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Green is Good?

An Empirical Analysis of Incentives in the Green Bond Market

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NORWEGIAN SCHOOL OF ECONOMICS

Acknowledgement

This thesis was written during the spring of 2022 and concludes our master's degree in Economic and Business Administration at the Norwegian School of Economics. Both authors are majoring in financial economics with a special interest in green investing. Out of this interest, a topic looking into the up-and-coming green bond market, has emerged.

The point of view, or angle, of this thesis differs from earlier research in the green bond market. We look into the *firm's* perspective on green investing, not the perspective of investors. This will provide valuable insights for both parties, and hopefully result in more transparent research in the future.

We would like to thank NHH for the resources they have provided us, both in terms of data sources and our supervisor, Walter Pohl, who has contributed with valuable insights and guidance throughout the process.

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Abstract

Financial innovation has generated many new ideas which has contributed to solve challenges the world, as a community, is facing. Anything from sharing wealth by making the financial markets more accessible for everyone to structured products that has diversification benefits. Today, the world is facing a climate crisis which requires innovative thinking and through that, new products incentivizing to green investments coping with climate change. This thesis aims at quantifying whether a new financial innovation has succeeded in incentivizing companies to focus on green investing. This financial innovation is termed *green bonds*. More specifically, this thesis will study whether there exist incentives for riskier firms to utilize the green bond market to a wider extent than their counterparts. The riskiness of firms will be characterized by their credit rating prior issuance of the green bond.

We perform two analyses. First, we use ordinary least square regression to examine whether riskier firms have issued more green bonds in the period 2013-2021. Second, we perform a logistic regression estimating the probability of issuing a new green bond the next year as a function of the yield spread around issuance for a company's green and conventional bond. For this second regression, we use a matching methodology to find pairs of green and conventional bonds.

Our findings show statistically significant more issues from medium and upper-medium grade firms. They issue, on average, 44.92% and 44.77%, respectively, more green bonds than high quality-rated firms. On the contrary, no definite conclusion can be made for firms with non-investment grade. These results show that there is an indication of more issuances from riskier firms, especially when considering the small sample size for non-investment grade firms. Thus, we can certainly predict a different conclusion with a bigger sample. At least, we cannot exclude an economic relationship between credit ratings and the choice of green bond issuance. Furthermore, we find no evidence on a relationship between yield spread and the probability of issuing a new green bond the next 365 days following a green bond issuance.

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1 Introduction

There is no way around the climate issues the world is facing today. With global warming, deforestation, species on the verge of extinction, etc., there is no doubt that measures will need to be taken. The European Commission has estimated that the EU will need to make $350 billion worth of new investments each year in order to reach the target for reduction in emissions before 2030. Additionally, $130 billion worth of other investments are needed to achieve other environmental goals (Flood, 2022). These numbers are admittedly projected prior to Germany accelerating their transition towards renewable energy, caused by the attempt to liberate itself from being dependent on supplies of fossil fuel from Russia after their invasion of Ukraine in February 2022 (Flood, 2022). The numbers can only have become greater following this.

Climate changes can be approached in two different ways, namely through *mitigation* and/or *adoption*. While mitigation aims at reducing greenhouse gas emissions, adoption aims at adapting to the dynamic development in the climate through reducing our vulnerability to climate change (NASA, n.d.). This could for example mean that we try to adapt to the rising sea levels and other consequences of global warming. It is easy to recognize that we do not only need to be innovative and creative in problem solving of these issues, but nations do also need to unite and solve them in community. Green bonds are exactly an answer to the former, while they are increasingly becoming a solution to the latter. First, green bonds are innovative financial products that can satisfy demand for green investments. Second, governments around Europe have pledged to reach net zero emission within 2050 through the European Green Deal, while the international Paris Agreement are uniting the global commitment towards a more sustainable future.

1.1 Motivation

Regular pricing of assets ultimately relies on supply and demand, where the prices are determined in market equilibrium. Therefore, it is reasonable to state that asset prices have been and will be heavily influenced by stakeholder's preference for different asset classes. These preferences can originate from diversification benefits, sustainability concerns, time horizon, etc. We will look further into sustainability concerns and examine sustainability

investing in debt capital markets. More explicitly, this thesis will look into if there exist incentives for risky firms to utilize the green bond market to a wider extent.

Chava (2014) looked relatively early into if environmental concerns could affect the cost of capital for firms (both equity and debt). He anticipated that if investors excluded firms with environmental concerns, the expected return for these firms could increase, and thus the equity cost of capital; for the debt cost of capital, he anticipated that lenders could be reluctant to lend to these firms with environmental concerns, thus charging higher interest rates on their loans. He found evidence for his anticipations to be correct. Companies with environmental concerns had both higher cost of equity and debt. Indeed, these companies were charged higher interest rates on their bank loans (Chava, 2014). Other reasons why these companies have higher borrowing costs are increased likelihood of getting into legal conflicts, reputational damage, and other regulatory concerns (Bauer & Hann, 2010). This is in accordance with findings from Oikonomou et al. (2014). They found that companies with good corporate social performance (CSP[1]) receive lower yield spreads on their bond issuances with resulting lower cost of debt, and vice versa (Oikonomou, Brooks, & Pavelin, 2014).

Traditional pecking-order theory suggests that firms will always choose debt before equity as external financing (Berk & DeMarzo, 2020, p. 1132). The reason is information asymmetry where investors will require a rate of return when providing funds to a company they have limited information about. In this respect, debt will be cheaper, resulting from the observation that debtholders are requiring a lower rate of return than shareholders due to its higher seniority. The cheapness of debt financing will furthermore rely on how robust and solid the firm is. Namely, the more robust and solid a firm is, the higher its credit rating will be. Credit ratings are negatively correlated with the cost of debt financing, where lower credit rated firms will have to pay higher interest on their debt (Aktan, Çelik, Abdulla, & Alshakhoori, 2019).

[1] CSP is an industry-specific measure on corporate social responsibility (CSR) and is stakeholder's own assessment of a company's CSR when taking into account industry-specific competition (Oikonomou, Brooks, & Pavelin, 2014).

Furthermore, green bonds often give investors more information about the projects being financed (the use of proceeds from the issue). The most apparent notation is that the investors believe the funds will be used for sustainable projects. The pricing of green bonds might therefore be more project-specific than firm-specific. In this way, risky firms have an opportunity to get cheaper financing instead of having to issue bonds which are priced completely on the firm's bad credit rating.

We find motivation in this, and it will be interesting to see if there is a trend in more issuances of green bonds by more risky firms, and if there exist incentives for firms to issue more green bonds after experiencing the green bond market. We will anticipate that the latter depends on whether this experience brings positive or negative feedback. As a result, our research question is

Do riskier firms issue more green bonds to gain cheaper financing?

We try to answer this through two hypotheses:

H1 *Riskier firms issue more green bonds than less risky firms.*

H2 *The yield spread between green and conventional bonds increases the probability of issuing a new green bond the following 365 days.*

The topic and hypothesis are highly relevant. Looking into if there exist incentives for riskier firms to utilize the green bond market to a wider exist is a new topic that admittedly have been present since the green bond market was introduced. For example, and as we will see, the first ever corporate issuer of green bonds, Vasakronan, justified their first issuance in 2013 with a desire to diversify and thereby reduce their borrowing costs (Vasakronan, n.d.). We will prolong this and see if the yield spread between green and conventional bonds leads to more intensive utilization of the green bond market.

2 Background

In this section, we briefly introduce the concept of green bonds, whilst also discussing its history and impact on financial markets.

2.1 What are Green Bonds?

While green bonds essentially have the same characteristics as conventional bonds, there is one important distinction: “Green” bonds are meant for *environmental-friendly* projects. The purpose is therefore to cope with climate change and encourage sustainability into companies’ business. Some areas which are considered as green projects are renewable energy, waste management, energy efficiency, etc.

2.2 The Green Bond Market

The first issuance of a green bond was made by the European Investment Bank in 2007 (Zhang, Li, & Liu, 2021). In late 2008, the World Bank followed up with a new issue. Then, Scandinavian bankers from SEB felt the need to expand the horizon as the only measure investment companies did when it came to investing for the future was to *exclude* companies. In effect, they had a desire to invest, on behalf of clients, in companies that actually did something good for the planet. They had data from clients that they wanted something familiar, but a product labeled “green”. Bonds are simple financial products, thus giving rise to a product labeled *green bond*.

The market was somewhat dull the first six years. When the first public company issued a (corporate) green bond in November 2013, the market became more heated. This happened in Sweden when Vasakronan, a Swedish property company, decided to issue a green bond amounting to SEK 1.3 billion (Vasakronan, n.d.). They invested with the purpose of reducing energy use and their climate impact. In addition, they had a desire to diversify their portfolio, and thereby lowering their borrowing costs. In the aftermath, the corporate and the total market for green bonds have expanded rapidly, and still are. In 2021, there were issued $517.4 billion worth of green bonds globally (Jones, 2022). Compared to numbers for 2015, with $41.8 billion (Climatebonds, 2016), this is a 1137.8% increase, and 52.1% annual increase. While cumulative issuance was $521 billion in 2018 (Fatin, 2019),we see that this was almost

the issuance in 2021 *only*. This trend is not only expected to continue but also to exceed these annual growth rates. At the end of 2025, for example, Climatebonds expect a total issuance of close to $5 trillion. In other words, 20 times the issuance in 2021 will be reached over the next four years (Jones, 2022).There is no doubt that green bonds will be an important financial instrument in the fight against climate change and global warming.

The total issuance of green bonds in Europe in 2021 amounted to $265 billion, where Germany was clearly the biggest issuer with $63.2 billion, followed by France and the UK with $36.3 and $33.9 billion, respectively (Statista Research Department, 2022). A global overview of distribution follows in figure 1.

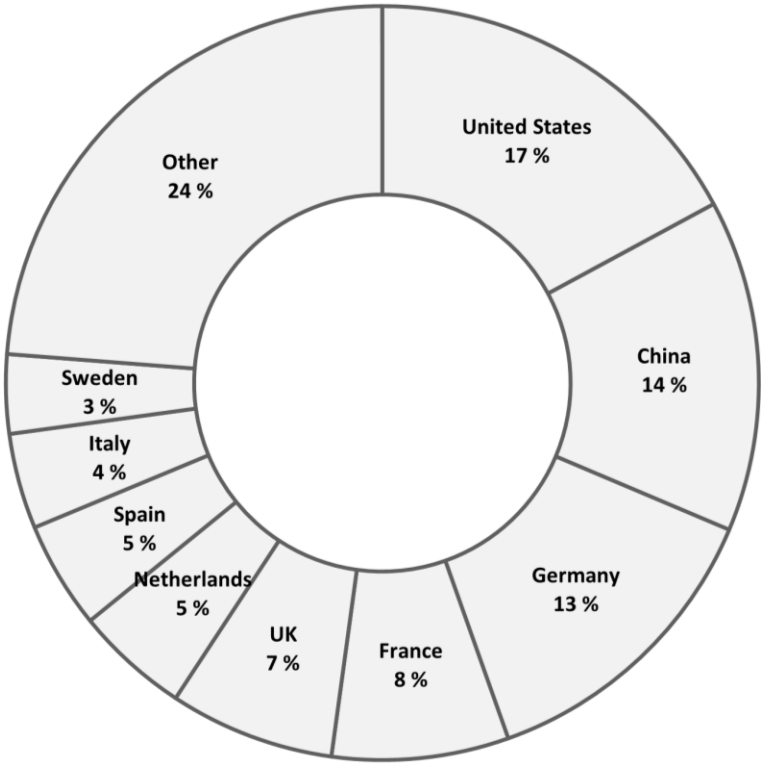

Figure 1: Green bonds distribution by country 2021. Source: Statista, Authors' calculations

The largest part is issued by financial corporations (36.9%), followed by non-financial corporations (26.4%) and government-backed entities (24.2%). A large part is also sovereign issues (20.4%). As we later will see, this thesis focuses on non-financial corporations. Furthermore, the annual growth rate of total issuance in Europe has averaged 50% between 2015 and 2020 (European Parliament, 2022). While the green bond market is rapidly growing,

it is still small compared to the overall bond market. Green bonds represented roughly 3-3.5% of total bond issuance globally in 2020 (European Parliament, 2022).

2.3 Return Characteristics

Green bonds are no different from regular bonds in terms of return characteristics. They are still fixed-income securities where the issuer will repay the bond over and within a specified period of time. In addition, the investor will receive interest (assuming it is not a zero-coupon bond), thus contributing to the total rate of return. This interest is based on either a fixed or variable coupon rate. The total rate of return is generally referred to as the yield to maturity (YTM) of the bond, assuming the investor holds the bond till maturity.

2.4 Green Bonds Principles and Certification

There exist two main market standards for guidance when it comes to green bonds, namely the Green Bond Principle of the International Capital Market Association and the Climate Bond Standard of the Climate Bonds Initiative (European Parliament, 2022). Since the former has emerged to be the dominant standard, due to its less stringent guidelines, we focus on this.

Green bonds are not free of concerns. The use of proceeds, for example, cannot be forced upon an issuer. There exist measures, however, in which try to cope with this information asymmetry. Green Bond Principles (GBP) does this exactly through four pillars (ICMA, 2021):

1. Use of proceeds
2. Process for project valuation and selection
3. Management of proceeds
4. Reporting

The first pillar aims at ensuring that the issuer of the bond indeed utilizes the funds for environmental purpose(s). There does not exist any complete list that captures the definition of such projects. The projects will need to provide environmental benefits, which ideally should be quantified by the issuer. As indicated above, these environmental benefits can for

example take the form of utilizing or investing in renewable energy or some form of energy-efficiency program.

The second pillar tries to induce issuers of green bonds to sufficiently provide information on their specific green projects to investors. In other words, they should communicate their environmental/sustainability objectives clearly.

The third pillar aims at describing how the proceeds of the issue should be managed. This is to ensure transparent communication. Specifically, it guides the issuer to credit the net proceeds to a sub-account which is tracked in an "appropriate manner" and ensures that they are linked to the initial green project.

The fourth pillar is also making sure that the issuer is providing information to investors, namely that they report on the use of proceeds. Either annually, or when material developments dictate that it is necessary. In an annual report, for example, the issuer should list what specific projects the funds are allocated to as well as their expected environmental impact (ICMA, 2021). Both qualitative and quantitative performance indicators are recommended, where the latter must include the underlying assumptions.

2.5 Potential Complications in the Green Bond Market

As suggested above, green bonds do not come without complications. Followingly, we present the most prominent complications, namely information asymmetry and greenwashing.

2.5.1 Information Asymmetry

One of these complications is with respect to the use of proceeds from the issue and the cost of capital, which give rise to the well-known phenomenon in financial markets, *moral hazard* (a principal-agent conflict). An investor (principal) might seek to invest in green bonds due to its environmental benefits while the issuer (agent) might mislead the principal of the use of proceeds in order to obtain lower financing costs. This is indeed what standards, regulations, external parties, etc., are trying, and will try, to minimize. According to research done by Climate Bonds Initiative on green bond issuance in the period November 2017 to March

2019, 77% of issuers documented the use of proceeds, while only 59% made an attempt to quantify the environmental impact of the project financed (Powell, 2021). While 77% is high in percentage terms, it raises the question on what the remaining 23% do to document their environmental impact. It certainly makes it more difficult for investors to consider these bonds as investment objects, whilst also contributing to the mentioned information asymmetry.

2.5.2 Greenwashing

Greenwashing is the phenomenon where a firm is communicating positively about its environmental performance when the performance is bad (Netto, Sobral, Ribeiro, & Soares, 2020). Issuers can decide to not use the proceeds of the green bond as intended. In other words, they are labeling something as "green" when it is. Not only will the issuer benefit from the lower cost of capital but he can also yield reputation benefits. The issuer can obtain higher customer satisfaction from customers who are more environmentally concerned, and appear as a "green" company who cares deeply for the environment. This assumes that the bond is not externally reviewed and exposed to the *real* use of proceeds.

Quilter Investors looked into the awareness of greenwashing in the investment circuit in May 2021. They conducted a survey on ESG investing, which found that 44% of investors in this space had greenwashing as their biggest concern (Powell, 2021). These ESG investors were especially concerned about companies exaggerating their environmental commitment, potentially dampening the investors' positive contribution towards a more sustainable future.

3 Literature Review

In this section, we discuss earlier findings in the green bond market and other relevant literature for our research. First, we discuss the impact of green bond labeling on the cost of debt for issuers. Obtaining cheaper financing by issuing green bonds can help firms invest in environmental-friendly projects, thus contributing to the shift towards these green projects. Second, we look into if research have found a premium for green bonds ("*greenium*"), relative to conventional bonds, which will, in the case of existence, suggest that investors find green bond investing attractive (among other things). Third, we derive any

findings on the impact of credit ratings on the greenium. Lastly, we discuss findings on the impact credit ratings have on the *choice* of financing source. In other words, the impact of credit ratings on capital structure.

3.1 Debt Cost of Capital

A lot of earlier studies have focused on the relative reduction in cost of debt when trying to finance a firm's environmental-friendly projects in capital markets. We introduced Chava (2014) and his findings on how environmental concerns could affect the cost of capital for firms (both equity and debt) in the introduction. He found that companies with environmental concerns received higher interest rates on their borrowings due to lenders being reluctant to lend to these firms (Chava, 2014). This was not the only reason, however. Bauer and Hann (2010) found that companies with environmental concerns have greater likelihood of getting into legal conflicts, receive reputational damage, and other regulatory concerns (Bauer & Hann, 2010). Furthermore, Chava (2014) states that stakeholders value issuer's social commitments (Bhutta, Iqbal, Tariq, Farrukh, & Raza, 2021). In effect, there will be higher demand for green bonds, thereby introducing the well-known phenomena "*greenium*". Greenium implies that investors are willing to accept a lower yield for a green asset compared to its conventional counterparts (MacAskill, Roca, Liu, Stewart, & Sahin, 2020). On the other side, researchers such as Magnanelli and Izzo (2017) suggest that green projects introduce more risk. Therefore, investors will demand higher returns (Bhutta, Iqbal, Tariq, Farrukh, & Raza, 2021).

The liquidity was found to have an effect on the cost of debt at an early stage in the green bond market. The reason being due to the market not being mature, introducing liquidity risk, and thus higher cost of debt. However, Febi et al. (2018) found evidence that this effect disappears over time, as the market is maturing (Bhutta, Iqbal, Tariq, Farrukh, & Raza, 2021). Traditionally, investments in green bonds have been dominated by so-called long-term investors, e.g., insurance companies and pension funds (Nordea, 2020). General liquidity premium theory on bonds states that if the market is dominated by long-term investors, the liquidity premium will be negative, thereby resulting in a liquidity discount.

Further, and more specific research by Zerbib (2019) studied what was actually driving the lower cost of debt when issuing green bonds. He found that it is not the greenness of the issue itself that is driving the cost of debt down. Instead, he for example found that mitigation of search for green investments by investors and risk management due to intangible asset management, were driving the cost of debt down (Bhutta, Iqbal, Tariq, Farrukh, & Raza, 2021).

3.2 Green Bond Premium ("*Greenium*")

As indicated in the last section, there has been extensive research on whether there exists a "greenium" (i.e., a premium for green bonds relative to conventional bonds at issuance). Sean Kidney, CEO of the Climate Bonds Initiative, finds exactly evidence for this. He explains this through the observation that investors view green bonds as a low-risk investment relative to conventional bonds. Additionally, he finds evidence that they come out and hold better in downturns (Mutua, 2022), contributing to them being viewed as a less-risky investment. Furthermore, Agliardi and Agliardi (2019) points to oversubscription by investors when there is an issue of a green bond. The reason being due to investors becoming more and more aware of ESG objectives (Bhutta, Iqbal, Tariq, Farrukh, & Raza, 2021). Also, in a study done by Sangiorgi and Schopol, 70% of the respondents reported higher demand for their green bond issuances, and almost all respondents said that green bond issuances attracted new investors (Sangiorgi & Schopohl, 2021).

Volatility does affect pricing of bonds, mainly through interest rate changes. The effect depends mostly on the time to maturity of the bond, which is captured in the financial measure *duration*[2]. Chung et al. (2019) argued that bonds with more idiosyncratic risk tend to yield higher expected returns (Bhutta, Iqbal, Tariq, Farrukh, & Raza, 2021). Thus, diversification benefits can be retrieved by issuing different bonds, for example green *and* conventional bonds. Research from Europe and the United States find increased risk-adjusted returns for portfolios including green bonds compared to portfolios excluding green bonds

[2] *Duration* is a measure on the value-weighted average timing, or maturity, of the cash flows from a bond (Berk & DeMarzo, 2020, p. 1125). Followingly, it is a measure on bond price sensitivity to yield curve changes.

(Han & Li, 2021). Not only is the return for the former better, but the volatility also decreased. The authors also state that investors in the stock and commodity markets, especially, benefit greatly from this. They explain this through the observation that green bonds have weak(er) correlations with these markets.

Another interesting finding is the observation that characteristics of the issuer influence the presence of a greenium for the issuance. Ferrell et al. (2016) found that stakeholders value companies with great CSR performance, and through that supply benefits to these companies, introducing a greenium (Bhutta, Iqbal, Tariq, Farrukh, & Raza, 2021). This is in accordance with Huynh et al. (2022), who found a positive impact on the greenium when there exists an ESG rating (Huynh, Ridder, & Wang, 2022). Wang et al. (2020) studied this in the Chinese capital markets in the period 2016-2019. He also found that a good social reputation of the issuer helps create a greenium. In addition, he argued that less ownership concentration and more long-term investors were beneficial (Bhutta, Iqbal, Tariq, Farrukh, & Raza, 2021).

History shows that external, unbiased auditing of financial information is important to give transparent financial markets. Huynh et al. (2022) suggest that this also provides benefits for non-financial information. Namely, they find a higher premium for green bonds which are externally reviewed (Huynh, Ridder, & Wang, 2022). This highlights the importance of future development in (mandatory) reporting when it comes to green financing.

Furthermore, Fatica et al. (2021) found that when financial institutions issue green bonds, there will most likely not be a premium. For corporates and supranational institutions, however, there will be a premium. Following corporates and supranational institutions, the effect is smaller for one-time issuers, while companies returning to the green bond market, receive an additional premium. The authors also state that these findings are only true in developed countries, not emerging countries. They conclude that green labeling is not sufficient to raise funds at a lower cost and explain this through the observation that investors have a hard time differentiating issuers who actually use the proceeds for environmental-friendly projects and those who only engage in “greenwashing”. In other words, signaling your green commitment has been difficult. This helps explain the finding that financial issuers

have a hard time receiving a greenium, as lending practices in banking require a lot of information to be held private (Fatica, Panzica, & Rancan, 2020).

3.3 Credit Ratings and Green Bonds

Credit rating and green bonds, in combination, have not been heavily researched. The reason can partly be explained through the findings that green bond issuers are unlikely to have a credit rating (Löffler, Petreski, & Stephan, 2021). However, the same authors find that issuers of green bonds tend to be lower rated than issuers of similar conventional bonds, whilst also the issue size tending to be greater for these green bonds. Furthermore, Huynh et al. (2022) looked into the green bond premiums, external review of green bonds, and credit ratings. They found that an external review of the issuance helps firms with lower credit ratings obtain a higher premium when issuing green bonds (Huynh, Ridder, & Wang, 2022). This is not surprising, considering that transparence will enable green investors to make a better judgement of the use of proceeds.

3.4 Credit Rating and Capital Structure

Capital structure decisions are a part of any firm's decision-making processes. Heavily influenced by the pecking order theory, firms need to weigh equity financing against debt financing and/or against internal financing. Kisgen (2003) looked into whether credit ratings influence this decision-making process. In more detail, he investigated firms near a credit rating change and whether it influenced the preference for debt over equity. He found that firms near a rating upgrade chose to issue equity in order to benefit from the higher rating at a new debt issue when the change has happened (Kisgen, 2003). On the other side, firms near a downgrade would minimize the extra cost from the rating downgrade and chose to issue less debt. Thus, he finds that firms near a rating change will in fact issue less debt in either case to avoid downgrades and obtain upgrades for the firm's credit rating. This is not in correspondence with the financial distress argument of capital structure decisions, which will predict a firm to issue more debt when near a rating upgrade (Shin, Kyungpook, & Kim, 2015). This is due to the firm being of better credit quality. Conclusively, we can certainly observe the potential connection between credit rating and capital structure. In the context of

this thesis, this is important as it can influence the decision to issue green bonds, thereby making the topic of research both interesting and relevant.

4 Data and Sample Screening

In this section, we first describe the screening process of our main sample of green bonds. Throughout the data collection, we primarily retrieve data from the Refinitiv database.

We find corporate green bonds issued by companies globally in the period between the 1st of January 2013 and 31st of December 2021. We include both active and inactive bonds as we want to include matured bonds. Since we are screening the riskiness of firms by their credit rating, we include a criterion that the issuers' credit rating must be available. The credit rating agency used is Moody's. While this introduces a bias concerning a firm's choice of being credit rated by a public firm such as Moody's, it is a total necessity to include this criterion. This is because this thesis is looking specifically into the relationship between credit ratings and green bond issuance. Furthermore, we choose to exclude issues from banks and other financial institutions as they do not use the proceeds for green projects themselves; instead, they issue green bonds in which they use to make loans to companies who thereafter use the loans for green projects.

In the end, we arrive at a sample of 764 green bonds. Our sample is dominated by issues late in our time period, which is illustrated in figure 2 and corresponds to the general increase in green bond issuance in the period 2019-2021.

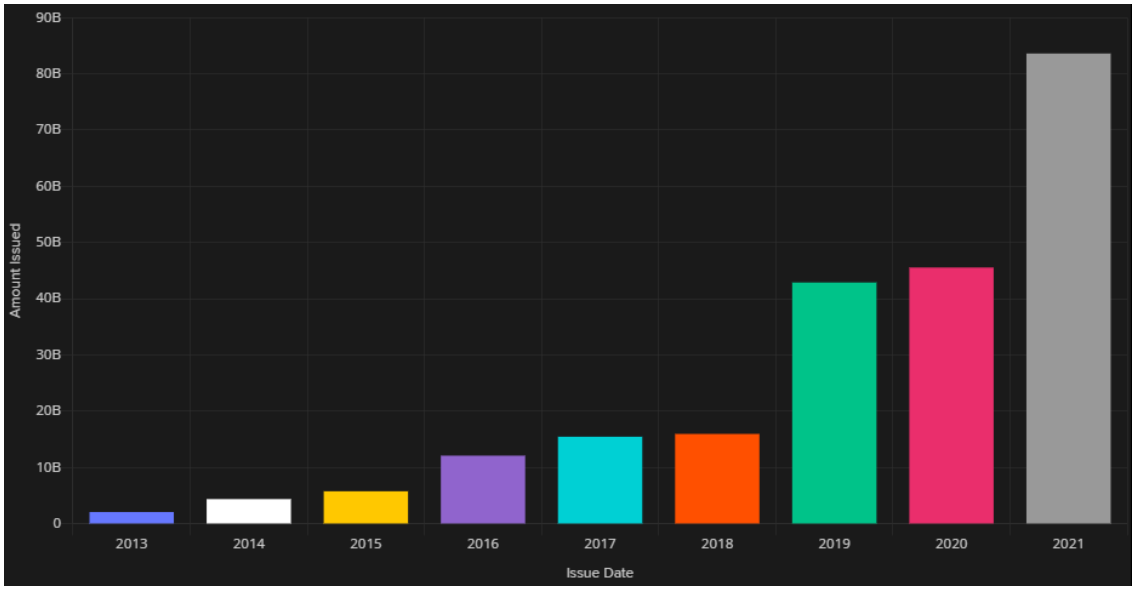

Figure 2: Sample Green bonds issuance 2013-2021. Source: Refinitiv

We will later see that our original sample of 764 bonds will be reduced. In the first regression, we put together green bonds issued by the same issuer in the same year into one observation and exclude bonds that are missing values for any of the control variables. In effect, our total sample size is reduced to 263 observations. In the second regression, we use the sample of green bonds with all financial data and perform a matching methodology for the green bonds, which reduces the sample size to 203 for the second regression.

5 Empirical Methodology

As introduced, our research question is presented through two hypotheses, which need to be analyzed individually with separate regressions. We will present the first regression model in section 5.1, followed by the second regression in section 5.2. Since we have two different outputs in the two regressions, we will provide descriptive statistics of both under their respective sections.

5.1 Regression 1 – Green Bond Issuance

To analyze whether riskier firms issue more green bonds, we perform an Ordinary Least Square (OLS) regression. Specifically, we will want to estimate the effect of credit ratings on

the amount of green bond issuances. We therefore regress green bonds issuance on credit rating with a number of control variables, which we present in the following section.

5.1.1 Control Variables

Our regression method assumes that the zero conditional mean assumption is not violated. Control variables are necessary to satisfy this assumption or at least minimize a potential violation. In detail, we include control variables to remove their effect on issuances, thereby enabling us to isolate the effect of our main variable of interest, namely credit rating. The control variables are firm-specific and include return on equity (ROE), interest coverage ratio, debt-to-equity ratio, assets, total bond issuances, country, and sector.

Return on Equity

Return on equity (*ROE*) is a financial performance that measures the profitability of a company, and how efficiently it generates returns on its equity investments. In effect, it will influence a company's attractiveness as an investment objective in capital markets – both debt and equity. In other words, it affects a company's choice of financing source.

The Interest Coverage Ratio

The interest coverage ratio shows a company's ability to meet its debt obligations by dividing the reported earnings before interest and taxes (EBIT) with interest expenses during a given year. Thus, it can be viewed as more of a cash flow measure compared to ROE. Lenders and other debt investors (i.e., creditors) extensively use the measure to analyze a company's riskiness, either/or on its existing debt investment or for future investments (Hayes, 2021).

Debt-to-Equity Ratio

Debt-to-equity ratio reflects how leveraged a company is. It will therefore affect to what extent a company is able to issue more bonds, and in our analysis, *green* bonds. We use Refinitiv's debt-to-equity one year prior to the issuance of the green bond. Refinitiv reports a modified ratio which focus on long-term debt in the numerator.

Assets

Company size is negatively associated with credit risk (Lui, 2021). Diversification benefits and easier access to capital markets make larger companies more robust to uncertainty, thereby inducing lower credit risk. This affects, or could affect the choice of financing sources, thereby leaving it necessary to include as a control variable. We use the natural logarithm of assets one year prior to the green bond issuance as a control variable for company size. The reason for using logs is to transform the features of the variable into being more normally distributed.

Total Bond Issuance

We control for *total bond issuance* in order to capture any general increase in a firm's bond issuance over our time period. This could result from different firms preferring different financing sources. Some firms prefer bonds, some prefer bank loans, some prefer equity issuance, etc. If the preference is for bonds, it could help explain the choice of issuing green bonds. Another, similar company could prefer equity financing for different reasons, thus potentially explaining the choice of *not* issuing green bonds. We use the natural logarithm of total bonds issued the same year as the green bond is issued.

Sector and Country Risk

We are characterizing riskiness of firms by their creditworthiness which admittedly does not capture any risk a firm will face. Two other types of risk that needs to be controlled for are *sector* and *country* risk. Some sectors are generally more leveraged, for example airline and retail store (Adkins, 2021). Being more leveraged can introduce more risk. To a certain extent, this is captured in the D/E-ratio. Due to the observation that some sector can be viewed as riskier, credit ratings can substantially differ between sectors. Country risk represents an uncertainty related to investing in a particular country and the potential losses for investors (Scott, 2020). Realistically, both sector and country will also affect a firm's credit risk, thus introducing less precision in our estimates through multicollinearity[3]. On the other side, leaving out controls on sector and country could lead to omitted variable bias, thus

justifying the inclusion of sector and country as control variables. We will later see that the correlation is not sufficiently large to become a problem. This is also the case for our other firm-specific control variables, which could be anticipated to correlate largely with credit risk.

In our sample, there are a total of 22 different sectors represented and specified by Refinitiv. Five of these include the term "other" (e.g., "Industrials – Other"), which give room for confusion. Let us derive what these five include of more specific sector specifications, while we interpret the other 17 as they are more self-explanatory. By using The Refinitiv Business Classification[4] we arrive at the following specifications.

- *Industrial – Other:* This is mainly "hydroelectric & tidal utilities", but one company is classified as "vegetable, fruit & nut farming".
- *Retail Stores – Other:* Regular department stores, retail distributers, gasoline stations, and retail real estate rental & development.
- *Service – Other:* This can be anything from "real estate rental, development & operations" to "heating, ventilation & air conditioning systems", but also "universities". The reason for the potential of many different industries, is that services can be provided in any industry.
- *Transportation – Other:* This can be commuting services, airport operators & services, passenger transportations, logistics, etc.
- *Utility – Other:* This is mainly electronic power companies and can be anything from electric or multiline utilities to independent power producers to electrical transmission and grid equipment.

As we see, the original sector classifications were considerably more general and included many different *industries*. It should be mentioned that we derived only the observed sector classifications from TRBC relevant for and observed in our sample. We still use the original

[4] TRBC is a classification system of sectors created and operated by Refinitiv (Refinitiv, 2022). The method for classification is based on the market the company are operating in and not directly the products or services the company is offering.

sector classification provided by Refinitiv since it helps us not making the classification more complicated than it needs to be by maintaining a limited number of categories.

"Utility – other" is by far the largest represented sector with 112 observations. In our original sample, however, "home builders" were the largest sector with 247 green bond issuances compared to 242 for "utility – other". This means that there was more issuance from the same company in the same year for "home builders". Since "utility – other" includes a more variety in companies, we choose to include 21 dummy variables with the sector "home builders" as reference.

For country of issue, we also use Refinitiv's categorization. There are 17 different countries of issues with very differing number of issues, which makes it even more important to include as a control variable. Our original sample of 764 green bonds was dominated by Eurobonds[5], followed by Sweden, China, and the United States. When we sum the value of a firm's green bond issuance in a specific year into one observation, the situation changes (more on this merging in section 5.1.3). For Sweden, a large portion of the issues are done by the same issuer in the same year, reducing the number of issues for this first regression from Sweden considerably. In fact, our sample is now dominated by Eurobonds and the United States. As a consequence, we use the United States as a reference for the dummies. The distribution on both sector and country of issue from our sample can be seen in figures 3 and 4, respectively.

[5] A Eurobond is a bond issue denominated in different currency than that of the country it is issued in (Berk & DeMarzo, 2020, p. 1126), e.g., a bond issued in Japan which is denominated in Euro. We do not want to overcomplicate our analysis by changing each Eurobond into a country, thus leaving "Eurobond" as one of the "countries" of issue.

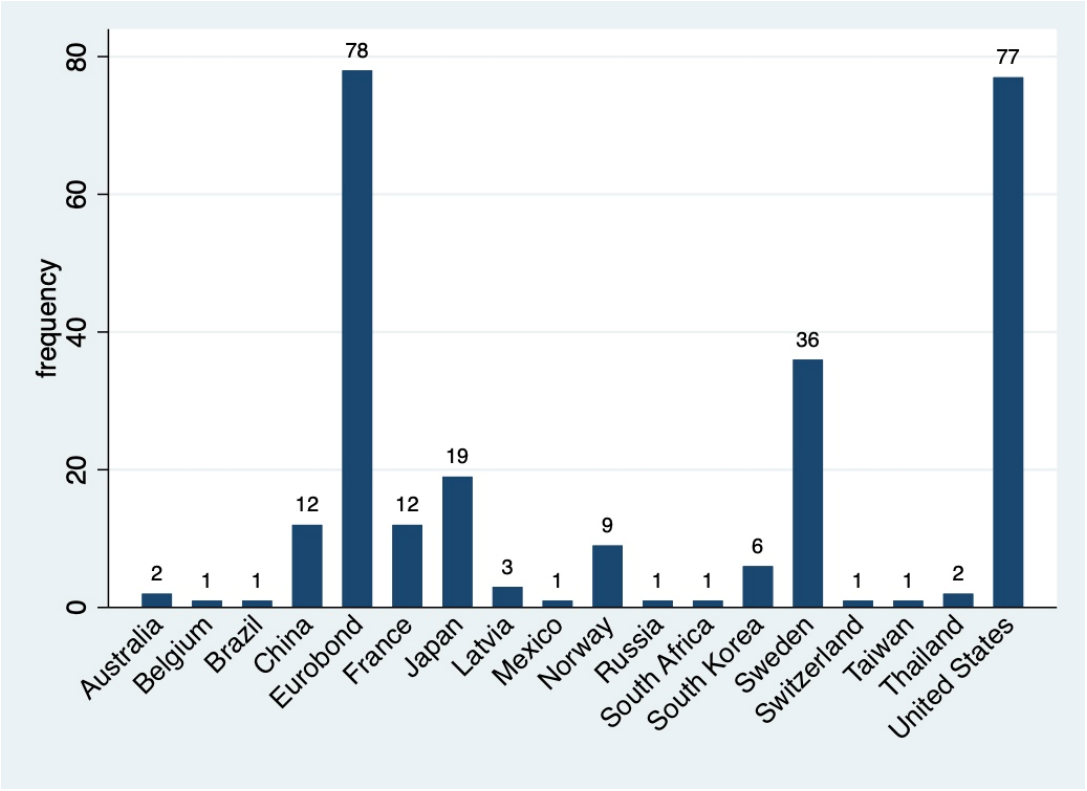

Figure 3: Green bond issues by country (compressed sample, regression 1)

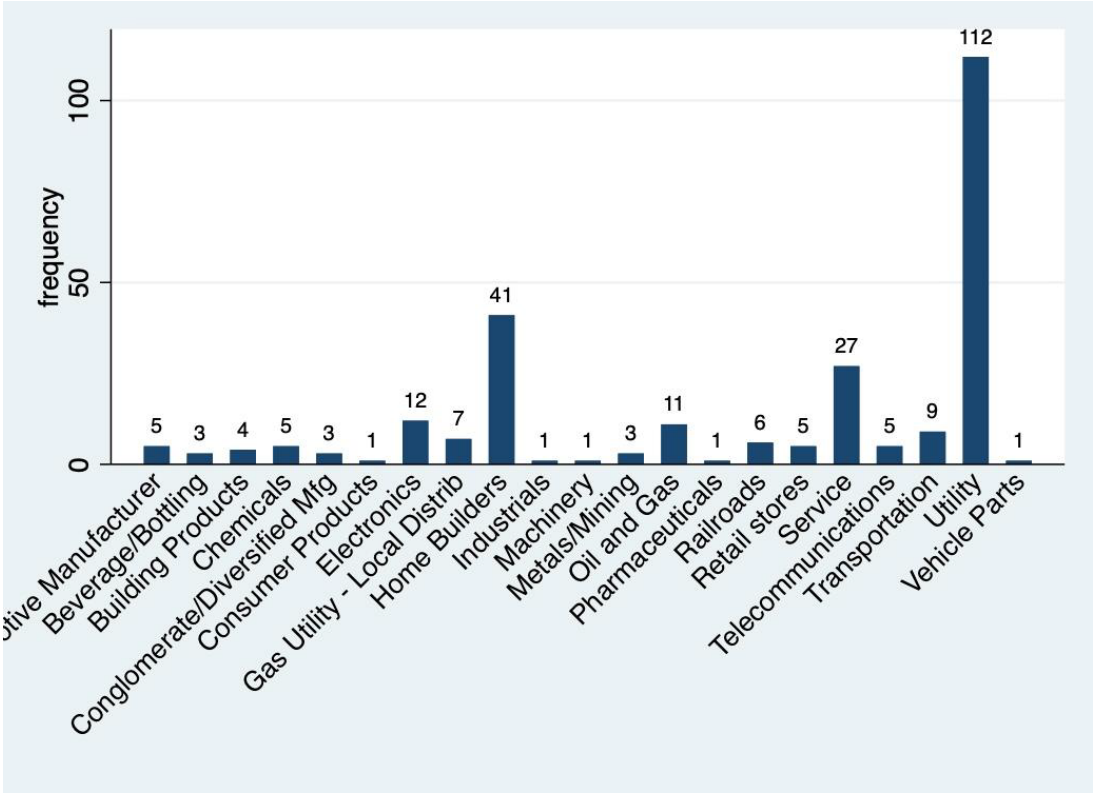

Figure 4: Green bond issues by sector (compressed sample, regression 1)

5.1.2 Missing Data

For some firms, we are not able to retrieve either some or all financial information needed to control for the firm-specific characteristics. The number of green bonds is therefore reduced from 764 to 622. This could introduce bias if there are particular reasons for the lack of financial information. There are mostly Asian firms in which have this problem, which reduces the contribution from this region considerably. The sample from Asia is still large, however. Thus, we do not believe this to be a major concern.

5.1.3 Regression Model

From our main sample, we sum the value of a firm's green bond issuance in a specific year into one observation, reducing our observations from 622 to 263. We match the firm's total bond issuances in this specific year, together with the firm-specific control variables one year prior, as independent variables. Lastly, we include credit rating as our explanatory variable. We redefine the scale into four grades, namely "Non-investment grade", "Medium-grade", "Upper-medium-grade", and "High quality", which corresponds with Moody's definition of its ratings (Moody's, 2009). The only difference is that we have categorized the highest rating, "Aaa", as "High quality". "Aaa" is by Moody's categorized as "Highest quality", but due to the low number of observations with this grade, we choose to include it in "High quality" together with the Aa-rated firms. We then make use of dummy variables, where "High quality" is used as reference. This yields the following regression model

$$y_{i,t} = \beta_0 + \beta_{um}x_{um} + \beta_m x_m + \beta_{\text{ni}}x_{\text{ni}} + \sum_{i=1}^{N}\sum_{t=2013}^{2021} s_{i,t-1} + \beta_b \sum_{i=1}^{N}\sum_{t=2013}^{2021} b_{i,t} + u_{i,t}$$

$y_{i,t}$ and $b_{i,t}$ represents the natural logarithm of green and total bond issuance for firm i in year t, respectively, where the former is our outcome variable. $s_{i,t-1}$ captures all the firm-specific control variables one year prior to the green bond issuance, while $u_{i,t}$ represents the error term (unobserved effects). The terms $\beta_g x_g$ represent the companies' credit rating coded as dummies. $B_{um}x_{um}$, for example, represents the dummy with its coefficient for "upper-medium" graded companies.

5.1.4 Descriptive Statistics

In this section, we summarize characteristics of our final sample for the first regression. The section should be interpreted as a visual illustration of our data, and therefore an overview of the most important aspects of the final data.

Table 1 summarizes the distribution of credit ratings for the companies left in our sample. We notice that we have most observations in the middle, which corresponds to upper-medium-grade and medium-grade (87,5%). The companies ranked as non-investment grade is all companies rated Ba1 or lower. Moody's non-investment grade include Ba1 down to C, but the only non-investment grade ratings we have in our sample is Ba1, Ba2 and B2. We have neither any observations of Aaa, which is the highest ranking a company can have, above Aa1.

	Non-investment Grade			Medium-grade			Upper-medium-grade			High quality		
Rating	B2	Ba2	Ba1	Baa3	Baa2	Baa1	A3	A2	A1	Aa3	Aa2	Aa1
N	1	3	8	27	53	54	58	22	16	7	11	3
∑N (%)	12 (4,6%)			134 (51,0%)			96 (36,5%)			21 (8,0%)		

Table 1: Credit ratings (regression 1)

The next table describes the distribution of the remaining variables included in our regression model. Return on equity (ROE) has a mean of 10.1% with values between -41% and 317.5%. Interest coverage ratio has a mean of 0.089 with values between -0.027 and 3.575. As with ROE, the range is large. Considering these extreme observations and large ranges, especially for ROE, a possibility had been to find a moving average of the companies' ROE in a certain period before issuance. We chose to only include the last observed value to maximize sample size. If we had set a moving average of, the last three years, for example, some firms would not have data from these years, and we would have been forced to exclude them. Also, the most recent year's ROE prior to a bond issuance will be the most important one. We see that the mean for "Debt to Equity" is slightly above one, which means that the companies, on average, have almost equal amounts of debt and equity. However, it varies substantially with values ranging from almost zero debt to as much as eight times the equity. Furthermore, assets have a larger standard deviation than the mean, which illustrates that the sample consist of both big and small firms. Total bonds issued have the same characteristics as assets. It could

be the case that they correlate, but without analyzing the data, it could as well be the case that certain companies are taking advantage of the bond market to a wider extent than others. We will come back to this in section 6.1.5. Looking at all these figures combined, the sample is colorful by the means of variation. This indicates a good sample where we have a wide range of different companies.

Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
ln (Green bonds issued)	263	19.854	20.038	1.057	13.448	21.955
Credit rating	263	2.479	2	.709	1	4
ROE	263	0.119	0.101	.212	-.41	3.175
Interest coverage ratio	263	0.089	0.044	.243	-.027	3.575
Debt-to-equity	263	1.046	0.915	.78	.009	8.653
ln (Assets)	263	16.646	16.612	1.262	13.484	19.568
ln (Total bonds issued)	263	20.778	20.596	1.366	17.034	24.39
Sector	263				1	21
Country	263				1	18

Table 2: Descriptive statistics (regression 1)

5.2 Regression 2: Yield Spread and its Effect on Green Bond Issuance

To answer whether the yield spread between green and conventional bonds increases the probability of issuing a new green bond the following 365 days, we need to examine the difference in YTM between green and conventional bonds.

5.2.1 Matching Method

We will perform a matching method with the purpose of comparing YTM between a green and conventional bond. This method of matching is inspired by similar research conducted by Zerbib in 2018 who matches a green bond with two conventional bonds, thereby creating a triplet of bonds. Thereafter, he either interpolate or extrapolate to create a synthetic conventional bond yield with the same properties as the green bond, except for liquidity. Then, he compares the yield spread between the green bond and the conventional bond (Zerbib, 2018). Although inspired from this method, our method differs notably.

From our main sample, we have a total of 764 green bonds, with 622 having access to all of the financial data. In the first regression, these 622 green bonds were compressed into 263 observations when adding issues from the same firm in the same year into one observation. In this dataset, there are 141 companies. We download every bond issuance of these companies that is not quoted as "green" from Refinitiv in the period 01.01.2010 to 20.04.2022. We do this to match the green bonds with the conventional bonds from the same issuer. This process of selection (or "matching") contains a number of restrictions in order to obtain comparable bonds and thus reliable results. First, the issue date needs to be within three years prior the issue date of the green bond. Second, the difference in total maturity in days cannot be greater than three years. Third, the issue amount cannot be less than half the size or twice the size of the green bond. Furthermore, the currency in which the bond is nominated in as well as the seniority[6], needs to be equivalent, while the coupon type[7] needs to be similar. The restrictions on issue date and issue amount are particularly important, as they can introduce a substantial liquidity bias in our analysis (Zerbib, 2018). Compared to Zerib (2018), our restrictions are stricter. This is necessary, however, due to this thesis directly comparing bond yields between two comparable bonds where the difference between the two is aimed at being only the green labelling. This is not possible in practice, but our strict restrictions let us do this direct comparison. In the end, we find 160 matching bonds in our sample.

5.2.2 Yield Spread

The explanatory variable of interest is the yield spread between a green and conventional bond issued by the same company with the same characteristics. Generally, a yield spread represents the difference in the quoted rate of return for a bond for bonds with different characteristics (e.g., short vs. long maturity) We define the yield spread as

$$\Delta y_{g,b} = y_c - y_g$$

[6] The full sample consist of bonds with "junior unsecured or junior subordinated unsecured", "subordinated unsecured", "unsecured", and "senior unsecured" as seniority. The matched sample ends on bonds with either "unsecured" or "senior unsecured".

[7] Most of our bond sample has "plain vanilla fixed coupon". They are matched with each other, but not with variable rates or zero-coupon bonds, for example. However, "fixed margin over index" are matched.

where y_c and y_g are the yield to maturity (YTM) for the conventional and green bond, respectively. We define the spread in this direction to get a positive premium when the YTM is lower for the green bond, although it has no direct impact for the analysis. Furthermore, we would like to narrow the analysis down to see the effect on green bond issuance between positive and negative spreads. For this purpose, we code a dummy variable where "0" represents a negative spread (i.e., YTM for the green bond is bigger than for the conventional bond), and "1" represents a positive spread.

5.2.3 Control Variables

The control variables in this logistic regression will practically have the same rationale as that of our first regression. We include control variables in which we believe affect the choice of issuing a new green bond, other than that of our variable of interest, namely the yield spread. The firm-specific control variables include return on equity (ROE), credit rating and total assets, whilst we include another variable that defines whether the firm issued any conventional bond within the following 365 days. To not unnecessary repeat ourselves, we only comment the adjustments we do to ROE and assets. For the economic rationale, see section 5.1.2. The new control variables are commented more deeply, however.

Return on Equity (ROE) and Assets

Since we are narrowing the examined period post issuance of the original green bond into 365 days, we arrive at a concern with respect to financial years and reporting. The regression is simple in many ways. The firm issues a new green bond within 365 days or not. If it does, there are no complications, as we simply use the last year's value of ROE and assets. If the firm does not issue, however, a hypothetical new issue could have happened within the same financial year or the next. Should we use the value before the same or the next financial year? We chose neither and use a weighted average between the two. For instance, if a company issues a green bond the 30th of June 2020 but not within the next 365 days, we weigh the 2019 and 2020 values for ROE and assets with 50% each. Since our analysis has a company perspective, this is reasonable. Inside the company, they have continuous information on the value of their assets and profitability. Thus, the financial statement does not need to be published before they can consider their financing sources.

Credit Rating

In our first regression, credit rating was our variable of interest. We found statistically significant relationships between the amount of green bond issuance in the period 2013-2021 and credit ratings. It therefore makes perfectly sense to add credit rating as a control variable. We can then remove its effect on the probability of a new green bond issuance within the next 365 days, and thereby isolate the effect of the yield spread.

Conventional Bond Issuance

We need to control for whether a firm has issued any bonds in the year after the green bond issuance. This is important because if the firm did not need any debt financing in the following year, it is not surprising that they neither issued any new green bond(s). We add dummies for whether the company issued any conventional bonds in the following year.

5.2.4 Missing Data

In section 5.2.1, we revealed 160 matching pairs. This is not the final sample, however. Our sample is shrinking through three more stages. First, we collect yield to maturity (YTM) from Refinitiv. For some bonds, the YTM is not reported before the next green bond issue or before the next 365 days have passed. For these bonds, the bid-yield spread is used as a proxy for the YTM. The bid yield is also missing for 17 bonds, reducing our sample to 143 matching bonds. Second, we lack financial data on four companies, representing 11 matched bonds. Out of these 11 matches, one is already missing the yield spread. In effect, our sample is reduced with 10 from 143 to 133 matches. Lastly, one company with three matches does not have a credit rating. These pairs are left out, reducing our final sample prior the regression to 130.

5.2.5 Regression Model

We are trying to quantify the probability of issuing a new green bond the next year as a function of the yield spread at issuance for the green bond. The most prominent regression method for this purpose, is a logistic regression. This method aims at predicting the probability of an outcome (Lövås, 2018, p. 424). In our case, the outcome represents two alternatives, namely issuing a new green bond the following year (success) or not issuing a new green bond the following year (failure). This yields the following regression model

(1) $$p(s) = \frac{1}{1+e^{-(\beta_0+\beta_c\Delta y_{c,b}+z)}} + u$$

(2) $$ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_c\Delta y_{c,b} + \beta z + u$$

where (1) represents the logistic function and the probability of success *p(s)*, while (2) represents the logit (log odds) function which is defined as the inverse of the logistic function. β_c is the coefficient to the variable of interest, namely the yield spread, $\Delta y_{c,b}$. In the regression, we assume that the yield spread found through the matching method is a perfect match. As we will see in section 6.3.3, this is not entirely correct. The coefficient β_c reports an odds ratio, which is defined in section 6.2.2. The expression for the control variables, z, is simplified for illustrative purposes. This means that z, with the coefficient β, captures all the firm-specific control variables as well as the country and sector dummies. u captures the unobserved effects.

5.2.6 Descriptive Statistics

In this section, we summarize characteristics of our final sample for the second regression. Table 3 summarizes the relevant statistics for both the full and adjusted version. We focus in this section on the former.

Green bond issuance has a mean of 0.596, which gives a 60% success rate (i.e., 60% issues green bond within 365 days following a green bond issue). The yield spread has a mean of 0.333, meaning that 33.3% of the bonds have a positive spread. In 66,7% of our sample, a "greenium" does not exist, and the green bond could be said to be more expensive than the conventional bond. This is surprising, given the former theory and research on "greenium". Approximately half of the sample (52.5%) issue conventional bonds the following year. Return on equity (ROE) has a mean of 11.4%. The measure varies but not nearly as much as we saw in our first regression. This is as expected considering the reduction in sample size. On the contrary, assets still vary considerably, illustrating that this sample consist of both big and small firms. Since credit rating is not of particular interest other than to be a control variable in this regression, we do not provide a separate statistics for the different ratings in our sample. From the table, we still see that we no longer have any non-investment grade

firms since the minimum value for the variable is "2". Originally, in the sample of 130 bonds (i.e., before the regression was performed), we had two observations with non-investment grade. However, they predicted success perfect, and were excluded from the regression.

Logistic regression (1)	Obs.	Mean	Median	Std. Dev.	Min	Max
Green bond issuance	99	0.596	1	0.493	0	1
Yield spread	99	0.333	1	0.474	0	1
Conv. bond issuance	99	0.525	1	0.502	0	1
ROE	99	0.114	0.107	0.070	-0.088	0.26
Assets	99	3.56e+07	1.43e+07	5.82e+07	3503248	2.86e+08
Credit rating	99	2.545	2	0.576	2	4
Country	99				1	7
Sector	99				1	7
Logistic regression (2)				.		
Green bond issuance	126	0.532	1	0.501	0	1
Yield spread	126	0.381	1	0.488	0	1
Conv. bond issuance	126	0.548	1	0.500	0	1
ROE	126	0.156	0.103	0.452	-0.234	5.059
Assets	126	48624017	1.63e+07	75089105	2018657.5	3.102e+08
Credit rating	126	1.778	2	0.838	2	4
Country	126				1	8

Table 3: Descriptive statistics (regression 2)

6 Results

The following paragraphs will present our main results on whether riskier firms issue green bonds to gain cheaper financing. We will first present the results from the regression answering whether riskier firms issue more green bonds. Followingly, we present the results from the second regression answering if there exist a relationship between the yield spread and probability of issuing a new green bond the next year following a green bond issuance. Throughout the discussion, we set 95% significance level as the baseline.

6.1 Green Bonds Issuance

The following table summarizes the regression results for our first regression.

Green bonds issued	Coefficient	Std. error	t-value
Upper-medium-grade	0.371*	0.264	2.35
Medium-grade	0.370*	0.159	2.33
Non-investment grade	0.154	0.264	0.58
ROE	-0.011	0.227	-0.05
Interest Coverage Ratio	0.049	0.151	0.32
Debt-to-equity	-0.086	0.074	-1.16
ln (Assets)	-0.100	0.056	-0.12
ln (Total bonds issued)	0.423**	0.056	7.51
Automotive Manufacturer	-0.328	0.348	-0.94
Beverage/Bottling	-0.985**	0.377	-2.61
Building Products	-0.309	0.338	-0.92
Chemicals	-0.365	0.309	-1.18
Conglomerate/ Diversified Mfg	-0.261	0.370	-0.70
Consumer Products	-1.911**	0.588	-3.25
Electronics	-0.275	0.257	-1.07
Gas Utility	-0.393	0.284	-1.38
Industrials - Other	-0.414	0.609	-0.68
Machinery	-0.980	0.589	-1.66
Metals/Mining	-0.428	0.392	-1.09
Oil and Gas	-0.103	0.278	-0.37
Pharmaceuticals	-0.329	0.586	-0.56
Railroads	-0.419	0.303	-1.38
Retail Stores	-0.194	0.318	-0.61
Service - Other	-0.235	0.197	-1.19
Telecommunications	-0.951**	0.346	-2.75
Transportation - Other	0.190	0.307	0.62
Utility - Other	-0.204	0.193	-1.06
Vehicle Parts	0.262	0.644	0.41
Australia	-0.591	0.413	-1.43
Belgium	-0.447	0.687	-0.74

Brazil	-0.740	0.598	-1.24
China	-1.244**	0.201	-6.19
Eurobond	-0.088	0.097	-0.91
France	-0.176	0.223	-0.79
Japan	-1.448**	0.181	-7.99
Latvia	-1.412**	0.343	-4.12
Mexico	-6.727**	0.611	-11.00
Norway	-0.428	0.227	-1.88
Russia	-0.923	0.571	-1.62
South Africa	-2.152**	0.612	-3.51
South Korea	-0.938**	0.273	-3.43
Sweden	-1.063**	0.201	-5.28
Switzerland	-0.221	0.658	-0.34
Taiwan	-1.099	0.597	-1.84
Thailand	-1.843**	0.405	-4.55
Constant	11.662**	0.907	12.86
N	263		
Adjusted R^2	0.735		
Prob > F	0.000		

Standard error in parenthesis
**p < 0.05, **p<0.01*

Table 4: Regression 1 results, green bond issuance

6.1.1 Model Fit

As indicated, we arrived in the end at 263 observations. The variation in green bond issuances is to a large extent explained by our independent variables (the model's adjusted R-squared reaches 0.735). R-squared is though not so important since we are interested in finding the relationship between credit ratings and green bond issued, rather than to predict total green bond issued for a given firm.

6.1.2 Variable of Interest

Since this is an OLS regression, the interpretation of the coefficient is straightforward. For the estimated coefficients to be statistically significant at the 5% level, the t-value needs to be higher than 1.96. These coefficients are marked with "*", while the coefficients significant at the 1% level are marked with "**". When a coefficient is statistically significant, we can

reject the null hypothesis of the coefficient being equal to zero and thereby conclude with a *statistically* significant relationship.

From a total of 263 observations, we find significant coefficients on both upper-medium- and medium-grade at 5% significance level. Companies with these credit ratings are on average issuing 44.92% and 44.77%[8], respectively, more green bonds than high quality-rated firms. Both these categories have by A similar conclusion cannot be made for non-investment grade firms. Even though we cannot conclude with any significant results for these firms, specifically, we cannot exclude a relationship. In other words, we should not exclude any economic significance solely because there is no statistical significance. The most apparent pitfall when studying green bonds today, is sample size. With a total sample size of 263 observations, we could theoretically believe the sample size is sufficient. However, non-investment grade firms have the least observations by far, followed by high quality-rated firms. The t-test on non-investment grade firms has therefore only few observations, contributing to the non-significant result. Despite the market for green bonds experiencing considerably growth the recent 2-3 years, the problems surrounding lack of data is still present. Having a small sample increases the likelihood of rejecting a true null hypothesis.

Furthermore, we would like to gain inference on the difference between upper- and medium-grade firms. We can achieve this by adjusting the dummies for credit rating to have upper-medium-grade as reference, we find no significant difference between upper- and medium rated firms. Not surprisingly, there is neither any difference between upper-medium rated firms and non-investment rated firms.

In conclusion, we cannot reject our hypothesis stating that riskier firms issue more green bonds. While the riskier upper- and medium-graded firms issue more green bonds, according to the regression results, the even more risky non-investment grade firms do not. A small sample size for the latter invalidates our results, potentially leaving the conclusion different at a later point in time with more data.

[8] Interpretation of a coefficient (β) in a log-level regression is $100 \times (e^{\beta} - 1)$

6.1.3 Control Variables

Our control variables are seldom significant, which do not introduce any particular concern, as they are included for this purpose only. However, some comments are necessary. Among the financial control variables, only total bonds issued is significant. This is not surprising as issuing more green bonds should also increase the total bonds issued by the firm.

Among the sectors, 10 out of 21 have five or less observations, making the statistical tests exposed to both potential outliers in either direction and the effect on the t-test from small sample size. The coefficients on sectors are more negative than positive, with only two observed positive coefficients. They are non-significant, and the trend can therefore be interpreted as home builders being the companies issuing most green bonds, after controlling for other factors such as company size, profitability, etc. Specifically, companies operating in beverage/bottling, consumer products, and telecommunications are the only sectors with significant coefficients, and seem to have less issues compared to home builder companies. The rise of ESG concerns have introduced water waste management for companies operating in the beverage industry, especially, as they are relying on significant usage of water in the production process. In fact, water is the single, most important ingredient (Labs, 2021). Barclays bank suggests the concern will only increase in the following years (Ackerman, Lieberman, Lazar, Theurer, & Whyatt, 2021), while beverage companies themselves are navigating towards investing in water waste management (Labs, 2021). Therefore, it is somewhat surprising to recognize the significant negative coefficient for beverage and bottling companies. However, since companies are starting to navigate themselves towards such ESG investments, the conclusion could be different in a few years' time. The same rationale could be said for consumer products, as McKinsey suggests the industry will have to half its greenhouse-gas emissions by 2030 to meet EU climate targets (Bar Am, Engels, Gatzer, & Lang, 2022). Telecommunications, however, have low direct impact on environmental-related topics like pollution, greenhouse-gas emissions, waste, etc., despite S&P reporting some green bond issuance (Habib, 2019). The negative coefficient is therefore not surprising. On the other hand, they are certainly exposed to social- and governance-related topics like consumer behavior and changing demographics, social media, privacy, security,

regulations, etc. For these reasons, it is probable to believe that general ESG investing will be on the agenda in the future.

For countries, there are not only more significant coefficients. All of them are also negative, indicating that the United States are indeed issuing more green bonds. Similar to that for sector, several countries have only few observations. Among the 18 countries in our sample, 10 have three or less observations. China is not one of them, making it noteworthy to mention the significant negative coefficient for China. This means that China seems to issue fewer green bonds than the United States, after controlling for firm-specific factors.

6.1.4 Comparison with Earlier Research

As explained, our topic of research has not been directly looked into earlier, leaving us unable to compare our results with that of similar research. However, comparing this to the results found by different papers on credit rating and capital structure, yields differing results. Kisgen (2003) looked into credit rate *changes* and its effect on capital structure. From this, we can to a certain degree compare the findings and draw some nuances. He found evidence that credit ratings have a direct and significant effect on capital structure, and thereby debt issuances (Kisgen, 2003). In the same manner, we find that credit rating *does* matter for the choice of issuing *green* bonds.

Furthermore, the pecking order theory states generally that companies will prefer retained profits as financing, then debt financing, and then as a last resort, equity financing (Berk & DeMarzo, 2020, p. 1132). This is due to information asymmetry. However, credit ratings are exactly limiting this. Therefore, we could anticipate an ambiguous effect of credit rating on the choice of financing. Earlier research on bond issuance and credit rating specifically, finds a positive relationship, meaning that high-rated firms choose debt financing over cash or equity (Kang & Ausloos, 2017). On the other side, high-rated firms will also consider the effect of new bond issuance on their existing credit rating (Al-Hindawi & Al-Farah, 2010). Issuing new debt will potentially hurt their credit rating. Considering these ambiguous research results, our combination of significant and non-significant results when studying green bonds specifically, are not surprising.

6.1.5 Analysis of Correlation – Multicollinearity

When performing an ordinary least squares regression, the covariates between the variables used in the regression must be uncorrelated to avoid problems with collinearity (Martínez, Leiva, Saulo, & Liu, 2021). Table 5 below is a correlation matrix of all our variables in the regression. This provides us an overview of the correlation between *all* variables in our regression.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Green bonds issued	1.000								
(2) Credit rating	0.232	1.000							
(3) ROE	-0.011	-0.035	1.000						
(4) Interest coverage ratio	0.001	0.068	0.070	1.000					
(5) Debt-to-equity	0.006	-0.130	0.562	0.010	1.000				
(6) ln(Assets)	0.464	0.314	-0.123	0.028	-0.016	1.000			
(7) ln(Total bonds issued)	0.630	0.348	-0.014	0.041	0.093	0.758	1.000		
(8) Sector	0.106	0.150	-0.038	-0.093	0.084	-0.070	-0.033	1.000	
(9) Country	0.017	-0.057	-0.040	-0.069	-0.156	-0.101	-0.162	0.010	1.000

Table 5: Correlation matrix (regression 1)

From the matrix, we see that all variables correlate to a certain extent, but some more than others. We find one example of high correlation in our matrix, which is the correlation between "Assets" and "Total bonds issuance" of 0.758. To see if multicollinearity is present, we calculate the variance inflation factors (VIFs) for each independent variable (see appendix 3). A cutoff value for VIF is often set to 10 and suggests that multicollinearity could be present (Wooldridge, 2012, p. 98). We find no values above 10, suggesting that multicollinearity is not a problem in our regression. Wooldridge suggest that the VIF is prone to be misused (Wooldridge, 2012, p. 98). Hence, we examine what kind of effect the high correlation between assets and total bond issued has on our results. We perform the regression both with and without assets as an independent variable and compare the results. We find that the estimated coefficients for our variables of interest, which is the credit rating dummy variables, are practically unchanged with only a few hundredths difference, both in the

coefficients and t-values. Moreover, adjusted R-squared is merely reduced by 12 hundredths. In conclusion, multicollinearity does not seem be a problem.

6.2 Yield Spread and Its Effect on Green Bond Issuance

Table 6 summarizes our logistic regression results estimating the probability of issuing a new green bond within the next year as a function of the yield spread. In the first version (1), we have included all our derived control variables. In the second version (2), we have made some adjustments by excluding sector as a control variable. In the following sections, we will first discuss the result of the first version thoroughly, before we briefly comment the rationale for and results of the adjusted version.

Green bond issuance	Odds ratio (1)	Z-value (1)	Odds ratio (2)	Z-value (2)
Yield sread	0.532 (0.370)	-0.91	0.479 (0.239)	-1.47
Conventional bond issuance	0.353 (0.257)	-1.43	0.206*** (0.127)	-2.56
ROE	7.127 (51.428)	0.27	0.418 (0.778)	-0.47
Assets	1 (2.62e-08)	-0.64	1 (3.87e-09)	0.31
Non-investment grade	-	-	1.475 (3.044)	0.19
Medium-grade	0.231 (0.411)	-0.82	0.526 (0.582)	-0.58
Upper-medium-grade	1.933 (3.791)	0.34	1.336 (1.429)	0.27
China	3.519 (5.924)	0.75	3.424 (3.735)	1.13
Eurobond	2.145 (2.765)	0.59	0.854 (0.603)	-0.22
France	92.769 (483.435)	0.87	12.039** (13.378)	2.24
Japan	0.716 (1.183)	-0.20	0.216 (0.264)	-1.25
Norway	4.08e+08 (5.65e+11)	0.01	45.165*** (56.464)	3.05
South Korea	-	-	4.573 (4.623)	1.50
Sweden	58.594 (127.328)	1.87	26.617*** (23.212)	3.76

Automotive Manufacturer	56.718 (424.435)	0.54		
Gas Utility	3.826 (7.321)	0.70		
Oil and Gas	19.878 (62.918)	0.94		
Railroads	8.581 (22.501)	0.82		
Service - Other	2.11e-07 (0.0003)	-0.01		
Utility - Other	2.288 (4.170)	0.45		
Constant	0.566 (1.591)	-0,20	1.596 (2.014)	0.37
N	99		126	
Pseudo R^2	0.376		0.323	
LR Chi2(18)	50.20		56.23	
Prob > Chi2	0.0001		0.0000	

Standard error in parenthesis
**p < 0.05, **p<0.01*

Table 6: Regression 2 results, yield spread and green bond issuance

6.2.1 Model Fit

We mentioned in section 5.2.1 that we had 130 matched pairs. In the table, however, we notice 99 observations. It is not that these 31 observations have any missing values, as usually the explanation is when observations are dropped in a regression. The sample was reduced from 160 to 130 due to missing data in section 5.2.4. The reason for this reduction to 99 is because some sectors, countries, and non-investment grade firms have only few observations, and they all predict either failure or success perfectly for our outcome variable (i.e., the issuance of a new green bond issuance the following year). Let us illustrate with an example. The odds ratio and standard error for the country Thailand are reported as "1" and "empty", respectively, in Stata. The one observation we have from Thailand predicts failure perfectly, meaning that the firm did not issue a green bond in the following year. Therefore, the observation is dropped. We report South Korea and non-investment grade in the table above since they are included in the adjusted version. For the final number of issues by country and sector in this second regression, see Appendix 1 and 2, respectively.

The model fit parameters differ from the output of an OLS regression. Log likelihood is in our case mostly relevant when calculating Pseudo R-squared. Beyond that, it is just of practical use when comparing the model to other models. Chi-square equals 50.20, which is a measure

of model fit where the model is compared to a model *without* independent variables. The corresponding p-value is almost zero, indicating a statistically significant model. The calculation of Pseudo R-squared is not identical to that of the R-squared in an OLS regression. Stata provides McFadden's Pseudo R-squared, which compares the log likelihood of our model with that of a null model[9] (Bartlett, 2014). Despite this and for our practical purposes, the measure can be interpreted in the same manner because it measures the explained variance. We see from the table that the explained variance in the model amounts to 37.6%. In a logistic regression, the outcome variable can take on 0 or 1 as values. Generally, in empirical research, it is hard to find variables who all predicts probabilities of either 0 or 1. Therefore, the value of the Pseudo R-squared should not be emphasized too much.

6.2.2 Variable of Interest

Compared to our OLS regression, the interpretation of the coefficients differs. Let us first introduce the Odds ratio. While a *probability* represents how likely an outcome is in percentage terms, an *odds* is a ratio comparing the probability between two outcomes. In our case for example, this means that the "odds ratio" represents the probability of issuing a new green bond next year (success) divided by the probability of not issuing (failure). Taking this into account, an odds ratio equal to one represents no linkage between the independent variable and outcome. If the ratio is greater than one, the outcome is more likely to happen, and vice versa. In a regression, you additionally need to consider the statistical significance. As long as the confidence interval includes the value one, the estimated coefficient will not be statistically significant.

Since the yield spread is coded as a dummy, its coefficient should be interpreted as the relative odds of issuing a new green bond the following year between companies that experienced a negative spread with the firms experiencing a positive spread. The coefficient is 0.532 which could indicate a lower probability of issuing a green bond the following year for the companies experiencing a positive yield spread. The estimate is not statistically significant, however, and we cannot reject the null hypothesis stating that there is no

[9] A null model represents a model excluding covariates and therefore includes only the intercept (Bartlett, 2014).

relationship between the direction of the yield spread and probability of success or failure. Thus, it does not seem to be a higher probability of issuing more green bonds when experiencing a positive yield spread, and we have to reject our second hypothesis.

A possible explanation to the result could be that we are using the observed yield spread at issuance (or at least the earliest possible observed spread). Admittedly, it is probable that firms observe and analyze the spread over time, leaving the spread at issuance not all too important. Another could be that firms might have other reasons for issuing green bonds than that of the obtained yield spread. They could be only focusing on green investing, thus utilizing the green bond market not because they experience a positive or negative yield spread, but because the use of proceeds fits well with their investment plans and/or business model.

Despite our non-significant estimate, we should be careful to exclude the potential of an economic relationship. As with the first regression, we suffer from small sample size, and having a small sample size increases the likelihood of rejecting any null hypothesis (here: the t-tests). As more data and better matches for the green and conventional bonds become available, the results could change.

6.2.3 Control Variables

We have already touched upon the concerns for our control variables. The sectors especially suffered from few observations, leaving several to perfectly predict either failure or success, and thus being left out of the regression. This was also the case for some countries and the non-investment grade firms.

Out of all our control variables, there are zero significant coefficients. This is not a concern, as they merely serve as controls, and the non-significance is partly explained through small sample size. The dummy variable representing whether a firm issued a conventional bond in the following year or not, is not significant. The coefficient is below one, which could indicate that many companies chose to either issue a green *or* conventional bond. Of course, a lot of companies chose both but the coefficient below one indicates a negative relationship between issuing a conventional bond the following year and issuing a green bond the

following year. We cannot, however, state this with confidence, due to the non-significant estimate. Out of the countries, the closest variable to being significant is Sweden with a z-value of 1.87 and an estimated coefficient of 58.594. Although the significance of the country dummies relies on which country is being used as a reference, it is interesting to observe that it seems like there is a higher probability of success if experiencing a positive yield spread in Sweden compared to the United States.

6.2.4 Analysis of Correlation – Multicollinearity

In section 6.1.5, we touched upon the potential problems correlation between the independent variables could introduce. There is no difference when performing a logistic regression, as multicollinearity problem may still be present. Therefore, to make sure that we are not having a collinearity problem, we first create a correlation matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Green bond issuance	1.000							
(2) Yield spread	-0.247	1.000						
(3) Conv. bond issuance	-0.082	-0.014	1.000					
(4) ROE	0.207	-0.116	-0.127	1.000				
(5) Assets	-0.009	0.002	0.165	-0.438	1.000			
(6) Credit rating	0.065	0.224	-0.260	0.139	-0.096	1.000		
(7) Country	0.032	0.071	-0.021	0.209	-0.382	0.046	1.000	
(8) Sector	-0.313	0.350	-0.065	-0.229	-0.186	0.127	0.209	1.000

Table 7: Correlation matrix (regression 2)

From the matrix, we see that all variables have some correlation, but no values are notably high. To be certain that multicollinearity is not a problem, we once again calculate the VIFs for each independent variable (see Appendix 3). This time, we find values above 10, suggesting that multicollinearity might be problematic. However, if we are interested in the casual effect of one variable only, we should not pay too much attention to the VIFs of other coefficients. In fact, Wooldridge suggests that it should be ignored completely (Wooldridge, 2012). The VIF for the yield spread is 1.45, which is far below the cutoff value 10. Some scientists suggests that in weaker models, like logistic regression is, an indication of multicollinearity could already appear at values above 2.5 (Senaviratna & Cooray, 2019). The

VIF for the yield spread is also below this value, and we can safely conclude that multicollinearity, though present, do not raise any concerns in our regression.

6.2.5 Adjusting the Model

Because of the small number of observations for some sectors, we will adjust the model and try to gain inference on the estimated coefficients without sector as a control variable. This is not the only reason for adjusting the model. Admittedly, we have few observations (130) but a complex model with a wide range of control variables. Reducing the amount of control variables can enable us to gain inference in another way than with the full model, especially when we keep the full model in mind.

In table 6, we presented the regression results for both the full model and the adjusted model. We still lose out on four observations due to the observations from the countries Taiwan and Thailand predicting perfect failure. The fit of the model is similar with practically the only difference being a reduction in explained variance from 37.58% to 32.29%.

The coefficient of the yield spread is still below one, and non-significant. Despite us removing the control for sector, we cannot find any relationship between the yield spread and success. The dummy for conventional bond issue is now significant, and companies issuing conventional bonds in the following year have just 0.206 the odds of issuing a new green bond the following 365 days. In other words, they have lower probability of issuing a new green bond according to the model.

Among the country dummies, the results are showing more significant odds ratios. Not only are all France, Norway, and Sweden's estimates significant at the 95% level, but they are all surpassing one with quite the margin. This indicates that these countries have significant higher odds of success compared to the United States when we do not control for sector.

6.3 Limitations

Throughout our research, we have found and arrived at several weaknesses. We will in the following derive the most prominent.

6.3.1 Credit Rating

First, the process of being credit rated is neither random nor something every company choose to be. Credit rating firms uses financial ratios to quantify a company's creditworthiness. If a company wants to qualify for the best terms when using debt financing, it ideally should have a good credit rating. If a company will not yield a good rating, it probably will avoid being credit rated. In effect, there will be less risky firms who are willing to pay for a credit rating. This is evident from our sample with little to no "non-investment grade" bonds. Having said that, we still found a wide range of credit ratings. Even though there were practically no "risky"[10] firms issuing green bonds in our sample, there were *riskier* firms, which enabled a comparison. As the green bond market matures, these results can be used as a predictor for the likelihood of green bond issuance from particular companies with even lower (higher) credit ratings.

6.3.2 Endogeneity Problems

In our model, we can also face endogeneity problems, which means that the zero conditional mean assumption is violated.[11] Omitted variable bias is the most obvious concern as it is difficult to capture and include all variables having an effect on green bond issuance. Moreover, seeking to include as many independent variables as possible is neither a good strategy. We will then face multicollinearity problems, and followingly need to weigh bias up against more precise estimates. We saw the potential of biased estimates when we adjusted our logistic regression to exclude sector as a control variable. Although our variable of interest did not change significantly, some country dummies and the conventional bond issuance variable changed to become significant, illustrating potential pitfalls when both excluding and including variables.

Contributing to potential endogeneity problems, is the above-mentioned selection bias with respect to the choice of becoming credit rated. Furthermore, measurement error can occur

[10] By "risky", we mean bonds with "non-investment grade" as terminology.

[11] The zero conditional mean assumption is one of the classical linear model assumptions under the Gauss-Markov Theorem. It states that the expected value of the error term needs to be zero for any independent variable (Wooldridge, 2012).

through our independent variables. This is because we are using accounting figures reported by the company. Not all companies are publicly listed which means that they neither are subject to mandatory auditing nor obliged to follow the same standards. Our research has used a global sample. Different governments operate with different standards, regulations, procedures, etc. To some extent, we capture this in the country dummies, but it is safe to say that the measurement error problem is still present.

6.3.3 The Yield Spread

In the second regression, we wanted to estimate the probability of issuing a green bond the next year as a function of the yield spread observed at a prior issuance. An assumption we made was that this spread was correct and represented a perfect match. Even though we set constraints on bond characteristics like issue date, maturity, etc., it is practically impossible to retrieve a perfect match for the green bond. The yield spread (or *greenium*) itself have been heavily investigated earlier, and in such an analysis, we would have needed control variables for bond characteristics that do differ notably. In the following, we derive the characteristics in which could lead to differences in the spread of the green and conventional bond, and thus potentially creating an imperfect match.

Maturity

The *maturity* of a bond has an impact on its exposure to interest-rate risk, which is the observation that bond prices are inversely related to interest changes (i.e., when interest rates rise, bond prices fall, and vice versa). This exposure can be explained through two concepts, namely *probability* and *duration*[2]. First, interest rates are less likely to change in the short-term. Hence, if a bond investor wants to sell prior to maturity, he is less likely to sell at a heavily discounted price in the short term. Second, bonds with longer maturity will more often than not have a longer duration. The higher duration, the more sensitive a bond's price is to interest rate changes. Effectively, duration is a measure on a bond's interest rate risk. As a result of these two effects, it is important to control for differences in maturity of the bonds. A control variable should therefore have been the number of days left before the bonds mature.

Issuance Amount

Even though we have included a matching criterion for the *issuance amount*, it is necessary to control for the difference in issuance amount. We set it to minimum half the size or maximum twice the size of the green bon, thereby making the criterion one of the less strict one. This is partly because we were interested in finding matching bonds but explains why it is important to control for.

All these factors can influence the yield spread in either direction. Despite our strict constraints on issue date, maturity, and issuance amount, there will be differences in these characteristics influencing the yield on the bonds in our sample. In effect, we have no guarantee that the yield spread represent a perfect match. On the other side, in a qualitative sense, if there does not exist a perfect matching conventional bond at issuance, there is no possibility for the company to judge the yield spread in any better way than the closest match. Hence, it makes sense to use the closest match. Despite this, we are performing quantitative research, and to make a statistical conclusion, the spread must be representative. This is indeed the reason we have excluded conventional bonds which did not satisfy all the constraints imposed.

7 Conclusion

This section concludes the thesis and summarizes our findings. First, we summarize the findings on whether riskier firms issue more green bonds. Second, we summarize the findings on whether experiencing a positive yield spread increases the probability of issuing a new green bond the following year. Third, we answer if there exist incentives for risky firms to utilize the green bond market. In the end, we make some closing remarks for future research.

7.1 Does Riskier Firms Issue More Green Bonds?

Our first question we have tried to answer throughout this thesis was whether riskier firms have issued more green bonds in the period 2013-2021. Our regression results estimated that medium and upper-medium grade firms issued, on average, 44.92% and 44.77%, respectively, more green bonds than high quality-rated firms. These results were statistically significant.

No such conclusion could be made for non-investment grade firms, due to the non-significant estimated coefficient. Despite these findings, we find an indication of a trend in more issuances from riskier firms, and we cannot neglect the fact that the conclusion on non-investment grade firms was highly influenced by small sample size. Thus, we can certainly predict a different conclusion with a bigger sample. At least, we cannot exclude an economic relationship between credit ratings and the choice of green bond issuance.

7.2 Does the Yield Spread Influence the Probability of Issuing Green Bonds?

Our second question we have tried to answer is whether the yield spread affects the probability of issuing a new green bond within the following 365 days after a green bond issuance. Our regression result showed no significant relationship between the yield spread and the probability of issuing a new green bond the next year. Potential explanations could be generally that firms do not consider the yield spread before they issue green bonds. In fact, they could be a part of the green bond market for completely other reasons like the desire to make green investments because the use of proceeds for green bonds fits their investment plans and/or business model.

Adjusting the model to exclude sector as a control variable did not result in any relevant differences. No significant relationship between the yield spread and the probability of issuing a new green bond the next year could be found. We could, however, find a significant negative relationship between issuing a green bond within the next year and issuing a conventional bond in the same period. This means there was a tendency for firms to either issue a green *or* conventional bond in the year following a green bond issuance. Furthermore, the country dummies for France, Norway, and Sweden became significant, which indicated that they have significant higher odds of issuing a new green bond the following year compared to the United States.

In conclusion for this second question, based on our sample, we find no evidence on a relationship between the yield spread and the probability of issuing e new green bond the next year following a green bond issuance. Although this is true for our sample, we can neither for

this question exclude an economic relationship. Future research with more data and better matches for the green and conventional bonds, could yield different results.

7.3 Does it Exist Incentives for Risky Firms to Take Advantage of the Green Bond Market?

The thesis as a whole has tried to gain inference on whether there exist incentives, in terms of lower financing costs, for riskier firms to utilize the green bond market to a wider extent than their counterparts. First, we found evidence that riskier firms indeed issued more green bonds. Second, we did not find any evidence that firms with positive yield spreads issued more green bonds the next 365 days following a green bonds issuance. The results are in other words ambiguous. Riskier firms issue more green bonds, but the positive yield spread does not incentivize companies to issue more green bonds. Based on our sample and regression results, we cannot state that there exist incentives in terms of lower financing costs. What we can state, however, is that riskier firms have utilized the green bond market to a wider extent.

7.4 Closing Remarks

Green bonds are a relatively new security and research on this topic is fresh and at its very beginning. Earlier research on the subject have mostly focused on the greenium, which origin from a green investment perspective from investors who have a ESG focus. We have also considered the greenium through the yield spread. However, we have tried to angle the topic towards a new perspective in the green bond market, which creates opportunities for future research. As mentioned in section 7.1, with more data from non-investment grade firms, the conclusion could have been different. Hence, as the green bond market matures and more and more firms issue green bonds, the range of credit ratings on the firms will increase. We will be able to gather data on lower-rated firms, and thereafter look into whether there is a statistically significant relationship between riskiness of firms and issuing green bonds.

Furthermore, in the second regression, we saw that few observations from particular sector and countries resulted in some of our observations predicting perfect failure or success, and thereby being left out of the regression. This reduced the sample considerably. With more

observations from different countries and sector, we will not suffer from data being excluded. This can enable future research to gain inference on whether firms analyze the yield spread and make decisions on financing sources thereafter.

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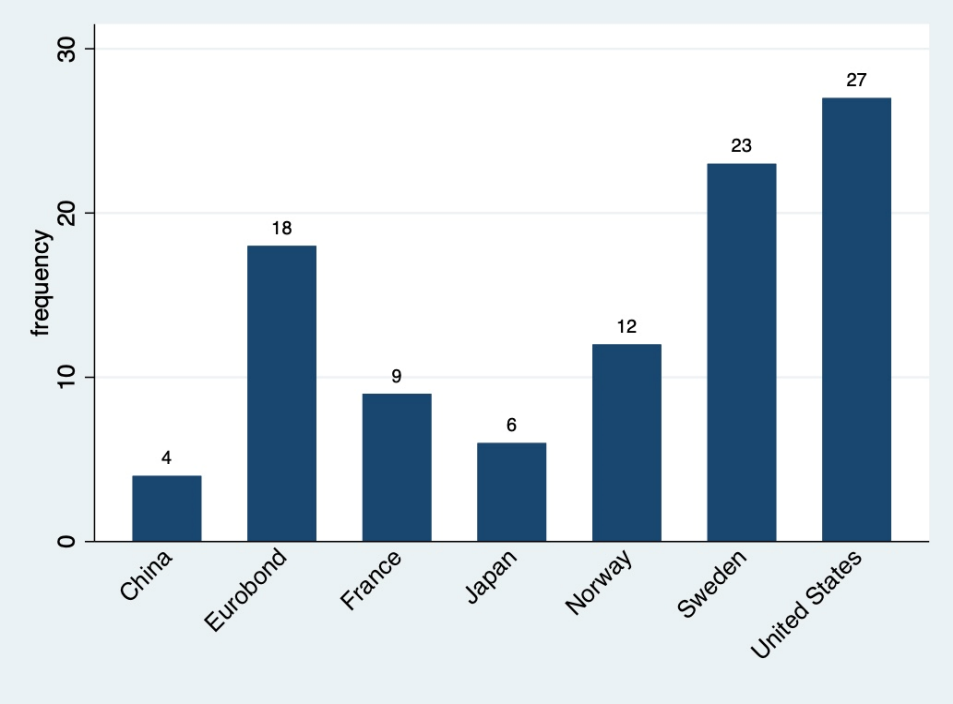
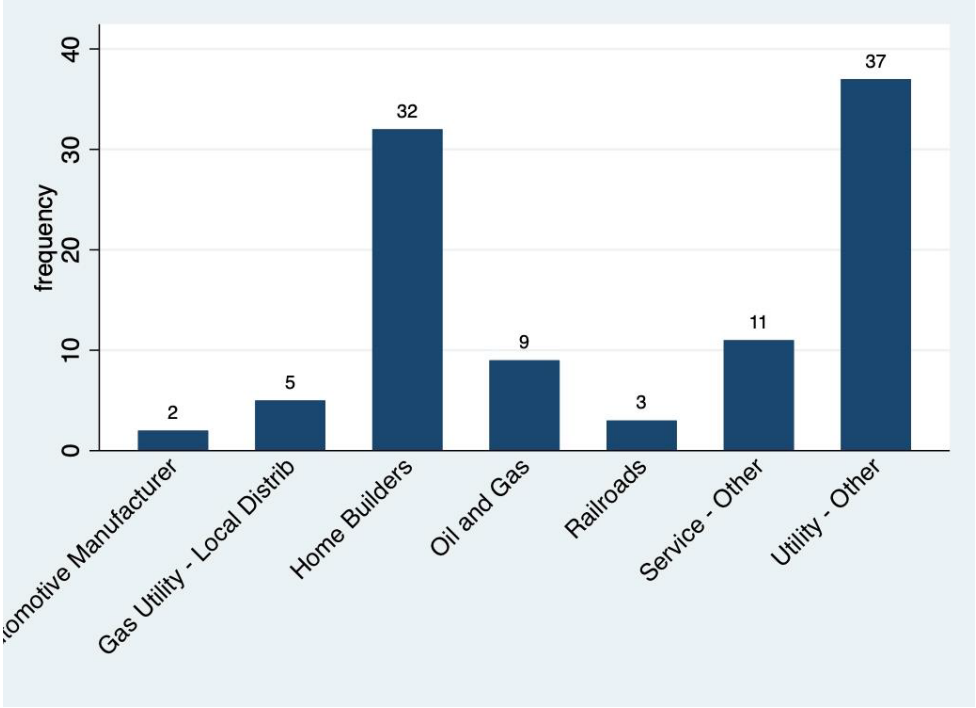
Appendix



Appendix 1: Green bond issues by country (regression 2)



Appendix 2: Green bond issues by sector (regression 2)

	VIF for regression 1	VIF for regression 2
Yield spread		1.45
Non-investment grade	2.71	
Medium-grade	5.648	11.28
Upper-medium-grade	5.163	11.95
Conventional bond issuance		1.49
ROE	2.059	2.83
Interest Coverage Ratio	1.199	
Debt-to-equity	2.995	
Assets		22.99
ln(assets)	4.384	
ln(Total bonds issued)	5.247	
Automotive manufacturer	2.011	11.22
Beverage/Bottling	1.433	
Building products	1.524	
Chemicals	1.59	
Conglomerate/Diversified mfg	1.378	
Consumer products	1.167	
Electronics	2.563	
Gas utility - local distrib.	1.865	2.22
Industrials	1.254	
Machinery	1.172	
Metals/mining	1.545	
Oil and gas	2.76	7.78
Pharmaceuticals	1.159	
Railroads	1.826	2.54
Retail stores	1.683	
Service	3.189	2.34
Telecommunications	1.989	
Transportation	2.778	
Utility	8.101	7.50
Vehicle parts	1.403	
Australia	1.144	
Belgium	1.246	
Brazil	1.209	
China	1.571	1.97
Eurobond	1.747	2.88
France	1.926	23.12
Japan	1.963	2.22
Latvia	1.182	4.11
Mexico	1.263	7.32
Norway	1.52	
Russia	1.102	
South Africa	1.267	
South Korea	1.483	
Sweden	4.27	
Switzerland	1.462	
Taiwan	1.203	
Thailand	1.104	
Mean VIF	2.188	7.07

Appendix 3: VIF calculations (regression 1 & 2)