Norwegian School of Economics
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# The Green Bond Markets in Norway and Sweden

*Exploring the differences between the two markets*

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# Acknowledgements

This thesis is written by two finance majors at the Norwegian School of Economics (NHH). It is with great enthusiasm that we conclude our education and time at NHH with this research paper.

Because of a large interest for and belief in a sustainable finance industry, the topic of green bonds was a quite compelling choice for our thesis. The work has been academically challenging, but also very educational and interesting.

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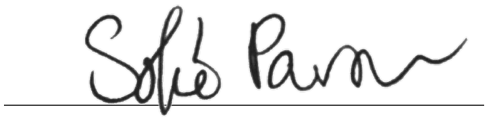

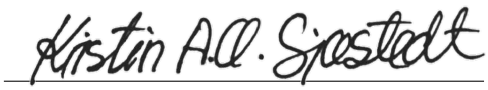

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# Abstract

This study explores the differences between the green bond markets of Norway and Sweden in an attempt to shed light on the markets' distinct evolution. First, the existence of green bond yield premiums in the primary and secondary capital markets is investigated. The primary market analysis finds a negative issue yield premium for green bonds in Sweden and a positive issue yield premium for green bonds in Norway, although none of them significant. Furthermore, the issue yield premium is discovered to have varied considerably over time. The secondary market analysis finds a significant negative ask yield premium for green bonds in Sweden and a significant positive ask yield premium for green bonds in Norway, providing evidence that Swedish secondary market investors have a higher demand for green bonds. The analysis further uncovers that issuer credibility plays an important role in green bond issuance, with bonds from governmental entities having negative premiums in both markets. The largest differences in premiums between the markets are found in the corporate sector. The final analysis of this thesis investigates whether these results can be explained by differences in *Green Focus* between companies in the two markets, where Green Focus is measured by the amount of sustainability related words in the companies' annual reports. The main finding is that companies who have issued green bonds in Sweden have a higher Green Focus than such companies in Norway, which is consistent with the results of the primary and secondary market analyses and with the growth in the Swedish green bond market.

***Keywords*** – Green bonds, Green bond premium, Textual analysis, Norway, Sweden, Master thesis

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# 1 Introduction

With a constantly growing population and human impact increasingly affecting our planet, limiting climate change has become one of the top priorities on the global political agenda (Stern, 2008). This can be seen through the adoption of the Paris Agreement in 2015. For the first time ever 195 countries committed to a universal, legally binding climate contract. The main goal of the agreement is to mobilise the global community and avoid the consequences of climate change by limiting global warming to 2 degrees Celsius above pre-industrial levels (*United Nations Treaty Collection*, 2016). The parties of the agreement are committed to working towards lowering their greenhouse gas emissions and fostering climate resilience, and also to promote finance flows consistent with making these commitments a reality.

Finance does indeed play an important part in limiting climate change and reaching the goals of the Paris Agreement. Firstly, the OECD estimates that in order to meet the 2030 targets agreed upon, an investment gap of $6.9 trillion needs to be filled yearly (*OECD*, 2018). This is more than any one government can provide, necessitating the channeling of global finance flows. Secondly, although it does not cause a lot of emissions directly, the finance industry contributes to emissions indirectly through the companies and projects it finances. Through its financing decisions the industry decides which companies and projects to bring to life, and thus holds the power to channel flows into more environmentally friendly companies and projects. Consequently, mobilising an environmental focus in the finance industry is a key element in reaching the climate goals.

The green bond is a financial instrument with this exact purpose. That is, it channels capital to environmentally friendly projects and promotes an environmental focus in the finance industry. Specifically, green bonds are bonds where the proceeds are earmarked for investments with positive environmental effects (*Climate Bond Initiative*, 2016). The idea is that companies may issue green bonds for these types of projects and receive cheaper financing than they would otherwise have gotten, incentivising environmentally friendly projects. A further element in the value proposition of the green bond is the reputational effect. As investors are becoming increasingly concerned with ESG (environmental, social and governmental) factors, companies may greatly benefit from being viewed as “green”.

There has been considerable scepticism regarding the value of the green bond, which may have been undermining the potential benefits the instrument has had for its issuers. Due to the lack of transparency and international standards in the green bond market, the label has been subject to distrust from investors. These investors suspect that the use of green bonds is simply just "greenwashing", that is, an attempt to appear more green without actually having an environmental focus (Milmo, 2007). If investors do not trust the green bond mechanisms, the benefits of cheaper financing and an improved reputation may be hindered.

Despite the scepticism there has been an exponential growth in the green bond market since its inception, and some countries have contributed more to the growth than others. From being a concept that barely existed a decade ago, global issuance has surpassed $200 billion in 2019 (Odaro et al., 2019). Top issuers have been USA, France and China, who have accounted for more than 40 percent of the green bond issuance to date (*International Capital Market Association*, 2018). The global green bond market is expected to continue to grow over the coming years.

In Norway, however, the growth of the green bond market has been muted. Since the first green bond was issued in 2010, there has been only a slight growth in the Norwegian green bond market (Filkova, 2018). One would not have to look any further than to our next door neighbour, Sweden, to find a different story. The first Swedish green bond was not issued until 2013, but the market has since seen a considerable growth. Sweden is now the sixth biggest green bond issuer globally. Why have the green bond markets in Norway and Sweden evolved so differently? This brings us to our research topic.

**This paper explores the green bond markets in Norway and Sweden, investigates the differences between the markets and discusses whether these differences can explain the markets' evolution.**

Our hypothesis is that there must be some factors that cause Swedish companies to issue more green bonds than Norwegian companies. Specifically, we start by investigating whether it costs less to issue these bonds in Sweden than in Norway. That is, whether there is a higher negative issue yield premium for green bonds in the Swedish primary capital market.

- **Hypothesis 1: It is less costly to issue green bonds in Sweden than it is in Norway**

Then, we examine whether this lower issuance cost is driven by strong investor demand. This is tested by looking at the post-issuance trading activity in the secondary capital market. If Swedish investors have a higher demand for green bonds than Norwegian investors, we expect a negative yield premium in the Swedish secondary market compared to the Norwegian secondary market.

- **Hypothesis 2: Swedish investors have a higher demand for green bonds**

Lastly, we explore whether the differences in issuance and yield premiums can be explained by a higher environmental focus in the Swedish bond market compared to the Norwegian bond market.

- **Hypothesis 3: Swedish companies have a higher focus on being green**

# 2 Background

This section provides some background information on relevant topics for this thesis. The first section covers the green bond, including its inception, guidelines and prevalence. Then, some insight in the Norwegian and Swedish green bond markets is provided. The last sections are about the methods used in the analyses, namely the ordinary least squares method for regressions and the textual analysis method.

## 2.1 The green bond

In 2007, a group of Swedish pension funds wanted to invest in climate friendly projects, but did not know how to identify them. They approached the World Bank with this issue, and by 2008 the World Bank had issued the first "Climate Awareness Bond" (*The World Bank*, 2019). From that, the road was short to what we now know as a *green bond*.

A green bond is a loan where the proceeds are earmarked for investments that have positive environmental effects (*ICMA*, 2018). The Green Bond Principles' list of eligible projects, developed by The International Capital Market Association, includes projects related to renewable energy, energy efficiency, pollution prevention and control, clean transportation, climate change adaptation and many others. Hence, a vast variety of projects are eligible for green bond financing.

The use of proceeds from green bonds may also affect several different aspects of businesses. For example, real estate companies have issued green bonds in order to raise capital for improving the energy efficiency of their buildings, and car manufacturers have issued green bonds in order to raise money for developing hybrid cars (*European Comission*, 2016). A green bond may finance anything from new business development to internal process improvements.

Thus, green bonds cannot be issued only by companies in "green" industries, such as providers of renewable energy or waste management companies. Companies in all industries may issue green bonds if they are going to use the proceeds to improve their business to be more environmentally friendly or if they want to develop new, environmentally friendly business segments or processes (*ICMA*, 2018). An example of a green bond that did not

come from a green industry company is Repsol's 2017 green bond. This was the first green bond from the oil and gas industry, and it was issued with the goal of cutting greenhouse gas emissions from refineries (Whiley, 2017).

The idea behind the green bond is to capitalise on the increasing ESG (environmental, social and governmental) focus seen in the capital markets in later years by providing companies with a cheaper way to finance environmentally friendly projects (*European Comission*, 2016). The green bond provides both companies with a way to mobilise capital specifically for environmentally friendly projects, and investors with a way to deliberately invest in these projects. The belief is that the increased focus on green investing among investors will increase the demand for green bonds, which in turn reduces the cost of issuing these bonds for companies. An additional benefit of issuing green bonds is that it may have positive reputational effects for issuers in the eyes of environmentally concerned investors.

The green bond label is not protected, and different countries and stock exchanges have different requirements for labeling a bond as green. There are some broadly accepted established frameworks that are used by most issuing companies, such as the Green Bond Principles and the EU Green Bond Standard (*ICMA*, 2018; *EU Technical Expert Group*, 2019). In addition, green bond issuers may employ certifying companies who can validate that the issuers' green bond frameworks are in accordance with the established guidelines. Certifying companies can be research companies, certification companies or audit firms. The biggest providers of this service are DNV-GL, Multiconsult and Cicero in Norway, and internationally, companies such as Sustainalytics and EY are commonly used (*Climate Bond Initiative*, 2019a).

Still, the lack of a transparent and universally enforced framework, in addition to the vast variation of projects eligible for green bonds, has sparked scepticism among investors about the validity of the green bond label. Investors suspect that green bond issuances might just be so-called greenwashing. That is, an attempt from the issuer to appear more green without actually committing to it (Milmo, 2007). Companies that operate in industries that are inherently environmentally damaging are especially prone to being subject of this scepticism, as it is harder to believe that these companies actually are committed to combating climate change. If there is suspicion that a green bond issuer is

greenwashing it may lead to less demand for their green bond, which would undermine the intention of cheap financing. It would also greatly counteract the positive reputational effects of the green bond.

Despite the existing scepticism, the popularity of green bonds has increased exponentially since the first issuance of the financial instrument. According to Bloomberg estimates, green bond issuance in 2012 amounted to $4.2 billion, increasing only six years later to $176.6 billion in global issuance (Pronina, 2019). For the third consecutive year, the United States, China and France were the three largest issuers in 2018, accounting for more than 40 percent of global issuance. Table 2.1 lists the five largest green bond issuing countries in 2018.

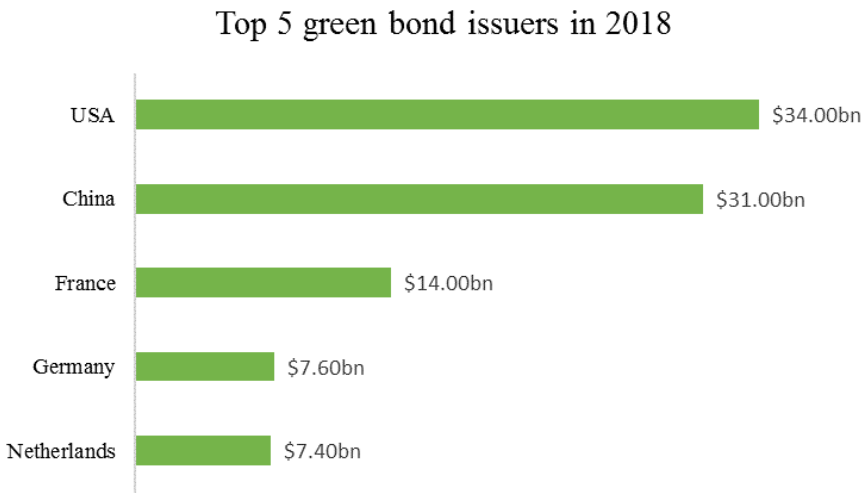


**Figure 2.1:** Five largest issuers globally in 2018
(*Climate Bond Initiative*, 2019b)

Even with the exponential growth in recent years, green bonds only make up about 1 percent of the global bond market (Odaro et al., 2019). The growth is expected to continue, however, with the non-profit organisation Climate Bond Initiative estimating global issuance of $250 billion by the end of this year (*Climate Bond Initiative*, 2019b). Issuance in following years is also expected to grow, driven largely by the significant investments necessary in order to meet the goals set in the Paris Agreement of 2015.

## 2.2 The green bond market in Norway and Sweden

Norwegian green bonds only make up a microscopic part of the global green bond market, but Norway has still played a significant role in developing the market. Norway entered the green bond market early, with the state-owned municipality funding company Kommunalbanken AS' first green bond issue in May 2010 (Filkova, 2018). Until 2014 Kommunalbanken was the only Norwegian issuer. This year, BKK AS became the first company to issue a green bond in European municipal energy. Furthermore, the Oslo Stock exchange became the first ever exchange with a separate green bonds list in January 2015, established with the intent of increasing green bond visibility (*Oslo Børs*, 2017).

Sweden did not enter the green bond market until October 2013, when Gothenburg was the first city to ever issue a city green bond (Filkova, 2018). In November the same year, Vasakronan AB was the first company in history to issue a corporate green bond, and the first real estate company in the green bond market. Green bond issuances grew significantly in the years following 2013, including more firsts with companies Svenska Cellulosa AB, Arise AB and Fastighets AB Förvaltaren who issued the first green bonds in forestry and paper, wind energy and municipal housing, respectively. In June 2015, Nasdaq Stockholm became the second exchange with a separate green bonds list.

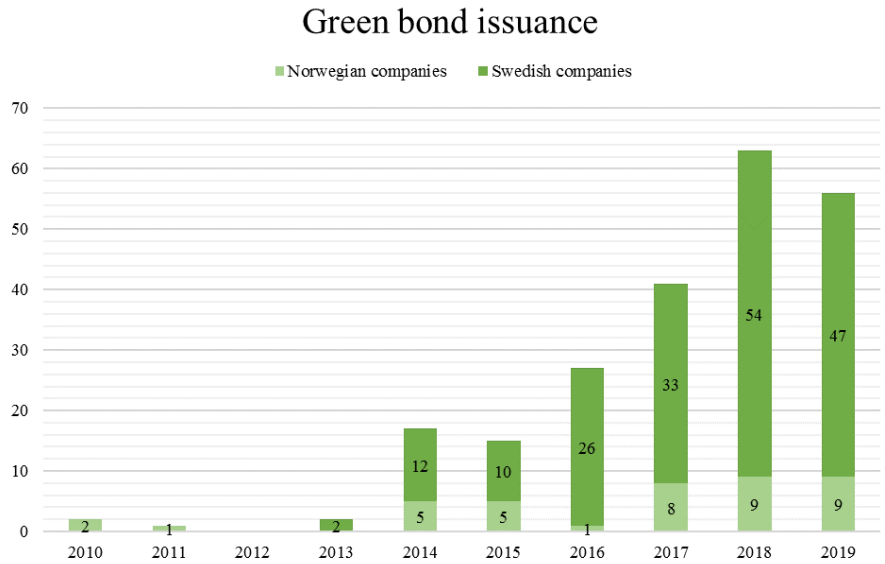


**Figure 2.2:** Green bond issuance in Norway and Sweden
*(Based on data collected from Stamdata, accessed in November 2019)*

Although Norway was early in issuing their first green bond, the Norwegian green bond

market has since experienced muted growth (Filkova, 2018). Sweden, on the other hand, has grown to be the sixth biggest issuer of green bonds globally. Furthermore, Sweden is the second largest issuer of local government green bonds and the third largest issuer in the low carbon building sector. In other words, the growth of Sweden's green bond market has greatly outpaced Norway's. In 2017, the share of outstanding green bonds to total bonds outstanding in Sweden was about 9 percent, while this figure in Norway was about 1 percent. Interestingly, total bond issuance in the countries were approximately equal.

There are growth prospects for the green bond markets in both countries, as both governments take actions to promote green finance. In mid 2018, Finans Norge published a report where they emphasised the importance of having an environmental focus in the finance industry and recommended that more green bonds should be issued in order to reach the goal of a sustainable industry (*Finans Norge*, 2018). The Swedish government are issuing a state green bond in 2020, which will promote the Swedish green bond market and aid the transition to sustainability (*Ministry of Finance, Sweden*, 2019). Sweden's Minister for Financial Markets, Per Bolund, commented the issue saying: *"The decision that the State will now issue green bonds is an important part of the transition to sustainable development. The financial market plays a key role in this transition, and the Government wants to improve the opportunities for sustainable investments by promoting the market for green bonds,"* (*Ministry of Finance, Sweden*, 2019).

## 2.3 Ordinary least squares method

The ordinary least squares (OLS) method is widely practiced in linear modelling. The method estimates unknown parameters by minimising the squared residuals between what is observed and what the model predicts (Wooldridge, 2008). Say we have a linear model as given by equation (2.1), where $y$ is the dependent variable, $x_i$ are independent variables, $\epsilon$ is the error term and $\beta_i$ are the population parameters we want to estimate. OLS determines the parameters $\beta_i$ by minimising the sum of squared residuals, as given by equation (2.2).

$$y_i = \beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + ... + \epsilon_i \tag{2.1}$$

$$SSE = \sum (y_i - \hat{y}_i)^2 = \sum (y_i - [\beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + ...])^2 \tag{2.2}$$

Given a number of assumptions, the OLS method gives the best unbiased estimators possible. This means that no other method can give estimators that have a smaller variance, or, in other words, estimators that are more precise than the OLS estimators. If the assumptions do not hold, however, the estimators are not reliable. Thus, it is important to investigate whether the assumptions hold when using the OLS method. The underlying assumptions for the regression models used in this thesis, which are linear regression and fixed effects regression, are explained in the following.

### 2.3.1 OLS for linear regression

The first underlying assumption is that the linear regression model needs to be linear in parameters (Wooldridge, 2008). This one is not very restrictive as the variables can be nonlinear, only the parameters have to be linear. The second is that the sample of observations needs to be random so that the observations are representative of the population. The third states that the conditional mean of the error term needs to be zero. This is given mathematically by equation (2.3), which says that the expected value of the error term given any value of a independent variable is zero.

$$E(\epsilon|x_i) = 0 \tag{2.3}$$

The fourth assumption is that there cannot be any perfect collinearity between variables, which means that no independent variable can be constant and that there are no linear relationships between variables (Wooldridge, 2008). The fifth assumption is that there is no heteroskedasticity in the error term. This entails that the variance of the error term is constant for different values of independent variables, mathematically given by equation (2.4).

$$Var(\epsilon|x_i) = 0 \tag{2.4}$$

Under these five assumptions, the OLS estimators are the best estimators available

(Wooldridge, 2008). A sixth assumption is needed, however, to be able to study the statistical significance of the estimators. This assumption states that the error term needs to be independent of the variables, and that it is normally distributed with a mean of zero and constant variance. These six assumptions are called the classical linear model assumptions, and if they hold the OLS estimators in the linear model are reliable and can be interpreted causally.

### 2.3.2 OLS for fixed effects regression

The assumptions for using the OLS method in a fixed effects regression are similar to those of the linear regression model, with two exceptions. Firstly, there is no random sampling requirement (Wooldridge, 2008). This is quite intuitive as fixed effects models are used on panel data with observations of the same individuals over time, which means the observations are not randomly picked. The second difference is that there is an additional assumption that needs to hold, which is that of no autocorrelation in the error term over time. The assumption is mathematically given by equation (2.5).

$$Cov(\epsilon_i \epsilon_j | x) = 0 \tag{2.5}$$

## 2.4 Textual analysis method

Textual analysis, or content analysis, is any technique for qualitatively, objectively and systematically processing and interpreting text data (Stemler, 2001). These tools are a contrast to manually analysing texts, which is often very time consuming, expensive to scale, prone to subjectivity biases and not necessarily replicable. Textual analysis models enables faster, more quantitative and more certain analyses.

The ability to quantitatively analyse text data increases the amount of data available for analyses and enables new types of analyses to be conducted. For instance, these models can be used to count word occurrences in texts, find patterns in language or examine the occurrence of trends (Stemler, 2001). A popular use in later years that businesses have adopted is sentiment analysis, which involves tracking (public) opinion on a company, brand, product or person using texts from Twitter, Amazon or other public forums (Mostafa, 2013). This paper adopts a textual analysis model that examines the

evolution of the terminology in communication from companies to investors.

# 3 Literature Review

This section provides an overview of previously published literature relevant for this thesis. A large amount of studies and reports has been published on the pricing components of bonds, which is the first topic of literature explored in this section. Further, several previous studies have investigated the existence of a green bond premium, and these are reviewed in the latter part of this section.

## 3.1 Bond pricing

The components of bond pricing and yield are broadly studied. There is a general agreement regarding the importance of some components of bond prices, such as bond liquidity and maturity, while other components are more disputed. In later years, a number of studies have argued that sustainability and climate risk is an important pricing factor and that it must be taken into account when studying the pricing of bonds.

### 3.1.1 Conventional bond pricing

A broadly cited study by Merton (1974) specified three fundamental drivers of the bond price, which were the underlying characteristics of the bond, the risk free rate and the probability of default. After the study was published, a number of researchers studied the effect of these three factors on the pricing of bonds and reported the existence of a number of other determinants as well. Huang and Huang (2012) showed that the effect of credit risk only accounts for less than 25 percent of the yield spread, indicating that other factors define a substantial part. Furthermore, Petitt et al. (2015) argued that three fundamental factors should be included in models that investigate bond pricing, namely maturity, liquidity and credit risk. For bonds with longer maturities, investors demand a maturity premium due to the risk of holding the instrument longer. The same is true for investors holding less liquid bonds, as these are more risky due to less trading of the asset. This finding adheres to the liquidity preference hypothesis presented by Hicks and John Richard Hicks (1946), which argues that returns are positively correlated with maturity. The argument is also confirmed by authors Fama and Bliss (1987). The effect of liquidity on bond spreads has further been validated by Fong et al. (2017) and

Dick-Nielsen et al. (2012), who stated that liquidity can be accounted for in a pricing model through correcting for the bid-ask spread of the respective bond or amount issued and issue date.

### 3.1.2 Sustainable bond pricing

A distinct branch of academic literature investigates the pricing of climate risk and sustainability in bond markets, although a limited consensus exists when it comes to its effect on price. Several studies have reported that a high sustainability performance is negatively related to yield spread. First, Hasan et al. (2017) studied US firms and provided evidence that firms with higher levels of social capital were able to issue debt at lower costs. Second, Oikonomou et al. (2010) argued that good performance in corporate and social responsibility (CSR) is rewarded in the market, and that financial risk is positively correlated with poor CSR achievement. Third, Flammer (2018) documented that green bonds yielded positive announcement returns in the stock market, indicating that investors expect the bonds to contribute to shareholder value. Furthermore, she reported improvements in long-term value and operating performance after issuing green bonds as well as an increase in green innovations. An increase in ownership by long-term and green investors was also detected.

Contrarily, other researchers have reported the opposite relationship between sustainability and debt pricing. Menz (2010) found that firms with a higher focus on sustainability exhibit a higher risk premium, indicating that more sustainable firms tend to be more risky debt issuers. In addition, a similar study by Izzo and Magnanelli (2012) documented a positive relationship between sustainability and the cost of debt. Despite this finding, the authors acknowledged the fact that a higher focus on sustainability is usually related to better financial performance. The writers suggested that their findings could be supported by common shareholder theory stating that investing in sustainability must be at the expense of shareholder value creation.

## 3.2 Green bond premium

A number of academic studies and scientific papers have been written with the aim of detecting whether a green bond premium exists and what the determinants behind a

potential premium is. The research is still fairly limited and the results tend to differ between publishes. The differing results can be explained by the fact that the green bond market is rather new and that the data availability has been and may still be insufficient. Another possible explanation could be the fact that the green bond market is rapidly growing and thus the amount and content of the available data would differ every year. The majority of the published papers have found that green bonds tend to trade at a negative yield premium, while the minority has found a positive or non existing premium.

### 3.2.1 Negative yield premium for green bonds

Preclaw and Bakshi (2015) studied the option-adjusted spread (OAS) of green bonds in comparison to other conventional bonds. They ran a regression on credit spreads that decomposed OAS into common risk factors and an indicator variable for green bonds. The study found that green bonds, as of mid-2015, traded at a statistically significant 17 basis points tighter OAS, after accounting for their other characteristics.

A study conducted by Zerbib (2017) detected a negative yield premium for green bonds equaling -2 basis points. He compared 110 green bonds matched with two similar conventional bonds from the same issuer and with the same attributes. In order to identify the green bond premium, he created a synthetic conventional bond from the two conventional bonds matching the green bond, and ran a fixed effects panel regression with yield difference as the dependent variable and liquidity difference as the independent variable. This matching method has been used in several other published articles that aim to detect a green bond premium.

A more recent study that used a similar approach to detect a potential green bond premium as Barclays was Kapraun and Scheins (2019). They studied the green bond premium in both the primary and secondary markets using different data sets for the two parts. In analysing the primary market they used a data set of 1,532 green and 216,793 conventional bonds. They regressed the issue yield on an indicator variable for green bonds and varying fixed effects, and could report a negative yield premium in the primary market of -21 basis points. They further found that the premium varied across currencies and issuer types. In particular, credibility was found to play an important role as bonds backed by a collateral or issued by more credible entities were issued at lower yields.

Analysing the secondary market they made use of a similar matching process as Zerbib. The difference from Zerbib's approach was that instead of creating synthetic conventional bonds, Kaprun and Scheins allowed up to 10 conventional bonds to be matched with each green bond. This resulted in a significantly larger amount of pairs, equal to 4,617. They could report a negative premium, also in the secondary market, of -43 basis points.

Another paper that used a similar matching method as Zerbib was Hachenberg and Schiereck (2018). In contrast to Zerbib, they only considered 63 pairs of green and conventional bonds, but they reported a similar negative yield premium of -1 basis points in the overall sample. Further, their results suggested that the premium was affected by company ESG (environmental, social and governmental) profiles and industries.

Consistent with the previously cited research, Ehlers and Packer (2017) documented that green bonds had at issuance been priced at a premium relative to conventional bonds in the primary market, and found a negative yield premium of -17 basis points. However, they could not find that the performance of green bonds in the secondary market was any different than that of other bonds if currency risks were accounted for. The researchers based the results on 21 green bonds issued between 2014 and 2017.

Baker et al. (2018) studied the primary market for U.S. corporate and municipal green bonds. They found that green municipal bonds were issued at a premium compared to otherwise similar conventional bonds and reported a negative yield premium of -5 to -7 basis points. They based the study on green and conventional bonds issued between 2010 and 2016, and regressed the after-tax yields on green bond indicators and a number of controls.

A paper published by Partridge and Medda (2018) performed a yield curve analysis on a selection of green label municipal bonds that were issued at the same time as conventional municipal bonds by the same issuers. Further, they refined their study to a pair-wise analysis, similarly to Zerbib, in order to check the for a yield differential between pairs of identical bonds. They found a growing trend in primary and secondary green premiums, using both yield curve analysis and pair-wise analysis.

### 3.2.2 Positive yield premium for green bonds

In contrast to the previously mentioned studies, a paper written by Bachelet et al. (2019) estimated a positive green bond premium of 2.06 to 5.9 basis points. The results varied depending on the model used to estimate the premium. The study applied both fixed effect regression and linear regression with varying independent variables and fixed effects. The study was based on a sample of 89 bond pairs. In addition to the higher green bond yield they also reported that green bonds were less volatile than their closest conventional bond correspondents. The study further narrowed the analysis of the green bond premium by looking into the differences of institutional and private issuers. They found that green bonds issued by institutions traded at a negative premium and were far more liquid, whereas private green bonds had a positive premium and were less liquid than their conventional peers. An interesting finding was that the premium for private green bonds changed sign when only considering private issuers with a documented "greenness" certification of the bond.

Another study that indicated a positive green bond premium was the study conducted by Karpf and Mandel (2018). They found that the overall mean spread in returns between conventional and green matched bonds was 23 basis points. The study further reported that although returns on conventional bonds were higher on average than the green bonds', this spread could to a large extent be explained by properties of the respective issuing entity and of the bond. The "green nature" of the bond seemed to be penalised by the market, as green bonds were traded at lower prices, or higher yield, than would otherwise be expected given their credit profiles.

# 4 Data and Methodology

This section describes the data and methodology used in order to investigate our hypotheses. Our analyses is divided into three main parts, which are the primary market analysis, the secondary market analysis and the Green Focus analysis. The two first analyses use linear and fixed effects regression models on green bond data from the Norwegian and Swedish stock exchanges. The model specifications and data included in the models are varied in order to capture the green bond yield premium accurately. The third analysis uses annual reports from Norwegian and Swedish bond issuers as data and textual analysis methods to find differences in the companies' environmental focus.

## 4.1 Primary market analysis

This analysis explores the issue yields of green bonds compared to conventional bonds in the primary capital market. The primary capital market is where firms sell new bonds and stocks to investors (Chisholm, 2009). These issues are often done with the assistance of investment banks who help the company find large, institutional investors wanting to buy the security. The demand from these investors determines the price at which the security will be issued. Thus, if there is a high demand from these primary market investors, the issue price of the security will be high. For bonds, this translates to a low issue yield as yield and price are inversely related (Lamy and Thompson, 1988). From the issuer perspective, this means that the cost of issuing the bond is lower as the yield for investors is lower. If the demand is low, on the other hand, the price at issuance will be low and the yield will be high. From the issuer's perspective, this means that the cost of issuing will be high.

### 4.1.1 Data

In building our data set, we started by downloading a list of green and conventional bonds listed on the Norwegian and Swedish stock exchange from Stamdata. Since the sample mainly consisted of bonds issued in the local currencies, we only included bonds in NOK and SEK. We could have included all currencies and then added fixed effects for currency in the regression models, but as there were very small samples of the other currencies

their coefficient estimates would most likely not be of statistical significance. In addition, the exclusion of non-local currencies removed relatively few bonds from the sample.

Further, we downloaded data on bond characteristics such as issuer, issue yield, issue price, issue date, maturity date, coupon at issuance, coupon type, coupon frequency collateral and green indicator from Bloomberg and Thomson Reuters Eikon. Some information was not available for all bonds in our initial sample. If the issue yield was not reported for a bond, we computed it using issue price, maturity, coupon and coupon frequency. If neither issue yield nor issue price was reported, however, we deleted it from the sample. The resulting data set consisted 128 green bonds and 2588 conventional bonds from 639 companies, spanning issue dates from 1993 to 2019. Figure 4.1 shows a plot of the data points in the sample.

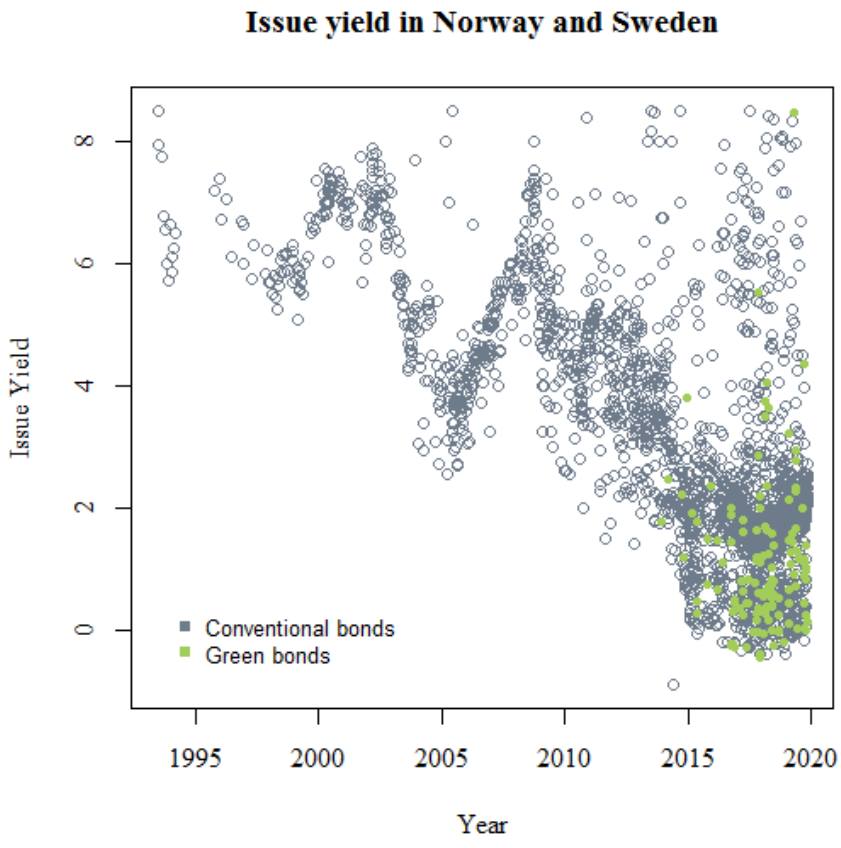


**Figure 4.1:** The green and conventional bonds in the primary market sample

The green and conventional bonds differ slightly in their characteristics. Tables 4.1 and 4.2 show the Norwegian green and conventional bonds in the sample. As can be seen,

the average issue yield for the green bonds is lower than the average issue yield for the conventional bonds, which is to be expected given the higher historical yields of conventional bonds seen in Figure 4.1. Further, the green bonds have longer maturities, with a 1.5 years higher average. The average issue amount of the conventional bonds is almost double the size of the green bonds' average issue amount. However, the green bonds have a higher 25 percent and 75 percent percentile, indicating that the higher average issue amount for conventional bonds is due to some considerably sized outliers. The average coupon of the green bonds is generally lower and has less variation than that of the conventional bonds in the sample.

**Table 4.1:** Primary market green bonds sample, Norway

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Issue Yield (%) | 18 | 2.66 | 0.97 | 1.64 | 2.01 | 2.94 | 5.54 |
| Maturity years | 18 | 7.16 | 2.90 | 3.13 | 5.00 | 8.32 | 15.01 |
| Amount issued (mill.) | 18 | 747.22 | 485.82 | 100 | 325 | 975 | 2,000 |
| Coupon (%) | 18 | 2.66 | 0.97 | 1.64 | 2.00 | 2.94 | 5.54 |

**Table 4.2:** Primary market conventional bonds sample, Norway

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Issue Yield (%) | 1,857 | 3.25 | 1.83 | 0 | 1.8 | 4.6 | 8 |
| Maturity years | 1,857 | 5.58 | 3.24 | 1.15 | 4.00 | 6.05 | 60.04 |
| Amount issued (mill.) | 1,857 | 1,133.84 | 5,332.84 | 30 | 175 | 699.9 | 92,000 |
| Coupon (%) | 1,857 | 3.25 | 1.83 | 0 | 1.8 | 4.6 | 8 |

Tables 4.3 and 4.4 show the Swedish green and conventional bonds in the sample. Here too, we can see that the green bonds have a lower average issue yield than the conventional bonds in the sample. In contrast to the Norwegian bonds in the sample, we can see that the green and conventional bonds from Sweden have fairly similar maturities with similar averages and percentiles. There is a great difference in average issue amounts, but the 25 percent and 75 percent percentiles are fairly similar which indicates that the larger average for the conventional bonds is due to some considerable outliers. Here too, the average coupon is larger for conventional bonds than for green bonds.

Comparing the Swedish and Norwegian bonds we can see that the average issue amounts are higher in the Norwegian samples. However, the 25 percent and 75 percent percentiles

are more similar. There are far lower issue yields and coupons in the Swedish bond samples, measured both in averages and in percentiles. Given Sweden's low interest rate levels, and even negative interest rates in later years, this is to be expected.

**Table 4.3:** Primary market green bonds sample, Sweden

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Issue Yield (%) | 110 | 0.93 | 1.13 | -0.43 | 0.30 | 1.28 | 8.47 |
| Maturity years | 110 | 4.44 | 1.32 | 2.00 | 3.00 | 5.01 | 10.01 |
| Amount issued (mill.) | 110 | 633.55 | 604.67 | 100 | 300 | 737.5 | 5,250 |
| Coupon (%) | 110 | 1.04 | 1.05 | 0.13 | 0.45 | 1.28 | 8.47 |

**Table 4.4:** Primary market conventional bonds sample, Sweden

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Issue Yield (%) | 731 | 1.99 | 2.06 | -0.88 | 0.43 | 3.34 | 8.51 |
| Maturity years | 731 | 4.85 | 3.60 | 0.69 | 3.00 | 5.01 | 62.04 |
| Amount issued (mill.) | 731 | 3,905.69 | 15,926.84 | 5 | 275.5 | 777.5 | 137,997 |
| Coupon (%) | 731 | 2.04 | 2.00 | -0 | 0.6 | 3.4 | 9 |

### 4.1.2 Regression model

For the primary market analysis we use linear regression models with a varying number of included variables and fixed effects. The initial regression is as follows:

$$IssueYield_B = \beta Green_B + \beta Green_B * Exchange_B + \beta FE_B + \epsilon \tag{4.1}$$

The dependent variable, $IssueYield$, is the bond's yield at issuance. $Green$ is an indicator variable equaling 1 if the bond is labeled as green, 0 if not. $Green$ is also included in an interaction term with $Exchange$, which is an indicator variable for the exchange of which the bond is listed (NO for Norwegian or SE for Swedish).This is added in order to capture the possible variation in the effect of a bond being green on the Norwegian and Swedish exchanges. $FE$ are different fixed effects that may affect the issue yield of a bond. This includes bond specific characteristics such as maturity, issue amount, coupon type, seniority (risk) and time period of issuance. In addition to the bond specific characteristics, a fixed effect for issuer are included. This is to capture company related

factors that may affect the issue yield, such as a company's reputation, size, sector and industry.

In order to include fixed effects for issue amount and maturity, which are inherently numerical and continuous variables, we created categorical variables. We created five categories for issue amount, with category 1 being assigned to a bond if its issue amount was among the 20 percent smallest values issued up until that point in time. Consequently, the bond was assigned category 2 if the issue amount was between the 20 percent smallest and 40 percent smallest amounts issued up until the date of issuance, and so on. For the maturity categories we divided the bonds into short, medium and long term. A bond was assigned the short term category if its maturity was less than 5 years, the medium category if its maturity was between 5 and 10 years, and the long term category if its maturity was 10 years or more.

A table of variable definitions can be found in section A1.1 of the Appendix.

## 4.2 Secondary market analysis

This analysis explores whether there is a yield premium for green bonds in the secondary market. The secondary capital market is where securities are traded after a company has issued their stock or bond in the primary capital market (Chisholm, 2009). As opposed to the primary market, small and private investors can buy securities in the secondary market. The price of the securities in this market will fluctuate with demand. Thus, if there is high demand for a bond in the secondary market the bond price will increase, which translates to a decrease in yield.

### 4.2.1 Data and matching method

In this analysis only bonds from issuers that have issued both green and conventional bonds are included, as opposed to the previous analysis which also included bond issuance from companies with only green or conventional bonds. The reason is that this analysis investigates the yield difference between pairs of bonds, one green and one conventional, with similar characteristics. The idea is that if the bonds are similar in their characteristics, they should have the same yield. If there is a difference in yield, however, it can be explained by the only differing characteristic, which would be the green label. This method

is known as *the matching method*, which is a statistical technique that seeks to find the effect of a treatment by comparing each treated unit with a non-treated unit with the same characteristics (Rosenbaum and Rubin, 1983). In this case, the treatment is a bond being green and the method is used to find its effect.

The first part of collecting data for this analysis was similar to the one described in the primary market analysis. We started by downloading lists from Stamdata of all green and conventional bonds listed on the Norwegian and Swedish stock exchanges. This data contained both issuer-specific information such as company name, country of origin and industry, and bond-specific information including issue date, maturity date, seniority and currency. Also for this analysis we excluded bonds listed in non-local currencies, for the same reasons as those previously stated. Further, bonds with missing information and bonds from companies that had issued only green or only conventional bonds were removed.

Because of the limited amount of data available, we included both fixed rate and floating rate bonds. This may cause a bias in the estimation of the yield premium if the yields differ significantly between the two coupon types. However, as a robustness check we plotted the distributions of the yield for fixed and floating rate bonds, which showed fairly similar distributions between the different bond types (see Figure A2.1 in the Appendix). Also, the possible bias that the coupon types may have on our results may be partly controlled for in the regression model by adding coupon type fixed effects. Overall, the first part of the data preparation resulted in 29 green and 1831 conventional bonds in the Norwegian market sample, and 152 green and 991 conventional bonds in the Swedish market sample.

Then, the bonds were matched into pairs. Each green bond was to be matched with one conventional bond with regards to a number of criteria on the bonds' characteristics. Ideally, all the bonds' characteristics would be the same except for the green label. This would increase the comparability of the bonds, mitigating the possibility that the difference in yield was due to other factors than the green label. However, the green bonds that did not have a conventional counterpart that met the matching criteria were removed from the sample and while some of the characteristics could easily be matched exactly, others could not. Thus, determining the criteria involved a trade-off between more precise

matches on one hand and eliminating too many observations on the other, and it was necessary to introduce some slack in the criteria. The resulting matching criteria are listed in Table 4.5.

**Table 4.5:** Matching criteria

| Bond characteristic | Criteria |
|---|---|
| Issuer | Same |
| Bond structure | Same |
| Coupon type | Same |
| Seniority | Same |
| Collateral | Same |
| Issue year | +/- 2 years |
| Maturity in years | +/- 2 years |
| Amount issued | +/- 400 % |
| Coupon rate | +/- 0.30 bps |

Having slack in the criteria introduces the risk of biases in our model. That is, the risk that the estimated yield difference between green and conventional bonds is due to some other factor than a bond being green. Having differences in maturity between the pairs may lead to a maturity bias, as bonds with a higher maturity have a higher yield. In addition, differences in amount issued may result in a liquidity bias, as bonds with larger issue amounts are often more liquid, which gives a lower yield. This is not optimal, alas inevitable, as matching the bonds exactly on all characteristics would exclude nearly all bonds. Also, the regression model may somewhat control for these potential biases through fixed effects variables.

We could have controlled for maturity differences between the green and conventional bonds by creating synthetic bonds with the same maturity as the green bonds. This method might have increased the precision of the matches in the sample. However, using this method would also greatly reduce the data in our sample both because we would exclude all the issuers with only one conventional bond, and because we would need two conventional bonds that were adequately similar to the green bond instead of one. Thus, we decided not to use this method in order to get as many matches in our sample as possible. Consequently, the matching process left us with 18 pairs of Norwegian green and conventional bonds and 143 pairs of Swedish green and conventional bonds, both samples consisting of bonds issued between 2012 and 2019. Lists of the included bonds can be

found in sections A2.1 and A2.2 of the Appendix.

In order to conduct analysis on the yields of the bonds, we downloaded daily data on ask yield to maturity, bid price, ask price and bid-ask spread from Bloomberg for each bond in both samples. We chose to use quoted bid and ask prices instead of trading prices as the trading prices would be missing for days without trades, which would substantially reduce the amount of data in our sample. Bid-ask spread was included as a liquidity proxy, the rationale of which is further discussed in the method section. Within each pair, we ensured that there were equal daily data points, starting from the issue date of the latest issuance in the pair and ending at the download date November 1st 2019. This left us with unbalanced panel data sets for Norway and Sweden, with the earliest observation of daily prices being 1st of January 2014 in both samples.

As these bonds were matched with regards to their characteristics, the descriptive statistics of the green and conventional samples were expected to be fairly similar. This proved to be the case, as can be seen in Tables 4.6-4.9. In contrast to the green and conventional bond samples in the primary analysis, which were considerably different in their average maturity and issue size, the secondary market samples has quite similar characteristics. The green bonds have slightly higher yields and smaller issue amounts on average in both markets. They also have a higher bid-ask spread, indicating a lower liquidity for green bonds compared to conventional bonds in both markets.

There is more variation when comparing the different markets. The average maturity of Norwegian bonds is around 2 years higher than that of Swedish bonds. Furthermore, issue amounts are generally higher in the Norwegian sample. Also, the average yield is higher for the Norwegian bonds compared to the Swedish bonds. However, it would seem the Swedish sample has some considerable outliers considering the wide spread of the min and max ask yield compared to the percentiles. The bid-ask spread is generally lower for the Swedish bonds, which indicates a slightly better liquidity in the Swedish bond market than in the Norwegian bond market.

**Table 4.6:** Secondary market green bonds sample, Norway

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Daily Bid | 5,933 | 99.90 | 1.48 | 95.44 | 99.41 | 100.42 | 107.25 |
| Daily Ask | 5,933 | 100.18 | 1.40 | 95.76 | 99.75 | 100.60 | 107.60 |
| Daily Ask Yield | 5,933 | 2.26 | 0.70 | 1.02 | 1.82 | 2.60 | 3.93 |
| Bid-Ask Spread | 5,933 | 0.29 | 0.20 | 0.01 | 0.17 | 0.34 | 1.34 |
| Maturity | 5,933 | 6.56 | 2.18 | 2 | 5 | 8 | 10 |
| Amount issued (mill) | 5,933 | 1,398.76 | 830.81 | 75 | 500 | 2,000 | 3,000 |

**Table 4.7:** Secondary market conventional bonds sample, Norway

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Daily Bid | 5,933 | 100.90 | 2.65 | 95.87 | 99.79 | 100.90 | 112.40 |
| Daily Ask | 5,933 | 101.16 | 2.63 | 96.20 | 100.10 | 101.11 | 112.73 |
| Daily Ask Yield | 5,933 | 2.04 | 0.57 | 0.51 | 1.61 | 2.46 | 3.23 |
| Bid-Ask Spread | 5,933 | 0.26 | 0.18 | 0.00 | 0.13 | 0.35 | 0.83 |
| Maturity | 5,933 | 6.55 | 2.10 | 3 | 5 | 10 | 10 |
| Amount issued (mill) | 5,933 | 1,492.16 | 1,000.99 | 200 | 458 | 2,000 | 3,000 |

**Table 4.8:** Secondary market green bonds sample, Sweden

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Daily Bid | 81,314 | 101.01 | 1.50 | 96.61 | 100.00 | 101.66 | 108.30 |
| Daily Ask | 81,314 | 101.24 | 1.54 | 97.21 | 100.14 | 101.95 | 108.81 |
| Daily Ask Yield | 81,314 | 0.27 | 0.54 | -4.44 | -0.07 | 0.51 | 4.50 |
| Bid-Ask Spread | 81,314 | 0.24 | 0.16 | 0.00 | 0.12 | 0.35 | 1.26 |
| Maturity | 81,314 | 4.47 | 1.30 | 2 | 3 | 5 | 7 |
| Amount issued (mill.) | 81,314 | 688.52 | 526.65 | 100 | 350 | 920 | 6,000 |

**Table 4.9:** Secondary market conventional bonds sample, Sweden

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| Daily Bid | 81,314 | 100.91 | 1.40 | 96.89 | 100.00 | 101.44 | 108.30 |
| Daily Ask | 81,314 | 101.09 | 1.44 | 97.41 | 100.08 | 101.67 | 108.59 |
| Daily Ask Yield | 81,314 | 0.16 | 0.50 | -6.03 | -0.12 | 0.37 | 3.71 |
| Bid-Ask Spread | 81,314 | 0.18 | 0.13 | 0.00 | 0.07 | 0.28 | 1.46 |
| Maturity | 81,314 | 4.22 | 1.20 | 2 | 3 | 5 | 8 |
| Amount issued (mill.) | 81,314 | 807.93 | 2,249.55 | 100 | 250 | 700 | 29,527 |

The market samples also differ in their industry compositions, as illustrated by Figures 4.2 and 4.3. In the Norwegian sample most bonds are issued by companies in the utility

industry, representing 44 percent of the total 36 bonds. Real estate companies are the second largest industry, accounting for 22 percent of the bonds, and the banking industry is third largest with 17 percent of the bonds in the sample. 2 pairs of Norwegian bonds have issuers in the public sector, and only 1 pair is issued by a company in the consumer services industry. In the Swedish sample most bonds are issued by companies in the real estate industry, which has a share of 61 percent of the total sample of 286 bonds. Second largest is the public sector industry, with 24 percent of the bonds. The banking industry accounts for 7 percent of the sample, and the rest come from the transportation, utilities and forestry industries.

The Norwegian and Swedish samples are more similar when considering the sector allocations. The biggest sector in both markets is by far non-financial corporations, accounting for 71 and 72 percent of the bonds issued in the Norwegian and Swedish samples, respectively. The second largest sector in Norway is the financial sector with 17 percent of the bonds, while government is third with 11 percent. The Swedish sample has government as second biggest, with a 22 percent share, and the financial sector as third, with the remaining 6 percent of the sample.

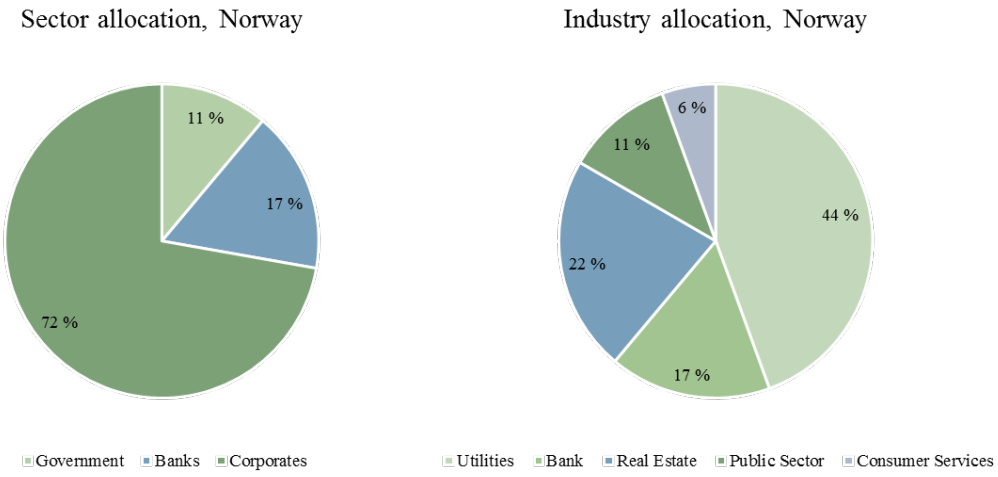


**Figure 4.2:** Sector and industry allocation of the Norwegian sample

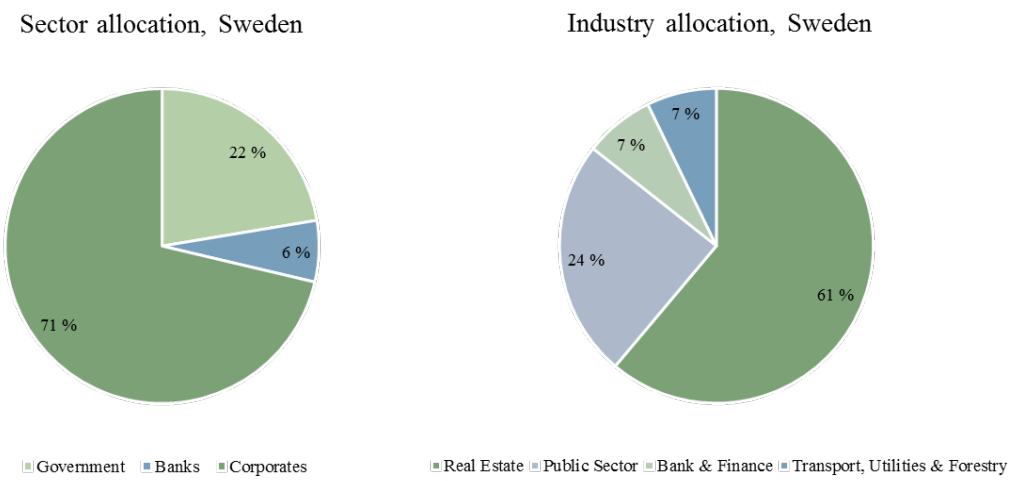


**Figure 4.3:** Sector and industry allocation of the Swedish sample

### 4.2.2 Regression model

For the secondary market analysis we use a similar regression as the one used in the primary market analysis, with three main exceptions. First, the dependent variable is daily ask yield instead of issue yield. Second, the bid-ask variable is added to the model in order to account for daily liquidity differences. Third, the variable indicating which exchange the bond is listed on is not included because the model is run on the Norwegian and Swedish markets separately.

$$AskYield_{B,t} = \beta Green_B + \beta BidAsk_{B,t} + \beta FE_B + \epsilon \tag{4.2}$$

The dependent variable, $AskYield$, is the ask yield to maturity of a given bond on a given day, determined by the level of the quoted ask price. The independent variable $Green$ is a dummy variable equal to 1 if the bond is green. $BidAsk$ is the bid-ask spread for a given bond on a given day. This variable is added as a liquidity proxy, which is consistent with the finding of Fong et al. (2017) that bid-ask spread is the preferred liquidity proxy when working with low-frequency data. The $BidAsk$ variable thus controls for the residual liquidity difference not captured in the matching procedure. $FE$ are different fixed effects, and they are mainly the same as in the primary analysis model. A table of the variable definitions can be found in Table A2.3 of the Appendix.

## 4.3 Green Focus analysis

The third and final analysis in our study investigates the differences in *Green Focus* between Swedish and Norwegian companies, and explores the possibility that this might explain differences in green bond yield premiums and green bond issuance in these markets. We define a company's Green Focus as their focus on the environment and sustainability, the measurement of which is done using textual analysis.

Intuitively, a high Green Focus in a company might be related to a negative green bond yield premium in the primary and secondary markets. This could be due to the fact that a company who openly prioritises environmental and climate concerns would appear more credible to investors wanting to invest in green bonds than companies that do not communicate that they prioritise such concerns. In addition, a high Green Focus may also be related to more issuance given that companies with a higher environmental focus are more likely to invest in projects eligible for green bond financing.

Note the use of the words *openly* and *communicate*. Generally, companies control the information that reaches investors through their announcements, reports, presentations, etc. Thus, if a company does in fact prioritise environmental concerns but does not consciously communicate it to investors through these channels, it might not have an impact on the investors' view of the credibility of the company. It is reasonable to assume, however, that companies are very conscious in what they communicate, and that positive aspects of a company such as a Green Focus will be well communicated.

This forms the basis of the final analysis. Assuming that a company with a green focus will try to communicate that effort to investors, a company's Green Focus can be measured using textual analysis on annual reports. Annual reports are thorough accounts of the operations and prospects of a company, and they communicate a company's priorities both during the year and moving forward. Annual reports are public, and therefore available for all existing and potential investors. Thus, we can use textual analysis on the annual reports of Norwegian and Swedish companies in order to find possible differences in Green Focus.

### 4.3.1 Data

We started by downloading all available annual reports from Norwegian and Swedish companies that had issued green bonds, hereafter called *Green Companies*. Not all of the companies in our initial Green Company samples had public annual reports, for instance private and governmental companies. Excluding these, the resulting Green Company samples were 18 Norwegian and 40 Swedish companies. Downloading the annual reports from these companies generated samples of 166 Norwegian company annual reports from the period 2000 until 2018, and 470 Swedish company annual reports form the period 1997 until 2018.

Having prepared the Green Company data we had to identify samples of companies with only conventional bonds, *Grey Companies*, to be used as a benchmark. We attempted to create samples with similar industry compositions as the Green Company samples, so that the Green and Grey Companies would be comparable. In order to get as much data as possible we also prioritised companies with many available annual reports. The resulting data samples consisted of 30 Norwegian and 36 Swedish Grey Companies with 327 and 367 annual reports from the same period as the respective Green samples. See Table A3.3 in the Appendix for a full list of the included companies.

### 4.3.2 Textual analysis

In order to analyse the downloaded data we built a textual analysis model in the open source statistical program R. Our model examined the downloaded annual reports for each company, extracting the Green Focus in each report. The code for the model can be viewed in Section A3.4 of the Appendix.

We measured Green Focus by calculating the number of *green words* used in the annual reports in ratio to the total number of words in the reports. The green words were determined by a dictionary defined by us, including a wide range of words related to climate, environment, waste, and so on. We based the choice of words in the dictionary on the UN's publicly available Global Sustainable Development reports. The dictionaries can be seen in Table A3.2 in the Appendix.

In order to capture the use of these words to a full extent, the words in both the

dictionary and in the reports were stemmed. For instance, the words “environmental”, “environmentally” and “environment” were all stemmed to “environmen”, which results in each version of the word being counted. We used dictionaries in English, Norwegian and Swedish, determined by the language of the report in question.

The model computed the ratio of green words, or Green Focus, for each company in each year. The average ratio for the companies in the Green and Grey Company samples were then computed, representing the average yearly Green Focus for each sample. Thus, we had yearly observations of Green Focus for the Green and Grey Companies in each country.

### 4.3.3 Regression model

In order to estimate the trend in Green Focus for the different countries we used a linear regression model. The model regression is defined in equation (4.3).

$$GreenRatio_t = \beta Year_t + \epsilon \tag{4.3}$$

$GreenRatio$ is the average ratio of green words to the total number of words in the reports for a sample in a certain year. $Year$ is a continuous variable for the year of the annual reports, added in order to capture the trend of Green Focus over time.

# 5 Results

This section presents the results of our three analyses. As previously stated, the primary market analysis investigates whether there is an issue yield premium for green bonds and whether this premium differs between the Norwegian and Swedish green bond markets. The analysis of the secondary market similarly investigates the two markets, only with regards to daily ask yield premiums. The final analysis explores possible differences in Green Focus between Norwegian and Swedish companies.

## 5.1 Primary market analysis

In order to test the first hypothesis, the primary market analysis explores whether there is a yield premium at issuance for green bonds in Norway and Sweden. We use an ordinary least squares (OLS) linear regression model, the equation of which is stated in equation (4.1). As previously mentioned, there are some requirements for interpreting the OLS estimates of a linear model causally. The models in this analysis have been tested for whether the classical linear model assumptions hold, and the findings were that there was a clear presence of heteroscedasticity across all models. Given this, heteroscedasticity consistent robust standard errors are used for all the models in order to improve the quality of the estimates. The results of the OLS tests for one of the models can be viewed in detail in section A1.2 in the Appendix.

The four models presented in Table 5.1 are run on the entire data sample with varying fixed effects included. The first model has only fixed effect on issuer, and finds a greatly significant negative coefficient for the *Green* variable. This indicates that green bonds have a -77.8 basis points lower yield than conventional bonds at issuance. Including fixed effects for issue year greatly reduces the magnitude and erases the significance of the negative premium, which implies that a bond being green does not have a significant effect on its issue yield. In model (3) all fixed effects variables are included. We can see that the negative green bond premium estimate increases compared to the second model, although it is still not statistically significant. Across all models we see significant and negative coefficients on $ExchangeSE$, which shows that issue yields in Sweden are lower in general than issue yields in Norway. This is consistent with the descriptive statistics

shown in Tables 4.1-4.4 in Section 4.1.1.

The only difference between model (3) and (4) is that in model (4) we include an interaction term between *Green* and *Exchange* in order to capture the market-specific effects of being green. As can be seen, this has a notable effect. The coefficient on *Green* goes from being non-significant and negative in model (3) to estimating a 15.7 basis points positive yield premium for green bonds, although the effect is not statistically significant. This, however, is the estimation for the green bonds listed in Norway. To get the estimation for green bonds listed in Sweden, the interaction term needs to be taken into account. The model estimates a negative premium of -12.8 basis points for green bonds in Sweden, and the effect is significant at the 5 percent level. Thus, the model indicates that there is no issue yield difference between green and conventional bonds in Norway, and that there is a negative issue yield premium for green bonds in Sweden[1]. This model has the highest r-squared out of the four.

[1]In untabulated results, we have also tried using year-month fixed effects in order to increase the precision of our estimate. Our results remain similar – economically and statistically different at-issuance yield rate for green bonds in Sweden. However, the reader should be cautioned that fixed effects defined at such a granular level may be inappropriate given the relatively small size of our sample.

**Table 5.1:** Primary market regression results with varying fixed effects

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Issue Yield | | | |
| | (1) | (2) | (3) | (4) |
| Green | -0.778*** | -0.035 | -0.079 | 0.157 |
| | (0.135) | (0.072) | (0.058) | (0.127) |
| Exchange SE | -0.558* | -1.403*** | -1.230*** | -1.223*** |
| | (0.299) | (0.210) | (0.149) | (0.149) |
| Green * Exchange SE | | | | -0.285** |
| | | | | (0.141) |
| Constant | 5.850 | 5.699*** | 5.915*** | 5.923*** |
| | | (0.525) | (0.636) | (0.637) |
| Issuer FE | Yes | Yes | Yes | Yes |
| Year FE | No | Yes | Yes | Yes |
| Seniority FE | Yes | Yes | Yes | Yes |
| Coupon Type FE | Yes | Yes | Yes | Yes |
| Maturity FE | Yes | Yes | Yes | Yes |
| Issue Amount FE | Yes | Yes | Yes | Yes |
| Observations | 2,716 | 2,716 | 2,716 | 2,716 |
| $R^2$ | 0.711 | 0.956 | 0.970 | 0.970 |
| Adjusted $R^2$ | 0.629 | 0.942 | 0.960 | 0.960 |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

The further analysis investigates the effect of limiting the years included in the data sample. Regression (4) in Table 5.2 is the same as regression (4) in Table 5.1. Regression (5) excludes all bonds issued before 2010. As can be seen, this has a considerable effect on the coefficients and their significance. The issue yield premium estimate for Norwegian green bonds is reduced to 0.2 basis points, the effect still not being significant. The estimate for Swedish green bonds is a -7.3 basis points negative premium, and it is no longer statistically significant. Models (6) and (7) control for the effect of excluding bond issuance before 2012 and 2014, respectively. As can be seen, the estimated issue yield premium for Norwegian green bonds is very small and insignificant in these models as well, with a change in sign in model (6). The estimated negative issue yield premium for Swedish bonds diminishes in these models and is not significant in these either.

**Table 5.2:** Primary market regression results with varying subsets

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Issue Yield | | | |
| | (4) | (5) | (6) | (7) |
| Green | 0.157 | 0.002 | -0.018 | 0.008 |
| | (0.127) | (0.096) | (0.106) | (0.103) |
| Exchange SE | -1.223*** | -1.320*** | -1.299*** | -1.427*** |
| | (0.149) | (0.162) | (0.180) | (0.215) |
| Green * Exchange SE | -0.285** | -0.075 | -0.037 | -0.014 |
| | (0.141) | (0.115) | (0.125) | (0.124) |
| Constant | 5.923*** | 4.065*** | 3.546*** | 2.391*** |
| | (0.637) | (0.252) | (0.267) | (0.319) |
| Data subset | All | As of 2010 | As of 2012 | As of 2014 |
| Issuer FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Seniority FE | Yes | Yes | Yes | Yes |
| Maturity FE | Yes | Yes | Yes | Yes |
| Issue Amount FE | Yes | Yes | Yes | Yes |
| Coupon Type FE | Yes | Yes | Yes | Yes |
| Observations | 2,716 | 2,221 | 2,095 | 1,893 |
| $R^2$ | 0.970 | 0.964 | 0.965 | 0.965 |
| Adjusted $R^2$ | 0.960 | 0.952 | 0.953 | 0.953 |
| *Note:* | | | | *p<0.1; **p<0.05; ***p<0.01 |

A final analysis was made in order to investigate the magnitude and variation of the green bond issue yield premium over time. In order to do this, we added an interaction term of $Green$ and $Month - Year$ to model (5) in Table 5.2. The premium is plotted in Figure 5.1. The first years in the plot are based on few data points due to little issuance. Still, it is apparent that the issue yield premium of green bonds has been very volatile since the first issuance. The grey lines show the 95 percent confidence intervals of the premium at different times, and the considerable distance between these lines further show that the estimates are quite uncertain and volatile. It is worth noting that this is the average yield premium in Norway and Sweden combined.

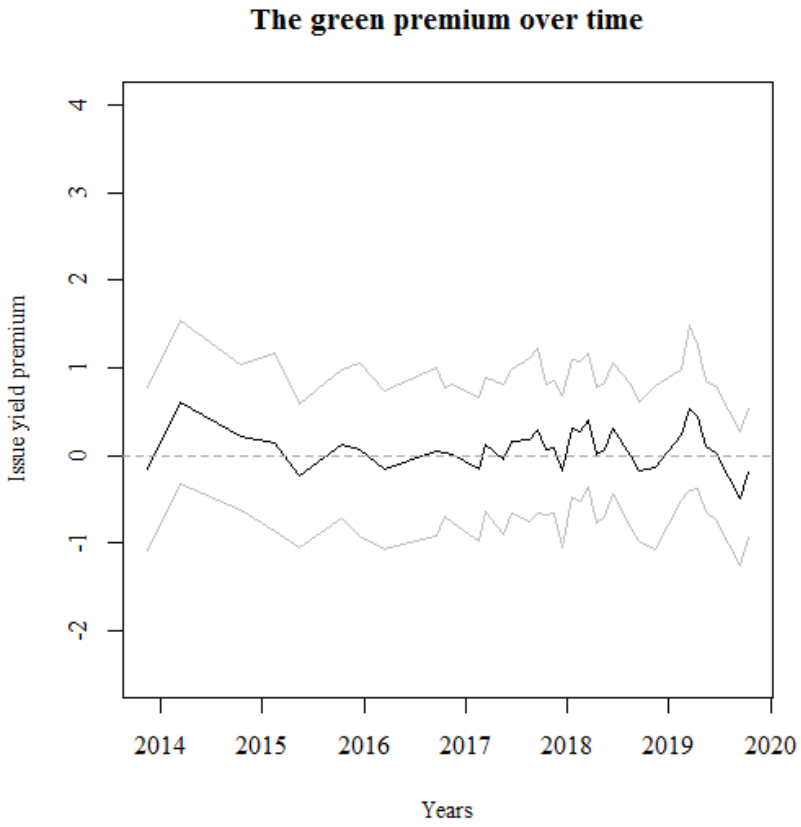


**Figure 5.1:** The green bond issue yield premium over time

## 5.2 Secondary market analysis

In order to study the accuracy of the second hypothesis, this section explores the green bond yield premium in the Norwegian and Swedish secondary market. We use an ordinary least squares fixed effects regression model, as stated in equation (4.2). As stated, there are some assumptions that need to hold for these estimations to be interpreted causally, which the models have been tested for. The findings were that there was a clear presence of autocorrelation and heteroskedasticity. Hence, robust standard errors are used in order to correct for the presence of these biases. Section A2.4 in the Appendix provides an overview of the test results for one of the models.

### 5.2.1 Norway

The three models in Table 5.3 show the regression of equation (4.2) on the entire sample of Norwegian paired bonds. The first model includes only fixed effects on year and month,

and estimates a significant yield premium of 10.8 basis points for Norwegian green bonds. The estimate increases to 15.5 basis points in model (2) when fixed effects for issuer and general bond characteristics are added, still significant at the 1 percent level. In model (3) all fixed effects are accounted for, and the green bond premium estimate decreases slightly to 15.1 basis points, significant at the 1 percent level. This model has the highest $R^2$ of the three models.

The liquidity proxy, or bid-ask spread, is positive and significant across the three models. This indicates that a higher bid-ask spread, and hence a lower liquidity, will result in a higher yield. Thus, our model shows that the market compensates low liquidity with a liquidity premium, which is consistent with the findings of previously published studies cited in Section 3.1.1.

**Table 5.3:** Secondary market regression results with varying fixed effects, Norway

| | *Dependent variable:* | | |
|---|---|---|---|
| | Ask Yield to Maturity | | |
| | (1) | (2) | (3) |
| Green | 0.108*** | 0.155*** | 0.151*** |
| | (0.022) | (0.010) | (0.023) |
| BidAsk | 2.259*** | 0.188** | 0.165* |
| | (0.164) | (0.075) | (0.097) |
| Issuer FE | No | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes |
| Seniority FE | No | Yes | Yes |
| Trustee FE | No | Yes | Yes |
| Coupon type FE | No | Yes | Yes |
| Maturity FE | No | No | Yes |
| Issue amount FE | No | No | Yes |
| Pair ID FE | No | No | Yes |
| Observations | 11,508 | 11,508 | 11,508 |
| $R^2$ | 0.463 | 0.857 | 0.859 |
| Adjusted $R^2$ | 0.461 | 0.856 | 0.858 |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 | | |

In order to get a better understanding of the yield premium for Norwegian green bonds, a subsample analysis on sectors is conducted. Due to the higher r-squared, we have used model (3) in Table 5.3 for the subsample analysis. Table 5.4 shows the results of

the regression on the government sector, bank sector and private corporations sector, respectively. As can be seen, the model estimates a negative green bond premium equal to -10.2 basis points in the government sector, significant at the 1 percent level. In the financial sector the green bond premium is also estimated to be negative, equaling -3.9 basis points, strongly significant at the 1 percent level. In the private corporations sector, on the other hand, the model estimates a positive green bond premium equal to 21.5 basis points, also significant at the 1 percent level.

Contrary to the previously cited studies some of our models, including model (2) in table 5.4, find a negative coefficient on the *BidAsk* variable. This indicates that the market penalises low liquidity with a lower yield. This is quite counterintuitive, and may be explained by the coefficient being based on a small sample of unrepresentative observations.

**Table 5.4:** Secondary market regression results with sector subsets, Norway

| | *Dependent variable:* | | |
|---|---|---|---|
| | Ask Yield to Maturity | | |
| | (1) | (2) | (3) |
| Green | -0.102*** | -0.039*** | 0.215*** |
| | (0.016) | (0.013) | (0.061) |
| BidAsk | 0.157** | -2.276*** | 0.270 |
| | (0.078) | (0.460) | (0.185) |
| Data subset | Government | Bank | Corporate |
| Issuer FE | Yes | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes |
| Seniority FE | Yes | Yes | Yes |
| Trustee FE | Yes | Yes | Yes |
| Coupon type FE | Yes | Yes | Yes |
| Maturity FE | Yes | Yes | Yes |
| Issue amount FE | Yes | Yes | Yes |
| Pair ID FE | Yes | Yes | Yes |
| Observations | 1,024 | 1,942 | 8,542 |
| $R^2$ | 0.505 | 0.930 | 0.828 |
| Adjusted $R^2$ | 0.492 | 0.929 | 0.827 |
| *Note:* | | | *p<0.1; **p<0.05; ***p<0.01 |

The industry composition within the government and financial sector is fairly homogeneous,

mostly consisting of companies in similar industries. In the private corporation sector, on the other hand, there is a lot more variation in the company industries. In order to shed light on the differences within the sector, the same regression as in 5.4 is run on industry subsets of the corporate sector. The results are shown in Table 5.5. For private companies in the consumer service and utilities industries combined, the green bond yield premium is estimated to be 27.3 basis points, strongly significant. For green bonds issued in the real estate industry, the model estimates a positive yield premium of 16.8 basis points.

**Table 5.5:** Secondary market regression results with corporate sector industry subsets, Norway

| | *Dependent variable:* | |
|---|---|---|
| | Ask Yield to Maturity | |
| | (1) | (2) |
| Green | 0.273*** | 0.168*** |
| | (0.032) | (0.029) |
| BidAsk | 0.424*** | -1.399*** |
| | (0.111) | (0.156) |
| Data subset | Consumer/Util | Real Estate |
| Issuer FE | Yes | Yes |
| Month-Year FE | Yes | Yes |
| Seniority FE | Yes | Yes |
| Trustee FE | Yes | Yes |
| Coupon type FE | Yes | Yes |
| Maturity FE | Yes | Yes |
| Issue amount FE | Yes | Yes |
| Pair ID FE | Yes | Yes |
| Observations | 6,842 | 1,700 |
| $R^2$ | 0.865 | 0.851 |
| Adjusted $R^2$ | 0.863 | 0.849 |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 | |

### 5.2.2 Sweden

The same analyses as those conducted on the Norwegian sample are done on the Swedish data. The three models in Table 5.6 show the results of running the regression on the entire sample with varying fixed effects included. The first model has only fixed effect on year and month, and finds a small positive but insignificant yield premium for green bonds

issued in the Swedish market. When including fixed effects for issuer and general bond characteristics in model (2), the yield premium estimate increases slightly and becomes significant at the 10 percent level. In model (3) all fixed effects are included, which has a considerable effect on the yield premium estimate. The model estimates a negative yield premium of -0.5 basis points, significant at the 1 percent level. This model has the highest $R^2$ out of the three.

The liquidity variable is significant and positive across all models, implying that an increase in the bid-ask spread would lead to higher yield. Our model confirms that lower liquidity, or higher bid-ask spread, is compensated in the market with a liquidity premium. This is consistent with economic theory.

**Table 5.6:** Secondary market regression results with varying fixed effects, Sweden

| | *Dependent variable:* | | |
|---|---|---|---|
| | Ask Yield to Maturity | | |
| | (1) | (2) | (3) |
| Green | 0.002 | 0.004* | -0.005*** |
| | (0.002) | (0.003) | (0.002) |
| BidAsk | 1.523*** | 1.599*** | 1.426*** |
| | (0.055) | (0.036) | (0.037) |
| Issuer FE | No | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes |
| Seniority FE | No | Yes | Yes |
| Trustee FE | No | Yes | Yes |
| Coupon type FE | No | Yes | Yes |
| Maturity FE | No | No | Yes |
| Issue amount FE | No | No | Yes |
| Pair ID FE | No | No | Yes |
| Observations | 154,588 | 154,588 | 154,588 |
| $R^2$ | 0.326 | 0.714 | 0.768 |
| Adjusted $R^2$ | 0.325 | 0.714 | 0.768 |
| *Note:* | *p<0.1; **p<0.05; ***p<0.01 | | |

In order to get a better understanding of the yield premium for green bonds in Sweden, the same regression as in model (3) Table 5.6 are run on different sector subsets of the data sample. Table 5.7 shows the results of the regression run on the government sector, financial sector and the private corporation sector. The model estimates a negative green

bond premium for the government sector equal to -1.7 basis points, significant at the 10 percent level. For the financial sector the model estimates a positive green bond premium of 3.5 basis points, significant at the 1 percent level. For private corporations, a negative green bond premium of -1.3 basis points is estimated, also significant at the 1 percent level.

**Table 5.7:** Secondary market regression results with sector subsets, Sweden

| | *Dependent variable:* | | |
|---|---|---|---|
| | Ask Yield to Maturity | | |
| | (1) | (2) | (3) |
| Green | -0.017* | 0.035*** | -0.013*** |
| | (0.010) | (0.010) | (0.002) |
| BidAsk | 0.845*** | 1.415*** | 1.631*** |
| | (0.078) | (0.104) | (0.031) |
| Data subset | Government | Bank | Corporate |
| Issuer FE | Yes | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes |
| Seniority FE | Yes | Yes | Yes |
| Trustee FE | Yes | Yes | Yes |
| Coupon type FE | Yes | Yes | Yes |
| Maturity FE | Yes | Yes | Yes |
| Issue amount FE | Yes | Yes | Yes |
| Pair ID FE | Yes | Yes | Yes |
| Observations | 34,832 | 7,554 | 112,202 |
| $R^2$ | 0.640 | 0.680 | 0.722 |
| Adjusted $R^2$ | 0.639 | 0.678 | 0.722 |
| *Note:* | | | *p<0.1; **p<0.05; ***p<0.01 |

Also in the Swedish sample the government and bank sectors consist of homogeneous companies, while the private corporation sector consists of companies from a range of industries. In order to further narrow the analysis of the Swedish green bond yield premium, the regression is run on subsets of industries within the corporate sector. The results are shown in Table 5.8. The analysis reveals a strongly significant positive yield premium of 6.5 basis points for green bonds in the combined transportation and utilities industry. For companies in the industry labeled as industry, which comprises operations related to infrastructure and renewables, the yield premium is estimated to 7.1 basis points, significant at the 10 percent level. For the real estate industry the green bond

premium is estimated to be negative and equal to -1 basis point, significant at the 5 percent level.

**Table 5.8:** Secondary market regression results with corporate sector industry subsets, Sweden

| | *Dependent variable:* | | |
|---|---|---|---|
| | Ask Yield to Maturity | | |
| | (1) | (2) | (3) |
| Green | 0.065*** | 0.071* | -0.010** |
| | (0.022) | (0.039) | (0.004) |
| BidAsk | 0.472* | -0.489*** | 1.613*** |
| | (0.241) | (0.138) | (0.038) |
| Data subset | Transp/Util | Industry | Real Estate |
| Issuer FE | Yes | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes |
| Seniority FE | Yes | Yes | Yes |
| Trustee FE | Yes | Yes | Yes |
| Coupon type FE | Yes | Yes | Yes |
| Maturity FE | Yes | Yes | Yes |
| Issue amount FE | Yes | Yes | Yes |
| Pair ID FE | Yes | Yes | Yes |
| Observations | 6,593 | 10,536 | 93,691 |
| $R^2$ | 0.736 | 0.670 | 0.731 |
| Adjusted $R^2$ | 0.734 | 0.668 | 0.731 |
| *Note:* | | | *p<0.1; **p<0.05; ***p<0.01 |

## 5.3 Green Focus analysis

The textual analysis tests the third hypothesis by investigating the differences in Green Focus between companies that have issued green bonds, Green Companies, and companies that have only issued conventional bonds, Grey Companies. Assuming that a company will communicate their priorities to investors through their annual reports, Green Focus can be defined as the ratio of green words used in annual reports to the total number of words in the reports. Potential differences in Green Focus between Green and Grey Companies in Norway and Sweden may be instrumental in explaining the variations in green bond yield premiums and green bond issuance in these markets.

### 5.3.1 Norway

Figure 5.2 shows the observation points and regression line for the Green and Grey Company samples in Norway. The regression model estimates a 0.01 percent annual growth in the green word ratio for Green Companies, significant at the 5 percent level. For Grey Companies the model estimates an annual growth in the green word ratio of 0.015 percent, significant at the 1 percent level. This indicates that the growth in Green Focus has been larger on average for companies that have not issued green bonds. However, the estimated constant for Green Companies is considerably larger, indicating that the green word ratio for these companies was initially at a higher level.

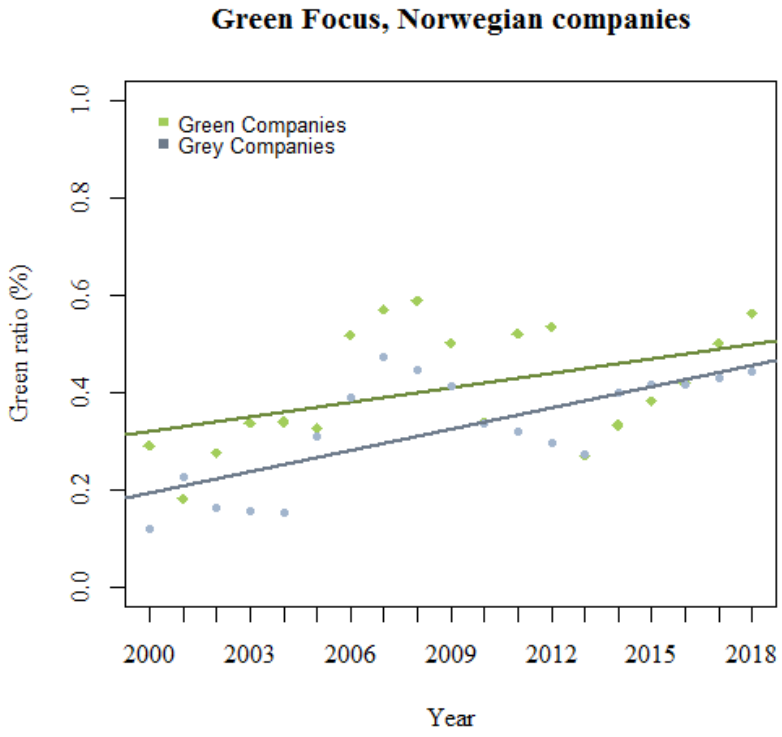


**Figure 5.2:** The Green Focus of Green and Grey Companies in Norway

There is a lot of variation in the observations for both groups, as can be seen in the green and grey observation points. The average growth trend given by the regressions therefore differs from the actual change between years. One can also see that the green data points are mostly plotted above the grey ones, illustrating that the Green Company annual reports indeed have a higher green word ratio than the Grey Company annual reports. As the latest green and grey points in the plot show, the current level of Green Focus for

the Green Companies is about 0.5 percent, while the level for Grey Companies is about 0.4 percent.

Considering the regression lines, one can see that the trend lines for the Green and Grey companies are fairly similar. Consequently, a t-test testing for difference between the samples could not reject the null hypothesis that the annual growth in Green Focus between the groups is the same. A test determining whether the average level of the Green Focus differs between the groups could however reject the null hypothesis, indicating that the Green Companies do have a higher level of Green Focus than the Grey Companies.

### 5.3.2 Sweden

Figure 5.3 shows the observation points and regression lines for Green and Grey Companies in Sweden. The regression model estimates positive growth trends for both groups, with a 0.029 percent annual growth estimated for Green Companies and a 0.007 percent annual growth estimated for Grey Companies. Estimations for both groups are significant at the 1 percent level. The regression estimates a constant of 0.114 percent and 0.231 percent for Green and Grey Companies, respectively. This indicates that the annual growth in Green Focus has been higher for Green Companies, but that these companies started out at a lower level initially. Thus, the Grey Companies are estimated to have a lower growth but a higher starting point.

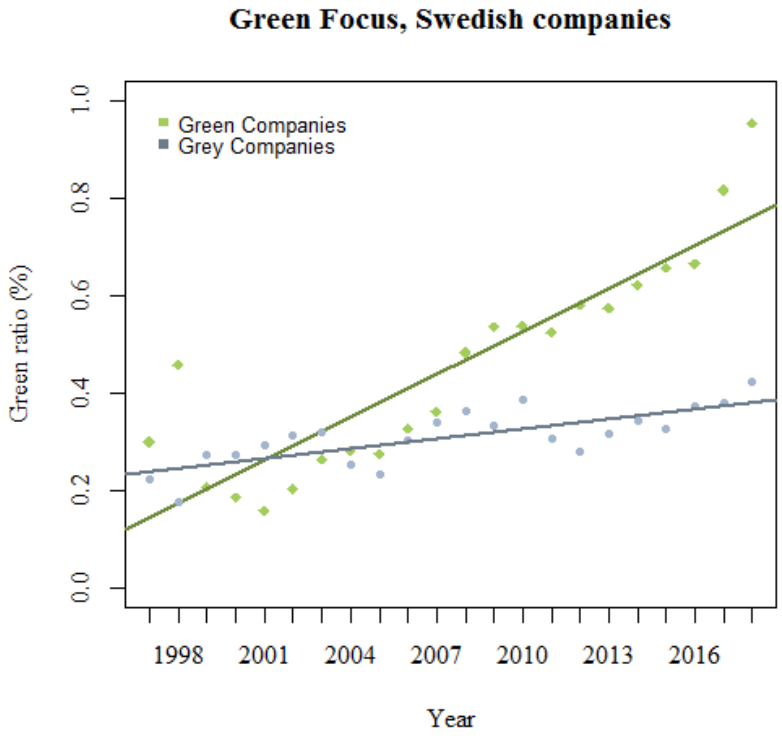


**Figure 5.3:** The Green Focus of Green and Grey Companies in Sweden

The regression results should, however, be interpreted with the observation points in mind. As can be seen, there is a significant growth trend for Green Companies, especially after around 2006. Before this point the green observation points are more scattered. The plot shows that the low constant estimate for the Green Companies is due to the model fitting the overall growth trend, and that there are no observations at this low level. Thus, the regression results must be interpreted with caution. However, the plot also shows that the regression line fits the grey observation points fairly well. The current level of Green Focus is around 0.9 percent for Green Companies and around 0.4 percent for Grey Companies, as can be seen in the last points in the plot.

In a t-test investigating the differences in Green Focus growth between the Green and Grey Company samples the null hypothesis of equal growth was rejected, which is reasonable given the pronounced difference in trends seen in the regression lines. Additionally, a test determining whether the level of the Green Focus differs between the samples could also reject the null hypothesis of equality, implying a higher Green Focus for the Green Companies.

# 6 Discussion

The discussion section elaborates on the results presented in the previous section, examining their validity and their adherence with our initial hypotheses. Specifically, we hypothesised that because of the vastly different evolution of the markets 1) it must be less costly to issue green bonds in Sweden, 2) Swedish investors must have a higher demand for green bonds and 3) Swedish companies must have a higher Green Focus.

## 6.1 Primary market analysis

The initial analysis using all available bond issuance data estimated an insignificant 15.7 basis points issue yield premium for Norwegian green bonds and a significant -12.8 basis points negative premium for Swedish. This result implies that in Norway, the issue yield for green bonds is not different from that of conventional bonds, while there is a significant negative issue yield premium for green bonds in the Swedish market.

When restricting the time period of the data to include only issuance as of 2010, the coefficients and significance of the premiums in both markets were diminished. The yield premium for Norwegian green bonds was estimated to 0.2 basis points, while the premium for Swedish green bonds was estimated to -7.3 basis points. In this model, none of the estimated effects were of statistical significance. This was also the case when restricting the model to only include issuance as of 2012 and 2014.

Intuitively, the greater significance when using all the data compared to using only issuance data as of 2010 results from there being more data on conventional bonds that the model tries to fit. This older data may not be entirely comparable to the green bonds that entered the market around 2014, and considering Figure 4.1 in Section 4.1.1 it is apparent that yields in the early 2000s differed considerably from yields in 2014. This results in the differences in yield between green and conventional bonds being overcalculated due to an outdated estimation of conventional bond issue yields. Thus, when limiting the sample to include only issuance from 2010 and later, the conventional bond data may provide a better basis for finding an accurate green bond premium.

Assuming that the limited models provide the most accurate results, we get an insignificant

and very small positive green bond yield premium in Norway and an insignificant negative green bond yield premium in Sweden. As the effects are not estimated to be significant, the results imply that there are no issue yield differences between green and conventional bonds in Norway and Sweden. Still, across all models the estimated issue yield premium for Norwegian green bonds have been positive, while they have been negative across all models for Swedish green bonds. This could indicate that primary capital market investors in Sweden have been willing to pay more for a green bond than a similar conventional bond, and that these investors in Norway have been willing to pay less for a green bond than a similar conventional one. From the issuer perspective, this translates to a lower issuance cost for green bonds compared to conventional bonds in Sweden, and a higher issuance cost for green bonds compared to conventional in Norway, which is consistent with our hypothesis. In the following, these results are further discussed.

The green bond market in Sweden is far more mature than the green bond market in Norway, which may explain the negative coefficients on the Swedish issue yield premium. Although Norway issued a green bond first in 2010, Sweden has since caught up and has issued more green bonds every year. This may have reduced the greenwashing scepticism in Sweden, as green bonds have become more and more common. In Norway, on the other hand, the instrument is not as common, and investors may not be entirely sure of its validity and value. This would explain the indicated result that Swedish investors are more willing to pay a premium for green bonds than Norwegian investors.

A factor that may explain the insignificance of the results is that the green bond markets in Norway and Sweden are relatively small, which could lead to the instruments being priced similarly as conventional bonds. This might be due to a lack of data on demand for green bonds or former green bond issues. Then, there would be no difference in issue yield between conventional and green bonds. If this is the case for some of the bonds in this sample, it would explain why the estimations on issue yield premiums are not significantly different from zero.

Furthermore, the added liquidity risk of the green bonds may explain why we did not find a negative issue yield premium in the Norwegian bond market. As seen in the descriptive statistics, the green bond issued amounts in the sample are smaller on average than those of the conventional bonds. In addition to the fact that the green bond market is far less

mature than the conventional bond market, this leads to a lower liquidity which increases the risk of holding the instrument. Thus, Norwegian primary market investors may not be willing to pay a premium for these bonds.

The insignificant premium estimates may also be explained by the volatility of the green bond issue yield premium. Figure 5.1 in Section 5.1 provides evidence that the magnitude of the premium has varied significantly over time, changing between negative and positive signs in different periods. Thus, it may be hard to find a significant constant effect over time.

An important limitation for this analysis is that the availability of data constricts the quality of the results. There are relatively few green bond issuances in Norway and Sweden initially, and the sample was further restricted by the issue yield or issue price data requirement. This resulted in a data set with only 128 green bond observations, of which 18 were listed at a Norwegian stock exchange. Thus, the findings in the analysis may be biased due to the low number of observations. Naturally, the quality of the results would have improved with more data.

## 6.2 Secondary market analysis

The results of our secondary market analysis support our initial hypothesis of a higher demand for green bonds among investors in Sweden. Our model estimated a negative yield premium in Sweden and a positive yield premium in Norway. Narrowed down to the sector level, we found that Swedish investors are willing to pay more for green bonds in the corporate sector compared to Norwegian investors, while the opposite holds for the bank sector. Both markets have an estimated negative yield premium for green bonds issued by governmental entities. The differences and validity of these results will be further discussed in this section.

In Sweden, the green bond yield premium in the secondary market was estimated to be significant and negative equal to -0.5 basis points. A negative yield premium for Swedish green bonds indicates that they are priced higher than similar conventional bonds on average in the secondary market. The estimated effect may reflect a growing interest for green bonds among investors, resulting in higher demand and thus higher prices. This could arise from changing preferences among Swedish investors, which could be the case if

the benefits of investing in a green bond offset the lower cash flow. These benefits could be related to increased brand value, or simply personal preference.

In the Norwegian secondary market green bonds are estimated to trade at 15.1 basis points higher yields than comparable conventional bonds on average. This result could indicate that Norwegian investors do not have an interest in green investing, which lowers the demand and reduces the price of these bonds. It could also imply that Norwegian investors distrust the green label and doubt the credibility of the issuers. Substantial parts of the Norwegian bond market in general are made up by bonds from companies in industries such as oil, gas and shipping. It is fair to say that these industries have not traditionally been very concerned with the environment or sustainability, and given their large share of the bond market this may increase the green bond issuer scepticism among Norwegian investors.

Green bonds issued by Swedish and Norwegian governmental entities both trade at a positive price premium, illustrated by the estimated negative yield premium of 1.7 and 10.2 basis points, respectively. This finding clearly underlines the importance of the issuer's credibility in a green bond issuance. It is reasonable to believe that issuers within the government sector are more likely to attract large corporate investors who allocate significant resources to fixed income instruments, as governmental entities may be viewed as more "safe". The significant amount of capital from these investors may be a key factor in the high price of these bonds. In addition, issuers within the government sector are likely to have more strict reporting and transparency policies, which increases their credibility and reduces investor scepticism. It is worth noting that our sample of Norwegian companies in the government sector consists of only two issuers, Oslo Kommune and Kommunalbanken. Thus, the lack of variation in issuers may reduce the quality of the yield premium estimate, as it may not be representative of the industry-wide average.

Further, the sector subset analysis displays that the difference in overall yield premiums between the two markets can, to a great extent, be explained by the market for green bonds in the corporate sector. Swedish green bonds issued in the corporate sector are traded at a negative yield premium of -1.3 basis points, while this premium is estimated to be 18.3 basis points in Norway. In both markets the corporate sector accounts for the majority of the green bond issuance, and it is thus a decisive component of the estimated

overall premiums.

When considering the corporate sector industry subsets of the Swedish market one can clearly see that the negative overall premium is driven by the negative yield premium in the real estate industry. Swedish companies operating within the real estate industry account for 60 percent of all green bonds issued in the market. In addition, the first green bond of the Swedish corporate sector was issued by a real estate company. This considerable amount of green bond issues and relatively early issue in the industry may have increased the credibility of the real estate company issuers, enabling a negative yield premium for the bonds. Looking at the industry subsets of the Norwegian corporate sector, all industries show a positive yield premium for green bonds. It is reasonable to believe that in a young market, such as the Norwegian green bond market, private companies lack credibility relative to the government or large prominent banks, which may explain the estimated positive premium.

The only estimated result that contradicts our initial hypothesis is the yield premium for green bonds from companies in the bank sector. For this market subset, our model provides evidence of Norwegian investors having a higher demand than Swedish investors. That being said, when interpreting this result one should take into account the limited data sample. In the Norwegian data set only three green bonds have been issued by banks, and one of the issuing entities is the largest bank in Norway. This could play a key part in explaining the estimated negative yield premium. The largest bank in Norway is likely to be highly credible and to have a large network of potential investors, which may enable a willingness to pay a premium among investors. Consequently, given the possibility of a unrepresentative sample from the bank sector, the inference quality of the results could be questioned.

The findings in this analysis are subject to a number of limitations that require attention. The varying availability of data and limited sample sizes are arguably the most important limitations. Firstly, we were not able to obtain data on bond ratings without being forced to limit the sample size significantly. The implications is that some bonds in our matched pairs may have different ratings, which can impact the yield difference and thus create a biased estimate. Second, it is worth mentioning that a part of the matching process included subjective selection. Although this process was done very thoroughly

and carefully, there is a possibility that for some green bonds there might exist closer conventional matches than our choice. This also reduces the replicability of our analysis. Third, and as stated previously, since the bonds are unlikely to trade at a high frequency we downloaded the daily quoted bid and ask price. To get a more realistic result one would prefer the actual trading price of the bonds, but for our analysis this would have limited the data too much. Finally, we operate with a relatively limited sample size due to the young market for green bonds in Sweden and particularly in Norway. This limited sample size raises concerns regarding whether the sample is representative and whether the results are valid estimates. Especially for the Norwegian green bond market, the limited sample size makes it problematic to interpret the estimates of the green bond premium within industry and sector. Even the estimates for the full sample can be argued not to be representative due to the small sample size.

## 6.3 Green Focus analysis

The textual analysis showed that there are considerable differences in Green Focus between companies that had issued green bonds, Green Companies, and companies that had only issued conventional bonds, Grey Companies. These differences varied across Norway and Sweden.

The annual growth in Green Focus in Norway was estimated to be 0.01 percent for Green Companies and 0.015 percent for Grey Companies in the period 2000 until 2018. This indicates that the growth in Green Focus has been slightly higher for companies not issuing green bonds. As previously stated, however, a t-test could not reject the null hypothesis of equal growth rates between the groups. A t-test testing whether the level of Green Focus in the groups were different could confirm that the Green Focus for Green Companies has in fact been higher. The current level of Green Focus is about 0.5 percent of Norwegian Green Companies, and 0.4 for Grey Companies.

In Sweden, the difference in the Green Focus between the Green and Grey Companies was more pronounced. The annual growth in Green Focus was estimated to 0.029 percent for Green Companies and 0.007 percent for Grey Companies in the period 1997 until 2018, both significant at the 1 percent level. Reviewing the plotted observation values also revealed that Green and Grey Companies had fairly similar green word ratios from 1997

until around 2006, after which the Green Companies' growth significantly outpaced the Grey Companies'. Further, when using a t-test to check if the Green and Grey Companies were significantly different, we could reject the null hypothesis of similarity in growth and in level of Green Focus. The current level of Green Focus for Green Companies in Sweden is about 0.9 percent, while the current level for Swedish Grey Companies is 0.4 percent.

Thus, this analysis found that 1) in Norway, Green Companies have a slightly higher Green Focus than Grey Companies, but there is no statistically significant difference between the growth in Green Focus, 2) Swedish companies that have issued green bonds have a significantly higher Green Focus level and growth than Swedish companies with only conventional bonds, and 3) the current Green Focus for Green Companies in Sweden is considerably higher than that of Green Companies in Norway. This adheres to our hypothesis of a higher Green Focus in Sweden, but only for Green Companies as the level of Green Focus for Grey Companies are approximately equal in both markets.

It is worth noting that this analysis does not state whether Swedish companies with green bonds *are* more green than Norwegian companies with green bonds. It does, however, find evidence supporting a view that the Swedish Green Companies have a more pronounced Green Focus in their communications with investors, namely through their annual reports. These results may be able to explain the results from the primary and secondary market analyses and the difference in the markets' evolution.

As previously stated, an issuer's credibility is important when it comes to green bonds. If a company issues a green bond but does not appear to be concerned with actually being green, investors might suspect them to be greenwashing. Thus, investors are more willing to pay a premium for a green bond if the company seems genuinely concerned with becoming more green. The textual analysis showed that the companies issuing green bonds in Sweden have a more distinct communicated Green Focus in their annual reports, and that the focus has increased significantly over the years. This may have convinced investors on the Swedish stock exchanges that the companies are credible green bond issuers. This adheres to the results in the two previous analyses. The primary market analysis indicated, although not significantly, a negative issue yield premium for green bonds on the Swedish stock exchanges, while the secondary market analysis found a significant negative ask yield premium for corporate green bonds. Thus, investors are

willing to buy these bonds at a premium compared to similar conventional bonds.

In Norway, on the other hand, the growth in Green Focus for companies issuing green bonds was found to be considerably lower than in Sweden, and we found no significant difference between companies that have issued green bonds and those that have not. This may result in investors on the Norwegian stock exchange being more sceptical to the companies issuing green bonds. This is consistent with the findings in both the primary and secondary analysis. The primary analysis indicated, although not significantly, that green bonds in Norway are issued at a higher yield than conventional, and the secondary market analysis found a significant positive ask yield premium on corporate green bonds. This implies that investors are willing to pay less for a green bond than a conventional bond, and that they may be suspecting greenwashing in the Norwegian green bond market.

The stronger Green Focus for Swedish Green Companies may also explain the higher number of green bond issuance's in Sweden directly. It is reasonable to assume that companies who are more concerned with sustainability and the environment will be more likely to invest in environmentally friendly projects, which are eligible for green bond financing. Thus, a weaker Green Focus among Norwegian companies may indicate that these companies are not as concerned with sustainability, which could explain a lower green bond issuance.

Another possibility is that the content of annual reports are affected not only by what is going on in the company, but also what its investors want to read about. In this case, this would imply that Swedish investors are demanding more green reporting than the Norwegian investors. In other words, Swedish investors could have a stronger focus on green concerns themselves. This would also explain the negative yield premium in the primary and secondary market in Sweden, as more environmentally concerned investors would be likely to have a higher demand for green financial instruments. The lack of increased green reporting in Norway could then indicate that Norwegian investors are not concerned with the environmental aspects of a company, which can also explain the low demand for the green instrument in Norway.

There are some limitations to the results in this analysis. Firstly, annual reports are not necessarily objective accounts of what is actually taking place in a company. While annual reports are an important means of communicating a company's operations and outlook to

investors, it is also a "sales document". Companies want to appear attractive to investors and may exaggerate some aspects of their business that they believe investors might value, for example their focus on environmental concerns. However, it is reasonable to assume that this bias applies to the companies in both the green sample and the grey sample. Thus, the estimated differences between the samples will be independent of this effect as it is fixed for both.

An issue occurs, however, if the likeliness of exaggerating environmental concerns is larger for one group than for the other. One could argue that a company that issues green bonds might be more concerned with appearing green than a company that only issues conventional bonds. This could be the case if companies that issue green bonds only do so in order to appear more green, as they would most likely also overstate green aspects in the annual report. It could also be the case if companies with green bonds wish to appear more green in their reports in order to be perceived as credible issuers. In these cases, we would have biased estimations. On the other hand, if investors catch a company lying in their reports, the company would most likely suffer severe reputational and credibility consequences. As this is something one would assume that most companies are aware of, one could argue that companies in general are relatively truthful in their disclosures.

A further limitation of this analysis is that the textual analysis does not capture the context of the green words in the reports. Firstly, there is the possibility of the word "green" being counted a number of times only in relation to a company's green bond. This would be irrelevant for the analysis, and is likely to be the case as the textual analysis model was not able to exclude these occurrences. However, seeing as the word "green" was only one out of many words in the dictionary and that it is a word used in relation to many subjects, the consequences of this issue are likely to be limited.

Secondly, the sentiment of the report is not captured, so we do not know whether the green words are conveyed in a positive or negative sense. For example, there would be no difference in the analysis of the sentences "Our environmental impact has worsened" or "Our environmental impact is greatly reduced". This may lead to the model estimating a company's Green Focus as high, when the company has written mostly negatively about the environment. On the other hand, it is not very likely that sentences such as the former are written in any company's annual reports. It is, as mentioned, a sales document, and

companies will be conscious about how they convey their information. Further, one might argue that both positive and negative mentions of green words count as a Green Focus, as they both show consideration for environmental aspects.

Furthermore, a limitation related to the dictionary is that it may not contain the "optimal" words in order to capture the Green Focus in a company. Developing the dictionary was done by researching common words related to the environment, climate and renewability. Although the job was done thoroughly and involved a lot of consideration, there is still a risk of missing an important word or including the "wrong" terms.

A final limitation, which has been a recurring issue throughout the paper, is the amount of available data. Naturally, this analysis is limited to the number of public companies that have issued green bonds in Norway and Sweden. Further, the number of available annual reports from these companies also affected the quality of the sample. The average number of annual reports in the Green Company samples were 9.22 per company for Norway and 11.75 for Sweden, while the averages for Grey Companies were 10.9 per company for Norway and 10.19 for Sweden. Because of the relatively low number of companies and the lack of available annual reports for certain years, estimations may not reflect the situations accurately. Naturally, the quality of our analysis would have improved if there were more data.

# 7 Conclusion

In a world where transitioning to a sustainable finance industry is becoming increasingly crucial, it is important to understand the differences in green bond markets. Previous papers have studied the existence of green bond premiums in the primary and secondary market and have found results similar to ours. Still, we contribute to the existing literature in two ways. First, we provide a more in-depth analysis of the Norwegian and Swedish green bond markets, specifically. Second, we study the effect of the issuing companies' Green Focus, measured using textual analysis of annual reports.

The primary market analysis found an insignificant and very small positive issue yield premium for green bonds in Norway and an insignificant negative issue yield premium for green bonds in Sweden. Based on these results, it is hard to conclude that it actually is cheaper to issue green bonds in Sweden. The negative premium estimate in the Swedish primary market does, however, provide an indication that this has historically been the case, which is consistent with our hypothesis and the higher market growth in Sweden.

The analysis of the secondary markets found a positive yield premium for Norwegian green bonds and a negative premium for Swedish, providing evidence of a stronger demand for green bonds among Swedish investors. In a more narrow analysis it became clear that governmental entities benefit from a high credibility, as the sector's yield premium is negative in both markets. The bank sector has a positive yield premium in Sweden and a negative in Norway, although an unrepresentative Norwegian sample of bank bonds may somewhat invalidate these results. Furthermore, we see a positive yield premium for Norwegian corporate bonds and a negative premium for Swedish. This is largely due to the Swedish real estate industry's large proportion of bonds with negative yield premiums.

Finally, the Green Focus analysis found evidence that Swedish companies that have issued green bonds have a higher level of Green Focus than Norwegian companies with green bonds. This result adheres to our hypothesis and the results of the primary and secondary market analyses. A more pronounced communicated Green Focus increases the credibility of Swedish issuers, and thus the investors' willingness to pay for Swedish green bonds. Furthermore, companies with a stronger Green Focus are initially more likely to invest in environmentally friendly projects, and are consequently more likely to issue green bonds.

# References

Bachelet, M. J., Becchetti, L., and Manfredonia, S. (2019). The green bonds premium puzzle: The role of issuer characteristics and third-party verification. *Sustainability*, 11(4):1098.

Baker, M., Bergstresser, D., Serafeim, G., and Wurgler, J. (2018). Financing the response to climate change: The pricing and ownership of us green bonds. Technical report, National Bureau of Economic Research.

Chisholm, A. (2009). *An Introduction to International Capital Markets: Products, Strategies, Participants*. The Wiley Finance Series. Wiley.

Dick-Nielsen, J., Gyntelberg, J., and Sangill, T. (2012). Liquidity in government versus covered bond markets.

Ehlers, T. and Packer, F. (2017). Green bond finance and certification. *BIS Quarterly Review September*.

Fama, E. F. and Bliss, R. R. (1987). The information in long-maturity forward rates. *The American Economic Review*, pages 680–692.

Filkova, M. (2018). The green bond market in the nordics 2018. https://www.climatebonds.net.

Flammer, C. (2018). Corporate green bonds. *Available at SSRN 3125518*.

Fong, K. Y. L., Holden, C. W., and Trzcinka, C. A. (2017). What are the best liquidity proxies for global research? *Review of Finance*, 21(4):1355–1401.

Hachenberg, B. and Schiereck, D. (2018). Are green bonds priced differently from conventional bonds? *Journal of Asset Management*, 19(6):371–381.

Hasan, I., Hoi, C.-K., Wu, Q., and Zhang, H. (2017). Social capital and debt contracting: Evidence from bank loans and public bonds. *Journal of Financial and Quantitative Analysis*, 52:1–31.

Hicks, J. and John Richard Hicks, S. (1946). *Value and Capital: An Inquiry Into Some Fundamental Principles of Economic Theory*. Clarendon paperbacks. Clarendon Press.

Huang, J.-Z. and Huang, M. (2012). How much of the corporate-treasury yield spread is due to credit risk? *The Review of Asset Pricing Studies*, 2(2):153–202.

Izzo, M. F. and Magnanelli, B. S. (2012). Does it pay or does firm pay? the relation between csr performance and the cost of debt. *The Relation between CSR Performance and the Cost of Debt*.

Kapraun, J. and Scheins, C. (2019). (in)-credibly green: Which bonds trade at a green bond premium? *Available at SSRN 3347337*.

Karpf, A. and Mandel, A. (2018). The changing value of the 'green'label on the us municipal bond market. *Nature Climate Change*, 8(2):161.

Lamy, R. E. and Thompson, G. R. (1988). Risk premia and the pricing of primary issue bonds. *Journal of Banking & Finance*, 12(4):585–601.

Menz, K.-M. (2010). Corporate social responsibility: Is it rewarded by the corporate bond market? a critical note. *Journal of Business Ethics*, 96(1):117–134.

Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates. *The Journal of finance*, 29(2):449–470.

Milmo, C. (2007). The biggest environmental crime in history. *The Independent*.

Mostafa, M. M. (2013). More than words: Social networks' text mining for consumer brand sentiments. *Expert Systems with Applications*, 40(10):4241–4251.

Odaro, E. D., Peeters, S., Maria Paraan, O. K., and Avendano, F. (2019). Green bond impact report: Financial year 2019. https://www.ifc.org.

Oikonomou, I., Brooks, C., and Pavelin, S. (2010). The impact of corporate social performance on financial risk and utility: A longitudinal analysis. *Corporate Finance: Governance, Corporate Control & Organization eJournal*, 41.

Partridge, C. and Medda, F. (2018). Green premium in the primary and secondary us municipal bond markets. *Available at SSRN 3237032*.

Petitt, B., Pinto, J., Pirie, W., and Kopprasch, B. (2015). *Fixed Income Analysis*. CFA Institute Investment Series. Wiley.

Preclaw, R. and Bakshi, A. (2015). The cost of being green.

Pronina, L. (2019). What are green bonds and how 'green' is green? https://www.bloomberg.com/news/articles/2019-03-24/what-are-green-bonds-and-how-green-is-green-quicktake.

Rosenbaum, P. R. and Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1):41–55.

Stemler, S. (2001). An overview of content analysis. *Practical assessment, research & evaluation*, 7(17):137–146.

Stern, N. (2008). The economics of climate change. *American Economic Review*, 98(2):1–37.

*Climate Bond Initiative* (2016). Explaining green bonds. https://www.climatebonds.net/market/explaining-green-bonds.

*Climate Bond Initiative* (2019a). External review. https://www.climatebonds.net/market/second-opinion.

*Climate Bond Initiative* (2019b). Green bonds the state of the market 2018. https://www.climatebonds.net.

*EU Technical Expert Group* (2019). Report on eu green bond standard. https://ec.europa.eu.

*European Comission* (2016). Study on the potential of green bond finance for resource-efficient investments. https://ec.europa.eu.

*Finans Norge* (2018). Veikart for grønn konkurransekraft i finansnæringen. https://www.finansnorge.no.

*ICMA* (2018). The green bond principles. https://www.icmagroup.org/green-social-and-sustainability-bonds/green-bond-principles-gbp/.

*International Capital Market Association* (2018). Green bonds: The state of the market 2018. https://www.icmagroup.org.

*Ministry of Finance, Sweden* (2019). State to issue green bonds by 2020. https://www.government.se/press-releases/2019/07/state-to-issue-green-bonds-by-2020/.

*OECD* (2018). Financing climate futures: Rethinking infrastructure. https://www.oecd.org.

*Oslo Børs* (2017). Green bonds. https://www.oslobors.no/ob_eng/Oslo-Boers/Listing/Interest-bearing-instruments/Green-bonds.

*The World Bank* (2019). 10 years of green bonds: Creating the blueprint for sustainability across capital markets. https://www.worldbank.org/en/news/immersive-story/2019/03/18/10-years-of-green-bonds-creating-the-blueprint-for-sustainability-across-capital-markets.

*United Nations Treaty Collection* (2016). Paris agreement. https://treaties.un.org.

Whiley, A. (2017). An oil & gas bond we knew would come eventually: Repsol: Good on gbps, not so sure on green credentials. https://www.climatebonds.net/2017/05/oil-gas-bond-we-knew-would-come-eventually-repsol-good-gbps-not-so-sure-green-credentials.

Wooldridge, J. M. (2008). *Introductory Econometrics A Modern Approach*, volume 1. Cengage Learning.

Zerbib, O. D. (2017). Is there a green bond premium? the yield differential between green and conventional bonds. *Journal of Banking and Finance*, 98:39–60.

# Appendix

## A1 Primary market analysis

This section comprises of the appendixes related to the primary market analysis.

### A1.1 Variable definitions

Table A1.1 provides definitions of the variables used in the primary market analysis regressions.

**Table A1.1:** Variable definitions, primary market analysis

| Variable | Definition |
|---|---|
| IssueYield | A numerical variable equal to the bond's yield at issuance |
| Green | An indicator variable equaling 1 if the bond is labeled as green and 0 if not. |
| Exchange | A categorical variable for the exchange of which the bond is listed, NO for Norwegian and SE for Swedish. |
| Issuer | A categorical variable equaling the company name of the bond issuer. |
| Month-Year | A categorical variable for the month and year the bond was issued. |
| Seniority | A categorical variable for the different bond risk categories. |
| Maturity | A categorical variable equal to 1 if the bond's maturity is less than 5 years, 2 if it is between 5 and 10 years, and 3 if it is more than 10 years. |
| Issue amount | A categorical variable equaling 1 to 5, where 1 is assigned to a bond if the issue amount was among the 20 percent smallest values issued up until that point in time, 2 when the issue amount is between the 20 percent smallest and 40 percent smallest amounts issued, and so on. |
| Coupon type | A categorical variable for the bond's coupon type equaling Fixed or FRN. |

### A1.2 OLS assumptions tests

We tested the OLS assumptions for the models in order to make sure that the estimates of the regression models could be interpreted causally. This section shows the analysis for model (5) in Table X.

#### A1.2.1 OLS assumption 1: Linearity of parameters

Figure A1.1 shows the model's residuals plotted on the model's fitted values. There is a lot of variation, but no distinctive pattern is detected. We can see some increase in the variation for bigger fitted values. As can be seen, the trend line is straight. This indicates

that there is no curved relationship present, and thus that the parameters are linear and that the assumption holds.

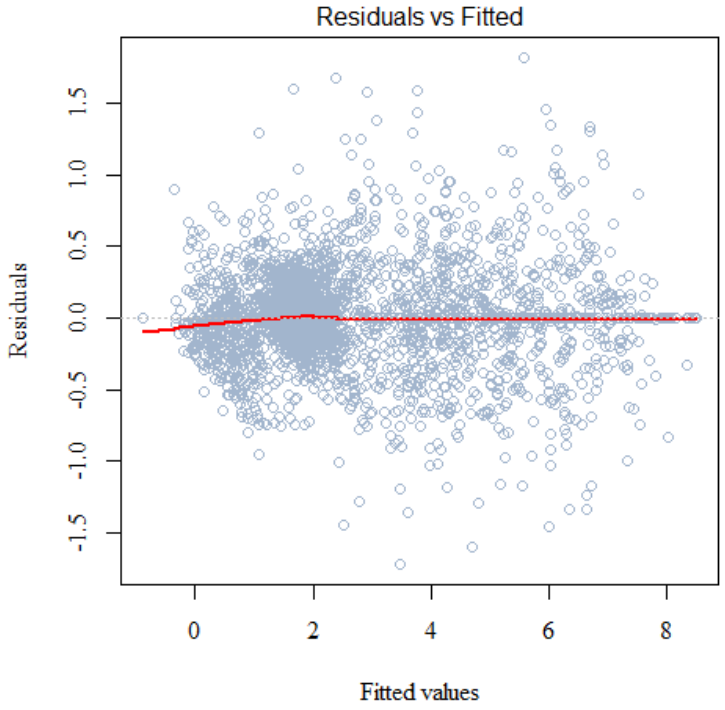


**Figure A1.1:** Plot of model residuals versus fitted values

### A1.2.2 OLS assumption 2: Random sample

The sample consists of all green and conventional bonds issued in Norway and Sweden, except those that did not have available information on issue yield or issue price. As long as these observations with missing information are a random selection, this assumption holds.

### A1.2.3 OLS assumption 3: Zero conditional mean of error term

The plot shown in Figure A1.1 shows that the residuals are fairly equally distributed and centered around zero for all fitted values. This is an indication that the conditional mean for the independent variables will have the same distribution.

### A1.2.4 OLS assumption 4: No perfect collinearity between variables

No perfect collinearity between the variables was been detected through covariance tests.

### A1.2.5 OLS assumption 5: No heteroskedasticity in the error term

The plot in Figure A1.2 shows the residual term in the Y axis standardized. Here, it can be seen that the absolute value of the residuals vary slightly for the fitted values. To further test for the presences of heteroskedasticity, a Breusch-Pagan test is conducted. The test is shown in Figure A1.2 and with a p-value of the test-statistic equaling 1.84*e-16, the null hypothesis of homoscedasticity is rejected. Thus, we have a heteroskedasticity problem.

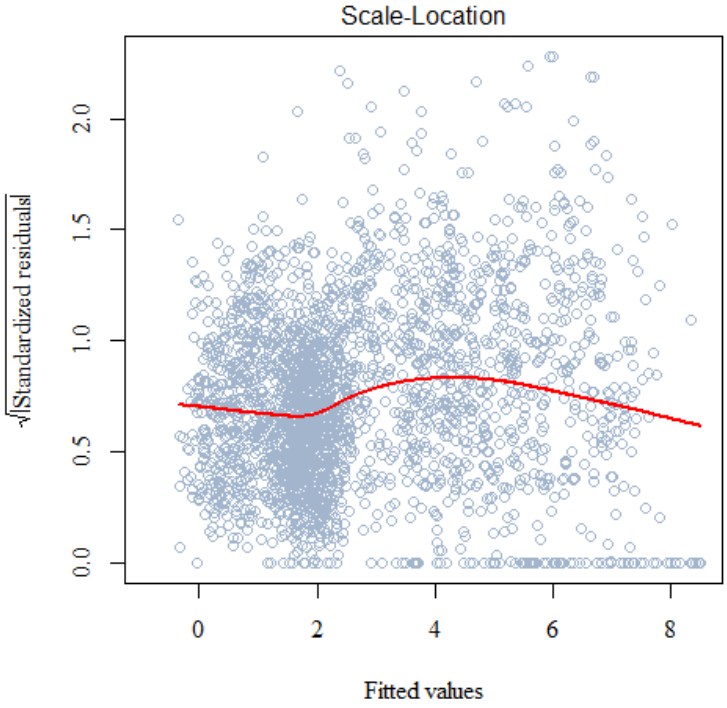


**Figure A1.2:** Plot of the models standardized residuals versus fitted values

**Table A1.2:** Results of the Breusch-Pagan test for Heteroskedasticity

| Breusch Pagan Test for Heteroskedasticity |
|---|
| Ho: the variance is constant<br>Ha: the variance is not constant |
| **Data** |
| Response: issue.yield<br>Variables: fitted values of issue.yield |
| **Test Summary** |
| DF = 1<br>Chi2 = 67.7633<br>Prob > Chi2 = 1.843491e-16 |

### A1.2.6 OLS assumption 6: The error term is independent and normally distributed

Taking the mean of the residual gave the value 2.04*e-18. This is very close to zero, indicating that the error term is independent with a mean of zero. In order to check for normality a QQ-plot was used, which is shown in Figure A1.3. This shows that the standardized residuals lie fairly straight in the middle, but there are some significant tails on both sides. This can also be seen in the histogram in Figure A1.4. Although this is not optimal, it is to be expected given the small sample of observations.

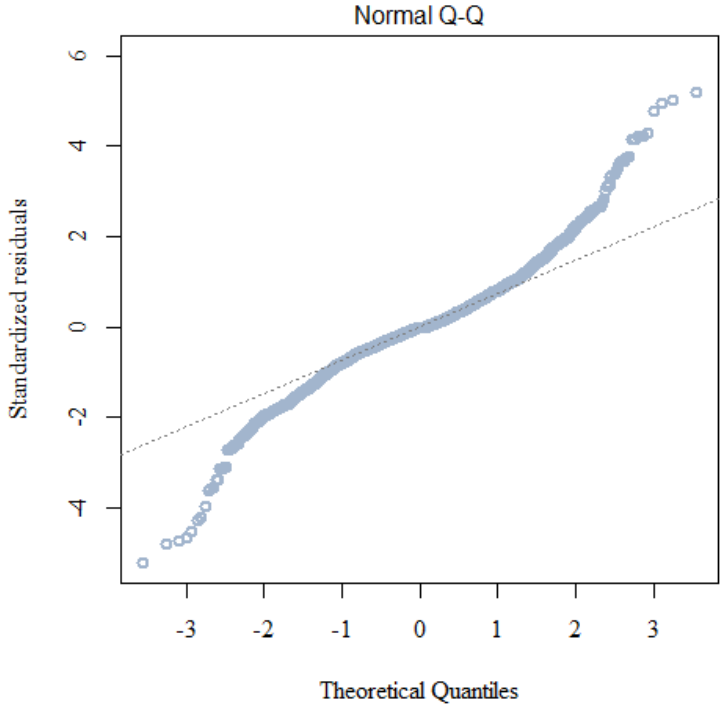


**Figure A1.3:** QQ-plot of model residuals

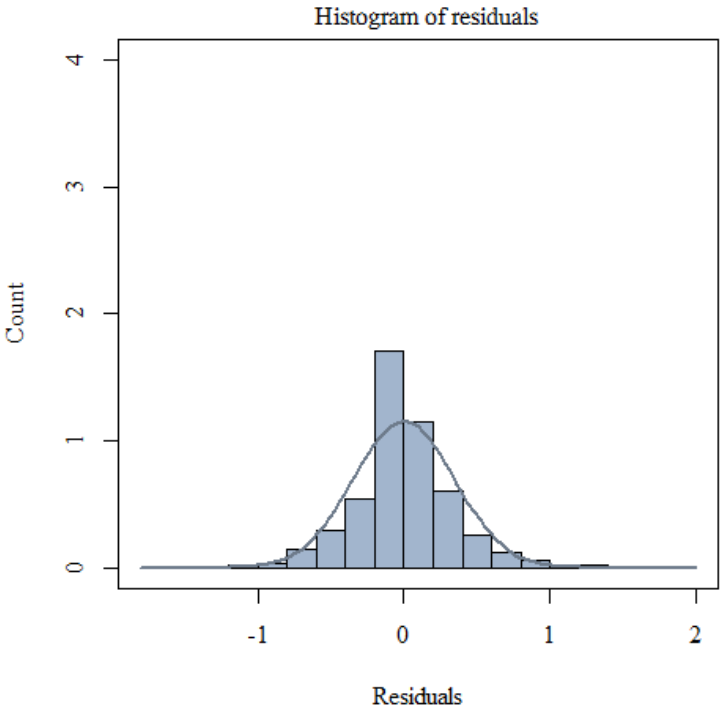


**Figure A1.4:** Histogram of model residuals

# A2 Secondary market analysis

This section comprises appendixes related to the secondary market analysis.

## A2.1 Yield spread of fixed vs floating bonds

In order to check whether we could include both fixed and floating rate bonds, we considered the distributions of the yield spreads for these two bond types. As can be seen in Figure A2.1 the distributions are fairly similar. This supports the inclusion of floating rate bonds in the data set as the bias will be relatively small and the effects may be corrected for using fixed effects.

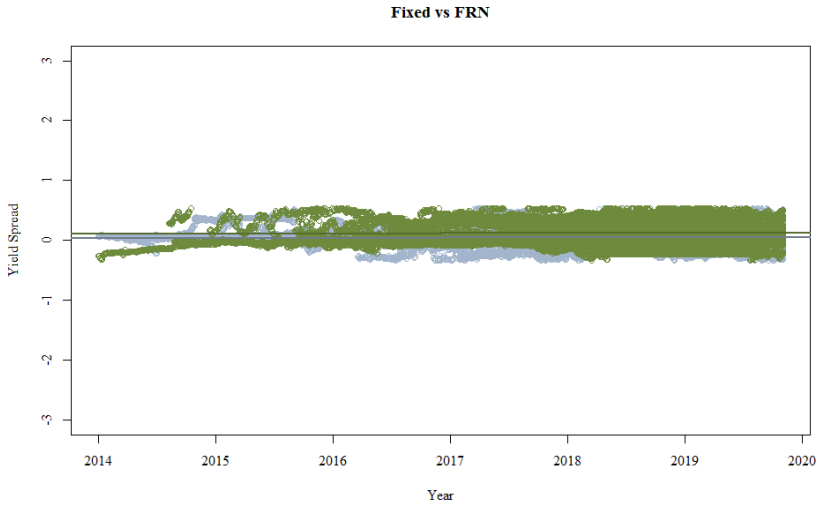


**Figure A2.1:** Yield spread distributions for fixed and floating rate bonds

## A2.2 List of included bonds

**Table A2.1:** Paired bonds, Norway

| BB.ticker | Pair.ID | Green | Issuer | Country |
|---|---|---|---|---|
| AP752464 Corp | 1001 | 1 | Agder Energi AS | Norway |
| AN724728 Corp | 1001 | 0 | Agder Energi AS | Norway |
| EK514502 Corp | 1002 | 1 | BKK AS | Norway |
| EK274528 Corp | 1002 | 0 | BKK AS | Norway |
| EK747189 Corp | 1003 | 1 | DNB Bank ASA | Norway |
| EK043522 Corp | 1003 | 0 | DNB Bank ASA | Norway |
| AP260256 Corp | 1005 | 1 | Eidsiva Energi AS | Norway |
| JV769334 Corp | 1005 | 0 | Eidsiva Energi AS | Norway |
| ZS655406 Corp | 1006 | 1 | Entra ASA | Norway |
| AQ201048 Corp | 1006 | 0 | Entra ASA | Norway |
| AM868733 Corp | 1007 | 1 | Entra ASA | Norway |
| LW218655 Corp | 1007 | 0 | Entra ASA | Norway |
| QZ595094 Corp | 1008 | 1 | Entra ASA | Norway |
| LW218620 Corp | 1008 | 0 | Entra ASA | Norway |
| AQ136788 Corp | 1009 | 1 | Kommunalbanken AS | Norway |
| ZR996396 Corp | 1009 | 0 | Kommunalbanken AS | Norway |
| AN152350 Corp | 1010 | 1 | Lyse AS | Norway |
| AM561745 Corp | 1010 | 0 | Lyse AS | Norway |
| AW905261 Corp | 1011 | 1 | NorgesGruppen ASA | Norway |
| AM699143 Corp | 1011 | 0 | NorgesGruppen ASA | Norway |
| AP671626 Corp | 1012 | 1 | OBOS Eiendom AS | Norway |
| AR829297 Corp | 1012 | 0 | OBOS Eiendom AS | Norway |
| QJ817514 Corp | 1013 | 1 | Oslo kommune | Norway |
| QJ680585 Corp | 1013 | 0 | Oslo kommune | Norway |
| ZS112701 Corp | 1014 | 1 | Sogn og Fjordane Energi AS | Norway |
| JK338630 Corp | 1014 | 0 | Sogn og Fjordane Energi AS | Norway |
| ZS113643 Corp | 1015 | 1 | Sogn og Fjordane Energi AS | Norway |
| AP123168 Corp | 1015 | 0 | Sogn og Fjordane Energi AS | Norway |
| AS669009 Corp | 1016 | 1 | Sogn og Fjordane Energi AS | Norway |
| EJ535421 Corp | 1016 | 0 | Sogn og Fjordane Energi AS | Norway |
| ZR403118 Corp | 1018 | 1 | Sparebanken Sogn og Fjordane | Norway |
| AW877592 Corp | 1018 | 0 | Sparebanken Sogn og Fjordane | Norway |
| AW898681 Corp | 1021 | 1 | Sunndal Sparebank | Norway |
| ZS112945 Corp | 1021 | 0 | Sunndal Sparebank | Norway |
| EK646500 Corp | 1022 | 1 | Vardar AS | Norway |
| EJ468148 Corp | 1022 | 0 | Vardar AS | Norway |

**Table A2.2:** Paired bonds, Sweden

| BB.ticker | Pair.ID | Green | Issuer | Country |
|---|---|---|---|---|
| AS773373 Corp | 1023 | 1 | AB Stena Metall Finans | Sweden |
| LW672287 Corp | 1023 | 0 | AB Stena Metall Finans | Sweden |
| AZ156655 Corp | 1025 | 1 | Akademiska Hus AB | Sweden |
| AO145575 Corp | 1025 | 0 | Akademiska Hus AB | Sweden |
| QZ666519 Corp | 1026 | 1 | Aktiebolaget Stångåstaden | Sweden |
| ZR723975 Corp | 1026 | 0 | Aktiebolaget Stångåstaden | Sweden |
| QZ666380 Corp | 1027 | 1 | Aktiebolaget Stångåstaden | Sweden |
| EK333856 Corp | 1027 | 0 | Aktiebolaget Stångåstaden | Sweden |
| UV670017 Corp | 1028 | 1 | Aktiebolaget Stångåstaden | Sweden |
| EK600187 Corp | 1028 | 0 | Aktiebolaget Stångåstaden | Sweden |
| AZ462579 Corp | 1029 | 1 | Atrium Ljungberg AB | Sweden |
| ZS634406 Corp | 1029 | 0 | Atrium Ljungberg AB | Sweden |
| AU309887 Corp | 1030 | 1 | Atrium Ljungberg AB | Sweden |
| AP639032 Corp | 1030 | 0 | Atrium Ljungberg AB | Sweden |
| AR873258 Corp | 1031 | 1 | Atrium Ljungberg AB | Sweden |
| AQ891864 Corp | 1031 | 0 | Atrium Ljungberg AB | Sweden |
| AM931543 Corp | 1032 | 1 | Atrium Ljungberg AB | Sweden |
| AN809661 Corp | 1032 | 0 | Atrium Ljungberg AB | Sweden |
| AM958673 Corp | 1033 | 1 | Atrium Ljungberg AB | Sweden |
| AN789684 Corp | 1033 | 0 | Atrium Ljungberg AB | Sweden |
| AM837845 Corp | 1034 | 1 | Atrium Ljungberg AB | Sweden |
| EK124983 Corp | 1034 | 0 | Atrium Ljungberg AB | Sweden |
| QZ692914 Corp | 1035 | 1 | Castellum AB | Sweden |
| EK854321 Corp | 1035 | 0 | Castellum AB | Sweden |
| QZ691594 Corp | 1036 | 1 | Castellum AB | Sweden |
| UV840128 Corp | 1036 | 0 | Castellum AB | Sweden |
| AX777186 Corp | 1037 | 1 | Electrolux AB | Sweden |
| AR831331 Corp | 1037 | 0 | Electrolux AB | Sweden |
| AS030818 Corp | 1038 | 1 | Fabege AB | Sweden |
| AU351849 Corp | 1038 | 0 | Fabege AB | Sweden |
| AR427250 Corp | 1039 | 1 | Fabege AB | Sweden |
| AU224954 Corp | 1039 | 0 | Fabege AB | Sweden |
| ZS896917 Corp | 1040 | 1 | Fastighets AB Balder | Sweden |
| AX452072 Corp | 1040 | 0 | Fastighets AB Balder | Sweden |
| AV827942 Corp | 1041 | 1 | FastPartner AB | Sweden |
| ZS589262 Corp | 1041 | 0 | FastPartner AB | Sweden |
| AV208498 Corp | 1042 | 1 | Göteborgs Stad | Sweden |
| AR668276 Corp | 1042 | 0 | Göteborgs Stad | Sweden |
| AV208356 Corp | 1043 | 1 | Göteborgs Stad | Sweden |
| AR667893 Corp | 1043 | 0 | Göteborgs Stad | Sweden |
| AN828739 Corp | 1044 | 1 | Göteborgs Stad | Sweden |
| AM780661 Corp | 1044 | 0 | Göteborgs Stad | Sweden |
| LW381399 Corp | 1045 | 1 | Göteborgs Stad | Sweden |
| JK955237 Corp | 1045 | 0 | Göteborgs Stad | Sweden |
| EK996049 Corp | 1046 | 1 | Göteborgs Stad | Sweden |
| QZ481260 Corp | 1046 | 0 | Göteborgs Stad | Sweden |

| BB.ticker | Pair.ID | Green | Issuer | Country |
|---|---|---|---|---|
| EK298633 Corp | 1047 | 1 | Göteborgs Stad | Sweden |
| EK544387 Corp | 1047 | 0 | Göteborgs Stad | Sweden |
| EK298615 Corp | 1048 | 1 | Göteborgs Stad | Sweden |
| EK111308 Corp | 1048 | 0 | Göteborgs Stad | Sweden |
| EJ856867 Corp | 1049 | 1 | Göteborgs Stad | Sweden |
| EJ478054 Corp | 1049 | 0 | Göteborgs Stad | Sweden |
| ZS565046 Corp | 1050 | 1 | Hemfosa Fastigheter AB | Sweden |
| AM627480 Corp | 1050 | 0 | Hemfosa Fastigheter AB | Sweden |
| LW259175 Corp | 1051 | 1 | Hemsö Fastighets AB | Sweden |
| LW061151 Corp | 1051 | 0 | Hemsö Fastighets AB | Sweden |
| LW260821 Corp | 1052 | 1 | Hemsö Fastighets AB | Sweden |
| LW061158 Corp | 1052 | 0 | Hemsö Fastighets AB | Sweden |
| AS727574 Corp | 1053 | 1 | Humlegården Fastigheter AB | Sweden |
| AV770332 Corp | 1053 | 0 | Humlegården Fastigheter AB | Sweden |
| AS746985 Corp | 1054 | 1 | Humlegården Fastigheter AB | Sweden |
| AQ374807 Corp | 1054 | 0 | Humlegården Fastigheter AB | Sweden |
| AW965734 Corp | 1055 | 1 | Jernhusen AB | Sweden |
| AM824742 Corp | 1055 | 0 | Jernhusen AB | Sweden |
| AV536417 Corp | 1056 | 1 | Jernhusen AB | Sweden |
| ZS146663 Corp | 1056 | 0 | Jernhusen AB | Sweden |
| AR813957 Corp | 1057 | 1 | Jernhusen AB | Sweden |
| AP286483 Corp | 1057 | 0 | Jernhusen AB | Sweden |
| AS174178 Corp | 1058 | 1 | Jernhusen AB | Sweden |
| AO997479 Corp | 1058 | 0 | Jernhusen AB | Sweden |
| AR831631 Corp | 1059 | 1 | Klövern AB | Sweden |
| AQ827604 Corp | 1059 | 0 | Klövern AB | Sweden |
| ZR545986 Corp | 1060 | 1 | Kommuninvest i Sverige AB | Sweden |
| AM568434 Corp | 1060 | 0 | Kommuninvest i Sverige AB | Sweden |
| AV074370 Corp | 1061 | 1 | Kommuninvest i Sverige AB | Sweden |
| AR669492 Corp | 1061 | 0 | Kommuninvest i Sverige AB | Sweden |
| AX452287 Corp | 1063 | 1 | Kungsleden AB | Sweden |
| ZR178640 Corp | 1063 | 0 | Kungsleden AB | Sweden |
| AS964140 Corp | 1064 | 1 | Kungsleden AB | Sweden |
| ZR572438 Corp | 1064 | 0 | Kungsleden AB | Sweden |
| AR691598 Corp | 1065 | 1 | Kungsleden AB | Sweden |
| AP420465 Corp | 1065 | 0 | Kungsleden AB | Sweden |
| AR772905 Corp | 1066 | 1 | Kungsleden AB | Sweden |
| AQ739088 Corp | 1066 | 0 | Kungsleden AB | Sweden |
| AS361812 Corp | 1067 | 1 | Landshypotek Bank AB | Sweden |
| AP092634 Corp | 1067 | 0 | Landshypotek Bank AB | Sweden |
| AN579521 Corp | 1068 | 1 | Lunds Kommun | Sweden |
| QZ631941 Corp | 1068 | 0 | Lunds Kommun | Sweden |
| ZR235804 Corp | 1069 | 1 | Malmö kommun | Sweden |
| ZR119693 Corp | 1069 | 0 | Malmö kommun | Sweden |
| ZS360746 Corp | 1070 | 1 | Malmö kommun | Sweden |
| ZS825351 Corp | 1070 | 0 | Malmö kommun | Sweden |
| AV687535 Corp | 1071 | 1 | Malmö kommun | Sweden |
| AN704731 Corp | 1071 | 0 | Malmö kommun | Sweden |

| BB.ticker | Pair.ID | Green | Issuer | Country |
|---|---|---|---|---|
| AQ267776 Corp | 1072 | 1 | Malmö kommun | Sweden |
| QZ454077 Corp | 1072 | 0 | Malmö kommun | Sweden |
| AQ267737 Corp | 1073 | 1 | Malmö kommun | Sweden |
| EK870594 Corp | 1073 | 0 | Malmö kommun | Sweden |
| AS919781 Corp | 1074 | 1 | Nacka Kommun | Sweden |
| AR625834 Corp | 1074 | 0 | Nacka Kommun | Sweden |
| QZ825136 Corp | 1075 | 1 | Norrköpings kommun | Sweden |
| AP220761 Corp | 1075 | 0 | Norrköpings kommun | Sweden |
| ZR723236 Corp | 1076 | 1 | Offentliga Hus i Norden AB | Sweden |
| AQ309052 Corp | 1076 | 0 | Offentliga Hus i Norden AB | Sweden |
| AP576802 Corp | 1077 | 1 | Rikshem AB | Sweden |
| AT498146 Corp | 1077 | 0 | Rikshem AB | Sweden |
| AP537535 Corp | 1078 | 1 | Rikshem AB | Sweden |
| AQ926989 Corp | 1078 | 0 | Rikshem AB | Sweden |
| AL290332 Corp | 1079 | 1 | Rikshem AB | Sweden |
| JK822115 Corp | 1079 | 0 | Rikshem AB | Sweden |
| AL245130 Corp | 1080 | 1 | Rikshem AB | Sweden |
| QZ789375 Corp | 1080 | 0 | Rikshem AB | Sweden |
| JK866580 Corp | 1081 | 1 | Rikshem AB | Sweden |
| LW116769 Corp | 1081 | 0 | Rikshem AB | Sweden |
| EK886037 Corp | 1082 | 1 | Rikshem AB | Sweden |
| EK626014 Corp | 1082 | 0 | Rikshem AB | Sweden |
| EK886043 Corp | 1083 | 1 | Rikshem AB | Sweden |
| UV540551 Corp | 1083 | 0 | Rikshem AB | Sweden |
| EK276259 Corp | 1084 | 1 | Rikshem AB | Sweden |
| EK140420 Corp | 1084 | 0 | Rikshem AB | Sweden |
| EK296651 Corp | 1085 | 1 | Rodamco Sverige AB | Sweden |
| EJ972079 Corp | 1085 | 0 | Rodamco Sverige AB | Sweden |
| EK296627 Corp | 1086 | 1 | Rodamco Sverige AB | Sweden |
| EJ972109 Corp | 1086 | 0 | Rodamco Sverige AB | Sweden |
| ZR421131 Corp | 1087 | 1 | SBB AB | Sweden |
| ZQ014252 Corp | 1087 | 0 | SBB AB | Sweden |
| AZ343853 Corp | 1088 | 1 | SBB AB | Sweden |
| ZR819927 Corp | 1088 | 0 | SBB AB | Sweden |
| ZS589247 Corp | 1089 | 1 | SBB AB | Sweden |
| ZS670766 Corp | 1089 | 0 | SBB AB | Sweden |
| AX029921 Corp | 1090 | 1 | SBB AB | Sweden |
| AX169486 Corp | 1090 | 0 | SBB AB | Sweden |
| AZ151967 Corp | 1091 | 1 | SBAB Bank AB | Sweden |
| ZQ124075 Corp | 1091 | 0 | SBAB Bank AB | Sweden |
| AZ151966 Corp | 1092 | 1 | SBAB Bank AB | Sweden |
| ZR664759 Corp | 1092 | 0 | SBAB Bank AB | Sweden |
| AP378720 Corp | 1093 | 1 | SBAB Bank AB | Sweden |
| AN789549 Corp | 1093 | 0 | SBAB Bank AB | Sweden |
| AP418914 Corp | 1094 | 1 | SBAB Bank AB | Sweden |
| AN789496 Corp | 1094 | 0 | SBAB Bank AB | Sweden |
| LW481856 Corp | 1095 | 1 | SBAB Bank AB | Sweden |
| QZ884299 Corp | 1095 | 0 | SBAB Bank AB | Sweden |

| BB.ticker | Pair.ID | Green | Issuer | Country |
|---|---|---|---|---|
| LW482922 Corp | 1096 | 1 | SBAB Bank AB | Sweden |
| JK789080 Corp | 1096 | 0 | SBAB Bank AB | Sweden |
| EK159145 Corp | 1099 | 1 | Skanska Financial Services AB | Sweden |
| EJ884353 Corp | 1099 | 0 | Skanska Financial Services AB | Sweden |
| QZ852078 Corp | 1100 | 1 | Skåne Läns Landsting | Sweden |
| JV258493 Corp | 1100 | 0 | Skåne Läns Landsting | Sweden |
| ZQ099054 Corp | 1101 | 1 | Sparbanken Skåne AB | Sweden |
| ZS383483 Corp | 1101 | 0 | Sparbanken Skåne AB | Sweden |
| AQ133574 Corp | 1102 | 1 | Specialfastigheter Sverige AB | Sweden |
| AN719987 Corp | 1102 | 0 | Specialfastigheter Sverige AB | Sweden |
| AQ133561 Corp | 1103 | 1 | Specialfastigheter Sverige AB | Sweden |
| AO839165 Corp | 1103 | 0 | Specialfastigheter Sverige AB | Sweden |
| ZR468607 Corp | 1104 | 1 | Stockholm Exergi Holding AB | Sweden |
| AQ081923 Corp | 1104 | 0 | Stockholm Exergi Holding AB | Sweden |
| EK901010 Corp | 1105 | 1 | Stockholm Exergi Holding AB | Sweden |
| EK484301 Corp | 1105 | 0 | Stockholm Exergi Holding AB | Sweden |
| EK900932 Corp | 1106 | 1 | Stockholm Exergi Holding AB | Sweden |
| EK483809 Corp | 1106 | 0 | Stockholm Exergi Holding AB | Sweden |
| AL371956 Corp | 1107 | 1 | SKB | Sweden |
| EK929330 Corp | 1107 | 0 | SKB | Sweden |
| AV759092 Corp | 1108 | 1 | Stockholms Läns Landsting | Sweden |
| AU197963 Corp | 1108 | 0 | Stockholms Läns Landsting | Sweden |
| AR783040 Corp | 1109 | 1 | Stockholms Läns Landsting | Sweden |
| ZR264311 Corp | 1109 | 0 | Stockholms Läns Landsting | Sweden |
| AN820058 Corp | 1110 | 1 | Stockholms Läns Landsting | Sweden |
| ZS835622 Corp | 1110 | 0 | Stockholms Läns Landsting | Sweden |
| EK271587 Corp | 1112 | 1 | Stockholms Läns Landsting | Sweden |
| EK329336 Corp | 1112 | 0 | Stockholms Läns Landsting | Sweden |
| EK271743 Corp | 1113 | 1 | Stockholms Läns Landsting | Sweden |
| EK329360 Corp | 1113 | 0 | Stockholms Läns Landsting | Sweden |
| JK212861 Corp | 1114 | 1 | Sveaskog AB | Sweden |
| EK031659 Corp | 1114 | 0 | Sveaskog AB | Sweden |
| JK213694 Corp | 1115 | 1 | Sveaskog AB | Sweden |
| EK031683 Corp | 1115 | 0 | Sveaskog AB | Sweden |
| AW856735 Corp | 1116 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| AR401929 Corp | 1116 | 0 | Svensk FastighetsFinansiering AB | Sweden |
| AX264970 Corp | 1117 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| ZR568228 Corp | 1117 | 0 | Svensk FastighetsFinansiering AB | Sweden |
| AU265301 Corp | 1118 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| AU169218 Corp | 1118 | 0 | Svensk FastighetsFinansiering AB | Sweden |
| AU265716 Corp | 1119 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| AS705588 Corp | 1119 | 0 | Svensk FastighetsFinansiering AB | Sweden |
| AP971032 Corp | 1120 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| AP061137 Corp | 1120 | 0 | Svensk FastighetsFinansiering AB | Sweden |
| AL335193 Corp | 1121 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| EK759117 Corp | 1121 | 0 | Svensk FastighetsFinansiering AB | Sweden |
| QZ928302 Corp | 1122 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| EK759177 Corp | 1122 | 0 | Svensk FastighetsFinansiering AB | Sweden |

| BB.ticker | Pair.ID | Green | Issuer | Country |
|---|---|---|---|---|
| QZ338173 Corp | 1123 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| LW151652 Corp | 1123 | 0 | Svensk FastighetsFinansiering AB | Sweden |
| QJ682884 Corp | 1124 | 1 | Svensk FastighetsFinansiering AB | Sweden |
| EK759075 Corp | 1124 | 0 | Svensk FastighetsFinansiering AB | Sweden |
| EK147537 Corp | 1125 | 1 | Svenska Cellulosa AB SCA | Sweden |
| EK953374 Corp | 1125 | 0 | Svenska Cellulosa AB SCA | Sweden |
| EK147567 Corp | 1126 | 1 | Svenska Cellulosa AB SCA | Sweden |
| EK953452 Corp | 1126 | 0 | Svenska Cellulosa AB SCA | Sweden |
| AR795552 Corp | 1128 | 1 | Swedbank AB | Sweden |
| AS507032 Corp | 1128 | 0 | Swedbank AB | Sweden |
| UV692166 Corp | 1131 | 1 | Uppsalahem AB | Sweden |
| EK267310 Corp | 1131 | 0 | Uppsalahem AB | Sweden |
| AU215476 Corp | 1137 | 1 | Vasakronan AB | Sweden |
| AM788752 Corp | 1137 | 0 | Vasakronan AB | Sweden |
| AU215385 Corp | 1138 | 1 | Vasakronan AB | Sweden |
| EK702456 Corp | 1138 | 0 | Vasakronan AB | Sweden |
| AT097587 Corp | 1139 | 1 | Vasakronan AB | Sweden |
| AS251581 Corp | 1139 | 0 | Vasakronan AB | Sweden |
| AS243883 Corp | 1140 | 1 | Vasakronan AB | Sweden |
| EK790947 Corp | 1140 | 0 | Vasakronan AB | Sweden |
| AR808577 Corp | 1141 | 1 | Vasakronan AB | Sweden |
| AR451065 Corp | 1141 | 0 | Vasakronan AB | Sweden |
| AR512915 Corp | 1142 | 1 | Vasakronan AB | Sweden |
| AQ706306 Corp | 1142 | 0 | Vasakronan AB | Sweden |
| AQ870714 Corp | 1144 | 1 | Vasakronan AB | Sweden |
| QZ329411 Corp | 1144 | 0 | Vasakronan AB | Sweden |
| AQ862989 Corp | 1145 | 1 | Vasakronan AB | Sweden |
| JV645825 Corp | 1145 | 0 | Vasakronan AB | Sweden |
| AQ688735 Corp | 1146 | 1 | Vasakronan AB | Sweden |
| EK930797 Corp | 1146 | 0 | Vasakronan AB | Sweden |
| AP606565 Corp | 1147 | 1 | Vasakronan AB | Sweden |
| QZ316076 Corp | 1147 | 0 | Vasakronan AB | Sweden |
| AP426671 Corp | 1148 | 1 | Vasakronan AB | Sweden |
| AO910884 Corp | 1148 | 0 | Vasakronan AB | Sweden |
| AO862546 Corp | 1149 | 1 | Vasakronan AB | Sweden |
| AM119701 Corp | 1149 | 0 | Vasakronan AB | Sweden |
| AN655412 Corp | 1150 | 1 | Vasakronan AB | Sweden |
| AO858190 Corp | 1150 | 0 | Vasakronan AB | Sweden |
| AM431760 Corp | 1152 | 1 | Vasakronan AB | Sweden |
| AM280148 Corp | 1152 | 0 | Vasakronan AB | Sweden |
| QZ916109 Corp | 1153 | 1 | Vasakronan AB | Sweden |
| QZ913313 Corp | 1153 | 0 | Vasakronan AB | Sweden |
| QZ869504 Corp | 1154 | 1 | Vasakronan AB | Sweden |
| QZ765512 Corp | 1154 | 0 | Vasakronan AB | Sweden |
| QZ869497 Corp | 1155 | 1 | Vasakronan AB | Sweden |
| QZ766185 Corp | 1155 | 0 | Vasakronan AB | Sweden |
| JK621523 Corp | 1156 | 1 | Vasakronan AB | Sweden |
| JK583355 Corp | 1156 | 0 | Vasakronan AB | Sweden |

| BB.ticker | Pair.ID | Green | Issuer | Country |
|---|---|---|---|---|
| QJ209937 Corp | 1157 | 1 | Vasakronan AB | Sweden |
| QJ634256 Corp | 1157 | 0 | Vasakronan AB | Sweden |
| QJ210510 Corp | 1158 | 1 | Vasakronan AB | Sweden |
| QJ566295 Corp | 1158 | 0 | Vasakronan AB | Sweden |
| UV522287 Corp | 1159 | 1 | Vasakronan AB | Sweden |
| UV484761 Corp | 1159 | 0 | Vasakronan AB | Sweden |
| EK755942 Corp | 1160 | 1 | Vasakronan AB | Sweden |
| EK724691 Corp | 1160 | 0 | Vasakronan AB | Sweden |
| EK594749 Corp | 1161 | 1 | Vasakronan AB | Sweden |
| EK479362 Corp | 1161 | 0 | Vasakronan AB | Sweden |
| EK180144 Corp | 1162 | 1 | Vasakronan AB | Sweden |
| EK052496 Corp | 1162 | 0 | Vasakronan AB | Sweden |
| EK127312 Corp | 1163 | 1 | Vasakronan AB | Sweden |
| EK095075 Corp | 1163 | 0 | Vasakronan AB | Sweden |
| EK127282 Corp | 1164 | 1 | Vasakronan AB | Sweden |
| EK169072 Corp | 1164 | 0 | Vasakronan AB | Sweden |
| EJ947148 Corp | 1165 | 1 | Vasakronan AB | Sweden |
| EJ969624 Corp | 1165 | 0 | Vasakronan AB | Sweden |
| EJ947154 Corp | 1166 | 1 | Vasakronan AB | Sweden |
| EJ909440 Corp | 1166 | 0 | Vasakronan AB | Sweden |
| AT059746 Corp | 1167 | 1 | Vellinge Kommun | Sweden |
| QZ499733 Corp | 1167 | 0 | Vellinge Kommun | Sweden |
| AR547471 Corp | 1168 | 1 | Vellinge Kommun | Sweden |
| AO901268 Corp | 1168 | 0 | Vellinge Kommun | Sweden |
| AN424921 Corp | 1170 | 1 | Volvofinans Bank AB | Sweden |
| AO002629 Corp | 1170 | 0 | Volvofinans Bank AB | Sweden |
| AL420471 Corp | 1171 | 1 | Västerås Stad | Sweden |
| JK241786 Corp | 1171 | 0 | Västerås Stad | Sweden |
| AL420337 Corp | 1172 | 1 | Västerås Stad | Sweden |
| JV058976 Corp | 1172 | 0 | Västerås Stad | Sweden |
| ZR318191 Corp | 1173 | 1 | Wallenstam AB | Sweden |
| AU573845 Corp | 1173 | 0 | Wallenstam AB | Sweden |
| ZS670496 Corp | 1174 | 1 | Wallenstam AB | Sweden |
| AV043801 Corp | 1174 | 0 | Wallenstam AB | Sweden |
| EK815744 Corp | 1175 | 1 | Wallenstam AB | Sweden |
| EK298861 Corp | 1175 | 0 | Wallenstam AB | Sweden |
| AZ098677 Corp | 1176 | 1 | Örebro kommun | Sweden |
| AV626647 Corp | 1176 | 0 | Örebro kommun | Sweden |
| AQ359652 Corp | 1177 | 1 | Örebro kommun | Sweden |
| AN132634 Corp | 1177 | 0 | Örebro kommun | Sweden |
| QZ735353 Corp | 1178 | 1 | Örebro kommun | Sweden |
| LW161152 Corp | 1178 | 0 | Örebro kommun | Sweden |
| EK539497 Corp | 1179 | 1 | Örebro kommun | Sweden |
| EK132188 Corp | 1179 | 0 | Örebro kommun | Sweden |
| ZR521404 Corp | 1180 | 1 | Östersunds Kommun | Sweden |
| ZS067572 Corp | 1180 | 0 | Östersunds Kommun | Sweden |
| AQ146665 Corp | 1181 | 1 | Östersunds Kommun | Sweden |
| AP569168 Corp | 1181 | 0 | Östersunds Kommun | Sweden |

## A2.3 Variable definitions

Table A2.3 provides definitions of the variables used in the secondary market analysis regressions.

**Table A2.3:** Variable definitions, secondary market analysis

| Variable | Definition |
|---|---|
| AskYield | A numerical variable equal to the daily yield to maturity, determined by the level of the ask price. |
| Green | An indicator variable equal to 1 if the bond is labeled as green and 0 if not. |
| BidAsk | A numerical variable equal to the daily bid-ask spread of a bond. |
| Issuer | A categorical variable equaling the company name of the bond issuer. |
| Month-Year | A categorical variable grouping daily dates into month of specific year. |
| Seniority | A categorical variable for the different bond risk categories. |
| Trustee | A categorical variable for the bond's assigned trustee. |
| Coupon type | A categorical variable for the bond's coupon type equaling Fixed or FRN. |
| Maturity | A categorical variable equal to 1 if the bond's maturity is less than 5 years, 2 if it is between 5 and 10 years, and 3 if it is more than 10 years. |
| Issue amount | A categorical variable equaling 1 to 5, where 1 is assigned if the amount issued was among the 20 percent smallest values, 2 when it was between the 20 and 40 percent smallest amounts issued, and so on. |
| Pair ID | A categorical variable with the ID's of each pair of bonds. |

## A2.4 OLS assumptions tests

The tests for OLS assumtions are shown in this section. We only included the tests for one of the models for the Norwegian market, as the results were similar in the Swedish market and for all models.

### A2.4.1 OLS assumption 1: Linearity of parameters

As can be seen in Figure A2.2, there is a pattern in the distribution of the residuals. The residuals get larger as we move left to right and there are a few potential outliers, so there may be some issues with our model. However, as can be seen, the trend line is straight. This indicates that there is no curved relationship present, and thus the parameters are linear and the assumption holds.

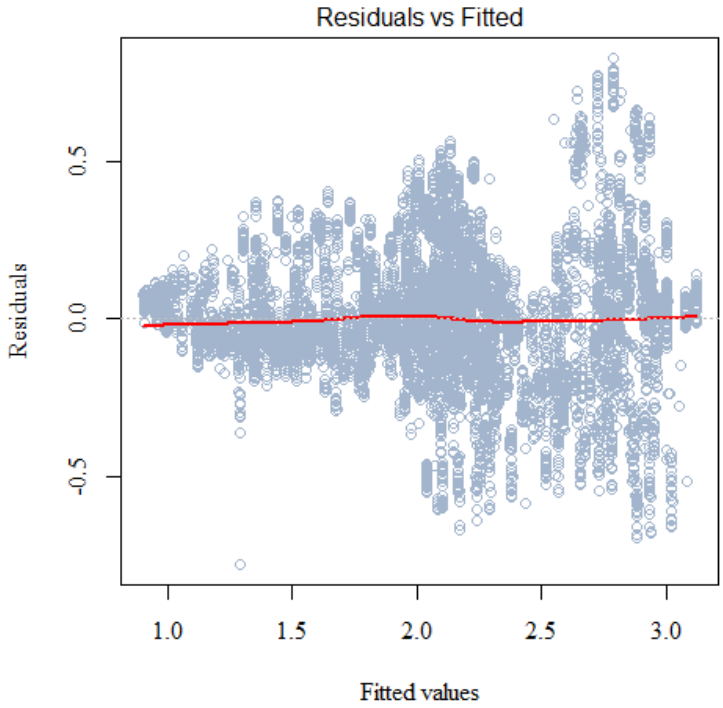


**Figure A2.2:** Plot of model residuals versus fitted values

### A2.4.2 OLS assumption 2: Zero conditional mean of error term

Considering Figure A2.2 of residuals vs fitted values, it is clear that the average mean of the residuals is equal to zero, and it is thus likely to assume that the zero conditional mean assumption holds. It is worth noting that conditionally they may have means some distance from zero.

### A2.4.3 OLS assumption 3: No perfect collinearity between variables

No perfect collinearity between the variables was detected, tested using covariance tests.

### A2.4.4 OLS assumption 4: No heteroskedasticity in the error term

In the case of no heteroskedasticity, Figure A2.3 would show randomly distributed points and a flat red line. However, the plot of standardized residuals versus fitted values shows that there is a trend in the residuals, and thus that there is a heteroskedasticity problem. This is further confirmed by the Breusch-Pagan test shown in Figure A2.4 where the null hypothesis if homoskedasticity is rejected.

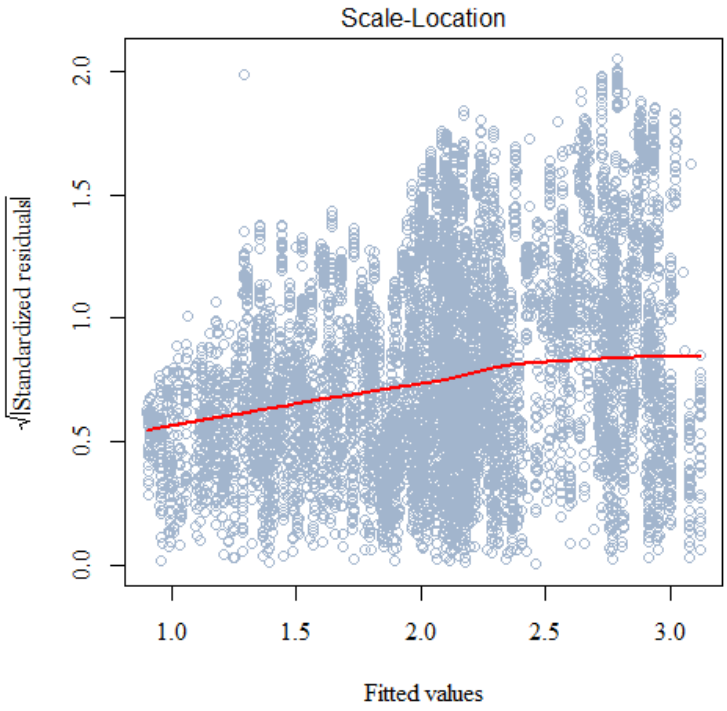


**Figure A2.3:** Plot of standardised residuals versus fitted values

**Table A2.4:** Results of the Breuch-Pagan test for heteroskedasticity

| Breusch Pagan Test for Heteroskedasticity |
|---|
| Ho: the variance is constant |
| Ha: the variance is not constant |
| **Data** |
| Response: ask.yield |
| Variables: fitted values of ask.yield |
| **Test Summary** |
| DF = 1 |
| Chi2 = 1218.2412 |
| Prob > Chi2 = 6.62233e-267 |

### A2.4.5 OLS assumption 5: No autocorrelation

In the case of no autocorrelation, Figure A2.4 would show lines within the blue dotted lines. As can be seen, this is clearly not the case, and there is thus a problem of autocorrelation in the sample. The Woolridge test in Figure A2.5 further confirms this as we reject the null hypothesis of no autocorrelation

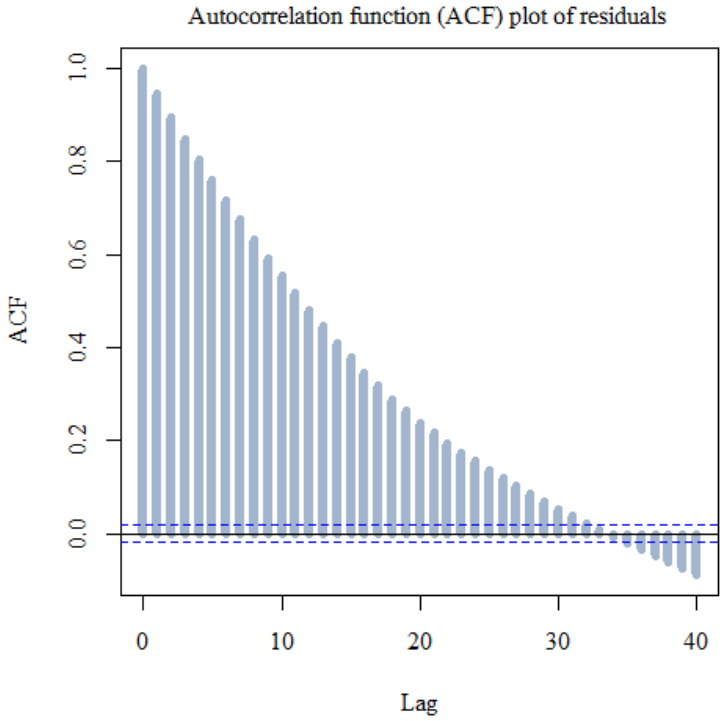


**Figure A2.4:** Plot testing for autocorrelation

**Table A2.5:** Results of the Woolridge's test for autocorrelation

| Wooldridge's test for serial correlation in FE panels |
|---|
| Ho: no serial correlation<br>Ha: serial correlation |
| Data = reg3.part1 |
| F = 34282<br>df1 = 1<br>df2 = 11444<br>p-value < 2.2e-16 |

### A2.4.6 OLS assumption 6: The error term is independent and normally distributed

Taking the mean of the residuals finds that the mean is zero. The QQ-plot in Figure A2.5 shows that the residuals somewhat follow a straight line, although there are some deviations in the beginning and end. The histogram of the residuals in Figure A2.6 show that they are somewhat normally distributed. The errors are assumed to be adequately independently and normally distributed, as some deviation is expected given the low

number of observations.

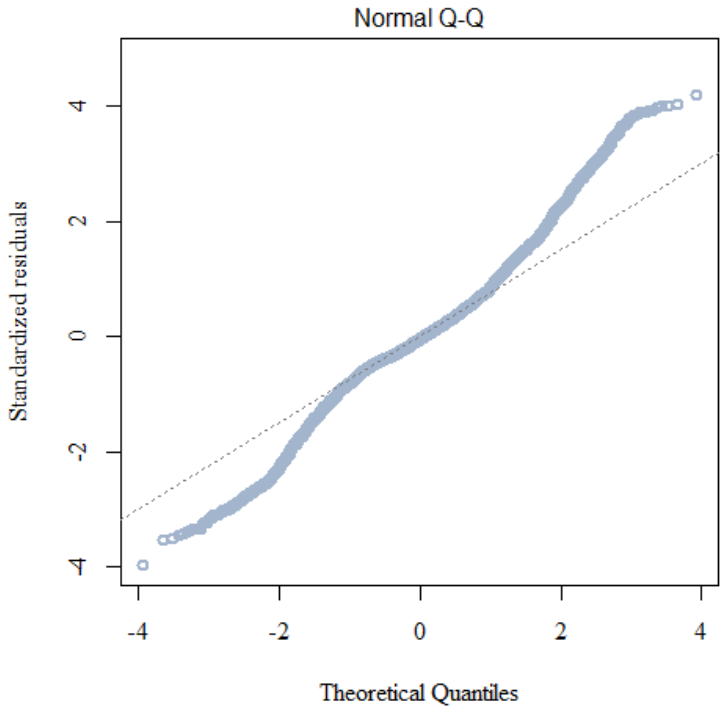


**Figure A2.5:** QQ-plot of residuals

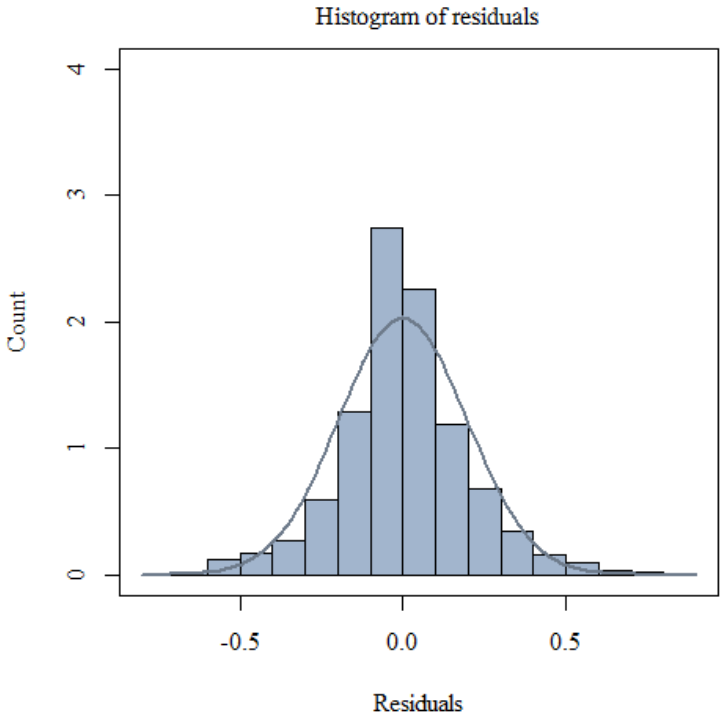


**Figure A2.6:** Histogram of residuals

# A3 Green focus analysis

## A3.1 Variable definitions

**Table A3.1:** Variable definitions, textual analysis

| Variable | Definition |
|---|---|
| GreenRatio | A numerical variable equal to the average ratio of green words to the total number of words in the annual reports |
| Year | A continuous variable for the year of the annual reports |

## A3.2 Green word dictionaries

Below, the English, Norwegian and Swedish dictionaries are listed. Because English words are often separated whereas Norwegian and Swedish words are often combinations of words, the English dictionary is shorter. For example, in English we have "climate change", "climate strategy", "climate concerns", etc., which are all captured by adding the word "climate" in the dictionary. In Norwegian (and Swedish) on the other hand, "klimaendringer", "klimastrategi" and "klimahensyn" are all separate words that need to be included in the dictionary.

**Table A3.2:** Green dictionaries

| Language | Words |
|---|---|
| English | green, environment, recycle, renewable, innovation, waste, ecosystem, ecology, emission, pollution, contamination, sustainable, esg, wind, hydropower, climate hydroelectric, biomass, consumption, carbon, greenhouse, ghg, biodiesel |
| Norwegian | grønn, miljø, miljøvennlig, fornybar, fornybarhet, bærekraftsmål, økosystem, økologi, utslippene, forurensning, bærekraftig, esg, vind, vannkraft, klima, klimavennlig, vindkraft, vindenergi, elkraft, kildesortering, miljøhensyn, miljømessig, klimahensyn, bærekraftsarbeid, klimaforkjemper, klimaendring, klimagass, biodisel, biogass, bioenergi, forbruk, vannforbruk, matsvinn, ressursforbruk, energisparing, solenergi, klimaregnskap, klimautslipp, klimastategi, klimarelatert, klimapanel, klimapolitikk, klimaregulering, klimasone, klimanøytral, klimagassutslipp, klimagassregnskap, drivhusgass, klimaforhold, klimadebatt, miljøansvar, miljøavgift, miljøavtale, miljøbelastning, miljøbevegelse, miljøbevisst, miljøeffekt, utslippskvote, miljøutslipp, karbon, karbonutslipp, energiforbruk, energibesparende, energisparende, gjenvinne |
| Swedish | grön, miljö, återvinna, förnybar, innovation, avfall, ekosystem, ekologi, utsläpp, föroreningar, hållbar, esg, vattenkraft, klimat, klimatvänlig, vindkraft, vindenergi, elkraft, fornybarhet, återvinning, miljövänlig, miljöhänsyn, klimathänsyn, hållbarhetsarbete, klimatförändringar, växthusgaser, biodisel, bioenergi, konsumtion, förbrukning, vattenförbrukning, resursförbrukning, energi, solenergi, klimatkonton, klimastategi, klimatrelaterade, klimatpolitik, klimatpanel, klimatreglering, klimasone, klimatneutralt, ghg, klimatförhållanden, klimatdebatten, miljöavtal, miljöpåverkan, miljörörelsen, miljömedveten, miljöeffekt, utsläppsrätter, miljöutsläppen, kol, koldioxidutsläpp, energiförbrukningen, energibesparing, miljöansvar, miljöskatt, energibesparande, recirkulering, miljömässigt, biogas |

## A3.3 Companies included in textual analysis

When creating the samples of companies with green bonds and companies with only conventional bonds we tried creating samples of companies with similar industry and sector compositions, while still prioritising companies with available annual reports for many years. Below, the resulting companies included in the samples are listed.

**Table A3.3:** List of Green and Grey Companies

| Country | Company |
|---|---|
| Norwegian Green Companies | Agder Energi, BKK, DNB, Eidsiva Energi, Entra, Kommunalbanken, Lyse, Norgesgruppen, NTE, OBOS Eiendom, Scatec Solar, Sogn og Fjordane Energi, Sparebank 1 Boligkreditt, Sparebanken Sogn og Fjordane, Sparebanken Sør Boligkreditt, SR Boligkreditt, Sunndal Sparebank, Vardar |
| Norwegian Grey Companies | Aker Solutions, Avinor, BN Borgestad, Etne, Felleskjopet, Gjensidige, Glitre Energi, Hafslund, Jotun, Kongsberg, Landkreditt Bank, Linstow, NEAS, Norwegian Property, OlavThon Eiendom, Orkla, Santander Consumer Bank, Sbanken, Schibsted, Selvaag, Sparebanken Øst, Statkraft, Statnett, Tafjord Kraft, Toten Sparebank, Troms Kraft, Trønderenergi, Veidekke |
| Swedish Green Companies | Advanced Soltech, Akademiska Hus, Arise, Atrium Ljungberg, Castellum, Electrolux, Essity, Fabege, Fastighets Balder, Fast Partner, Klovern,Handelsbanken, Hemfosa Fastigheter, Humlegarden Fastigheter, Jernhusen, Kungsleden, Landshypotek Bank, Nobina, Samhallsbyggnadsbolaget, SBAB, SEB, SFF, Skanska, SKB, Sodra Skogsagarna, Stena Metall, Stockholm Exergi, Sveaskog, Sveriges Sakerstallda Obligationer, Swedbank, Uppsalahem, Vacse, Vasakronan, Vattenfall, VolvoFinans, Wallenstam, Willhem |
| Swedish Grey Companies | Atella, Björn Borg, Bluestep Bank, Compactor, Consilium, Corem, Diamorph, Ferronordic, Granges, Hufvudstaden, Holmen, Ikano, Intea, LEAX, Lundbergsforetagen, M2, Magnolia Bostad, NCC, NIBE, Nordax Bank, Nordea, NP3, Offentliga Hus, PostNord, Prime Living, Resurs Bank, Sagax, Sandvik, Trelleborg, SAS, Serneke, Sparebanken Skåne, Stromma, Wihlborgs Fastigheter |

## A3.4 Textual analysis model: R-code

The textual analysis model was built in the open-source statistical program R. This section shows the code we wrote in order to analyse the annual reports of the Green and Grey Companies in Norway and Sweden. The code for extracting the green ratios is the same for both Green and Grey Companies, so instead of listing the same code again and again we have only included the code for analysing the reports of Green Companies written in English.

```
rm(list=ls())
library(dplyr)
library(plm)
library(stargazer)
library(data.table)
library(ggplot2)

######################################################## NORWAY ########################################################

############################## Textual analysis of Green Companies, English language ##############################

# Defining company name and preparing the green dictionary
company <- c("AgderEnergi", "DNB", "Kommunalbanken", "Lyse", "ScatecSolar", "Sparebank1Boligkreditt",
             "SparebankenSorBoligkreditt", "SRBoligkreditt")


greendict <- c("green", "environment", "recycle", "renewable", "innovation", "waste","ecosystem", "ecology",
               "emission", "pollution", "contamination", "sustainable", "esg", "wind", "hydropower",
               "hydroelectric", "climate" , "biomass", "consumption" , "carbon", "greenhouse", "ghg", "biodiesel")

language <- "english"
dict <- stemDocument(greendict, language = language)

# Textual analysis, looping through all annual reports for all companies extracting the Green Ratio
for (k in 1:length(company)) {
  setwd(file.path("M:/MASTER/Annual reports/NO Annual Report EN", company[[k]]))
  file_names <- list.files(pattern = "pdf$")
  files <- lapply(file_names, pdf_text)
  hypp <- list()

  for(i in 1:length(files)){
    fil <- files[[i]]
    txt_corpus <- Corpus(VectorSource(fil))

    # Preparing text (removing lowercase, punctuation, whitespace, stopwords and numbers)
    txt_corpus <- tm_map(txt_corpus, tolower)
    txt_corpus <- tm_map(txt_corpus, removePunctuation, ucp=TRUE)
    txt_corpus <- tm_map(txt_corpus, stripWhitespace)
    txt_corpus <- tm_map(txt_corpus, removeNumbers)
    txt_corpus <- tm_map(txt_corpus, removeWords, stopwords(language))
    txt_corpus <- tm_map(txt_corpus, stemDocument, language = language)

    # Creating document term matrix (transforming corpus into matrix)
    dtm <- DocumentTermMatrix(txt_corpus)
    dtm <- as.matrix(dtm)
    dtm <- t(dtm)

    # Calculates the sum of each mentioned word in the text
    number_occ <- rowSums(dtm)

    # Extracting only the word count for the words specified in the Green Dictionary
    hypp[[i]] <- colSums(data.frame(cbind(number_occ[dict])), na.rm = TRUE)/sum(number_occ)
  }

  # Creating a new data frame of the green ratio for each company, each year
  do.call(rbind, hypp)
  names(hypp) <- file_names
  assign(company[[k]],data.frame(matrix(unlist(hypp), nrow=length(hypp), byrow = T), row.names = file_names))
}

# Extract year as column and changing column names
setDT(AgderEnergi, keep.rownames = TRUE)[]
colnames(AgderEnergi) <- c("year", "AgderEnergi")
setDT(DNB, keep.rownames = TRUE)[]
colnames(DNB) <- c("year", "DNB")
```

```
setDT(Kommunalbanken, keep.rownames = TRUE)[]
colnames(Kommunalbanken) <- c("year", "Kommunalbanken")
setDT(Lyse, keep.rownames = TRUE)[]
colnames(Lyse) <- c("year", "Lyse")
setDT(ScatecSolar, keep.rownames = TRUE)[]
colnames(ScatecSolar) <- c("year", "ScatecSolar")
setDT(Sparebank1Boligkreditt, keep.rownames = TRUE)[]
colnames(Sparebank1Boligkreditt) <- c("year", "Sparebank1Boligkreditt")
setDT(SparebankenSorBoligkreditt, keep.rownames = TRUE)[]
colnames(SparebankenSorBoligkreditt) <- c("year", "SparebankenSorBoligkreditt")
setDT(SRBoligkreditt, keep.rownames = TRUE)[]
colnames(SRBoligkreditt) <- c("year", "SRBoligkreditt")

# Merging all data frames to one
NOfullEN <- Reduce(function(x,y) merge(x,y,by= "year" ,all=TRUE) ,list( AgderEnergi ,  DNB ,  Kommunalbanken ,  Lyse ,
       ScatecSolar ,  Sparebank1Boligkreditt ,  SparebankenSorBoligkreditt ,SRBoligkreditt ))

write.csv(NOfullEN,"M:\\MASTER\\Annual reports\\csv\\NOfullEN.csv", row.names = FALSE)

#The same code is conducted for annual reports written in Norwegian, as well as for the reports from
#Grey Companies (both languages).

# Green Companies: Downloading and preparing data for regression

NO.fullEN <- read.csv("M:/MASTER/Annual reports/csv/NOfullEN.csv", sep=",")
NO.fullNO <- read.csv("M:/MASTER/Annual reports/csv/NOfullNO.csv", sep=",")
NO.df <- merge(NO.fullNO, NO.fullEN, by ="year", all = TRUE)
NO.df2 <- NO.df
NO.df2$avg.ratio <- rowMeans(NO.df2[,-1], na.rm=TRUE)
NO.df2 <- NO.df2[ -c(2:20) ]
NO.df2$year <- substr(NO.df2$year, 0, 4)
NO.df2$avg.ratio <- NO.df2$avg.ratio*100
NO.df2$year <- as.factor(NO.df2$year)
NO.df2$year2 <- as.numeric(NO.df2$year)

# Grey Companies: Downloading and preparing data for regression

NO.CB.fullEN <- read.csv("M:/MASTER/Annual reports/csv/CB.NOfullEN.csv", sep=",")
NO.CB.fullNO <- read.csv("M:/MASTER/Annual reports/csv/CB.NOfullNO.csv", sep=",")
NO.df.CB <- merge(NO.CB.fullEN, NO.CB.fullNO, by ="year", all = TRUE)
NO.df2.CB <- NO.df.CB
NO.df2.CB$avg.ratio <- rowMeans( NO.df2.CB[,-1], na.rm=TRUE)
NO.df2.CB <- NO.df2.CB[ -c(2:31) ]
NO.df2.CB$year <- substr(NO.df2.CB$year, 0, 4)
NO.df2.CB$avg.ratio <- NO.df2.CB$avg.ratio*100
NO.df2.CB$year <- as.factor(NO.df2.CB$year)
NO.df2.CB$year2 <- as.numeric(NO.df2.CB$year)

# Regressions

NO.reg.G <- lm(avg.ratio ~ year2, data = NO.df2)
NO.reg.CB <- lm(avg.ratio ~ year2, data = NO.df2.CB)
stargazer(NO.reg.G, NO.reg.CB, type="text")

# Plot

plot(NO.df2$year2, NO.df2$avg.ratio, xaxt = 'n',
     ylim = c(0,1),
     type="p", pch = 18,
     col = "darkolivegreen3",
     main = "Norway - Green Focus", family = "serif",
     xlab = "Year", ylab = "Green ratio in percentage")
abline(NO.reg.G,
       col = "darkolivegreen4",
       lwd = 2)
points(NO.df2.CB$year2, NO.df2.CB$avg.ratio,
```

```
       type = "p",
       pch = 20,
       col = "lightsteelblue3")
abline(NO.reg.CB,
       col = "lightsteelblue4",
       lwd = 2)
axis(1,at=seq(1,19,1),labels=F)
axis(1,at=seq(1,19,1),tick=F,labels= seq(2000,2018,1), las = 1,family = "serif")


##################################################### SWEDEN ###################################################

############################### Textual analysis of Green Companies, English language ##############################

# Defining company name and preparing the green dictionary
company <- c("AkademiskaHus", "Arise", "AtriumLjungberg", "Castellum", "Electrolux", "Essity", "Fabege",
             "Klovern", "Kungsleden", "LandshypotekBank", "Nobina", "SamhallsbyggnadsbolagetNorden", "SBAB",
             "SEB", "Skanska", "SverigesSakerstalldaObligationer", "Swedbank", "SodraSkogsagarna", "Vattenfall")

greendict <- c("green", "environment", "recycle", "renewable", "innovation", "waste","ecosystem",
               "ecology", "emission", "pollution", "contamination", "sustainable", "esg", "wind", "hydropower",
               "hydroelectric", "climate" , "biomass", "consumption" , "carbon", "greenhouse", "ghg", "biodiesel")

language <- "english"
dict <- stemDocument(greendict, language = language)

# Textual analysis, looping through all annual reports for all companies extracting the Green Ratio
for (k in 1:length(company)) {
  setwd(file.path("M:/MASTER/Annual reports/SE Annual Report SE", company[[k]]))

  file_names <- list.files(pattern = "pdf$")
  files <- lapply(file_names, pdf_text)
  hypp <- list()

  for(i in 1:length(files)){

    fil <- files[[i]]
    txt_corpus <- Corpus(VectorSource(fil))

    # Preparing text (removing lowercase, punctuation, whitespace, stopwords and numbers)
    txt_corpus <- tm_map(txt_corpus, tolower)
    txt_corpus <- tm_map(txt_corpus, removePunctuation, ucp=TRUE)
    txt_corpus <- tm_map(txt_corpus, stripWhitespace)
    txt_corpus <- tm_map(txt_corpus, removeNumbers)
    txt_corpus <- tm_map(txt_corpus, removeWords, stopwords(language))
    txt_corpus <- tm_map(txt_corpus, stemDocument, language = language)

    #create document term matrix (transforming corpus into matrix)
    dtm <- DocumentTermMatrix(txt_corpus)
    dtm <- as.matrix(dtm)
    dtm <- t(dtm)

    # Calculates the sum of each mentioned word in the text
    number_occ <- rowSums(dtm)

    # Extracting only the word count for the words specified in the Green Dictionary
    hypp[[i]] <- colSums(data.frame(cbind(number_occ[dict])), na.rm = TRUE)/sum(number_occ)
  }
  # Creating a new data frame of the green ratio for each company, each year
  do.call(rbind, hypp)
  names(hypp) <- file_names
  assign(company[[k]],data.frame(matrix(unlist(hypp), nrow=length(hypp), byrow = T), row.names = file_names))
}

# Extract year as column and changing column names
setDT(AkademiskaHus, keep.rownames = TRUE)[]
```

```
colnames(AkademiskaHus) <- c("year", "AkademiskaHus")
setDT(Arise, keep.rownames = TRUE)[]
colnames(Arise) <- c("year", "Arise")
setDT(AtriumLjungberg, keep.rownames = TRUE)[]
colnames(AtriumLjungberg) <- c("year", "AtriumLjungberg")
setDT(Castellum, keep.rownames = TRUE)[]
colnames(Castellum) <- c("year", "Castellum")
setDT(Electrolux, keep.rownames = TRUE)[]
colnames(Electrolux) <- c("year", "Electrolux")
setDT(Essity, keep.rownames = TRUE)[]
colnames(Essity) <- c("year", "Essity")
setDT(Fabege, keep.rownames = TRUE)[]
colnames(Fabege) <- c("year", "Fabege")
setDT(Klovern, keep.rownames = TRUE)[]
colnames(Klovern) <- c("year", "Klovern")
setDT(Kungsleden, keep.rownames = TRUE)[]
colnames(Kungsleden) <- c("year", "Kungsleden")
setDT(LandshypotekBank, keep.rownames = TRUE)[]
colnames(LandshypotekBank) <- c("year", "LandshypotekBank")
setDT(Nobina, keep.rownames = TRUE)[]
colnames(Nobina) <- c("year", "Nobina")
setDT(SamhallsbyggnadsbolagetNorden, keep.rownames = TRUE)[]
colnames(SamhallsbyggnadsbolagetNorden) <- c("year", "SamhallsbyggnadsbolagetNorden")
setDT(SBAB, keep.rownames = TRUE)[]
colnames(SBAB) <- c("year", "SBAB")
setDT(SEB, keep.rownames = TRUE)[]
colnames(SEB) <- c("year", "SEB")
setDT(Skanska, keep.rownames = TRUE)[]
colnames(Skanska) <- c("year", "Skanska")
setDT(SverigesSakerstalldaObligationer, keep.rownames = TRUE)[]
colnames(SverigesSakerstalldaObligationer) <- c("year", "SverigesSakerstalldaObligationer")
setDT(Swedbank, keep.rownames = TRUE)[]
colnames(Swedbank) <- c("year", "Swedbank")
setDT(SodraSkogsagarna, keep.rownames = TRUE)[]
colnames(SodraSkogsagarna) <- c("year", "SodraSkogsagarna")
setDT(Vattenfall, keep.rownames = TRUE)[]
colnames(Vattenfall) <- c("year", "Vattenfall")

# Merging all data frames to one
SEfullEN <- Reduce(function(x,y) merge(x,y,by="year",all=TRUE) ,list(AkademiskaHus, Arise, AtriumLjungberg, Castellum,
      Electrolux, Essity, Fabege, Klovern, Kungsleden, LandshypotekBank, Nobina, SamhallsbyggnadsbolagetNorden, SBAB,
     SEB, Skanska, SverigesSakerstalldaObligationer, Swedbank, SodraSkogsagarna, Vattenfall))

write.csv(SEfullEN,"M:\\MASTER\\Annual reports\\csv\\SEfullEN.csv", row.names = FALSE)

#The same code is conducted for annual reports written in Swedish, as well as for the reports from
#Grey Companies (both languages)

# Green Companies: Downloading and preparing data for regression

SE.fullEN <- read.csv("M:/MASTER/Annual reports/csv/SEfullEN.csv", sep=",")
SE.fullSE <- read.csv("M:/MASTER/Annual reports/csv/SEfullSE.csv", sep=",")
SE.df <- merge(SE.fullEN, SE.fullSE, by ="year", all = TRUE)
SE.df2 <- SE.df
SE.df2$avg.ratio <- rowMeans( SE.df2[,-1], na.rm=TRUE)
SE.df2 <- SE.df2[ -c(2:41) ]
SE.df2$year <- substr(SE.df2$year, 0, 4)
SE.df2$avg.ratio <- SE.df2$avg.ratio*100
SE.df2$year <- as.factor(SE.df2$year)
SE.df2$year2 <- as.numeric(SE.df2$year)

# Grey Companies: Downloading and preparing data for regression

SE.CB.fullEN <- read.csv("M:/MASTER/Annual reports/csv/CB.SEfullEN.csv", sep=";")
SE.CB.fullSE <- read.csv("M:/MASTER/Annual reports/csv/CB.SEfullSE.csv", sep=",")
SE.df.CB <- merge(SE.CB.fullEN, SE.CB.fullSE, by ="year", all = TRUE)
```

```
261 SE.df2.CB <- SE.df.CB
262 SE.df2.CB$avg.ratio <- rowMeans( SE.df2.CB[,-1], na.rm=TRUE)
263 SE.df2.CB <- SE.df2.CB[ -c(2:37) ]
264 SE.df2.CB$year <- substr(SE.df2.CB$year, 0, 4)
265 SE.df2.CB$avg.ratio <- SE.df2.CB$avg.ratio*100
266 SE.df2.CB$year <- as.factor(SE.df2.CB$year)
267 SE.df2.CB$year2 <- as.numeric(SE.df2.CB$year)
268
269 # Regressions
270
271 SE.reg.G <- lm(avg.ratio ~ year2, data = SE.df2)
272 SE.reg.CB <- lm(avg.ratio ~ year2, data = SE.df2.CB)
273 stargazer(SE.reg.G, SE.reg.CB, type="text")
274
275 # Plot
276
277 plot(SE.df2$year2, SE.df2$avg.ratio, xaxt = 'n',
278      ylim = c(0,1),
279      type="p", pch = 18,
280      col = "darkolivegreen3",
281      main = "Norway - Green Focus", family = "serif",
282      xlab = "Year", ylab = "Green ratio in percentage")
283 abline(SE.reg.G,
284        col = "darkolivegreen4",
285        lwd = 2)
286 points(SE.df2.CB$year2, SE.df2.CB$avg.ratio,
287        type = "p",
288        pch = 20,
289        col = "lightsteelblue3")
290 abline(SE.reg.CB,
291        col = "lightsteelblue4",
292        lwd = 2)
293 axis(1,at=seq(1,22,1),labels=F)
294 axis(1,at=seq(1,22,1),tick=F,labels= seq(1998,2018,1), las = 1,family = "serif")
```