresponds with previous findings, but the effect was different by comparison. It is difficult to argue that the insignificant results are due to a lack of market reaction and not the small sample size. The study of financial data offers support to the positive effect of the announcements. However, the representativeness of the results is questionable due to the sample size. The same challenge of correlation, not causality, occurs with hypothesis two. This makes it challenging to reach a conclusion concerning the second hypothesis.

Overall, the findings of this thesis lead to the conclusion that the issuance of green bonds does not increase firm value in Norway. The study of real financial data finds some support for the effect of green bonds on firm value, but the overall conclusion remains the same.

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Appendix

A.1 Announcements dates

Name	First announcement	Second announcement
Entra	13.09.2016	15.03.2017
Aker Horizons	02.03.2021	-
Aker ASA	20.09.2022	10.11.2022
Lerøy	21.09.2021	-
Bonheur	07.09.2020	28.06.2021
Orkla	25.05.2021	-
Tomra Systems	24.10.2022	-
Arendals Fossekompani	12.02.2021	-
Grieg Seafood	11.06.2020	-
Mowi	16.01.2020	-
Salmar	07.04.2021	-
Scatec	09.11.2015	23.10.2017
Yara	22.09.2022	-
Bewi	27.10.2021	-
Norsk Hydro	21.11.2022	-
Wallenius Willhelmsen	04.04.2022	-
Odfjell	07.01.2021	-

Table A.1: Announcement dates

A.2 Confidence intervals Baseline Model from R

A.2.1 First announcements Baseline Model

2.5%	Median	97.5%
0.000000	0.0000000	0.0000000
-0.578881	0.2545538	0.9570308
-1.322987	0.1539733	0.8404197
-1.793593	-0.3281776	2.3558045
-1.784357	-0.3448180	2.4246459
-3.351758	-0.6549643	2.5364729
-3.364373	-0.1378001	1.7943905
-4.329506	-0.2754749	1.9059214
-4.718186	-0.4589928	2.3245407
-5.035374	-0.8137168	1.7951953
-5.215616	-0.4620632	3.5343611
-5.582875	0.9152106	3.3383004
-3.720370	0.4344581	3.0301091
-4.862613	0.8010814	2.6399387
-7.261809	-1.2263743	2.4823836
-8.868961	-0.8575764	2.3463852
-8.818622	-2.0709475	1.7331365
-8.145396	-1.4730816	1.9004824
-8.381804	-2.0451211	1.3244333
-8.462896	-2.5127831	2.2455183

Table A.2.1: Baseline model first announcement

A.2.2 Second Announcements Baseline Model

2.5%	Median	97.5%
0.0000000	0.0000000	0.0000000
-2.4698314	-0.5684645	2.1422872
-1.1175782	-0.6002206	1.4225192
-1.3096354	0.8571914	1.7299228
-1.3051406	-0.0904095	1.2310489
-1.8012483	-0.4598487	2.5311016
-3.0512556	-1.1107387	2.9055948
-2.8945781	-0.2783601	2.3130825
-2.8788618	-0.5115420	3.0855256
-3.2869180	-0.7852118	1.4728364
-1.5188516	-0.4281061	0.1351533
-1.2699460	-0.2722627	-0.0039821
-0.4491067	0.1350786	0.9014657
-0.9000957	-0.2145195	0.6885697
-1.0635770	0.1090362	0.7239138
-0.1471937	1.8139401	2.3238716
-1.5716717	-0.0890657	1.8759182
-1.7737206	-1.2556621	2.3492015
-2.9206987	-1.6927473	1.8040561
-2.6421296	-1.6504999	1.3585909

Table A.2.2: Baseline model second announcements

A.3 Confidence intervals with AM model from R

A.3.1 First announcements with AM model

2.5%	Median	97.5%
0.0000000	0.0000000	0.0000000
-0.2041581	0.3009099	1.0602927
-1.3387293	0.1391095	0.9319406
-1.7661113	-0.3565210	2.6361580
-1.1447135	-0.1157533	2.7597546
-2.0388802	-0.3370419	2.6847504
-2.2195645	0.2493213	2.1833646
-1.9303612	0.1043598	1.9314452
-2.8339859	-0.2701345	2.6186062
-2.9051251	-0.7688870	2.2517291
-2.6514202	0.0588812	3.9972392
-3.9457173	1.3313814	3.4930367
-2.4763888	0.7023041	3.4098167
-3.0220745	0.8891794	2.8701416
-4.1060111	-0.7649520	3.0548714
-5.1268128	-0.7279078	2.7253038
-6.4762478	-1.4841665	2.2199757
-5.9840238	-1.0264499	2.3667519
-5.8707662	-1.5060783	1.5297511
-6.0710669	-1.8065467	2.9579008

Table A.3.1: AM model first announcements

A.3.2 Second announcements with AM model

2.5%	Median	97.5%
0.000000	0.0000000	0.0000000
-2.284976	-0.5658328	2.1352451
-1.152513	-0.5454860	1.5023160
-1.313476	0.9088850	1.8142088
-1.288586	-0.0420826	1.4221761
-1.747547	-0.3774904	3.0251513
-2.965182	-1.2714244	-0.9503207
-2.856607	-1.7255111	1.0507558
-2.831408	-1.7338832	1.1118882
-3.366170	-2.8040526	1.4155865
-5.014028	-0.9064218	0.3293586
-5.527585	-0.1689692	-0.0024145
-4.129380	0.1207756	1.1511068
-3.694296	-0.2402036	0.9783450
-3.150851	-0.7077818	0.7241137
-2.036258	0.8158195	2.1927409
-3.364013	-1.4872375	2.0073346
-6.004652	-1.6231309	2.6790377
-7.138988	-2.1670506	2.2174757
-7.698303	-1.7028330	1.8737007

Table A.3.2: AM model second announcements

A.4 Financial reports

A.4.1 Annual reports first announcements

Name	Year	Total assets	Operating income	Employee costs
Entra	2013	26 646 000	1 576 000	148 100
	2014	30 849 700	3 227 400	144 200
	2015	33 619 000	3 862 000	155 000
	2016	38 890 000	4 840 000	144 000
	2017	43 410 000	5 820 000	164 000
Available from proff.no under Entra ASA – «konsernregnskap»				
Aker ASA	2018	92 758 000	42 163 000	13 963 000
	2019	106 706 000	48 756 000	15 884 000
	2020*	58 322 000	4 377 000	1 530 000
	2021	77 888 000	9 168 000	2 688 000
	2022	97 259 000	26 411 000	3 418 000
Available from akerasa.com under "Investor" – «Årsrapporter»				
Lerøy	2018	28 494 819 000	19 837 673 000	2 668 829 000
	2019	30 189 431 000	20 426 902 000	2 933 409 000
	2020	12 077 336 000	128 161 000	88 047 000
	2021	13 804 915 000	145 078 000	134 909 000
	2022	37 061 660 000	26 645 877 000	3 815 833 000
Available from lerøy.no under Investor – "Årsrapporter"				
Bonheur	2017	30 459 231	8 633 283	1 590 607
	2018	19 486 788	6 787 492	988 041
	2019	19 893 988	7 836 498	1 032 287
	2020	19 158 895	6 174 792	1 004 198
	2021	19 118 415	7 541 003	1 047 857
Available from proff.no under Bonheur ASA – "konsernregnskap»				
Orkla	2018	52 509 000	40 837 000	7 744 000
	2019	57 413 000	43 994 000	8 202 000
	2020	63 007 000	47 282 000	8 971 000
	2021	70 564 000	50 612 000	9 123 000

* Recalculated due to sale of controlling assets in Ocean Yields in November 2021

	2022	80 671 000	58 518 000	9 760 000
Available from proff.no under Orkla ASA – “konsernregnskap”				
	2018	5 891 781 000	4 871 817 000	2 419 703 000
Arendals	2019	6 145 317 000	4 806 770 000	1 413 499 000
Fossekompani	2020	6 986 887 000	3 617 526 000	1 360 419 000
	2021	6 837 898 000	4 196 380 000	1 421 931 000
	2022	7 840 462 000	4 568 534 000	1 691 116 000
Available from arendalsfossekompani.no under Investor Relations – “Reports, Presentations”.				
	2017	7 152 614	6 945 700	482 827
	2018	8 142 491	7 808 423	541 047
Grieg Seafood	2019	8 934 684	8 303 723	610 803
	2020	10 649 528	4 411 609	499 546
	2021	10 714 248	4 661 092	577 434
Available from proff.no under Grieg Seafood “konsernregnskap”				
	2017	4 330 000	3 649 000	478 000
	2018	5 145 000	3 812 000	505 000
Mowi	2019	5 841 000	4 136 000	564 000
	2020	5 847 000	3 760 000	558 000
	2021	6 259 000	4 202 000	568 000
Available form proff.no under Mowi Avd Hovedkontor – «konsernregnskap»				
	2018	15 135 564 000	11 342 554 000	1 040 438 000
	2019	17 986 057 000	12 237 589 000	1 202 494 000
Salmar	2020	10 224 676 000	81 288 000	57 180 000
	2021	13 665 468 000	84 321 000	65 882 000
	2022	37 403 949 000	1 487 791 000	94 044 000
Available from salmar.no under Investor – “Rapporter: Års- og bærekraftsrapporter»				
	2012	405 001	9 643	10 785
	2013	406 872	10 853	12 132
Scatec	2014	589 973	11 749	15 615
	2015	720 156	8 809	17 060
	2016	484 583	7 233	16 970
Available from proff.no under Scatec AS				

	2018	400 800 000	382 300 000	46 100 000
	2019	445 100 000	430 800 000	61 200 000
Bewi	2020	543 100 000	462 600 000	65 000 000
	2021	785 700 000	748 200 000	82 500 000
	2022	1 300 700 000	1 050 400 000	108 400 000
Available from bewi.no under Investors – "Reports and Presentations"				
	2018	7 414 000 000	4 065 000 000	406 000 000
	2019	7 796 000 000	3 909 000 000	403 000 000
Wallenius Willhelmsen	2020	7 628 000 000	2 958 000 000	362 000 000
	2021	7 794 000 000	3 884 000 000	393 000 000
	2022	8 394 000 000	5 045 000 000	447 000 000
Available from walleniuswillhelmsen.com Investor				
	2018	1 841 948	850 837	50 547
	2019	2 018 273	872 299	44 567
Odfjell	2020	2 220 089	939 060	47 086
	2021	2 073 130	1 038 367	49 291
	2022	2 008 719	1 309 545	54 961
Available from odfjell.no under Investors – "Reports and Presentations"				

Table A.4.1: Annual reports first announcements

A.4.2 Annual reports second announcements

Name	Year	Total assets	Operating income	Employee costs
Entra	2014	30 849 700	3 227 400	144 200
	2015	33 619 000	3 862 000	155 000
	2016	38 890 000	4 840 000	144 000
	2017	43 410 000	5 820 000	164 000
	2018	47 709 000	4 151 000	161 000
Available from proff.no under Entra ASA – «konsernregnskap»				
Bonheur	2018	19 486 788	6 787 492	988 041
	2019	19 893 988	7 836 498	1 032 287
	2020	19 158 895	6 174 792	1 004 198
	2021	19 118 415	7 541 003	1 047 857
	2022	21 752 639	11 432 995	2 006 242
Available from proff.no under Bonheur ASA – "konsernregnskap»				
Scatec	2014	589 973	11 749	15 615
	2015	720 156	8 809	17 060
	2016	484 583	7 233	16 970
	2017	463 738	7 008	12 251
	2018	594 383	9 439	13 486
Available from proff.no under Scatec AS				

Table A.4.2: Reports second announcements

A.5 R-file

```
################## Running Eventstudy #########################

library(readxl)
library(xts)
library(zoo)
library(eventstudies)
library(tidyverse)

############### Baseline model for first
announcements##################


#Creating a returns zoo-file
Returns <- read_excel("Returns_all.xlsx",
                      sheet = "Adjusted returns",
                      col_types = c("date", "numeric", "numeric",
"numeric",
                                    "numeric", "numeric", "numeric",
                                    "numeric", "numeric", "numeric",
                                    "numeric", "numeric", "numeric",
                                    "numeric", "numeric", "numeric",
                                    "numeric", "numeric"), na = "*")

str(Returns)

Returns$`Exchange Date` <- as.Date(Returns$`Exchange Date`)
Returns$Bewi <- as.numeric(Returns$Bewi)
Returns$`Aker Horizons`<- as.numeric(Returns$`Aker Horizons`)

str(Returns)
view(Returns)

Returns_xts <- as.xts(Returns)
str(Returns_xts)
Returns_zoo <- as.zoo(Returns_xts)
str(Returns_zoo)
head(Returns_zoo)
View(Returns_zoo)

#Creating an OSEBX zoo file
OSEBX <- read_excel("OSEBX-kopi.xlsx",
                         sheet = "Close", col_types = c("date",
                                                        "numeric",
                                                        "numeric",
"numeric",
                                                        "numeric"), na
= "*")
str(OSEBX)

OSEBX$`Exchange Date` <- as.Date(OSEBX$`Exchange Date`)
OSEBX$Close <- as.numeric(OSEBX$Close)
OSEBX$Adjusted <- as.numeric(OSEBX$Adjusted)
OSEBX$`Exchange rate` <- as.numeric(OSEBX$`Exchange rate`)
OSEBX$Retrun <- as.numeric(OSEBX$Retrun)

str(OSEBX)
```

```
head(OSEBX)

OSEBX_xts <- as.xts(OSEBX)
str(OSEBX_xts)
OSEBX_zoo <- as.zoo(OSEBX_xts)
str(OSEBX_zoo)
head(OSEBX_zoo)
View(OSEBX_zoo)

#Creating a data.frame for first announcements
Announcement_dates <- read_excel("Announcement dates.xlsx")

Announcement_dates <- as.data.frame(Announcement_dates)
Announcement_dates$when <- as.Date(Announcement_dates$when)
str(Announcement_dates)
View(Announcement_dates)

#Running eventstudy
es <- eventstudy(firm.returns = Returns_zoo,
                 event.list = Announcement_dates,
                 event.window = 10,
                 type = "marketModel",
                 to.remap = TRUE,
                 remap = "cumsum",
                 inference = TRUE,
                 inference.strategy = "wilcox",
                 model.args = list(market.returns=OSEBX_zoo$Adjusted))

plot(es)

view(es$result)

############ Baseline model for second
announcements####################

#Creating a data.frame for second announcements
Announcement_2 <- read_excel("Announcement_2.xlsx",
                             sheet = "Ark1", col_types = c("text",
                                                           "date"))

Announcement_2 <- as.data.frame(Announcement_2)
Announcement_2$when <- as.Date(Announcement_2$when)
str(Announcement_2)
View(Announcement_2)

#Running eventstudy
es_2 <- eventstudy(firm.returns = Returns_zoo,
                   event.list = Announcement_2,
                   event.window = 10,
                   type = "marketModel",
                   to.remap = TRUE,
                   remap = "cumsum",
                   inference = TRUE,
                   inference.strategy = "wilcox",
                   model.args =
list(market.returns=OSEBX_zoo$Adjusted))

plot(es_2)
```

```r
view(es_2$result)

#######Expanding to Augmented Market Model for first
announcements######


#Running eventstudy
es_AMM_1 <- eventstudy(firm.returns = Returns_zoo,
                 event.list = Announcement_dates,
                 event.window = 10,
                 type = "lmAMM",
                 to.remap = TRUE,
                 remap = "cumsum",
                 inference = TRUE,
                 inference.strategy = "wilcox",
                 model.args = list(market.returns=OSEBX_zoo$Adjusted,
                                   others=OSEBX_zoo$Retrun,
                                   market.returns.purge=FALSE))

plot(es_AMM_1)

view(es_AMM_1$result)

######Expanding to Augmented Market Model for second
announcements#######


#Running eventstudy
es_AMM_2 <- eventstudy(firm.returns = Returns_zoo,
                 event.list = Announcement_2,
                 event.window = 10,
                 type = "lmAMM",
                 to.remap = TRUE,
                 remap = "cumsum",
                 inference = TRUE,
                 inference.strategy = "wilcox",
                 model.args = list(market.returns=OSEBX_zoo$Adjusted,
                                   others=OSEBX_zoo$Retrun,
                                   market.returns.purge=FALSE))

plot(es_AMM_2)

view(es_AMM_2$result)


#########Alphas and betas for manual calculation of baseline
model#######

#First announcements

Entra <- read_excel("Augmented Model.xlsx",
                    sheet = "Entra", range = "B9:H260")
Beta_Entra <- lm(Entra$`Returns Entra`~ Entra$`Returns OSEBX`)
summary(Beta_Entra)


Aker_Horizons <- read_excel("Augmented Model.xlsx",
```

```
                            sheet = "Aker Horizons", range = "B9:H260")
Beta_aker_H <- lm(Aker_Horizons$`Returns Aker` ~ Aker_Horizons$`Returns
OSEBX`)
summary(Beta_aker_H)

Aker_ASA <- read_excel("Augmented Model.xlsx",
                       sheet = "Aker ASA", range = "B9:H260")
Beta_Aker_ASA <- lm(Aker_ASA$`Returns aker` ~ Aker_ASA$`Returns OSEBX`)
summary(Beta_Aker_ASA)


Lerøy <- read_excel("Augmented Model.xlsx",
                    sheet = "Lerøy", range = "B9:H260")
Beta_Lerøy <- lm(Lerøy$`Returns Lerøy` ~ Lerøy$`Returns OSEBX`)
summary(Beta_Lerøy)


Bonheur <- read_excel("Augmented Model.xlsx",
                      sheet = "Bonheur", range = "B9:H260")
Beta_Bonheur <- lm(Bonheur$`Returns B` ~ Bonheur$`Returns OSEBX`)
summary(Beta_Bonheur)


Grieg_Seafood<- read_excel("Augmented Model.xlsx",
                           sheet = "Grieg", range = "B9:H260")
Beta_Grieg_Seafood <- lm(Grieg_Seafood$`Returns grieg` ~
                           Grieg_Seafood$`Returns OSEBX`)
summary(Beta_Grieg_Seafood)


Mowi <- read_excel("Augmented Model.xlsx",
                   sheet = "Mowi", range = "B9:H260")
Beta_Mowi <- lm(Mowi$`Returns Mowi` ~ Mowi$`Returns OSEBX`)
summary(Beta_Mowi)


Orkla <- read_excel("Augmented Model.xlsx",
                    sheet = "Orkla", range = "B9:H260")
Beta_Orkla <- lm(Orkla$`Returns Orkla` ~ Orkla$`Returns OSEBX`)
summary(Beta_Orkla)


Salmar <- read_excel("Augmented Model.xlsx",
                     sheet = "Salmar", range = "B9:H260")
Beta_Salmar <- lm(Salmar$`Returns Salmar` ~ Salmar$`Returns OSEBX`)
summary(Beta_Salmar)


Tomra_Systems <- read_excel("Augmented Model.xlsx",
                            sheet = "Tomra", range = "B9:H260")
Beta_Tomra_Systems <- lm(Tomra_Systems$`Returns Tomra` ~
                           Tomra_Systems$`Returns OSEBX`)
summary(Beta_Tomra_Systems)


Scatec <- read_excel("Augmented Model.xlsx",
                     sheet = "Scatec", range = "B9:H260")
Beta_Scatec <- lm(Scatec$`Returns Scatec` ~ Scatec$`Returns OSEBX`)
```

```
summary(Beta_Scatec)


Yara <- read_excel("Augmented Model.xlsx",
                   sheet = "Yara", range = "B9:H260")
Beta_Yara <- lm(Yara$`Returns Yara` ~ Yara$`Returns OSEBX`)
summary(Beta_Yara)


Bewi <- read_excel("Augmented Model.xlsx",
                   sheet = "Bewi", range = "B9:H252")
Beta_Bewi <- lm(Bewi$`Returns Bewi` ~ Bewi$`Returns OSEBX`)
summary(Beta_Bewi)


Norsk_Hydro <- read_excel("Augmented Model.xlsx",
                          sheet = "Norsk Hydro", range = "B9:H260")
Beta_Norsk_Hydro <- lm(Norsk_Hydro$`Returns hydro` ~
                         Norsk_Hydro$`Returns OSEBX`)
summary(Beta_Norsk_Hydro)


Odfjell <- read_excel("Augmented Model.xlsx",
                      sheet = "Odfjell", range = "B9:H260")
Beta_Odfjell <- lm(Odfjell$`Returns O` ~ Odfjell$`Returns OSEBX`)
summary(Beta_Odfjell)


Wallenius_Wilhelmsen<-read_excel("Augmented Model.xlsx",
                                    sheet = "Wallenius", range =
"B9:H260")
Beta_Wallenius_Wilhelmsen <-
  lm(Wallenius_Wilhelmsen$`Returns w` ~ Wallenius_Wilhelmsen$`Returns
OSEBX`)
summary(Beta_Wallenius_Wilhelmsen)


Arendals_Fossekompani<-read_excel("Augmented Model.xlsx",
                                    sheet = "Arendal", range =
"B9:H260")
Beta_Arendals_Fossekompani <-
  lm(Arendals_Fossekompani$`Returns Arendal` ~
       Arendals_Fossekompani$`Returns OSEBX`)
summary(Beta_Arendals_Fossekompani)

#Second Announcements

Entra_2 <- read_excel("Augmented Model.xlsx",
                      sheet = "Entra", range = "M9:S260")
Beta_Entra_2 <- lm(Entra_2$`Returns Entra` ~ Entra_2$`Returns OSEBX` )
summary(Beta_Entra_2)


Aker_ASA_2 <- read_excel("Augmented Model.xlsx",
                         sheet = "Aker ASA", range = "M9:S260")
Beta_Aker_ASA_2 <- lm(Aker_ASA_2$`Returns aker` ~ Aker_ASA_2$`Returns
OSEBX`)
summary(Beta_Aker_ASA_2)
```

```
Bonheur_2 <- read_excel("Augmented Model.xlsx",
                        sheet = "Bonheur", range = "M9:S260")
Beta_Bonheur_2 <- lm(Bonheur_2$`Returns B` ~ Bonheur_2$`Returns OSEBX`)
summary(Beta_Bonheur_2)


Scatec_2 <- read_excel("Augmented Model.xlsx",
                       sheet = "Scatec", range = "L9:R260")
Beta_Scatec_2 <- lm(Scatec_2$`Returns Scatec` ~ Scatec_2$`Returns
OSEBX`)
summary(Beta_Scatec_2)


#######Alphas and betas for manual calculation of augmented
model########

#First announcements

Betas_Entra_AMM <- lm(Entra$`Returns Entra` ~ Entra$`Return Exchange
Rate` +
                        Entra$`Returns OSEBX`)
summary(Betas_Entra_AMM)


Betas_Aker_H_AMM <- lm(Aker_Horizons$`Returns Aker` ~
                         Aker_Horizons$`Return Exchange Rate` +
                         Aker_Horizons$`Returns OSEBX`)
summary(Betas_Aker_H_AMM)


Beta_Aker_AMM <- lm(Aker_ASA$`Returns aker` ~ Aker_ASA$`Return exchange
rate` +
                      Aker_ASA$`Returns OSEBX`)
summary(Beta_Aker_AMM)


Beta_Ler√∏y_AMM <- lm(Ler√∏y$`Returns Ler√∏y` ~ Ler√∏y$`Return Exchange
Rate` +
                       Ler√∏y$`Returns OSEBX`)
summary(Beta_Ler√∏y_AMM)


Beta_Bonheur_AMM <- lm(Bonheur$`Returns B` ~ Bonheur$`Return Exchange
Rate` +
                         Bonheur$`Returns OSEBX`)
summary(Beta_Bonheur_AMM)


Beta_Orkla_AMM <- lm(Orkla$`Returns Orkla` ~ Orkla$`Return Exchange
Rate` +
                       Orkla$`Returns OSEBX`)
summary(Beta_Orkla_AMM)


Beta_Tomra_AMM <- lm(Tomra_Systems$`Returns Tomra` ~
                       Tomra_Systems$`Return Exchange Rate` +
```

```
                       Tomra_Systems$`Returns OSEBX`)
summary(Beta_Tomra_AMM)


Beta_Arendals_Fossekompani_AMM <- lm(Arendals_Fossekompani$`Returns
Arendal` ~
                                  Arendals_Fossekompani$`Return
Exchange Rate` +
                                  Arendals_Fossekompani$`Returns
OSEBX`)
summary(Beta_Arendals_Fossekompani_AMM)


Beta_Grieg_Seafood_AMM <- lm(Grieg_Seafood$`Returns grieg` ~
                               Grieg_Seafood$`Return Exchange Rate` +
                               Grieg_Seafood$`Returns OSEBX`)
summary(Beta_Grieg_Seafood_AMM)


Beta_Mowi_AMM <- lm(Mowi$`Returns Mowi` ~ Mowi$`Return Exchange Rate` +
                      Mowi$`Returns OSEBX`)
summary(Beta_Mowi_AMM)


Beta_Salmar_AMM <- lm(Salmar$`Returns Salmar` ~ Salmar$`Return Exchange
Rate` +
                        Salmar$`Returns OSEBX`)
summary(Beta_Salmar_AMM)


Beta_Scatec_AMM <- lm(Scatec$`Returns Scatec` ~ Scatec$`Return Exchange
Rate` +
                        Scatec$`Returns OSEBX`)
summary(Beta_Scatec_AMM)


Beta_Yara_AMM <- lm(Yara$`Returns Yara` ~ Yara$`Return Exchange Rate` +
                      Yara$`Returns OSEBX`)
summary(Beta_Yara_AMM)


Beta_Bewi_AMM <- lm(Bewi$`Returns Bewi` ~ Bewi$`Return Exchange Rate` +
                      Bewi$`Returns OSEBX`)
summary(Beta_Bewi_AMM)


Beta_Norsk_Hydro_AMM <- lm(Norsk_Hydro$`Returns hydro` ~
                             Norsk_Hydro$`Return Exchange Rate` +
                             Norsk_Hydro$`Returns OSEBX`)
summary(Beta_Norsk_Hydro_AMM)


Beta_Wallenius_Wilhelmsen_AMM <- lm(Wallenius_Wilhelmsen$`Returns w` ~
                                  Wallenius_Wilhelmsen$`Return Exchange
Rate` +
                                    Wallenius_Wilhelmsen$`Returns
OSEBX`)
summary(Beta_Wallenius_Wilhelmsen_AMM)
```

```
Beta_Odfjell_AMM <- lm(Odfjell$`Returns O` ~ Odfjell$`Return Exchange
Rate`+
                         Odfjell$`Returns OSEBX`)
summary(Beta_Odfjell_AMM)

#Second Announcements

Beta_Entra_AMM_2 <- lm(Entra_2$`Returns Entra` ~
                          Entra_2$`Return Exchange Rate` +
                          Entra_2$`Returns OSEBX`)
summary(Beta_Entra_AMM_2)


Beta_Aker_AMM_2 <- lm(Aker_ASA_2$`Returns aker` ~
                        Aker_ASA_2$`Return Exchange Rate` +
                        Aker_ASA_2$`Returns OSEBX`)
summary(Beta_Aker_AMM_2)


Beta_Bonheur_AMM_2 <- lm(Bonheur_2$`Returns B` ~
                           Bonheur_2$`Return on Exchange Rate` +
                           Bonheur_2$`Returns OSEBX`)
summary(Beta_Bonheur_AMM_2)


Beta_Scatec_AMM_2 <- lm(Scatec_2$`Returns Scatec` ~
                          Scatec_2$`Return Exchange Rate` +
                          Scatec_2$`Returns OSEBX`)
summary(Beta_Scatec_AMM_2)
```

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