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Effect of green bond issuance to stock prices

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ABSTRACT:
Only been around 20 years, green bonds are new and growing financing method for companies to finance their green projects. Compared to traditional bond issuing, green bond issuing has not been studied extensively in the finance literature. There are several instances creating voluntary guidelines for green bonds. Currently, some governments give out subsidies for companies issuing green bonds. Additionally, several instances have rating systems for green bonds. In the empirical literature, researchers have found positive reaction to green bond issuing announcement. Potential reasons for positive reaction have been stated to be green premium, regulatory hedge, and reputation of the company.

Event study methodology is empirical analysis that is used to study specific event on the value of security. Event study is applied in the paper to study effect of green bond issuance to stock prices. Event windows of [-5, +10] and [-10, +10] are applied and robustness of the results is tested with different event windows, Fama-French three factor model, global market model and excluding green bond subsidies. Cumulative abnormal returns measured by CAPM are positive for event windows of [-5, +10] and [-10, +10] and significant in 5-percent confidence level for first green bond issuance and insignificant for subsequent issues. This is explained by green tag for the first-time issuer, which leads market to increase the value of issuing company. Green tag means that firm's green projects are certified to have positive environmental impact, which in turn leads to benefits for the green firm. Subsequent issues do not have new information coming into to market if green tag hypothesis is considered true. Therefore, subsequent issues do not have effect on stock prices.

KYEWORDS: green bonds, ESG, event study, market reaction, sustainable investing

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TIIVISTELMÄ:
Ensimmäiset vihreät joukkovelkakirjat tulivat markkinoille vuonna 2007. Tämä rahoitusmalli otettiin käyttöön yrityksille, jotka ovat sitoutuneet ympäristöystävällisiin projekteihin. Rahoituksen kirjallisuudessa vihreiden joukkovelkakirjojen liikkeellelaskusta ei ole tehty kattavaa tutkimusta, johtuen niiden lyhyestä historiasta. Useat tahot luovat vapaaehtoisia suuntaviivoja yrityksille, jotka haluavat lainata rahaa vihreiden joukkovelkakirjojen avulla. Tämän lisäksi useat tahot ovat luoneet vihreiden joukkovelkakirjojen arvostelujärjestelmiä, jotka luovat yhteyden rahoittajien ja vihreiden projektien välille. Empiirinen kirjallisuus on osoittanut positiivisen reaktion yhtiöiden osakkeille vihreiden joukkovelkakirjojen liikkeellelaskun julkistamispäivänä. Potentiaalista yhteyttä positiiviseen reaktioon on selitetty vihreällä preemiolla, suojaavalla vaikutuksella tulevaan ympäristösääntelyyn, sekä positiivisella vaikutuksella yhtiön maineeseen.

Tapahtumatutkimus on empiirisen analyysin muoto, jolla tutkitaan tietyn tapahtuman vaikutusta yrityksen osakkeen hintaan. Tässä tutkimuksessa tapahtumatutkimusta käytetään tutkimaan yhteyttä yrityksen vihreän joukkovelkakirjan liikkellelaskun julkistamispäivän ja osakkeen hinnan julkistamispäivän ympärillä. Tutkimuksessa löydetään 16 ja 21 päivän tapahtumaikkunoiden ympärillä kumulatiivisia epänormaaleja osaketuottoja verrattaessa vertailuindeksiin. Tulokset ovat kestäviä vertailtaessa tuloksia myös Fama-French kolmifaktorimallilla, globaalilla markkinamallilla ja eri pituisilla tapahtumaikkunoilla. Tulokset ovat kestäviä viiden prosentin luottamustasolla. Tutkimuksessa osoitetaan että yrityksen ensimmäinen vihreän joukkovelkakirjan liikkellelasku tuottaa ylituottoja, mutta vastaavia tuloksia ei löydy yhtiön seuraavilla joukkovelkakirjan liikkellelaskuilla. Ylituottoja selitetään vihreällä merkinnällä jonka yhtiö saa markkinoilta ensimmäisen liikkellelaskun yhteydessä. Markkina uskoo, että yhtiö kykenee jatkossa luomaan lisäarvoa osakkeen omistajille ja osakkeen arvo nousee tämän vuoksi.

AVAINSANAT: vihreät joukkovelkakirjat, yhteiskuntavastuullinen sijoittaminen, ESG, tapahtumatutkimus, markkinareaktio

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Abbrevations

ESG	Environment, Social, Governance
CAPM	Capital asset pricing model
MSCI	Morgan Stanley Capital International
FTSE	The Financial Times Stock Exchange
GBP	Green Bond Principles
ICMA	International Capital Market Association
CAR	Cumulative abnormal return
FF3	Fama-French three factor model
EMH	Efficient Market Hypothesis

1 Introduction

Climate change is threatening the world economy. Pereira da Silva (2016) describes climate change as a threat, which is the biggest negative externality of modern times. Curley (2015, p. 11) notes that due to population growth and advancement of developing economies, increasing demand for natural resources is inflating world's energy consumption. Curley (2015, p. 12) adds that energy and carbon cycling is essential for the prospering world as these resources are becoming scarce with the current development.

For the threat of climate change, environmental (green) finance might be the best solution. In this paper, terms environmental and green finance are used as synonyms. These terms include social and economic aspects, and they are under the broadest, sustainable finance term, which includes environmental, social, governance and economic aspects (UNEP, 2016). Green finance aims to "internalize environmental externalities and adjust risk perceptions" in order to reduce environmentally negative projects and increase positive projects (G20: GFSG, 2016). This means that green finance should be used to aim to make channeling money to green projects good investments, while making environmentally hurtful projects less-desirable investments. This would help to make green energy affordable, which in turn is needed for continued economic and social development. Insightful quote from the Curley (2015, p. 17) stands that "environmental finance is about creating the greatest environmental benefit for the largest number of people at the lowest possible cost".

Climate change is happening increasingly fast, threatening the existence of society, therefore world does not have time to wait for solutions. Governments have decided that is time to act on climate change. Even the largest carbon emitter China have realized need for a change because of the huge environmental costs it is paying if there is no change for the current development. China, which have previously grown with cheap polluting energy and is still the largest developing country, have advanced their green policies and is currently building green finance system to support environmentally

positive projects. Because of these new green policies, green bonds have emerged rapidly in country in the recent years. (Wang et al, 2020). Nowadays, China is leading example of green finance, but it does not mean that Chinese factories are not polluting, and Chinese fleet is fully renewed with cleaner vehicles. Still, government support for green bond usage is a good start. If the support comes from the government of the biggest carbon emitter of the world, it can be considered a good start.

Change is still not straightforward, even if a current sentiment is to promote green policies and cut emissions. Nevertheless, balancing of national competitiveness and climate goals is not an easy act to do. Pereira da Silva (2016) notes, that theoretically best solution to close the gap between social and private pollution costs would be to use taxes and subsidies. However, this might create political economic difficulties and therefore slow the process and potentially create more irreversible changes to world's ecosystem. Pereira da Silva (2016) adds that second best option would be to use combination of instruments that are equivalent of implicit pricing. On top of taxes and subsidies, Pereira da Silva (2016) suggests carbon pricing and -trading, environmental standards and regulations, and information and awareness with the involvement of all agents in the economy and across several sectors.

Pereira da Silva (2016) notes that financial sector has delicate role to try to tackle climate change, because of the magnitude of risk. Additionally, this is essential role for this huge task, as it is possible to raise awareness, finance innovation and change pricing of risk, through financial sector. Additionally, firms with big climate footprint have recognized risks that climate change brings to their businesses. Industries that are most affected are energy, transportation, and real estate but every industry is affected at least indirectly. These businesses might be due to risk of regulatory change, which would cause making business pricier or even impossible due to added costs. Furthermore, some investors might start to avoid investing to these firms due to their own environmental, social and governance (ESG) criteria if these firms ignore climate change. This creates motivation

for firms to start thinking greener and start to invest to projects that do not escalate climate change.

Green bonds are part solution for the above dilemma. Green bonds are structurally similar to traditional fixed income instruments, but all the proceeds of green bonds are used to wholly, or partially finance, or re-finance green projects. Another feature of the green bonds comes from reporting responsibility. Green bond issuers must report usage of funds, and usage of funds is regulated and oversee by the third party. Therefore, issuers of green bonds are faced with stricter rules how they use funds they borrow with green bond issuance, compared to issuers of traditional “vanilla” bonds.

Green bonds were invented to guide money to projects that have effectivity to slow down climate change. Nowadays, green bonds are used by public and private companies to raise money for green projects. Issuers use money raised by the bonds to eligible projects. Norton Rose Fullbright (2018) list projects funded by green bonds to include: renewable energy, pollution prevention, biodiversity conservation, clean transportation, green buildings, or sustainable water management. Big international companies such as Apple, Toyota, Unilever, and Bank of America have raised money through green bonds in recent years and other firms are following.

One of the biggest drivers for green finance is the European green deal. European Union (EU) is committed to transform into resource-efficient and competitive economy (The European green deal, 2019). The European green deal list main goals of the green deal to be net-neutral of greenhouse gases by 2050, separating economic growth from resource use, and leaving no persons or places behind of this advancement. European commission has adopted targets to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels. This target is achieved by policies related to climate, energy and transport, and taxation in the EU (EU Commission, 2021).

EU green bond standard (EUGBS) was published together with EU green deal, in the European green deal investment plan in 2020 (EU Commission, 2020). Objectives of the EUGBS are to scale up green investment and make green bond market transparent with tools to demonstrate legitimateness of the issued green bonds. Four core principles of EUGBS are taxonomy-alignment, transparency, external review, and supervision by the European Securities Markets Authority (ESMA) of external reviewers. These principles align with other core objectives mentioned previously in the paper by the green bond market supervisors.

Green bonds are relevant way to raise financing for firms' investments. Although, for firms new to green bond market, it might not be the most straight forward way to raise funds. Firms must learn about green bond regulation and specific rules related to green bonds; therefore, green bond issuance might add additional financing costs for firm in a short term. Alternatively, firms that are looking to finance a project with bond financing, might be more familiar with vanilla bond issuance, which would make it more efficient way to carry out bond issuance with their current knowledge. Because of this, it is interesting to find about motivations why firms opt to issue green bonds, instead of more traditional bond financing. After all, companies could invest to green projects without green bonds and regulation related to them. That is why it is worth of investigating to figure out why firms go out and make extra effort to raise money with the green bonds. Additionally, every nugget of new information about green bonds helps to shape out regulation and rules around green bonds, given that field is undeveloped, and rules are only beginning to take their form.

As there are dispute along ESG criteria in investing space, green bonds have same grey area where there are several instances creating guidelines for the bond market. Another problem is varying rules and regulation between different governments. Creating universal rulebook for ESG criteria and green bonds is challenging task to perform as a whole world economy should participate. Differences in regulation might create a measurement problems for the green bonds if rules are not incorporated universally.

Credibility of green bonds might be compromised if there are considerable measuring differences. One example of such a measurement problem was noted by Mackintosh (2018) as Tesla had both, the best and a worst ESG scores at the same time by different rating agencies in 2018. Tesla was ranked by Morgan Stanley Capital International (MSCI) at the top of the carmaker industry, and by Financial Times Stock Exchange (FTSE) as the worst. Even worse, third agency, Sustainalytics put it in the middle. Differences were explained by different measurements, MSCI measured carbon produced by Tesla cars and FTSE measured emissions by Tesla factories. Green financing industry suffers for this type of disorientation as it seems to outside observer that there is no uniformity in rules what is considered green and what is not.

There are two main instances who have created green bond guidelines. These instances are Green Bond Principles (GBP) and Climate Policy Initiative (CBI). GBP is voluntary process guidelines that are widely accepted in green bond market. GBP lists four core green bond components, which are reporting, use of proceeds, process for project evaluation and selection and management of proceeds. GBP is updated regularly, and latest or general version is a source in this paper, unless otherwise written. CBI has created climate bonds standard and certification scheme, which helps investors to find low-carbon and climate-resilient investments and avoid green-washing.

Interest to a topic comes partly due to its recency. Many authors have picked up topic recently and there are numerous recent studies executed in just previous two to three years. Secondly, green bonds usage has risen in recent years, which most likely have woken up interest of researchers. Before 2013, there were basically no green bond market in the world. According to Climatebonds (2021), market of green bond issuance is expected to grow to $1 trillion by the 2024. Therefore, research area feels somewhat undiscovered but still discovered enough that there is background literature for the paper. Additionally, interest to environmentally friendly financing has been increasing substantially in recent years. Therefore, not only topic itself is fresh, but topic umbrella over the green bonds is recent and popular in the literature.

1.1 Purpose of the study

Purpose of the study is to understand how market reacts to green bond issuance announcements. Market reaction is an important component of green bond issuance as it helps to understand how investors see such an announcement. Answer to that question would shine a light to discussion, if green projects are profitable for the shareholders. This answer would be helpful for not only investors but for issuers and regulators as well, who work in the green bond market. Most of the green bond issuance studies were published in the last five years, therefore it seems that research around the area is getting more interest every year.

Study plans to use event study methodology to find out market reaction to green bond issuance announcement. Event study methodology tells the story if there are observed abnormal- and cumulative abnormal returns (AR, CAR) around the event date. It is important to determine if stock market view green bonds usage beneficial for firms. Even though in the green bond field, there might be some investors, who do not prefer profit making over satisfying impact of investing for the environment. As Baulkaran (2019) notes, for example, 60% of Electricite de France's 2013 green bonds went to ESG criteria investors. Still, almost all of the shareholders want their investments to have biggest possible profit margin. Then again, financing is one of the decisions, which affect profitability largely.

1.2 Hypotheses

Majority of the green bond issuance studies conclude green bond issuance as a positive for the stock price. Market reaction to green bond issuance announcement is positive. Reason to include announcement to sentence is that stock market reacts to information as soon is aware of the said information. Therefore, study focus on issuance announcement day rather than issuance day. Later, I will explain how event study is concluded but as for clarity: green bond issuance is studied but green bond issuance

announcement day is the most important component for the research purposes. Positive market reactions studies include but not limited to Flammer (2020), Tang and Zhang (2020), Wang et al. (2020) and Baulkaran (2019). Concluding that positive reaction is outweighing studies that have find negative or no reaction and positive stance of different green bond mechanisms outweighs negatives, I conclude hypothesis of the study to be following:

Hypothesis one: Stock prices increase after a green bond issuance announcement

A Hypothesis one is based on the results of Flammer (2020), Wang et al. (2020), and Tang and Zhang (2020) who find positive market reaction to green bond issuance announcement. These papers find positive and statistically significant cumulative abnormal returns around an announcement date. Studies are executed with varying event windows, but all include some time before the announcement date. As Flammer (2020) notes, method of measuring abnormal returns with an event window, where some time before the announcement is included is done because of possible information leakage before the announcement day.

Every green bond issuance is not the same. In fact, Tang and Zhang (2020) and Flammer (2020) find that subsequent issues produce abnormal returns that are small and insignificant, therefore as Flammer (2020) note, subsequent issuers could be treated more as traditional bond issues, which have been found to produce weak positive to neutral returns (Buda et al, 2020). Later on the paper I will discuss the reasons why only the first green bond issue might create positive CARs.

Tang and Zhang (2020) examine reasons for positive abnormal returns as they consider potential channels for positive stock reaction to green bond issuance announcement. These channels are green premium, institutional ownership, and stock liquidity. Green premium infers that socially responsible investors are looking to hold green bonds to better their ESG scores, which creates more demand for the green bonds. Institutional

ownership might affect positively to stock prices as media attention from issuance is creating positive image of the company's investment opportunities. Positive media attention might affect to potential employees and might create bigger recruiting pool for the company. Stock liquidity implies that firm is fundamentally better investment opportunity in the long run.

I will expect all the mentioned channels to be contributors for positive market reaction. I expect that most important channel is potentially institutional ownership as it might drive most demand for green bond issuing firm's stocks. Institutional investors hold large amount of capital and can affect stock prices with their allocation of capital.

1.3 Contribution

In this sub-chapter I will represent possible contribution of the paper. Even though there are numerous studies on the topic of bond issuance effect to value of company, the effect of green bond issuance has not been studied extensively in financial literature as green bond financing method is relatively new compared to traditional bond issuing. Therefore, research topic is new and undeveloped. This thesis is contributing to the previous literature by adding one more stance to still limited number of green bond issuance announcement studies. Recent well-written papers of Flammer (2020), Tang and Zhang (2020), and Wang et al. (2020) have all find positive and significant market reaction to green bond announcement. Flammer (2020) and Tang and Zhang (2020) study reaction in international dataset, whereas Wang et al. (2020) with China specific dataset. This thesis builds into to these studies with the new dataset. Nevertheless, number of papers in the field is still limited, therefore it is useful to look if study field have been able to map out stock market reaction to green bond issuance accurately.

1.4 Structure of the study

This thesis is divided into eight chapters. Therefore, structure of this thesis as follows: first, thesis introduces theoretical background. First chapter after the introduction

chapter represent bonds as financial instrument and introduction to green bonds is followed. Bond types, and bond rating system is represented. Financial theory background of bonds is represented and most common bond formulas in the literature are represented. Then, thesis looks briefly into the short history of green bonds. Green bond taxonomy is following, where Green Bond Principles, green bond indices, and green funds are represented.

Second, thesis investigates previous literature on the topic. I will discuss on green bond performance channels, green premium, firm reputation and social trust, economic efficiency, solvency, ratings, and regulatory hedge. Building into the previous papers on the topic, I will discuss how the topic has been evolving in recent years and what previous research find so far.

Finally, I will present the event study tools; Fama-French three factor model (FF3), capital asset pricing model and event study methodology. After, event study methodology, chosen dataset and findings are represented. In the final chapter of the paper, I will conclude whole paper together. Lastly, I will list the references of the thesis.

2 Introduction to bonds and green bonds

In this chapter, paper is looking into the traditional bonds (vanilla bonds) as a financial instrument and introduce green bonds generally. Paper is introducing several instances, which have substantial presence in the bond market. These include governments and their own legislation regarding green bonds, external reviewers, Green Bond Principles, and green bond index providers.

2.1 Bonds as financial instrument

Firms cannot operate without a financing. Firms might be able to operate with their earnings but often it is not enough for firms to develop. A lot of money is needed for new investments, would it be a new equipment, research, or buildings. Firms have decision to either sell common shares or look for cash outside of the firm. Outside financing could be either short time loan from bank or other instances, or issuing bonds for longer investment. Essentially, bonds are just long-time loans from the borrower who decide to invest their money giving a loan to the company which needs financing.

A Bond is fixed-income instrument, where investor gives loan to borrower. Borrower is usually company or government. Investor receives either fixed or floating interest out of his loan to borrower. Bonds are one of the main asset classes in a balanced securities portfolio. Bonds hold advantage to historically balance risk of stock investments. Relatively, bonds have historically considerably lower return than stock investments. Average return of bonds has been 5-6% annually. There is different type of bonds which include treasury bonds, corporate bonds, savings bonds, and municipal bonds.

Risk of bonds, (which is in return is considerably lower than in the stock investments), comes from interest rates, currency risk, and credit risk. Changing interest rate might reduce the value of a bond. If an interest rate increase, the bond value decrease (and vice versa) to offset value to new, more attractive bond issues. As (Allen et al. 2010, p.50) note, more distant cash flows are more impacted by credit risk than the near term cash

flows. Therefore, prices of the long-term bonds are more affected with a changing interest rate.

A Currency risk realizes if currency that a bond is denominated decreases, compared to currency of the portfolio. Credit risk means that there is risk that issuer would default before it pays back loaned amount to borrower. There is considerable difference with credit risk between government issuers and business issuers. Credit risk is traditionally lower in bonds issued by governments as they have ability to collect and raise taxes and therefore have a lower risk of default than the firm issuers.

Popularity of bond financing have grown among the firms in recent years. Traditionally, as De Fiore and Uhlig (2005) note, in the EU area, financing has been more concentrated to the bank financing instead to bond financing. Whereas in the U.S, where bond financing has been more prevalent. De Fiore and Uhlig (2005) note an amplifier for this distinction to be lack of firms' credit worthiness and banks' edge with this information. Recently, as Darmouni and Papoutsi (2022) note, bond financing has grown in among corporation borrowers, compared to bank financing. Darmouni and Papoutsi (2022) add that since year 2000, aggregate market financing has grown faster than bank financing, especially in the Eurozone where bond financing had smaller share than bank financing.

2.2 Bond types and rating

There are many different bond types, which are presented in the following subchapters. Most commonly used bond types include U.S. treasury bond, corporate bond, municipal bond and government bond.

2.2.1 U.S. treasury bonds

U.S. treasury bonds are fixed rate U.S. government debt securities. They are issued by the Treasury Department and have maturity of 10-30 years. These are widely considered as virtually risk-free investment. Risk-free rate is widely considered as equal to U.S. 3-

month treasury bill rate. Interest of bond is paid every six months till the maturity when the face value of the bond is paid to the owner. Treasury notes (T-notes) and treasury bills (T-bills) have same features as treasury bonds but have shorter maturities. Treasury note maturities range between two to ten years and treasury bills between four to fifty-two weeks (up to a year). Treasury bills are sold at a discount to their value to the investor and do not pay interest. Return of the T-bills is discounted price, deducted from the face value.

2.2.2 Corporate bonds

Corporate bonds are issued by the firms and sold to investors. Corporate bonds are riskier than the government bonds as there is bigger default risk of issuer. This risk is usually compensated with higher interest rate. Corporate bonds are rated by the rating agencies before the time of issuing for their risk rating. Four major ratings agencies are Moody's, Fitch Ratings, Standard & Poor's, and Kroll. Each of the rating agencies have their own rating ranking. Highest rating for every one of the previously mentioned agencies is triple-A rating. Lowest rating is considered as high yield bond or junk bond due to their higher risk to the investor. Rating affects highly to the interest rates and bond pricing.

Table 1. Credit ratings for bonds from major rating agencies (Jiang, 2021)

Moody's	**Standard & Poor's**	**Fitch Ratings**	**Kroll**	**Category**
Aaa	AAA	AAA	AAA	Best quality
Aa1 Aa2 Aa3	AA+ AA AA-	AA+ AA AA-	AA+ AA AA-	High quality
A1 A2 A3	A+ A A-	A+ A A-	A+ A A-	Upper medium Grade
Baa1 Baa2 Baa3	BBB+ BBB BBB-	BBB+ BBB BBB-	BBB+ BBB BBB-	Investment Grade
Ba B Caa Ca C	BB B CCC CC C	BB B CCC CC C	BB B CCC CC C D (default)	Speculative

Above table (Jiang, 2021) shows bond ratings from major rating agencies and similarity between how agencies assign letter ranking but there is difference between different agencies as they create their own guidelines how to rate bonds according to their own rankings. Only Kroll rates defaulted bonds in their ratings.

2.2.3 Municipal bonds

Municipal bonds are generally issued by local, county or state governments. Funds raised by municipal bonds are used for capital expenditures such as financing school building projects or building highways. Interest of the municipal bond is usually paid semi-annually. Municipal bonds come with a tax benefit as the interest from bonds is exempt from federal income tax.

2.3 Most common bond formulas

A Zero-coupon bond is discounted at a face value without periodic interest paid during a date of issuance to maturity. A Zero-coupon bonds formulas present value (PV) and yield to maturity (YTM) are as follows:

$$\mathrm{PV} = \frac{FV}{(1+r)^t} \tag{1}$$

$$\mathrm{YTM} = \frac{FV^{\frac{1}{t}}}{PV} - 1 \tag{2}$$

Where, Pv is a present value of the bond, Fv is a future value of the bond, r is yield to maturity and t is a number of compounding periods.

Yield to call formula is used for a callable bond when bond is redeemed before maturity. Usually, a reason for early call is refinancing or reducing debt percent in the capital structure. A coupon bond formula (yield to call) is as follows:

$$\mathrm{C} \times \left(1 - \frac{\frac{1}{(1+\{r)\}^n}}{r} \right) + \frac{Call\ Price}{(1+\{r)\}^n} \tag{3}$$

Where C is coupon, n is number of periods until call date and r is yield to call.

Modified duration refers to price sensitivity of the bond. Modified duration follows basic concept that interest rates and bond prices are moving into opposite directions. When interest rates rise, bond prices are falling.

Macaulay duration refers to the weighted average of the times until bond's fixed cash flows are received. It is measured in years. Macaulay duration formula is presented as follows (Macaulay, 1938):

$$\frac{\frac{T \times \mathrm{C}}{(1+Y)^t} + \frac{N \times \mathrm{M}}{(1+Y)^n}}{Price} \tag{4}$$

Where, T is time, C is the coupon of the bond, N is number of the periods, M is maturity, and Y is periodic yield. Modified duration is the extension of the Macaulay duration formula. Lastly, modified duration formula is presented as:

$$\frac{Macaulay\ duration}{\left[1 + \left(\frac{YTM}{n}\right)\right]} \tag{5}$$

Where YTM is yield to maturity and n is number of coupon periods per year.

2.4 Brief history of green bonds

First green bond, (then called "climate awareness bond") was issued back in 2007 by EIB, European Investment Bank in Luxembourg (EIB, 2007). Proceeds of the climate awareness bond were to be earmarked to projects such as renewable energy and energy efficiency. Soon after, first so-called green bond was issued year after in 2008 by the World Bank. Therefore, it is relatively new financing method, which have been in use for under 20 years.

World Bank (2019) states, that need for green bond type of financing came after group of Swedish pension funds contacted World Bank of their need to invest in projects that help the climate back in 2007. Swedish pension funds become anxious of report by United Nations agency, Intergovernmental Panel for Climate Change. Report discussed and linked human actions to climate change undeniably. This started discussions that

were led by World Bank, pension funds and their bank Skandinaviska Enskilda Banken AB (SEB) and Centre for International Climate and Environmental Research (CICERO). These organizations had to find a compromise between finance, research, and development as there were deviant views in discussions by finance organizations and CICERO, which had expertise to see if projects were climate friendly. Finally, issuance of first green bond came to reality in November of 2008. CICERO was the instance giving second opinion on which projects would be eligible. (World Bank, 2019).

Important step for green finance and for green bonds was Copenhagen Accord in 2009. Accord stated that financial sector must be one of the main contributors against climate change. Bachelet et al. (2019) notes that Copenhagen Accord was huge boost for green bonds as green bonds. Green bonds were considered main example of stated financial products that appeal to investors with a substantial asset base. These types of assets were able to channel large pool of fixed income investors to allocate capital to projects that fight against climate change.

Noor (2019) notes another important landmark for green bonds, which was International Finance Corporation (IFC) partnership with Amundi, back in 2017. Partnership between Europe's largest asset manager Amundi and IFC meant the launch of green bond fund called Amundi Planet Emerging Green One (EGO). Noor (2019) notes that Asian markets have been one of the early adopters of the green bond issuance, especially China and Japan. Because of clear demand, ADB and World Bank has issued green bonds in Asian currencies since 2018. Current market size for green bonds in 2022, Q3 hit $2 trillion (CBI, 2022). In Q3 report CBI sees that market grows by the 2025 to $5 trillion, annually.

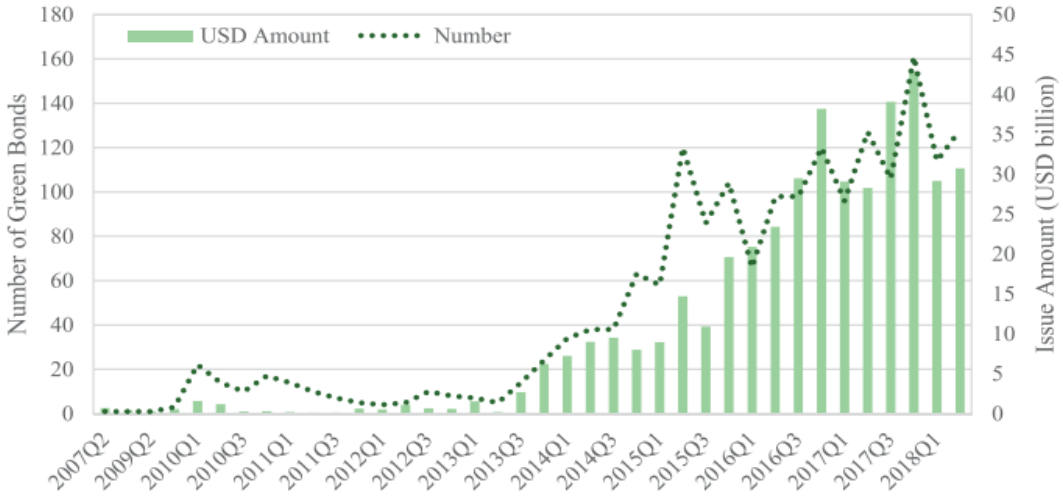

Figure 1. Global quarterly green bond issuance over time (Tang and Zhang, 2020)

Above figure (Tang and Zhang, 2020) shows growth of global green bond issuance starting from first green bond issued by EIB. Tang and Zhang (2020) created international green bond dataset which is constructed by merging Climate Bond Initiative (CBI) database with the Bloomberg green bond dataset. Tang and Zhang (2020) notes that during the first five years of green bond issuance history, number is growing slowly as development banks and supranational organizations are only issuers. After corporate bonds were introduced, number and value of issued bonds starts to increase exponentially.

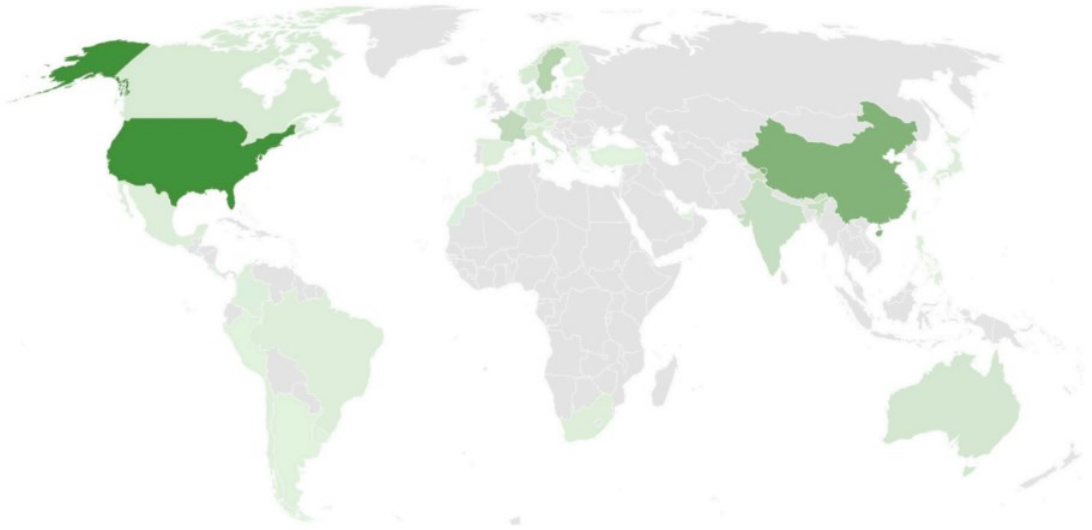

Figure 2. Distribution of issued green bonds (Tang and Zhang 2020).

Above figure (Tang and Zhang 2020) shows distribution of green bonds in the world. Darker green color refers to bigger number of issued bonds. Dataset is constructed as above, Tang and Zhang (2020) combine CBI database with the Bloomberg green bond dataset to construct an international green bond dataset. Picture shows that green bond issuance is widely global phenomena. Green bonds are issued in Europe, South- and North America, Asia, and Australia. Small amount of green bonds is issued in Africa as well.

Table 2. All Issued green bonds by year.

Year	All green bonds	Which of corporate green bonds
2007	1	-
2008	2	-
2009	5	-
2010	49	-
2011	28	-
2012	21	-
2013	45	3
2014	133	15
2015	293	99
2016	231	48
2017	394	95
2018	493	136
2019	849	288
2020	1103	336
2021	1887	649
2022	1650	575
2023	1488	503
2024	250	71
Total	8922	2818

Data from Refinitiv Datastream database shows growth issued bonds from the start of 2007, when first green bond was issued. Second year of corporate green bond issuing there were total of 133 issued green bonds, which of 15 corporate green bonds 10 years ago (2014) as seen from the table. Last year of 2023, 1488 issued green bonds, which of 503 were corporate green bonds. Table 2 shows all green bonds issued by 28th of February 2024.

2.5 Green bond taxonomy

As previously mentioned in the paper, there are several instances creating voluntary guidelines for the issuance of green bonds. Previously mentioned GBP and CBI are the considerable guideline makers. It should be noted that these are specifically voluntary guidelines, which are not binding for any of the firms that are issuing green bonds. Additionally, as Deschryver and de Mariz (2020) mentions, many countries have

developed their own taxonomies for green bonds. Deschryver and de Mariz (2020) add that many of the countries have set their own green finance working committees and developed guidelines for green bonds. As Ehlers and Packer (2016) note this type of development makes sense for bigger domestic markets but limits benefits for domestic investor base.

Important step regarding green bond guidelines is to harmonize them between different jurisdictions and nations. Convergent rules globally add to transparency and effectivity of green financing. This work has started between China and EU by EIB (2017) as EIB and Republic of China agreed to combine policies for better green bond market. Focus will be on more consistent definitions and methodologies. Although, there are still many disagreements over the definitions and rules regarding green finance. As Gilchrist et al. (2021) notes, China consider clean coal as a green energy product, which is supported by green bonds, whereas EU does not. Some of the disagreements are explained by different priorities as China consider air, soil, and water pollution huge problems as well, whereas EU does not have similar urgency with those issues. It is worth mentioning that governments might think their own interests with the rules considering green bonds as well. If one energy source is very important for the country, there might be a conflict of interest for the country. Therefore, global rulebook for the green bonds would be essential.

Additionally, as Ehlers and Packer (2016) note, lifeline of the green bond market future will be the solutions that provides way for asset managers and other investors to identify actual impact of green bonds they invest in. This will also be positive for the principals (green bond issuers), as most impactful projects are able to gather interest they deserve.

External reviewers such as Sustainalytics, ISS-Oekom and Norway-based CICERO, as noted in previous chapter, are also important stakeholders in the green finance. According to Green Bond Principles, four types of external reviewers exist: second-party opinion, verification, certification, and green rating. Specific green bond might have one

or several of the external review types. As Dorfleitner et al. (2021) note, external reviewers give a link between green bond issuers and investors and add important transparency to green bond market. Additionally, as Dorfleitner et al. (2021) note traditional rating agencies Moody's, Fitch Ratings, and Standard & Poor's release green rating reports. For example, Moody's have five categories for green bonds. These categories are from best to worst; excellent (GB1), very good (GB2), good (GB3) fair (GB4), and poor (GB5).

CICERO is independent environmental research center, which have taken more focus in climate financing in recent decades. CICERO have worked 13 years as a second opinion provider in the green bond market. Similarly to CICERO, Sustainalytics and ISS-Oekom provides second opinions for the green bond market participants. CICERO have developed three shades of green method to assess different green bonds in their evaluations. Three different shades: dark green, medium green and light green represent effectiveness of the bond for the green future. Dark green projects correspond to the long-term vision of a low carbon future and climate resilient future. Medium green projects do not yet have full contribution to long-term vision. Whereas light green projects are climate friendly but not yet able to provide long-term solutions. CICERO (2018) adds that all of the shades are important towards the low-carbon goal. As of 2024, shades of green have been sold to S&P Global but same rating system remains.

As Dorfleitner et al. (2021) note, shades of green reporting system seem like traditional rating agency reporting. Difference is that traditional rating agencies focus more on quantitative side, addition to issuer's green performance data. Additionally, second-party opinion reviews are more frequent comparing to traditional rating agency reports.

Shading	Examples
Dark Green is allocated to projects and solutions that correspond to the long-term vision of a low-carbon and climate resilient future.	Solar power plants
Medium Green is allocated to projects and solutions that represent significant steps towards the long-term vision but are not quite there yet.	Energy efficient buildings
Light Green is allocated to transition activities that do not lock in emissions. These projects reduce emissions or have other environmental benefits in the near term rather than representing low carbon and climate resilient long-term solutions.	Hybrid road vehicles
Yellow is allocated to projects and solutions that do not explicitly contribute to the transition to a low carbon and climate resilient future. This category also includes activities with too little information to assess.	Healthcare services
Red is allocated to projects and solutions that have no role to play in a low-carbon and climate resilient future. These are the heaviest emitting assets, with the most potential for lock in of emissions and highest risk of stranded assets.	New oil exploration

Figure 3. Shades of Green Methodology (S&P Global, 2023)

Above table shows shading examples from shades of green methodology by S&P Global (2023). Rating agency works as middleman for companies and green deb financing to connect financing to a firm need of financing. Shades of green methodology have been developed as one way to interpret what type of project needs financing.

2.5.1 Green Bond Principles

Green Bond Principles are released through International Capital Market Association (ICMA). GBP states that goal of the guidelines is to promote transparency, disclosure, and integrity in green bond market. Aim of the guidelines are to remove any arbiters in the market and promote efficient capital allocation to green projects. GBP have specified that all the proceeds from green bond issuance should be used for projects that have clear positive environmental impact. GBP notes that transparency, disclosure, and integrity is promoted through four core components and recommendations for alignment. Four core components are use of proceeds, process for project evaluation and selection, management of proceeds and reporting. Key recommendations for heightened transparency are green bond frameworks and external reviews.

GBP currently lists four different types of green bonds to exist. These categories are (1) standard green use of proceeds bonds, (2) green revenue bonds, (3) green projects bonds and (4) secured green bonds. (ICMA, 2021)

Table 3. Type of green bonds and definition

Type	**Definition**
Standard green use of proceeds bond	A standard recourse-to the-issuer debt obligation. Issuer should track proceeds by placing them to sub-portfolio or similar type of temporary placement.
Green revenue bond	A non-recourse-to the-issuer debt obligation. This type of bond repays investors based on cash-flows, fees and taxes.
Green projects bond	Non-recourse or recourse to the investor, where investor has direct exposure to green project(s) in question.
Secured green bond	A bond collateralized by green project(s) in question. Cash flow of assets is generally used first for repayment for the investor.

2.5.2 Green bond indices & funds

Green bond indices allow investors to buy several green bonds at the time by indexing many green bonds in together. In that way, investors can diversify their green bond investments. There are various green bond index providers, biggest are based in US and China but there are some in Europe as well. Bank of America Merrill Lynch, Barclays MSCI, Standard & Poor's and Solactive are US-based index providers and Shanghai Green Bond Index Series and CUFE-CNI Green Bond Index Series are China-based providers. As Ehlers and Packer (2016) note, these index providers work as sort of a certificate institution, but they all have their own methods of choosing eligible green bonds to their products.

On the other side, active green bond funds face a challenge as Fitch Ratings (2017) notes, that diversification is currently biggest challenge for active green bond funds due to small number of issuers. Additionally, issuers of the green bond market are sector concentrated. Diversification issue becomes problem when green bond issuers are

unable to attract investors due to their investing criteria related to concentration risk. Concentration in the green bond market makes it harder to differentiate for fund managers who are already criticized for closet indexing in the broader market, where differentiation is not seen as a problem.

2.6 Green bond investor perspective

Green bonds are only one sub-category of socially responsible investments (SRI). Motives of the green bond investors might vary but looking into broader category of SRI investors could give some insight to thinking process of green bond investors as well. SRI's have increased to be more important in recent decades. In the past decade increase has been massive, only in the United States, of professionally managed assets, socially responsible investments have grown from $2 trillion to $15 trillion (US SIF, 2020).

Essentially, socially responsible investing roots its origins hundreds of years back. Puaschunder (2016) lists historical development of SRI from Methodism against sinful investments and profit maximization exploitation to Quaker society against slave trade to Islamic banking nowadays. For current time, Junkus and Berry (2015) identifies that there are several motives for SRI investing. Green investors are looking to support environmentally positive projects, social investors are trying to improve social impact by their investment, and sustainable investors are aiming to maximize their impact to sustainable future.

Reichelt (2010) notes in the World Bank report that green bonds were to be built to appeal to investors with substantial asset base. Adding that these products must be discovered by these investors, such as pension funds and sovereign wealth funds as they are only ones that have enough asset base to make a substantial effect to climate change. These institutional investors are separated to groups by Pereira da Silva (2016), who identifies four major institutional groups of green bond investors. These groups are pure green investors, with green investing mandates, socially responsible investors, which have socially responsible investing mandates, asset managers, who report positive

impact of green investments on franchise value and lastly banks which move towards socially responsible investment options.

Flammer (2018a) finds that green bond issuance increases long-term investor base by 1.7 percent points and the long-term index of green bond issuers increase by 3.9 percentage points. Long-term index measures long-term orientation of investors based by textual analysis from firm's annual reports. Long-term orientation might have some shortcomings as well. Cao et al. (2020) criticizes SRI investors for lack of sensitivity to quantitative signals. Cao et al. (2020) finds that SRI-oriented institutional investors' focus on qualitative signals, might have effect to raise stock prices for firms with certain characteristics related to SRI, whereas not giving enough focus on fundamental value signals.

3 Green bond performance channels

In this chapter, paper is presenting green bond performance channels, which in the paper are listed as green premium, reputation, social trust, economic efficiency, solvency, ratings, and regulatory hedge. Through looking at these channels, paper is trying to make sense of possible reasons for a positive market reaction to a green bond issuance announcement.

3.1 Introduction to green bond performance channels

As noted previously, companies could fund their green projects with a traditional financing without having to take a burden of green bond regulation and other, sometimes even pricy obstacles. This does not mean that companies are looking for financing from green bonds without studying these obstacles. There are several reasons why companies would choose green bonds over traditional financing mechanisms.

Most of recent studies note that study field is far behind of evolvement of green bond market, therefore every piece of study helps to map out current field without being too repetitive. Wang et al. (2020) and Hachenberg & Schiereck (2018) and Zhang et al. (2021) find that green bonds have lower yield spreads than traditional bonds. Papers agree to find so called green premium, which affects to a lower cost of debt for green debt firms.

Azhgaliyeva and Kapsalyamova (2021) note that some governments are promoting green bond usage by subsidizing it for the users. These governments include Japan, Hong Kong, Taiwan, China, and Malaysia. Governments offer to help with legal costs and external review costs, which make green bonds more interesting for firms that have not yet to use green bonds for raising money. Subsidies are at least to some extent positive endorsements for firms to start thinking of financing their green bond eligible projects with green bonds. Anyhow, subsidies are still limited to small number of companies as currently only before mentioned Asian countries offer subsidies.

For the other reasons for firms to choose green debt financing, Tang and Zhang (2020) find that green bond issuance benefits shareholders by raising stock prices around an announcement date. Tang and Zhang (2020) find that effect is bigger for the first-time issuers. Additionally, share liquidity rise and institutional ownership increase after the issuance. Tang and Zhang (2020) also note several mechanisms which might affect positively to a stock price in green bond issuance. These mechanisms are financing cost, investor attention and firm fundamental channels. Financing cost refers to mechanism where socially responsible investing (SRI) investors would pursue their ESG scores with participating to a green bond financing and this would boost demand for the green bonds. Investor attention channel refers to a mechanism where green bond announcement fosters media attention for issuing firms. This would bring issuing firms to a positive light and grow demand of green bonds. Firm fundamental channel refers to a mechanism where green bond issuance tells the story that firm can find ESG related investments. This would be positive signal for a company's long-term survive potential and might make firm an attractive long-term investment. These reasons alone make green bond financing interesting for some companies.

Both stances to market reaction green bond issuance announcement remain among researchers. Lebelle et al. (2020) note that converse view of market reaction green bond issuance announcement remains a possibility. Lebelle et al. (2020) sees that market might have negative reaction to green bond announcement if it sees that firm is stepping outside of their main business model to look for green projects that might not be as profitable as their previous projects. This would mean negative effect to firm's profitability, thus leading to negative market reaction. Lebelle et al. (2020) find in their event study that green bond issuance affects negatively to share price. Lebelle et al. (2020) link this to the view that a green bond issuance announcement creates uncertainty for an issuing firm. Uncertainty is never a good thing for a firm's stock price, thus making it a valid argument.

3.2 Green premium

A premium bond is a bond that trades above its par value. A par value is the face value of the bond, which means that is the price which bond costs. A bond that is trading above its par value is paying lower yield. Negative premium for bonds means that bond is possible to be financed by a discount. Many green bond studies have focused on the green premium, which refers to higher price paid for the green bonds.

Sangiorgi and Schopohl (2023) find that issuers consider green bond issuing to have higher costs than traditional vanilla bonds but at the same time, issuer consider this cost to be acceptable due to benefits that green bonds offer for the issuer. Bachelet et al. (2019) compares green bonds to their brown bond (industries that create significant emissions) counterparts and find issuer characteristics as decisive factor. Overall, study find green bonds to have premium to brown bonds, addition to be slightly less volatile. Institutional green bonds have negative premium and superior liquidity. Whereas private issuers had positive premium and only slight volatility advantage. Third issuer characteristic in the study is certification. Non -certificated green bonds have strong positive premium. Nanayakkara and Colombage (2019) find that green bonds are trading with a premium of 63 basis points compared to traditional vanilla bonds. These findings suggests that green premium offers incentive for issuers to raise funding by green bonds. In summary, findings suggest to premium for green bonds, which offers considerable advantage for the issuer.

3.3 Reputation, social trust

Gilchrist et al. (2021) note that non-opportunistic social reputation is important for companies in the long run. Social capital works as a buffer, either from the community support, or with better relations with regulators and other firms, against misconducts and lower compliance costs.

Reputation related to green bond market is linked to a “greenwashing” and outside reaction to such an act. There are different stages of greenwashing, and one possible use of a greenwashing is firms that introduce their activities more environmentally positive than they are. Successful greenwashing is described by Bachelet et al. (2019) as gained reputation and successful persuasion of environmentally sensitive consumers. Controversially, unsuccessful greenwashing leads to mistrust among public and customers, which might affect to loss of a revenue.

Flammer (2018a) finds that firms with high CSR win more government procurement contracts. This indicates that CSR engagement through the stakeholders is a way to make difference in a tight tender race. Effect is seen stronger in more highly competitive industries with complex contracts and in a situation where company-government relationship is recent.

Wang et al. (2020) note that only minor fines are set for environmental breaches in a highly polluting countries like India and China. This means that positive reputational effects of “doing good” might be over-estimated. Penalties might not be reported as broadly if firms are not paying hefty fines for their environmental breaches. Firms might not be hit with reputation drawback due to low public coverage in the news.

Younger workforce is increasingly interested in the environmental impact of the company they work for. As Deloitte (2023) find over half of the Gen Z and Millennial workers expect their employee address climate concerns. Survey concludes about younger workforce’s mindset that “faced with cumulative challenges and rising uncertainty, they expect the organizations they work for, and the broader business community to play a bigger role in tackling societal and environmental challenges. They’re looking for employers who can empower them to make a difference and to help drive actionable change in our world.” Similar stance is with Bachelet et al. (2019) who find that developments of the financial market is clearly stating to direction of the world and green bond issuers have edge of diversification of the investor base, providing the

potential to enjoy long-term pricing advantages, pro-active messages to stakeholders on environmental sustainability and appealing to Millennials as employees and customers.

3.4 Economic efficiency

Flammer (2018b) finds increase in operating performance, measured by the return on assets (ROA). Additionally, Flammer (2018b) finds 2.4% increase in long-term value, measured by book to market ratio. Paper is also looking into comparing green bond issuers to control group of traditional bond issuers and find improved ROA of 0.6 percentage points after two years of issuing, noting that effects should be followed with longer timeline because green projects take more time to pay off.

3.5 Solvency, ratings, regulatory hedge

Possible regulatory hedge of green bonds is based on the statement that environmentally invested firms are well equipped for possible new regulations that firms are facing in the light of government's' climate goals. Obviously, state of preparation for regulation is diverse among green firms and it depends on industry of the firm as well. Ng (2018) notes, that issuance of green bonds increases information about issuers sustainability plans, as international regulations standards force firms to report about their use of funds.

Even it is stated otherwise above, regulatory hedge of green bond issuing firms might be overstated. Wang et al. (2020) note that several critics are contesting green bonds for their differences to traditional bonds as issuing firms still have operations outside of issued green bonds. These firms are still financing their other (polluting) operations with conventional bonds, which limits any hedge firm is gaining from the green bond issuance. Ehlers and Packer (2016) add that only handful of green bonds are project based, where proceeds come only from specified green project. Most of the green bond investors have claim to entirety of firm's operations with their green bond investment. This means that there are green bond investors who invests into companies with huge regulatory risks

even though company have some green projects, which they issued green bonds for. This creates a problem, where some investors might be unaware of the composition of their actual investment due to how green bonds are issued.

Additionally, to a possible exaggeration of regulatory hedge of green bond issuers, Moody's (2015) report notes, that credit impact from environmental sectors varies hugely between different sectors. Report shows that nearer-term risks are often priced into issuer credit profiles, but longer-term risks become widely unpredictable and are harder to price. Contrary to the negative stances, Flammer (2018b) finds that green bond issuing companies Thomson Reuters' ASSET4 scale is rising by 6.4 percentage points after green bond issuance. ASSET4 scale measures firms' CSR performance. Additionally, innovation increase in green bond issuance firms as number of filed "green" patents increased by 2.1 percentage points in these firms.

To summarize, green bond issuers have several advantages over non-issuers, which might create competitive edge. Long-term commitment to environmentally positive capitalism creates regulatory edge, larger pool of potential investors and employees. Contrarily, studies remain mixed about some stated advantages, positive reputation might be overstated as brown bond firms have not been found to face severe sanctions in some countries and mixed results remain on green bond's green premium, where some studies find positive premium, some find negative green premium.

4 Event study and asset pricing models

In this chapter, event study methodology is explained more carefully. Later, theoretical background of event study methodology is outlined. Additionally, most popular asset pricing models are presented. Capital asset pricing model and Fama-French three factor model is explained.

4.1 Event studies

Event study is empirical analysis, which is used to examine effect of significant catalyst (event) on the value of financial security. Event studies have been used in the research for almost 100 years. Addition to financial research, event studies are used widely in the other research as well. Some of the examples of event study usage in financial research are positive announcements of merger of the company, or inclusion to main index of the country and negative announcements about debt obligations, or exclusion from the main index.

Market model papers of Ball and Brown (1968) and Fama et al. (1969) are one of the most notable pieces from the early days of economics and finance research, but history of event study is dating even longer back. Dating back from Dolley (1933), who research price effects of stock splits, using stock price movements at the time of the split. Also, classic papers of Modigliani and Miller (1958) and Miller and Modigliani (1961, 1963) contribute largely to evolvement of event studies.

Methodologies using event studies as research tools have developed from the early days but generally event study is still one of the most effective and simple research method, which is used widely in research field. Still, as MacKinlay (1997) notes, market model remains most used method for calculating normal returns for the company in the event study. Typically, in market model, 120 days prior the event day estimation window is used to estimate beta of the stock.

First step of conducting event study is defining the event to analyze. Secondly, dataset for the event study is created. Herewith, researcher is picking the potential companies that event theoretically impact. Thirdly, normal returns and abnormal returns are determined by using asset pricing models such as market model or capital asset pricing model. Lastly, measurement and analysis of the abnormal returns is conducted. Additional things that researcher must think about is event window, estimation window for the market returns and robustness of the findings. Careful work should be done especially choosing the event window as wrongly chosen event window might create results that are not affected by the event.

In the next part, paper is presenting different methodologies to conduct event study. Generally, many of these methods are used in the same study to get more precise results for the research.

4.2 Market efficiency

Efficient market hypothesis (EMH) developed by Fama (1969) propose that at any given time, that prices of securities reflect all available information in the market. Based on EMH, there is no party in the market that has more information than other parties, which result to no one having advantage predicting prices of securities. Therefore, any stock picking strategy would lead to losing strategy when transaction and other costs would be included for the investor.

Market efficiency is present in three forms. Strong form, semi-strong form, and weak form. Pure market efficiency is called as strong form. It states that all information is displayed in the equity prices. Addition to public information, private information is included in the prices as well. Semi-strong form suggests that all the public information is included in the prices, but private information is not. Weak form refers to situation where all the past information is included in the prices.

Strong form where all the investment strategies would lead to losing strategy. Outperforming the market is impossible. Fundamental or technical analysis is not able to generate excess returns when market is in semi-strong form. In weak efficiency technical analysis is not able to generate excess returns. Strong form of market efficiency might be hardest to accept in a real-world setting because it would mean there is no use for all the investment workers, fund managers, financial analysts, portfolio managers, investments bankers and so on. Only thing that would make sense is to use services of index providers and buy the index investment products.

Efficient market hypothesis leads to following formula for market model, where expected return of the security R_i in time $_t$ is α_i intercept + β_i beta coefficient leads to (R_{mt}) market return:

$$R_{it} = \alpha_i + \beta_i(R_{mt}) + \varepsilon_{it} \quad (6)$$

As Fama (1969) notes, return of security or portfolio cannot differ from the market returns in the long run. This means that error term equals to zero. This leads to removal of error term ε_{it} from the formula. Then formula of the security or portfolio return is read as:

$$R_{it} = \alpha_i + \beta_i(R_{mt}) \quad (7)$$

After that, abnormal returns AR_{it} are calculated return of investment $R_{it} - \alpha_i$ intercept + β_i beta coefficient multiplied by market return (R_{mt}) - This leads to abnormal return formula as:

$$AR_{it} = R_{it} - [\alpha_i + \beta_i(R_{mt})] \quad (8)$$

Market model is one of the most used models for the event studies. One of the drawbacks of the model is that event window might include other company specific events that might make model results weakened.

4.3 Capital asset pricing model

Capital asset pricing model (CAPM) is model used to calculate asset prices or portfolios. It is based on portfolio theory work by Markowitz. Capital asset pricing model was originally presented by Sharpe (1964). The model is still widely used to calculate expected returns for financial assets or investments. The model does this by using the expected return on both the market and a risk-free asset, and the asset's sensitivity to the market, which is called as a beta.

Formula of the capital asset pricing model for expected returns is presented below. Where expected return of the security (ER_i) price is calculated by market risk-free rate (R_f) added with beta (β_i) of the security and multiplied by market risk premium $(ER_m - R_f)$.

$$ER_i = R_f + \beta_i(ER_m - R_f) \quad (9)$$

Capital asset pricing model is used for comparing if investments return is large enough compared to its sensitivity, called beta (β), when measuring against the market. Investors expect to get larger return with larger risk and CAPM assume that with larger beta, returns are larger as well.

Criticism over beta and how CAPM works, led Fama and French (1992) to create their own model, which Fama and French argue, are explaining security and portfolio returns with higher precision. Fama and French find that difference in beta did not explain returns well enough when measuring with long enough period. Additionally, over there is difference in linear relationship between beta and individual stock price in shorter time periods. These findings suggest that CAPM is not good model to explain returns.

Additionally, CAPM assumes that risk-free rate is constant over calculated time period. In reality, this does not work as risk-free rates change constantly. Still, CAPM is widely used model to this day. Next chapter is discussing more about the Fama and French three factor model.

4.4 Fama-French three factor model

Other well-known model is presented by Fama and French (1992), who argue against the CAPM and present a new model to explain asset returns. As the name says, The Fama and French model has three factors. The size of firms, book-to-market values, and excess return on the market. Therefore, The Fama and French Three-Factor Model expands on CAPM by adding size risk and value (book-to-market) risk factors to the market risk factor in CAPM. Fama and French broaden on CAPM with the before mentioned factors as small cap and value firms outperforms whole market historically. CAPM have not been able to predict outperforming of market by small cap and value firms. Size and value factors measure sensitivity of asset to the size and value portfolios.

Therefore, portfolios small minus big (SMB) and high minus low (HML) portfolios are created. SMB portfolio is calculated return of stocks of small market capitalization firms minus the return on stocks with big market capitalization firms. HML portfolio is calculated similarly, return of high book to market stocks minus low book to market stocks.

Therefore, formula of Fama-French three factor model is as follows:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_{i1}(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \in_{it} \qquad (10)$$

where R_{it} is the total return of a stock or portfolio i at time t, R_{ft} is the risk free rate of return at time t, R_{mt} is the total market portfolio return at time t, $R_{it}-R_{ft}$ is the expected excess return, $R_{mt}-R_{ft}$ is the excess return on the market portfolio (index), SMB_t is the

size premium (small minus big), HML_t is the value premium (high minus low) and β_1, β_2 and β_3 are the factor coefficients.

Original 3-factor model have seen many changes with how other researchers have put their own methodologies in use and added their own factors to the original model. As recently as 2015, Fama and French added new factors to their original 3-factor framework. These factors are robust minus week (RMW) where the returns of firms with high (robust) operating profitability are deducted from those with weak (low) operating profitability and conservative minus aggressive (CMA), where aggressively investing companies returns are deducted from the firms that invest more conservatively.

5 Data and Methodology

In this chapter, the data and methodology of the study is presented. Chapter explains data selection and methodology behind the study. Chapter discuss why chosen methodology was the one used. Further, possible limitations of the study are presented.

5.1 Data

Study uses data of Datastream (Refinitiv), which have its own directory of green bond listings in its software. This dataset covers green bond issuance since 2010 January for public and private companies. Additionally, Datastream covers announcement dates of bond issuance, which makes event study methodology possible. Datastream explains dataset announcement dates as “this is the original date on which the full bond details were announced to the market”. Therefore, methodology for study is to use event study to estimate if announcement of green bond issuance has effect to stock price in the event window. Announcement date data is more important for the study than actual issuance date as market reacts generally more to novel news rather than to past news.

As noted, study uses Datastream data library for the announcement days for green bonds. Datastream lists every issued green bond from the first issued green bond in their library. In the moment of 28.2.2024 library consists of 8922 issued green bonds from July of 2007. Additionally, Datastream covers data for public international companies’ stock returns for the past 15 years. Addition to company specific data for announcement days and stock returns, study uses country specific index returns from Datastream. Refinitiv Datastream covers index return data from the last 15 years from most of the major indexes. As green bond dataset is international, study uses country specific index returns as benchmarks.

Addition to country specific indexes, study uses international MSCI World Index data. According to MSCI (2022), the index covers large and mid-cap representation across 23 developed markets countries. Index has 1517 constituents, which means the index

covers approximately 85% of the free float-adjusted market capitalization in each country.

Study is interested green bonds with corporate issuer, where issuer firm is publicly listed company. Public listing is necessary as daily security data is available for publicly listed firms. Data corresponds to 784 green bonds issued by publicly listed issuer, which corresponds to 500 unique observations. Some firms issue multiple green bonds; therefore, study separate subsequent issues and compare if there is difference between cumulative abnormal returns of first and subsequent issue. Tang and Zhang (2020) find that subsequent issues do not produce abnormal returns and argue that there is relatively less information coming to the market from the subsequent issues. At the first issue, firm is receiving a green label tag from the market. Same does not recur when a secondary and later issues are made. Therefore, subsequent issues could be treated similarly as a traditional bond issues. Study finds if a subsequent issue not producing abnormal returns remains true.

Table 4. Issued corporate green bonds by country.

Argentine	6	**Japan**	91
Austria	2	**Lithuania**	1
Australia	2	**Luxembourg**	1
Belgium	6	**Mexico**	5
Bermuda	8	**Netherlands**	7
Brazil	13	**New Zealand**	2
Canada	9	**Norway**	13
Cayman	20	**Panama**	1
Chile	5	**Philippines**	1
Colombia	1	**Poland**	2
China	102	**Portugal**	2
Denmark	4	**Singapore**	1
Finland	8	**South Korea**	31
France	13	**Spain**	4
Germany	9	**Sweden**	16
Greece	2	**Switzerland**	5
Hong Kong	4	**Taiwan**	8
Hungary	1	**Thailand**	14
India	2	**Turkey**	3
Indonesia	1	**UK**	11
Ireland	2	**United States**	52
Italy	9		

Above table shows the corporate green bond issuers by country in Datastream database. High issuer numbers are shown especially in Asia (China, Japan, and South Korea) but as seen in the table, there are green bond issuers in every continent. Asian countries give subsidies to the green bond issuers, which might be an indicative of high issuance numbers.

There is some data limitation using Datastream library as some of the stock data is not available. Some green bond issuers had to be excluded because of a stock data limitation but library offers enough data coverage for the event study methodology. Additionally, some of the green bond issuers chosen for the event study had to be excluded because of a corrupted daily stock returns due to liquidity problems. Liquidity problems affected some of the daily returns to be more stagnant than realistically is expected. This was clearly noticeable as some firms had weekly returns of 0,00% with variance of 0. When

excluding subsequent issues, final number of green bonds chosen for the dataset is 300, where bond, country index and company data had enough data for the study.

5.2 Methodology

Study use event study methodology to find if green bond issuance is affecting to stocks produce abnormal returns. Next chapter is discussing about chosen study methodology more carefully, secondly applied methodology is connected to the construction of the study.

5.2.1 Event study methodology

Study is conducted as follows: firstly, I begin study by choosing event window for the study. As Krueger (2015), Flammer (2020) and Tang and Zhang (2020) use event windows starting before the event date to account for information spillage before the event I will keep up with the method. Addition to include previous days for some information leakage before the event, days after the event should be included for staggered response of the event.

Flammer (2020) and Tang and Zhang (2020) use event windows 5 days before to 10 days after [-5, +10] and 10 days before to 10 days after [-10, +10] the announcement day respectively. Other way, event windows of 16 days and 21 days are used, when including the event day zero (0). Tang and Zhang (2020) note that typical event window for bond issuance study is short window around an issuance date. Contrary to previous argument, Tang and Zhang (2020) is not using short window as 21-day event window can be considered long for this setting. Argument of using a longer window is that in green bond issuance study, actual bond issuance is not the most important factor. Instead, label effect is more important for green bond issuance study. When researchers study positive/negative event for the window or information disclosure of the company, longer window is used. Change in a firm label from neutral environmental impact to a certified positive environmental impact, could be a positive for the firm.

Therefore, I follow beforementioned papers of Flammer (2020) and Tang and Zhang (2020) to construct event window. Thus, event of 16 days and 21 days are chosen for the study ([-5, +10], [-10, +10]). I expect cumulative abnormal returns around both event windows with firm's first green bond issue announcement. I do not expect abnormal returns on secondary and subsequent issue announcements, based on findings by Tang and Zhang (2020) and Flammer (2020), who do not find cumulative abnormal returns with seasoned issuers.

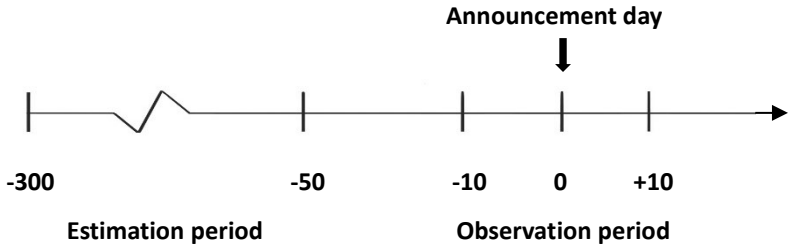

Figure 4. Event study timeline modified from Favato et al. (2015)

In above figure, I will present event study timeline, modified from Favato et al. (2015). Estimation period, observation period and announcement day are highlighted in the figure. Beta is estimated in the estimation window. Cumulative abnormal returns are calculated in the observation period. Observation period, or event window is around an announcement day 0, where green bond issuer announces a green bond issue.

Secondly, beta of each of the firms is estimated. Again, Tang and Zhang (2020) use windows starting from 300 trading days (not calendar days) to 50 trading days before the announcement days of issued green bonds. This corresponds to a beta estimation window of [-300, -50] before the announcement day zero. Contrary, Flammer (2020) use event window of 200 before the first event window. This corresponds to usage of [-220, -21] window as multiple windows are used in a study and first is [-20, -11] before the event date. Beta estimation window of [-300, -50] is chosen for the study after the paper of Tang and Zhang (2020).

After estimating beta for each firm, event windows of 10 trading days before, to 10 trading days after [-10, +10] is used to calculate the cumulative abnormal returns. Method of estimating a beta and choosing event window is done after Tang and Zhang (2020). For estimations, index return minus 10-year treasury bond yield is used by Tang and Zhang (2020). As Flammer (2020), I use S&P 500 for the United States and as so, leading stock market index of the countries is used for all the other countries. (e.g., NIKKEI 225 for Japan, DAX for Germany, FTSE100 for United Kingdom and SHANGHAI SHENZHEN CSI 300 for China).

For the results, study use same methods as Flammer (2020), to check for a robustness of the results. Window of 5 days before to 10 days after the green bond issuance announcement is used [-5, +10] to calculate abnormal returns. Additionally, windows of [-20, -11], [-10, -6], [+11, +20] and [+21, +60] are used to see if there are any run up in the stock prices before or after the original event window. Furthermore, global stock market index MSCI All Country World Equity Index is used to see if the results are the same than using a country-specific indices. After, Fama-French 3-factor model is used to check robustness of the results. Lastly, I calculate the abnormal returns without the countries where the government offers subsidies to a green bond issuers. Excluding countries with subsidies, results are robust with the notion that stocks are not reacting extremely to a cheaper loaning, which subsidies offer.

5.3 Possible limitations of the study

Clear limitation is sample size. Due to data limitation, many green bond issuers had to be excluded from the study. Additionally, even with international dataset, sample size is relatively small because of recency of the financing method. Green bonds have been in use under 20 years, which makes it a new financing method. Additionally, corporate green bonds have been in use only 10 years and use of them as one of financing options has only grown in the last couple of years. Every year there is new firms issuing green bonds but still, green bond issuance can be considered rare. It means that country-

specific studies are impractical to conduct and most of the green bond studies have been conducted with international dataset for that reason. Several studies including Wang et al. (2020) and Fan et al. (2023) focus on China on their studies but China remains the only country where there is possible to conduct a country-specific study on the green bonds. If issuance numbers grow yearly with a double- or triple digit percentages, more country and area specific studies are attainable to be conduct in the next couple of a years.

6 Results

This chapter discusses about findings of the study and what conclusions can be drawn from the findings. In each of the following tables, results are presented. Every table presents cumulative abnormal returns based on capital asset pricing model with respective p-values, in different event windows. I conduct Wilcoxon sign rank test, testing the significance of cumulative abnormal returns. Robustness of the results is tested in global market model using MSCI World Index, addition to the Fama-French 3-factor model and excluding countries with the green bond subsidies. Lastly, I discuss if I should reject the null hypothesis that green bond issuance produces returns that are non-zero.

6.1 Cumulative abnormal returns, first time issues vs. secondary issues

As stated previously in the introduction part of this paper, majority of the green bond issuance studies conclude green bond issuance as a positive for the stock price. Tang and Zhang (2020), Wang et al. (2020) and Baulkaran (2019), Fan et al. (2023), Flammer (2020) find positive reaction to issuance announcement. Studies that find negative or neutral reaction include Lebelle et al. (2020), Aini et al. (2023). Applying same methods as Tang and Zhang (2020) and Flammer (2020) I find that the first-time green bond issuance is producing cumulative abnormal returns (CARs) in the measured event windows of [-5, +10] and [-10, +10]. Effect is only found with first time issues as with the subsequent issues effect is not found. Therefore results for first time issues and secondary issues remains matched with the previous studies on the comparison between the first time issues vs. secondary issues.

In order to find effect of the issuance of green bonds, abnormal returns are calculated by calculating residual of the stocks by removing expected return of issuing firm stock returns from actual returns. Other way, abnormal returns by Tang and Zhang (2020) for issuing firm are as follows:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i \times \left(R_{m,t} - R_f\right) + \epsilon_{i,t} \quad (11)$$

$$\mathrm{AR}_{it} = R_{it} - \hat{R}_{it}$$

Where α and β are estimated parameters from the CAPM model. Following Flammer (2020) I calculate the cumulative abnormal returns for each time interval by summing up the abnormal returns within the different event windows and report cumulative abnormal returns for the event times [–20, –11], [–10, –6], [+11, +20], [-5, +10] and [+21, +60] in addition to the original event window [–10, +10].

In next paragraphs I will report results of the event study. Table 5 shows event study results for the first-time issuers. Table 6 will show subsequent issues, where only secondary and issues after that are calculated. Tables will demonstrate cumulative abnormal returns and p-values calculated from the returns. Tables will also display significance of the returns.

Table 5. Event study results, first time issuers

	(1)	(2)
Event time	**CAPM_CAR**	**p-value**
[-20, -11]	-0,23	0,3236
[-10, -6]	0,26	0,1100
[-5, +10]	0,62**	0,0199
[-10, +10]	0,89**	0,0165
[+11, +20]	0,22	0,6720
[+21, +60]	-0,12	0,4421
Observations	300	300

**CARs are significant at 10% level*
***CARs are significant at 5% level*
****CARs are significant at 1% level*

Tables 5 above report the event study results. Table 5 sample includes all the 300 observations from the individual issuers. Cumulative abnormal returns are reported for each event window in the second column and corresponding p-value of the returns in the third column. Column (1) of table 5 shows cumulative abnormal returns for the main event window of 21-day [-10, +10]. I find that the stock market reacts positively (0,89%) and statistically significant at the 5-percent level (p-value of 0,0165) around the green bond announcement. In column (2) of second event window, 5 days before to 10 days

after the announcement date shows stock market reaction, where the CAR is 0,62%, and statistically significant p-value of 0,0199 at 5-percent level. Cumulative abnormal returns produced in the other event windows [–20, –11], [–10, –6], [+11, +20], and [+21, +60] are small and insignificant. Insignificance of returns in other windows might signal that other events around a green bond issuance event are not drivers for returns.

Table 6. **Subsequent issues**

	(1)	(2)
Event time	**CAPM_CAR**	**p-value**
[-20, -11]	0,13	0,3155
[-10, -6]	0,29	0,2111
[-5, +10]	0,12	0,3316
[-10, +10]	0,09	0,3325
[+11, +20]	0,06	0,4633
[+21, +60]	-0,14	0,3523
Observations	224	224

**CARs are significant at 10% level*
***CARs are significant at 5% level*
****CARs are significant at 1% level*

Table 6 sample includes 224 secondary issues. Similar to table 5 above, cumulative abnormal returns are reported for each event window in the second column and corresponding p-value of the returns in the third column. In table 6, cumulative abnormal returns for subsequent issues are small and insignificant for every event window including event windows of [-5, +10] and [-10, +10]. Results are in line with previous literature of Flammer and Tang and Zhang, who find cumulative abnormal returns of subsequent green bond issue announcements to be small and insignificant.

6.2 Robustness

After Flammer (2020) I use global market model of MSCI index to calculate the abnormal returns for robustness of the results. Additionally, I use Fama-French three-factor model (Fama & French, 1993) to calculate the abnormal returns for robustness. Lastly, I exclude countries where government offers subsidies to green bond issuers. Excluded countries from this regression are Asian countries: Japan, Hong Kong, Taiwan, and China. Dataset with excluded countries include 175 observations.

Table 7. **Event study results (other models)**.

	(1)	(2)
	CAR [-10, +10]	**p-value**
Global market model (MSCI)	0,77**	0,0166
Fama-French 3-factor model	0,92**	0,0102
Excluding countries with green bond subsidies	0,69**	0,0275

**CARs are significant at 10% level*
***CARs are significant at 5% level*
****CARs are significant at 1% level*

I find that in the [-10, +10] event window (21 days), global market model produces CARs of 0,77% and p-value of 0,0166. Global market model CARs are statistically significant at five percent level. Additionally, I find that Fama-French three-factor model is associated with 0,92% (p-value 0,0102). FF3 statistically significant at five percent level. Lastly, I find that excluding countries which give out green bond subsidies (China, Japan, Taiwan, Hong Kong), cumulative abnormal returns are 0,69% (p-value 0,0275). Model excluding countries is significant at five percent level. Therefore, my findings are robust with all of the models.

Results shown in table 5, (where event windows [-5, +10] and [-10, +10] produce CARs of 0,62% and 0,89% with the p-values of 0,0199 and 0,0165) tell that I can reject the null hypothesis that cumulative abnormal returns are not different from zero with 5-percent confidence level. Contrary, I can partially accept hypothesis one that firm's stock prices increase around a green bond issuance. Stock prices increase after firm's first green bond issuance announcement. When considering that secondary issues are not producing cumulative abnormal returns, I can conclude that first green bond issuance can be indicative of higher firm value, which is shown with cumulative abnormal returns. Market sees first green bond issue as positive signal for the firm as issuing firm is committed to environmentally positive projects, therefore market reaction happens with first issue but as market have already learned about green label, it does not react positively to subsequent issues. In this setting, subsequent bonds are comparable to traditional bonds, as literature have not found cumulative abnormal returns after the bond announcement.

Results follow to previous literature on the topic as Flammer (2020) and Tang and Zhang (2020) find that first green bond issuance signals to the market, that firm is committed to green projects and first project have been certified to have environmental impact. This certification creates green bond issuers tag for the firm and the market sees this tag positive for the company and this creates positive abnormal returns for the issuer. Market does not react to a second and the subsequent issues as the market has already learned that company is a green bond issuer and therefore subsequent issues do not produce significant abnormal returns.

7 Conclusions

In this final chapter of the thesis, I will summarize objectives of the paper, compile study topic umbrella, and summarize presented findings. I will draw conclusions of the findings and present potential new areas of study from the topic.

Objective of this study was to study effect of green bond issuance to stock prices with the international perspective. Green bond issuance has been growing rapidly in the last 10 years after first green bond was issued back in 2007. Growing number of studies about green bond issuance have been conducted in the last five years but overall number of papers remains low. Therefore, findings in this paper establish ground of previous green bond issuance studies, either confirming or rejecting previous results.

So far, green bond issuance studies have been conducted mainly with international datasets, which is result of still low numbers of green bond issues. This thesis adds to the previous studies with the new dataset. I compare green bond issuance with the first-time issuers and seasoned issuers. First time and subsequent issuers have been compared previously in the literature, but number of studies in the topic remains low. Study topic comparing first time issuer versus subsequent issuer can be considered rare preposition, as green bond issue announcement is effectively firm publishing usage of specific financing, where financial information is not the most important factor of the said financing, based on previous literature.

I confirm robustness of the findings with the various methods. I find that stock prices increase around a green bond issuance announcement in the event windows of [-5, +10] and [-10, +10]. Results are robust to Fama-French three factor model, global market model and excluding countries with green bond subsidies (China, Japan, Taiwan, Hong Kong). Additionally, I find that subsequent green bond issues produce cumulative abnormal returns that are small and insignificant.

Hypothesis one of this paper is that firm's stock price increase around a green bond issuance announcement. There is strong evidence in favor of rejecting null hypothesis that stock price reaction to green bond issuance announcement is not different from zero. Contrary, I can confirm hypothesis one that stock price increase after a green bond issuance announcement. Hence, the robust results inside the total sample show high positive cumulative abnormal returns inside the event study window.

Considering high positive cumulative abnormal returns around firms first green bond issuance and weak and insignificant returns in subsequent issues, there is strong support to line with previous studies of Flammer (2020) and Tang and Zhang (2020), who consider that first green bond issue represents green bond tag, which stock market consider to be positive sign for firm's certified and impactful environmental projects. Several underlining mechanisms are noted in the paper, where green bond issuer might gain value for the company. These included regulatory hedge, social trust, green premium and economic efficiency. Therefore, overall stock market considers positive mechanisms outweighing potential drawbacks for the bond issuer and rewards first-time issuers with the higher firm value.

Potential future research could be a country-specific green bond issuance study. Especially given that Sweden and Swedish bank SEB was in big role in the birth of green bonds, Nordic-related green bond issuance study would shine a light to question if results are in line with international and Chinese datasets. I expect that some time is needed for big enough datasets for the issued green bond in Nordics but if green bond issuance keeps growing, that type of study would be a possible in the future.

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