Course: BE305E

Effect of Green Bonds on corporate financial performance

"An event study to understand the effect of green bonds issuance on performance of public listed companies at Oslo stock exchange".

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Foreword

Master thesis is the final submission of the masters in business science program. It focuses on the Green Bonds issuance and resulting impact on the performance of public listed companies in Oslo stock exchange. Thesis work not only summarizes the learning from the empirical research but also manifests the application of coursework studied during finance specialization.

Green bond is not a maiden concept, the first green bond was issued in 2007 when the European Investment Bank (EIB) and other international banks initiated this instrument by issuing 600 million Euro climate awareness bond to create sustainable projects. A lot of research has been carried out on various aspects of Green Bonds globally however research on Norwegian market is fairly limited hence, this thesis attempts to contribute to the existing knowledge on green bonds in the context of Norwegian firms. It aims to discover to what extent Norwegian market behaves in the same way as other markets globally.

The thesis work would not have been completed without the support and guidance of Oleg Nenadic, my thesis supervisor as well professor who taught Financial Econometrics and R which was crucial to perform the analysis. I am very grateful to other professors including Thomas, Irena, Frode Kjærland who taught specialization topics in finance. Lastly, I would also like to thank my family, my husband and daughters who are constant source of motivation for me to challenge myself and fulfill my quest for learning.

Contents

Executive Summary

Sustainability finance and green bond is not a maiden but relatively new concept in the history of finance. Green bonds are financial instruments enabling firms to raise capital for their climate initiatives. There is no standardized definition of green bond however, over the period certain bodies have been established to set the standards around green bonds and provide certifications. According to ICMA, Green bonds are defined as loan instruments that enable capital raising and investment in new and existing projects, which promote environmental benefits. These are issued by the conventional financial institutions however the proceeds are strictly used for the sustainability projects. A lot of work has been carried out by various bodies in the US, Europe, China and Asia however, there is strong need for harmonization or standardization to achieve the global collaboration in broadening the geo base and diversifying the ownership across globe.

The first green bond was issued in 2008, however they have experienced exponential year on year growth after the Paris agreement in 2015 where the need to support climate initiatives with sustainable green finance was stressed upon and it was regarded as a catalyst to promote climate initiatives. According to climate bond market intelligence report the green bond market reached the 2 trillion USD mark by Q2'2022.

As far as the motivation behind issuing green bonds is concerned, the corporates issue green bonds with various objectives in mind for instance; as a marketing gimmick to tap into the consumer segment that is willing to pay premium for the products designed and developed via sustainable means and resources. Another driver could be the signaling effect. Signaling effect implies that the issuance of green bonds by firms sends a strong and credible signal of firm's commitment towards environmental sustainability. Such a signal can be valuable, as investors often lack sufficient information about the company's environmental commitment[2] (Lyon and Montgomery, 2015). Additionally, companies issuing green bonds can benefit from the green premium also termed as Greenium. It means that investors are willing to hold the investments in green bonds considering the environmental aspects of the investment and are willing to accept lower return for long term sustainable benefits for society. In the nutshell, the issuance of green bonds has benefits for both issuers, investors and policy makers.

This thesis focusses on understanding the impact of green bond issuance on companies' performance in Norwegian market and contributes to the existing research on the topic globally. The performance could be described in multi/dimensional way for example impact on the ESG rating of the firm, how does it effect the tock returns at stock exchange, the impact on the financial performance of the firm and the ability of the firm to raise cheaper capital.

Review the existing researches available on the subject, the researchers have shown that green financing exerts a positive impact on firm value and financial performances both in the short run and in the long term, however, there is still a gap and a strong need to gather more proof points in establishing the relationship between green bond and corporate performance as the existing literature indicates positives as well as no or negative impact of green bonds on the performance.

Zerbib (2019) discovered that the difference between green bond yields and their matched counterparts is 2 bps. Barber et al. (2018) analyzed 5000 VC funds and find that impact funds have a 14.1% higher probability of attracting investment, a phenomenon they attribute to growing market demand indicating lower cost of capital. Recent empirical studies indicate positive, negative and no relationship between the green bond issuance and the response from the stock market. Zang and Tang (2020) examine an international green bond dataset based on 28 countries findings of their study substantiate Flammer (2020), they also find a positive stock market reaction to green bond issuance. Another study conducted on Chinese firms by Zhou, X., & Cui, Y. (2019) analyzed cumulative corporate abnormal returns (CAARs) and the issuance of green bonds using the even analysis approach, the result indicated that CAARs are not significantly positive or negative prior to the event.

Considering the Norwegian green bond market and the limitation on availability of the data for empirical research the scope of research is confined to understanding the effect of green bond issuance by listed companies on stock returns. The required stock data as obtained from Oslo stock exchange and Euronext. Green bond list was gathered from Euronext whereas market index OSCBX was downloaded from yahoo finance and lastly, the Fama French factor data was collected from Bernt Odegaard website.

In order to investigate the effect, short term event study method was deployed. Event study method assumes that markets are efficient and that there will be immediate response of an event in short term which will fade away in long term. As a first step, the event, estimation, and observation window were defined. One trading day before and after the event data in calendar was taken as event window whereas three different periods 5, 7 and 11 days before event were taken as 3 iterations of estimation period and similarly same period was chosen after event as observation period. As second step to normal or expected returns were calculated by deploying three different models namely Cumulative Average Returns, Market adjusted returns/ market model and Fama /French model. In the first model simple returns of each event were accumulated, later cumulative average was taken where in later two models the simple daily stock returns were regressed with market index and Fama French factors respectively. The objective was to compare the outcomes while testing the hypothesis. Abnormal returns were determined by subtracting expected returns from the actual or realized returns.

The results indicate that in case of unadjusted cumulative return model with 5 days estimation ^ observation window there is effect at 10% significance level whereas in the later two models we fail to reject the null hypothesis as the effect is not significant. The change in the stock prices could be due to the influence of the market, not the event.

This study does substantiate the existing literature that indicates no effect on stock performance. However, there is a dire need for future research measuring the impact of bond issuance on company ESG ratings, financial/accounting performance. It was a revelation that the ESG reporting of the listed firms is not mandatory. Once we have robust databases of the additional variables such as ESG performance, announcement date of the said events and stock performance data, the depth and scope of empirical research around green bonds in Norwegian markets could be expanded.

Introduction:

The thesis aims to study issuance of Corporate Green Bonds and their impact on the Firms' performance. The performance of a firm could be related to societal, environmental and financial i.e., stock market performance aspects. The purpose of the study would be to contribute to the existing research that exists in in the field of sustainable finance and green bond. To define the research question and hypothesis, existing literature on the subject matter was studied and reviewed. A broad understanding around the green bonds and corporate performance is developed through existing literature in trying to answer basic questions such as why do firms issue green bonds, their motivation and rationale along with its implications on the firm, short- and long-term commitment to environment and society, how stock market responds to the issuance of green bonds in short and long term, how does green financing benefit stakeholders including shareholders, how does green finance via green bonds impact the cost of capital. Is green finance cheaper or a green premium that could benefit firm.

After the review of literature on various markets globally, the problem statement for this thesis will be formulated while also taking data availability on Norwegian market into consideration.

Review of the literature:

Green Bonds Market:

The climate conference COP21 held in Paris in 2015 resulted in a breakthrough that pushed global cooperation to combat the challenge of climate change in the world. The Paris Agreement was adopted and signed by the 196 countries. Later, in the COP26 climate finance was one of the main topics necessitating the need to have easy access to finance to fund climate initiatives such as development of required infrastructure and technology.

In 2018, the European Commission published an action plan for financing sustainable Europe and the plan represents a comprehensive strategy for linking sustainability and financial growth ore closely together (European Commission, 2018). Today, the action plan is included as part of the European Green Deal that was presented by EU in 2019. This is a growth strategy that will make Europe the first climate-neutral region in the world by 2050 and reduce net greenhouse gas emissions by 55 percent within 2030 (NHO, 2022). Sustainable finance represents a key role in this growth strategy.

Green bonds are financial instruments enabling firms to raise capital for their climate initiatives. As described by Flammer, C. (2021), Green bonds are fixed income securities issued by capital raising entities to fund their environmentally friendly projects, such as renewable energy, sustainable water management, pollution prevention, climate change adaptation and so on.[1]

ICMA (International Capital Market Association) is an authority to set the standards and frameworks around sustainable finance. According to ICMA, Green bonds are defined as loan instrument that enables capital raising and investment in new and existing projects, which promote environmental benefits. These are issued by the conventional financial institutions however the proceeds are strictly used for the sustainability projects.

Types of green bons: green bonds could be categorized into 4 types.

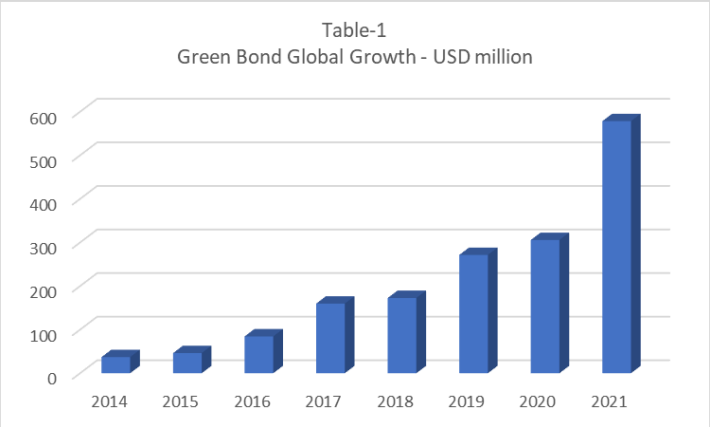
a. Conventional bonds invested in green projects.
b. green bonds guaranteed by income.
c. project-specific obligations
d. securitized green bonds

Table 1. Four categories of green bonds (ICMA, 2018).

Category	Definition
Green Use of Proceeds Bonds	Similar to traditional bonds by offering full recourse to the issuer and sharing the same credit rating as the issuer.
Green Use of Proceeds Revenue Bonds	Non-recourse to the issuer and repays investors based on a revenue stream such as tolls, fees, and taxes.
Green Project Bonds	Recourse or non-recourse to the issuer.
Green Securitized Bonds	Bond collateralized by one or more specific Green Project(s). The first source of repayment is generally the cash flows of the assets.

Net proceeds from a green bond issuance must be credited to a sub-account, placed in a secondary portfolio, or be the subject of a suitable form of allocation. The essential characteristic of green bonds is to associate the use of proceeds to specific environment-friendly projects. Green bonds address climate change mitigation and adaptation goals, answering the growing awareness of systemic climate damage by investors, insurers, banks, and governments. Deschryver, P., & De Mariz, F. (2020).

Although green bonds are relatively new phenomenon, the first green bond was issued in 2008, however, they have seen an exponential year on year growth across the globe. According to Climate Bonds' Market Intelligence quarterly report, the cumulative value of green bonds ever issued have reached 2 trillion USD mark by Q3'2022. Table-1 depicts the year-on-year growth of the Green Bonds.



Source: Climate Bond Initiative.

Data from the Climate Bond Initiative shows annual green bond issuance broke through the half-trillion mark for the first time in 2021, ending with $522.7 billion, a 75% increase compared with 2020. Europe was the most prolific issuance region, while Asia-Pacific experienced the strongest annual growth (129%). The green bonds have not just experience hyper growth in terms of value, according to Standard and Poor's the geographical base and institutional ownership has also been broadened over time.

Key stakeholders, Principles and frameworks:

Sustainable finance and green bonds are relatively nascent phenomenon but considering its role of a catalyst in achieving the sustainable goals, it lacks the harmonized principles and standards. The harmonization or standardization is required to achieve the global collaboration in broadening the geo base and diversifying the ownership across globe.

Green bond Standards: In general, there are two green bond "standards": Green Bond Principles (GBP) by ICMA and the Climate Bond Initiative (CBI). GBP is a voluntary guideline established in 2014 by investment banks, including Bank of America Merrill Lynch, Citi, JPMorgan, BNP Paribas, and HSBC.12 GBP requires transparency and disclosure and its four

green bond components (use of proceeds, process of project evaluation and selection, management of proceeds, and reporting) are widely accepted by the market.

Climate Bonds Initiative (CBI) is a not-for-profit international organization with the aim of promoting capital solutions via green bonds for environment-related projects. CBI plays a prominent role in the green bond market and its Climate Bond Standard is adopted by many countries. CBI also approves the qualifications of third-party green bond verifiers such as KPMG, Deloitte, and Sustainalytics, it provides eligible criterion and a detailed green taxonomy by sector that third parties can adopt to assess the qualification of a green bond.

Green bond indices:

Internationally there are a few indices for green bonds for example S&P Dow Johan green bond index and green bond project index, Bloomberg MSCI global green bond index.

Frameworks and methodologies:

There exists a hand full of regional, country level and stakeholders/ institution level frameworks and methodology to structure sustainable finance, for example European Union action plan for sustainable growth (SFAP). The prime objective is to channel the funds towards sustainable projects and to increase transparency and governance. Similarly, France, Netherland and chain have national level frameworks and action plan for certain sectors where environmental impact is

Categorie	Name
International standards	Green Bond Principles (by ICMA)
	Climate Bond Standards (by Climate Bond Initiative)
International indices	Barclays/MSCI Indices
	S&P Dow Jones Green Bond Index and Green Bond Project Index
Regional frameworks	ASEAN—ASEAN Green Bond Standard (GBS)
	European Union—Action Plan for Financing Sustainable Growth
SPO Frameworks and methodologies	VigeoEiris (CBI's Verifier), Second Party Opinion Methodology for green bonds
	Oekom, Green Bond Analysis Framework
Stakeholders' frameworks (issuers /Investors)	(Issuer) Citi Green bond Framework
	(Issuer) Asian Development Bank Green bond framework
	(Investors) Axa Transition Bond Guidelines
National frameworks	China—Green Bond Endorsed Project Catalogue (or the Catalogue); Green Bond Assessment and Verification Guidelines
	France—Energy Transition Bill and National Low-Carbon Strategy
	Netherlands—Green Funds Scheme

at the core e.g., energy transition bill in France. These regional jurisdictions have developed their national green instrument taxonomies. Several countries (e.g., UK, China, Mexico, Morocco) and regional organizations (e.g., EU, ASEAN countries) have adopted green bonds guidelines and they have formed taskforces (e.g., The Expert Panel on Green Finance, the Central Bank-led Network for Greening the Financial System). Some programs are also helping to both sustain and go beyond green bonds. In addition to lack of harmonization in taxonomy and guidelines, green bond harmonized labelling is another challenge, different countries and exchanges have different requirements for labelling.[5] *Schoenmaker, D., & Schramade, W. (2018).* Recognizing that the lack of standardization the dialogue between China and the European Union has started to draft a harmonized language. It would be a first but needed step towards a global standardized green certification scheme, which goes beyond a domestic investor base (Packer and Ehlers 2017).

Motivation and rationale for green bonds – Issuers and investors perspective

After the Paris agreement, the collective efforts to increase awareness around combating climate change have increased manyfold. A sizeable segment of consumer prefers products that are environment friendly or are from the companies that care for the environment with their commitment towards the sustainable future hence issuance of green bonds could indicate Greenwashing phenomenon from issuers perspective. Skeptics believe that issuer issue green bonds as market gimmick. According to Terra Choice[2], the act of misleading consumers regarding the environmental practices of a company or the environmental performance and positive communication about environmental performance. *Lyon, T. P., & Maxwell, J. W. (2011).* Tateishi describes it as communication that misleads people regarding environmental performance/benefits by disclosing negative information and disseminating positive information about an organization, service or product. It could be summarized as claims by the firms to invest in the processes that are environment friendly and projecting that image towards the market and customers. In all definitions the element of disinformation regarding environmental performance is present with the intent of gaining positive response towards products and services.

Greenwashing could take several forms, for example companies choosing selective disclosure, unclear and misleading labelling and narratives as marketing gimmicks. If greenwashing is prevalent than green bonds shall not have a positive impact on the environmental rating of the firm however the literature suggests otherwise. According to Flammer, C. (2021), the environmental performance of the firms increased post issuance of green bonds. Two dimensions i.e., ASSET4 environmental rating and a constructed variable of ratio of CO2 emissions to the book value of assets of the company indicating environmental performance were analyzed for this purpose.

Second important driver for the issuers is signaling effect. Signaling effect implies that the issuance of green bond by firms sends a strong and credible signal of firm's commitment towards environmental sustainability because the proceeds are to be utilized for initiation and completion of green projects. Such a signal can be valuable, as investors often lack sufficient information about the company's environmental commitment[2] (Lyon and Montgomery, 2015). The studies have shown that the green bond issuance does increase the environmental rating of the firm and from investors perspective the issuance of green bonds indicates that the firm is more committed to environmental sustainability compared to those who do not. Another aspect that makes the signaling effect more credible is third party certification and the reporting requirements. According to Flammer (2020) green issuers leave significant environmental footprints, as shown by their environmental ratings and CO2 emissions, arguing that green bonds constitute a successful commitment mechanism for issuing corporations and that investors value such a practice substantiating the argument of signaling effect.

Thirdly, issuers of the green bond can benefit from the green premium also termed as Greenium. It entails that investors are willing to hold the investments in green bonds considering the environmental aspects of the investment and are willing to accept lower return for long term sustainable benefits for the society. Another aspect to consider is if issuer can obtain cheaper financing also called cost of capital argument. While arguing cost of capital it is important to

consider that green bonds had additional costs such as third-party verifications, processes and reporting as well as constraints/ limitation on the utilization of the funds.

In the nutshell, green bonds offer several benefits for issuers, investors, and policymakers. For issuers, green bonds align with long-term project maturities, reduce debt financial expenses, and improve firm-level environmental footprints and financial performance (Flammer 2018). Investors can better support their investment strategies with additional information on issuers' sustainability plans and increase their exposure to less volatile instruments, which is appealing to both traditional profit-seeking investors and socially responsible investors[6] (Cheong, C., & Choi, J. (2020)).

Green bonds' impact on firm performance:

Reviewing the existing literature on issuance of green bonds and its link with corporate performance, it could be ascertained that the performance of the firm could be termed in multi – dimensional ways. For instance, the stock market response on the issuance, the impact on the firm's profitability as well as its value. Are issuers able to secure green finance cheaper than the conventional ways. The profitability of the project funded via green bonds etc. In addition to performance aspects one can also add the time horizon to be able to distinguish short and long-term impact on the performance. Lastly, an important question to empirically examine the extent to which green finance has real effects beyond finance.

In the last decade, the researchers have shown that the green financing exerts a significantly positive impact on firm value and financial performances both in the short run and in the long term, however, there is strong need to gather more proof points in establishing the relationship between green bond and corporate performance as the existing literature indicates positives as well as no or negative impact of green bonds on the performance. Key takeaways from the existing research on green bonds and various aspects of firms' performance are summarized below:

Returns on Environmental/ Sustainable projects: Marks & Spencer (UK retailer) implemented a comprehensive sustainability program in 2007 to become the world's most sustainable retailer. Five years later, this program turned out to be very profitable and is regarded as a strong business case for sustainability with £185 million in net benefits (Flammer, C. (2021)

Green Premium and Cost of Capital: Using this matched comparison sample, Zerbib (2019) found that the average greenium, the difference between green bond yields and their matched counterparts, is 2 bps. He further estimated that the green premium can be as high as 8 bps when accounting for the difference in liquidity as well, considering that green bonds tend to be less liquid. Because the methodology he adopted was matched comparison between comparable green and non-green bonds the sample size of his study was small.

Agliardi, E., &Agliardi. (2021) used a two-factor structural model for corporate bond valuation to understand the Greenium they found that the size of the greenium is positively affected by more volatile asset prices, larger interest rate and corporate taxes, and, more importantly, the issuers' creditworthiness depends on the correlation of the green project with the core business of the firm. This result is important because it gives an indication on the benefits in the form of a lower cost of capital that firms in different sectors may obtain from issuing green bonds. Their results were also consistent with Gianforte and Peri (2019), who found that, in the primary market, the greenium is more pronounced for corporate issuers in the utility and power sector, while it is smaller for issuers whose core business is not strictly related with the green project. It showed that alongside the obvious benefits that green bonds give to the development of sustainable investing, they indirectly contribute to an enhancement of a company's debt quality and creditworthiness, and thus they may offer stability in times of market volatility, which investors and governments.

Barber et al. (2018) analyzed 5000 VC funds and find that impact funds have a 14.1% higher probability of attracting investment, a phenomenon they attribute to growing market demand. Growing demand for green bonds indicates the lower cost of capital of issuing firms. Therefore, based on the financing cost mechanism, we expect green bonds to be priced at a premium (lower yield) in the primary market

Stock market response on green bond issuance: Recent empirical studies indicate that there is a positive relationship between the green bond issuance and the response from the stock market. Flammer (2020) used a firm level data of publicly listed green bonds and found that in addition to positive stock market returns, the positive response to green bond issuance is stronger in 3rd party certified bonds and the first-time issuers. Zang and Tang (2020) examine an international green bond dataset based on 28 countries and ask whether green bond issuance benefits issuers' shareholders. The findings of their study substantiate Flammer (2020), they also find a positive stock market reaction to green bond issuance.

Another study conducted on Chinese firms by Zhou, X., & Cui, Y. (2019) analyzed cumulative corporate abnormal returns (CAARs) and the issuance of green bonds using the event analysis approach, the result indicated that CAARs are not significantly positive or negative prior to the event, while the CAAR is significantly positive at the 10% level in the [−1, 1] event window, indicating that green bond issuance has a positive impact on the stock prices of issuing companies[10] .

Unlike the abovementioned studies that document positive value for equity holders, some studies provide evidence that the market does not always welcome green bond issuance. Lebelle et al. (2020) examine a dataset on international corporate green bonds to analyze issuers' financial performance as measured by their cumulative stock returns. Their main results show that cumulative stock returns around green bond issuance range between 0.5% and 0.2%, depending on which asset-pricing model is used to calculate abnormal stock returns. This result indicates that green bond issuance can be costly.

Firms' liquidity post issuance: This stock market reaction is not, however, associated with a significant price premium for green bonds but is instead related to a more extensive institutional firm ownership after green bond issuance. The liquidity of an issuing firm's stock also improves the following issuance.

Economic Indicators: Expanding on the impacts of the green bond issuance on Economy beyond financial benefits to look for the real effects, Glomsrød and Wei (2018) used a general equilibrium model to simulate how green finance might affect not only the economy but also climate change. They find that green investing increases GDP and that it shifts income from

capital owners to wage earners. It also reduces global coal consumption, increases the market share of non-fossil electricity, and reduces global CO2 emissions.

Green bond issuance and firm performance including micro level performance indicators:

To examine the impact of green bond issuance on corporate performance, three aspects of corporate performance were measured by Zhou, X., & Cui, Y. (2019). Those aspects included Profitability, operational performance, and innovation capacity. Return on total assets (ROA) was used to analyze profitability. This is the ratio of the total returns achieved by an enterprise over a given period to the enterprise's average total assets and represents overall profitability. Gross profit margin (GPM) is used to represent operational performance, and it is an important operational indicator for listed companies, as it reflects both the current profitability and potential profitability of a company. The ratio of research and development (R&D) to total operational income (short for RDTOI) is used to represent innovation capacity, as this is the enterprise's key means of achieving core competitiveness and sustainable development. It includes expenses incurred during R&D of products, technologies, materials, processes, and standards, and represents the enterprise's level of investment in innovation.

Propensity Score Match (PSM) and Difference in Difference (DID) methodology using the control and treatment group of firms was used to compare the results of green bond issuers and comparable firms with conventional bonds. The results indicated a significant relationship between green bond issuance and companies' ROA. In other words, sufficient capital is raised for corporate projects through green bond issuance, and corporate investments achieve adequate returns. This indicates that green bond issuance can improve operational performance and innovation capacity.

According to a very recent study by Tan, X., Dong, H., Liu, Y., Su, X., & Li, Z. (2022)[7], they have identified micro performance factors contributing to firm's performance. The study used the panel data of firms with green bonds and analyzed short and long terms impact elements such

as stock returns, green financing brings the required cashflow and can directly increase long-term investment in green innovation, which is consistent with the concept of green sustainable development. In addition, the study observed that through environmental commitment via green bonds, the firms gain market and government trust and avoided the penalties. This holds especially true for the industries where environmental footprint is crucial Therefore, green bonds can reduce corporate operation risk and enhance the confidence of their stakeholders, which will improve financial performance in the end.

Another important aspect to consider is that bond financing will bring large cash flow to companies, thus supporting research development and promoting innovation. However, the short-term cash flow will also lead to over-investment, which usually reduces production efficiency. Therefore, the relationship between green bond financing and corporate performance needs more in-depth research.

1. **Future of Green bonds:**

The exponential growth in green bond market implies that the investors are finding it attractive, and issuers are motivated to use this instrument to grab the demand and get the green premium and cheaper cost of capital. However, a structured, and more directed efforts are required from the institutional bodies to further facilitate and play the role of a catalyst in attracting new issuers and a more diversified base of investors.

Research Question and hypothesis:

The literature on green bond suggests that various aspects of firm's performance could be studied for Norwegian market such as green bond impact on firm's performance at stock exchange, impact on its financial performance via the financial results as well as impact on the ESG rating of the firm. However, in order to research all these aspects high frequency data of the firms ESG performance, financial performance and stock market performance would be required.

Oslo Stock Exchange, EuroNext were engaged to understand the availability of such data. I learnt that even though climate change and green finance is high on the agenda in Norway, it is a voluntary practice by the listed companies to report on their ESG performance and initiative hence the ESG data of all listed companies that have issued green bonds is not available.

The focus then is to study the Green Bond effect on stock prices. As suggested by the literature some studies have concluded positive impact on the stock prices (Zhou, X., & Cui, Y. (2019) , Flammer (2018) whereas some recent studies have shown negative impact of green bond issuance on company's stock returns specially in developed countries Lebelle et al. (2020). I will investigate how Norwegian stock exchange reacts to such event of green bond issuance.

The research questions could be described as to whether the issuance of green bonds impacts companies' performance (positive or negative) in the short term. The research question is then translated to formulate hypothesis as under:

H0: Green bond issuance does not affect (positive/ negative) the stock returns.

H1: Green Bond issuance affects (positive/ negative) stock returns.

Data and Method:

Most of the empirical research is carried out for the US or China or non/European markets. It was challenging to gather the long-term time series data of the Norwegian listed companies with green bonds. Although Norway has been the pioneer in issuing green bond yet the index with green label is not established at Oslo stock Exchange. In the Euronext green bond indicator, the issuance date, amount , currency and volume of green bond was provided.

The stock prices data was obtained from Oslo Stock Exchanged via Titlon as well as Euronext because data from 2020 onwards is maintained at Euronext. The green bond indicator for Norwegian listed companies was also obtained from Euronext.

To calculate the market models i.e., Fama French and CAPM the market factors were downloaded from the website Bernt Odegaard (https://ba-odegaard.no/). OSCBX benchmark index was used as market index, the data of OSCBX index was obtained from yahoo finance.

Dataset preparation and variables construction:

Public listed companies with green bonds - Norway	
Number of unique companies (excluding public sector) with Green Bonds	26
Total number of events	41
Total number of unique companies after data cleaning	26
Total number of unique events	33

In order to prepare the comprehensive dataset for required analysis, daily stock data from Oslo stock exchange and Euronext was combined from 2014 until 2022.

Daily stock returns of all companies listed at Oslo stock exchange and have issued green bonds were combined from both the databases. ISDIN numbers were used to join and create a comprehensive table.

Master dataset comprised of 41 unique events from 26 unique companies. However, after performing the quality checks and defining the estimation and observation windows without overlapping timeline between the events of a same company only 33 unique events remained to be further included in the analysis phase. It is important to note that these 33 events represent the total market as such. To perform the analysis the stock data of event date + 12 trading days and event date -12 trading days was extracted as dataset for the analysis. Once we consider the daily stock returns of these events for the entire timeline (estimated & observation period) we get 825 observations to perform regression analysis in case of market model.

Apart from stock data, the OSCBX benchmark was used as market index for the market model and factors including size, market capitalization and market risk free rate were utilized as variables to regress stock returns for Fama French three factor model.

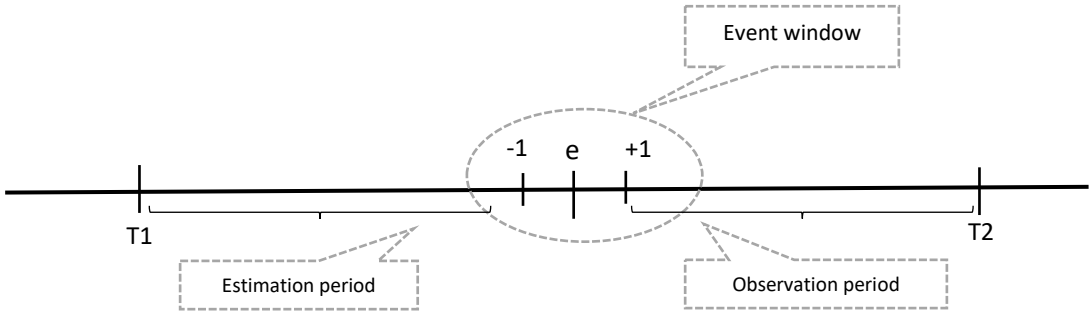
Method:

To understand the issuance impact, various methods have been used by researchers such as event study method, Difference in Difference method based on the hypothesis to be tested and if the research question is multi-dimensional for example determining the effect on stock price, different between the behavior of companies with both conventional and green bonds. For thesis, event study method has been applied following the same practice deployed by Lebelle et al. (2020), Flammer (2018) for such purpose.

In the context of finance, an event study can simply be described as a study to measure the impact of an event on the value of the firm using the financial market data. It assumes that given the rationality in the market and that markets are efficient there will be immediate impact of the event on the stock prices in the short term. However, for the long-term impact and productivity/ performance of the event, a longer time horizon needs to be observed. Event studies have become a common tool for researchers who aim to determine the impact of an announcement of category of announcements. Event studies are performed aiming to analyze short term horizon. Assuming markets are efficient and stock prices reflect the latest information. If we keep long-term horizon the noises of other news in the market starts to creep in (Kothari & warner 2007)

Step by step process:

As a first step in the event study, the timeline with event, estimation and observation period was defined. Let's assume "e" denotes the event date (date of issuance) on a calendar. I took +1 & -1 trading day from event date as event window in order to exclude them from the calculation of accumulated returns.



- Event: launch date of green bonds in calendar time
- Estimation period: The estimation period is the period before the event. Data of estimation period is used to calculate normal returns or expected returns. For short horizon event study, the length of estimation period ranges from 1 to 11 days. Wiles, Morgen, and Rego 2007 used estimation window 6 days before the event. For this thesis I took the daily return data of +12 and – 12 days of the event to be able to run multiple iterations and experiment different lengths (5 days, 7 days, and 11 days) of the estimation period.
- Observation period: The observation period is the period after the event. Data from this period is used in calculation of the abnormal returns. To remain symmetric, the same length of observation period was chosen to run multiple iterations of the analysis.

Assuming efficient market theory that the stock process reflects all information and that stocks are traded at their fair market value at exchange as a second step abnormal returns were calculated using the following approaches.

Cumulative average return model:

In this approach, daily simple stock returns were accumulated for estimation period and observation period for individual event. The cumulative returns of estimation period are denoted as expected or normal return whereas the cumulative returns of observation periods are considered as actual returns. Once I had the accumulated returns of all 33 unique events, I calculated the mean of the accumulated returns of all unique 33 events in estimation and observed period. The difference between expected and actual returns was called abnormal returns. If the difference of expected/normal return and actual return post event is zero, we accept null hypothesis. If the difference between expected and actual return is not zero that difference is considered the effect driven by the event i.e., issuance of green bonds.

a. Market adjusted return Model:

The market adjusted model is quite a frequently used model. In this approach, the market index has been used to determine abnormal returns. In this model we regress daily simple stock returns with the market index. Rm is the market returns and R_i is the stock returns and e_i is the abnormal return.

$$R_i = \alpha + R_m + e_i$$

Once the expected returns are calculated using an estimation period, we follow the same approach of subtracting expected returns from the actual returns of the observation period. Cumulative abnormal to determine the event effect.

b. Fama – French Model:

Fama French three factor model was used as another alternative to calculate the expected returns.

$$E(R_i) = R_f + \beta_{i,M}(R_M - R_f) + \beta_{i,SMB}SMB + \beta_{i,HML}HML$$

Here $E(R_i)$is the expected risk of the stock. R_f is the risk free rate, R_M is the return of the market index whereas SMB and HML are the size and value factors respectively.

In the analysis I took the daily simple stock returns of individual events and regressed the data of with the Fama- French factors. Once the residuals were calculated we derived Cumulative Average Abnormal Returns using the same approach of subtracting expected return from the actual realized returns in the observation period.

Results and findings:

This table below summarizes the mean values and associated *t-stats* of the differences between cumulated unadjusted returns, market adjusted returns and Fama-French 3 factors model adjusted returns for all three iterations used for the estimation and observation period as described in the method section earlier.

Item	Model		
	CAR	**CAAR-MKT**	**CAAR-FF3F**
Mean (E+5 - E-5)	0.223*	0.148	0.014
t-stat	*1.8*	*1.40*	*1.35*
Mean (E+7 - E-7)	0.016	0.008	0.007
t-stat	*1.33*	*0.73*	*0.68*
Mean (E+11 - E-11)	0.015	-0.014	-0.013
t-stat	*0.99*	*-1.22*	*-1.09*

** , * means significant at 5% and 10% level respectively. All values except *t-stats* are percentages.

CAR is the cumulative Abnormal Return, CAAR is the Cumulative Average Abnormal Return.

Cumulated unadjusted returns for each event are estimated by adding daily log returns of bond issuing firm's stock for the 5, 7 and 11 days before and after the event (event comprises of three days; bond issue day, previous trading day and subsequent trading day). Market and Fama-French 3 Factors' adjusted returns or abnormal returns are estimated by regressing bond issuing firm's stock daily simple returns against the market return and Fama-French 3 factors respectively where residuals from these regressions are added for the estimation and observation windows.

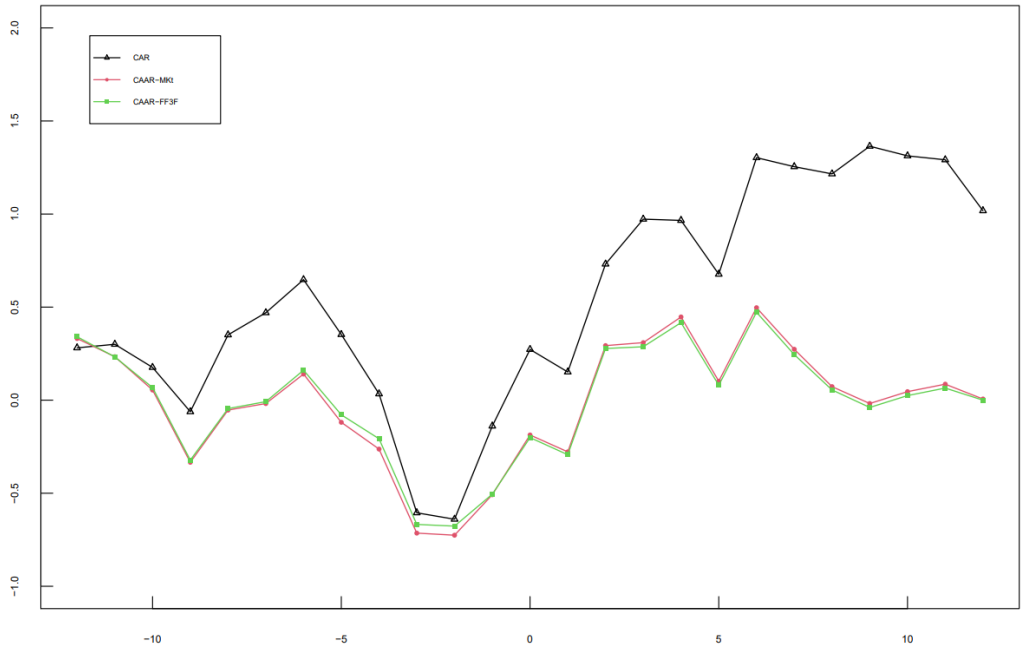
This table shows that we fail to reject the null hypothesis that issuance of green bonds has an impact on the returns of the bond issuing firm's stock. The first row of the table shows results for the 5 days estimation and observation window. The first value 0.223 shows that on average the unadjusted returns of bond issuing firm's stock for 5 days are 0.223 percent higher during the observation period than that of the estimation period. This effect is only significant if we take the

significant level of 10%, however, conventionally in the finance literature 5% significance level is used.

Considering the second column first row, we see that in market adjusted returns the *t-stat* value drops to 1.4. It shows that the mean difference is not significant even at the 10% level. It indicates that the effect on the unadjusted returns is driven by the market because when we control for the market the significance level drops.

As we go from lower window to higher window (from first row to third row of the table) the *t-stats* keep falling and the mean differences become lower monotonically. It indicates that as we expand the window the effect of green-bond issuance on stock returns becomes lower. The last two columns of the table show that the sign reverses if we consider market as well as Fama-French 3 factors' adjusted returns to measure the effect. It suggests that in terms of risk adjusted returns and longer horizon green bond issuing firm's stocks perform poorer after issuance of the bond, however, it is not significant. In a nutshell, I fail to reject the null hypothesis that issuance of green bonds has an impact on the returns of the bond issuing firm's stock.

The graph below is a visual representation of the results. In the graph, the time horizon is plotted on the x-axis where we can observe all three iterations of the time windows considered i.e., 5, 7 and 11 days whereas y-axis depicts the mean cumulative abnormal return corresponding to various lengths of estimation and observation period.



It can be seen on the graph that there is a slight upward trend after the event window as per the existing studies that there should be an immediate reaction of the market near the announcement date and no further reaction on the subsequent date. However, once the t- test was performed we observed that only in case of unadjusted cumulative mean return method and 5 days window the results are meaningful at significance level of 10%. In case of other methods including market model and Fama French model the results are not significant. It can be inferred that the effect is due to the influence of the market factors and not the green bond issuance event under study.

Conclusion and future research:

The existing research of event studies on the same topic have mixed results. Some studies indicate positive effects(Zang and Tang (2020), (Flammer 2020). These were multi country research including both developed and underdeveloped countries whereas some studies indicate no or negative effect of green bonds on stock performance.

As we fail to reject the null hypothesis. It means that there is no effect of green bond issuance on stock returns of the listed companies on Norwegian Stock Exchange. The results of this research do no substantiate existing studies (Flammer 2020), Zang and Tang (2020), in form of positive or negative effects.

There is huge potential for carrying out future research on this topic with some improvements. For instance:

- Historical data availability and robustness: Norway is one of the pioneering countries that issued Green and sustainability bonds however, the historical data is missing. The stock and bond data does not have a separate indicator for green bonds. Apart from this, the stock data available is not so robust.
- ESG reporting: In Norway the ESG reporting is voluntary, Considering the focus of the Government on climate, environmental and social factor, the ESG reporting shall be made compulsory specially for public companies whose stocks are traded at Oslo stock exchange.
- Announcement date vs issuance date: As the literature suggests, markets are efficient, and prices reflect the latest information. Due to lack of availability of announcement dates, issuance date was considered as the even date in calendar. I believe that stock returns are more driven by the news and new information rather than the event such as issuance of the bond hence availability of announcement data is very important and can impact the results of the study.

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Annex I

Detailed output of the regression model for various iterations of time windows:

Results of Cumulative returns (CR) before and after the event

Time window 11 days	Time window 7 days	Time window 5 days
Data: tests$ret11 t = 0.9929, df = 32, p-value = 0.3282 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.01589232 0.04612054 sample estimates: mean of x 0.01511411	data: tests$ret7 t = 1.3336, df = 32, p-value = 0.1917 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.008606244 0.041243854 sample estimates: mean of x 0.0163188	data: tests$ret5 t = 1.8, df = 32, p-value = 0.08129 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.002946128 0.047715859 sample estimates: mean of x 0.02238487

Market model: Results of Cumulative abnormal average returns (CAAR) before and after the event # estimated as Ri= a+Rm+ei, here ei is abnormal return

Time window 11 days	Time window 7 days	Time window 5 days
data: tests$mk11 t = -1.222, df = 32, p-value = 0.2306 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.038079234 0.009521926 sample estimates: mean of x -0.01427865	Data: tests$mk7 t = 0.72777, df = 32, p-value = 0.472 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.01351021 0.02853105 sample estimates: mean of x 0.007510418	Data: tests$mk5 t = 1.4018, df = 32, p-value = 0.1706 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.006714419 0.036355360 sample estimates: mean of x 0.01482047

Fama French Model: Results of Cumulative abnormal average returns (CAAR) before and after the event # estimated as Ri= a+Rm+SMB+HML+ei, here ei is abnormal return # and the test are of CAAR(t+x) - CAAR(t-x)

Time window 11 days	Time window 7 days	Time window 5 days
data: tests$ff11 t = -1.0917, df = 32, p-value = 0.2831 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.03689223 0.01114667 sample estimates: mean of x -0.01287278	data: tests$ff7 t = 0.68026, df = 32, p-value = 0.5012 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.01401755 0.02807489 sample estimates: mean of x 0.00702867	data: tests$ff5 t = 1.3539, df = 32, p-value = 0.1853 alternative hypothesis: true mean is not equal to 0 95 percent confidence interval: -0.007234691 0.035913371 sample estimates: mean of x 0.01433934

Annex II

R Code for analysis

```
require(readr) || {install.packages("readr"); require(readr)}
require(stringr) || {install.packages("stringr"); require(stringr)}
require(data.table) || {install.packages("data.table"); require(data.table)}
# importing events data
library(readxl)
events <- read_excel("events.xlsx", col_types = c("numeric",
 "text", "text", "text", "date", "numeric",
  "text", "text"))
# Importing euronext data
euronext <- read_delim("euronext001.csv",
                       delim = ";", escape_double = FALSE
                     , col_types = cols(`Effect date` = col_date(format = "%Y-%m-%d")
                                        ,`log return` = col_number())
                     , locale = locale(decimal_mark = ",", grouping_mark = "."), trim_ws = TRUE)
# Separating specific column for exporting to sql
sql_euronext <- euronext[,c(1,2,3,24)]
colnames(sql_euronext) <- c("date", "isin", "name", "lgrt")
# importing titlon oslo børs data
oslodata <- read_delim("oslobor001.csv",
                       delim = ";", escape_double = FALSE
                     , locale = locale(decimal_mark = ",", grouping_mark = "."), trim_ws = TRUE)
# Separating specific column for exporting to sql
sql_oslodata <- oslodata[,c(1,5,6,42)]
colnames(sql_oslodata) <- c("date", "isin", "name", "lgrt")
```

```
alldata <- rbind(sql_euronext,sql_oslodata)
alldata <- unique(alldata)
write.csv(test1, file = "temp_rets.csv", row.names = F, quote = F)
rm(sql_euronext,sql_oslodata)
xx <- unique(oslodata[,c(1,37,38)])
setDT(xx)
xx <- xx[Date > "2016-01-01",,]
write.csv(xx, file = "ff3f2020.csv", row.names = F, quote = F)
rm(xx)
reg_data <- read_excel("reg_data.xlsx"
                       , col_types = c("date", "text", "text", "numeric", "numeric"
                        ,"text", "numeric", "numeric", "numeric", "numeric"))
mkt_res <- data.frame(mkt_res=summary(lm(ret~mkt, data = reg_data))$residuals)
ff3f_res <- data.frame(ff3f_res=summary(lm(ret~mkt+smb+hml, data = reg_data))$residuals)
reg_results <- cbind(reg_data,mkt_res,ff3f_res)
write.csv(reg_results, file = "reg_results2.csv", row.names = F, quote = F)
tests <- read_excel("tests.xlsx")
tests
means <- read_excel("means.xlsx")
setDT(means)
# Results of Cumulative returns (CR) before and after the event
# estimated as CR(t+x) - CR(t-x)
t.test(tests$ret11)
t.test(tests$ret7)
t.test(tests$ret5)
# Results of Cumulative abnormal average returns (CAAR) before and after the event
# estimated as Ri= a+Rm+ei, here ei is abnormal return
```

```
# and the test are of CAAR(t+x) - CAAR(t-x)
t.test(tests$mk11)
t.test(tests$mk7)
t.test(tests$mk5)

# Results of Cumulative abnormal average returns (CAAR) before and after the event
# estimated as Ri= a+Rm+SMB+HML+ei, here ei is abnormal return
# and the test are of CAAR(t+x) - CAAR(t-x)
t.test(tests$ff11)
t.test(tests$ff7)
t.test(tests$ff5)
# plot data
pdata <- read_excel("ts_plot_caar.xlsx")
pdata <- pdata[,c(1,5,6,7)]
plot(x=pdata$day,y=pdata$CAR, type="o", col=1, pch=24, cex=0.7
    , ylim=c(-1,2), lwd=1.2, xlab = ""
    , ylab="", tck = 0.02, cex.axis = 0.7)
lines(x=pdata$day,y=pdata$CAAR_MKT, type = "o", col = 2, pch=16, cex=0.7, lwd=1.2)
lines(x=pdata$day,y=pdata$CAAR_FF3F, type = "o", col = 3, pch=15, cex=0.7, lwd=1.2)
legend("topleft", legend = c("CAR", "CAAR-MKT", "CAAR-FF3F"), lty = 1, lwd=1.1, col =
1:3, pch= c(24,16,15), cex = 0.5, inset = 0.05)
```