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ESG Performance, Green Bonds, and Yield Spreads

An empirical study of the Norwegian corporate bond market

Master Thesis

by
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MSc in Finance

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ABSTRACT

This paper seeks to study the relationship between environmental, social, and governance (ESG) performance, green bonds, and yield spreads in the Norwegian corporate bond market. By imposing a clustering model with fixed effects and a linear mixed effect model, we intend to answer whether ESG performance and sustainability, proxied through ESG ratings and green bonds, impact corporate yield spreads, following the belief that ESG- and sustainability-linked risks are financially material. The analyses utilize Nordic Bond Pricing's historical bond price data, paired with a database consisting of ESG ratings, company-specific financials, and bond characteristics. Our results suggest that aggregated ESG performance is unrelated to yield spreads, while higher individual pillar performance is penalized with higher yield spreads in the Norwegian secondary bond market. On the other hand, green bonds appear to trade at lower yield spreads compared to their non-green counterparties, but poor data quality is believed to contaminate the results, rendering the results questionable.

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Thank you.

Per Børge Bakke

Marie Dale

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Abbreviations

CSP Corporate Social Performance

CSR Corporate Social Responsibility

D/E Net Debt to Equity

D/EBITDA Net Debt to EBITDA

ESG Environmental Social and Governance

ESGE Environmental pillar

ESGG Governance pillar

ESGS Social pillar

LMM Linear Mixed Model

NAS Norwegian Air Shuttle ASA

NBP Nordic Bond Pricing

OLS Ordinary Least Squares

OSE Oslo Stock Exchange

P/B Price to Book

RoA Return on Assets

SDG Social Development Goal

SIC Standard Industrial Classification

TTM Time to Maturity

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1 Introduction and motivation

Environmental issues, social responsibility, and governance matters have gained increasing awareness and momentum during the last decades. Now, environmental, social, and governance challenges are being put on the political and social agenda, with increased coverage in media. A new generation of young adults is at the forefront of demanding change as they seek to reduce pollution, inequality, and unjust. As a result of increased awareness, firms are starting to consider these issues. Some due to shareholder demand, others due to the belief that Environmental Social and Governance (ESG) issues are financially material (Bersagel et al., 2018). The UN Global Compact-Accenture CEO (Sachs et al., 2021) survey stated that 93% of 750 CEOs believe that sustainability is financially material, providing evidence of ESG's importance for financial performance.

Several real-world examples substantiate the supposed relation between ESG and firm value. Bonds issued by BP traded at a 30bps premium compared to average junk bonds following the 2010 Mexico Gulf oil spill scandal. BP's credit rating was slashed only days later, from AA to BBB, by the rating agency Fitch (Oikonomou et al., 2014). Facebook experienced similar turmoil when its stock price plummeted 19%, wiping out $119bn worth of market value after it became publicly known that 87m users were affected by the Cambridge Analytica scandal (Neate, 2018). It seems evident that ESG-related matters may indeed have financially material impact. Several studies have been trying to link Corporate Social Responsibility (CSR) to financial performance. However, a consensus has not yet been reached (Oikonomou et al., 2014).

As the broader topic of ESG is a relatively new subject on the agenda, there are several unexplored paths that need discovering. One of these paths revolves around the potential relationship between ESG performance and the cost of capital. Currently, there is mixed evidence linking ESG performance to cost of equity. While some suggest that high carbon-emitting firms should yield higher returns as compensation for higher risks (Hong and Kacperczyk, 2009), European data shows that low carbon-emitting firms have outperformed the stock return of high carbon-emitting firms since 2009 (Ryszka, 2020). The mixed evidence indicates a need for further analysis. In addition, there is currently an overweight of empirical studies covering ESG performance and the equity market. In contrast, relatively few studies cover the relationship between ESG performance and the debt market (Bersagel et al., 2018). As stated by Gerard (2019): *"Very few studies examine the link between firm ESG policies and bond prices, risks and returns, and the performance of SR FI funds"*. As of 2019, the global market capitalization was split 47% and 53% between the equity and bond markets, respectively (Kolchin and Podziemska, 2019), suggesting that the bond market should not be overlooked. With a significant overweight of empirical studies covering the equity market, we believe it is highly relevant to shed light on the link between ESG performance and the bond market.

The importance of providing easily detectable sustainable investment opportunities became evident in 2008, with the introduction of a new asset class referred to as green bonds. Green bonds are in essence, regular bonds whose proceeds are used to finance projects which have a positive or non-negative environmental impact. Subsequently, green bonds are less exposed to environmental risk. Previously conducted empirical studies find mixed evidence on the relationship between green bonds and the cost of capital (Zerbib, 2019; Karpf and Mandel, 2018), implying a need for further research.

In terms of geographical delimitation, this study will cover the Norwegian corporate bond market and thus contribute to an area with limited available empirical research. As previously mentioned, there is an underweight of empirical studies concentrating on sustainability and performance in the bond market, and most of these studies are centered around the USD- and EUR markets. To our knowledge, no research has been conducted on these topics with a sole focus on the Norwegian market. We, therefore, deem it relevant to further broaden the empirical landscape by researching the impact of sustainability and ESG performance in the Norwegian bond market. Norway, and the Nordic countries in general, were ranked among the top countries in the 2020 Social Development Goal (SDG) index, which measures total progress towards achieving UN's 17 SDGs (Sachs et al., 2022). This indicates that ESG awareness is high in these regions, and the Norwegian market therefore provides an interesting case. We believe a successful identification of a relationship between sustainability and yield spread is ought more likely to be found in an area with high sustainability awareness and performance.

This paper intends to shed light on the relation between ESG performance, sustainability, and yield spreads by conducting three separate analyses. The first analysis will try to identify a relationship between ESG performance (proxied using Refintiv's ESG Score) and yield spread in the secondary bond market, following the methodological approach developed by Thompson (2011) and later used by Oikonomou et al. (2014). The second analysis decomposes the combined ESG Score into three separate pillar scores and investigates each pillar's relationship to yield spreads. The third analysis uses a linear mixed-effects model to investigate whether green bonds trade at lower yield spreads than their non-green counterparties. A successful identification of a relationship between ESG performance, or green bonds, and yield spread can prove helpful and possibly value-creating for firms. Firms that (to a certain extent) seek capital at the lowest possible cost could potentially reduce their cost of capital by improving their ESG performance or investing in positive environmental impact projects. Thus, implying that firms can potentially increase their firm value by becoming "greener" or investing in positive ESG measures. Subsequently. we formulate our research question: *"What is the relationship between*

ESG performance, sustainability, and bond yield in the Norwegian corporate bond market. ”

2 Literature review

A limited number of academic articles cover the relationship between sustainability and credit metrics. Of the studies conducted so far, most cover either the environmental or the social aspects, while relatively few cover the governance-related aspects. The exception is Oikonomou et al. (2014), which touch upon all three aspects. Gerard (2019) underlines that the research on jointly aggregated ESG performance's impact on corporate bond yield is still unclear: ”... *the research on this topic is limited, and perhaps not of the highest quality.*”

2.1 ESG performance

The first relevant study, conducted by Bhojraj and Sengupta (2003), focuses solely on governance and primary issue bond yields. Using a pooled Ordinary Least Squares (OLS) model, they found that US corporate bonds issued by firms with greater board independency received better credit ratings in addition to lower bond yields. They claim that: *”Governance mechanisms can reduce default risk by mitigating agency costs and monitoring managerial performance and by reducing information asymmetry between the firm and the lenders”.* Furthermore, they found that a less diverse ownership structure is associated with lower credit ratings and higher yields and that the impact of governance mechanisms is more important for lower-rated bonds.

Menz (2010) investigates the impact of CSR on European credit spreads. Utilizing Sustainable Asset Management Research as the provider for data on company-specific Corporate Social Performance (CSP), the analysis covers 498 corporate bonds over a 38-month period through May 2006. Using a fixed-effects model with robust standard errors, he estimates that poor CSP yields lower risk premia. The results contradict the belief that socially responsible firms are less risky and thus should have lower credit spreads. Note that these results are only weakly statistically significant.

A study conducted by Oikonomou et al. (2014) found evidence supportive of ESG performance impacting both yield spread and credit rating. The study, which covers more than 3 240 US corporate bonds traded in the 1991 to 2008 period, suggests "... *support for local communities, higher levels of marketed product safety and quality characteristics, and avoidance of controversies regarding the firm's workforce, can materially reduce the risk premia associated with corporate bonds and thus decrease the cost of corporate debt.*"

Table 1, by Gerard (2019), summarizes relevant studies.

Study	**Focus**	**Dep. Var.**	**Main Findings**
Menz, 2010	E,S	CS	High CSR score increase CS
Stellner, Klein, Zwerged, 2015	E,S	CS	High CSR score reduces CS
Bauer, Hann, 2014	E	CS, BV	High E score increase BV, decreases CS
Chava, 2014	E	CS	Low E scores increase CS, high cores no impact
Oikonomou, Brooks, Pavelin, 2014	E,S	CS	CS negatively related to CSR score
Ge, Liu, 2015	E,S	BV	New issue discount negatively related to CSR score
Attig, El Ghoul, Guedhami, 2013	E,S	CR	Positively related to CSR score
Shi, Sun, 2015	E,S	Cov	# of covenants negatively related to CSR score
Bhojraj, Sengupta, 2013	G	CS, CR	Better G, lower CS, higher CR
Hoepner et al., 2014	E	CS	Cross-country, country score matters, issuer score does not
Deng, Kang, Low, 2013	E,S	Merger BR	Negative, low CSR acquirers; zero, high CSR acquires

Table 1: Studies on ESG and bond value relation

To summarize, the empirical evidence tends to support the view of a negative relationship between ESG performance and yield spread. While Menz (2010) finds a weakly statistically significant positive relationship, Stellner et al. (2015), Bauer and Hann (2010), and Oikonomou et al. (2014) all find evidence that directly supports the hypothesis that higher ESG performance is associated with lower yield spread. However, most of the available empirical studies are based on older data samples, mostly covering the US bond market.

Menz (2010) study on European bonds finds a positive relationship, suggesting that the European bond market does not share the same view on ESG risks as the US bond market. Furthermore, the availability, quality, and magnitude of ESG metrics have significantly improved in recent years, possibly giving rise to better ESG performance approximation and accessibility.

2.2 Green bonds

The available empirical evidence covering green bonds and yield spread is indecisive. Zerbib (2019) investigates bond prices on both USD and EUR-denominated bonds in the 2013-2017 period. By matching green bonds to non-green bonds with similar characteristics (coupon, maturity, credit rating, etc.), he finds a minor negative (-2bp) premium for green bonds compared to conventional bonds. The study utilizes a two-step regression methodology to estimate the relationship. Thus, the results support the belief that green bonds trade at a lower yield spread. Furthermore, the premium is slightly more pronounced for financial companies and lower-rated bonds.

Karpf and Mandel (2018) studied 1880 US municipal bonds issued in the 2010-2016 period. By performing a similar matching technique, their results suggest that green bonds trade at a 7.8bp premium compared to the non-green comparables, arguing that being green is "punished" by investors through higher yield spreads. The study makes use of the Blinder-Oaxaca decomposition method to estimate the premium. Moreover, they argue that green investments were initially thought of as suboptimal, in the sense that investors had to forgo return in order to achieve positive environmental impact, thus leading to a "green premium." However, they find indications of the premium turning negative from 2015 onwards, meaning that investors are potentially changing their view upon green bonds. Bos et al. (2018) find both similar results and trends in their study covering the global green bond market.

Like ESG performance, the relationship between green bonds and yield spreads is unclear. While Karpf and Mandel (2018) and Bos et al. (2018) find a positive premium (higher yield spreads) for green bonds, Zerbib (2019) finds a minor negative premium. Thus, no clear relation between sustainability, proxied through green bonds, and yield spread is established. It is worth keeping in mind that the green bond asset class is relatively new (with the first green bond being issued in 2008) and that the market is growing steadily. The data availability will thus continue to improve in the years come, allowing for better empirical studies. It is also worth noting the trend described by Karpf and Mandel (2018) and Bos et al. (2018), which could indicate that investors are starting (or have started) to change their view on the risks (and thus return) embodied in green bonds.

3 Theory

This section will cover relevant theories linking CSR and ESG to financial performance and bond prices. First, we touch upon the two most established theories regarding the discussion on the purpose of corporations by reviewing the shareholder- and stakeholder theory. Next, we cover the bond pricing topic before formally introducing the ESG term. Lastly, we link the two subjects by providing a theoretical justification for why ESG performance may impact bond prices.

3.1 Shareholder vs. stakeholder theory

The purpose of corporations has been subject to extensive debates throughout time, and to this date, no clear answer exists. However, two theories have emerged to become the benchmark principles that disputants refer to, namely the stakeholder- and the shareholder theory. The two theories take opposing views in the discussion and thus highlight why ESG and CSR are much debated topics.

The shareholder theory was first introduced by Milton Friedman in his book *Capitalism and Freedom* in 1962. The theory emphasizes that the sole responsibility of a corporation is to maximize shareholder value while operating within the ”rules of the game” and engaging in ”open and free competition” (Friedman, 1962). The rationale behind this doctrine is that shareholders are the residual claimants of firms; therefore, maximizing their value is the equivalent of maximizing the firm's profits and, consequently, the total cash flow to all claim holders. Supportive to this statement is that other stakeholders have their protection through contractual agreements, as they often have well-defined claims on the firm like a fixed salary or debt repayment agreement through signed contracts. This type of contractual protection does not apply to the shareholders. Hence, Friedman (1962) argues that corporations' only obligation is their shareholders, and to strive towards giving them their deserved return as compensation for the risk taken when investing in the firm, emphasizing no other social responsibilities beyond that. It seems evident that Friedmann suggests that firms should not pay attention to ESG-related matters, as they are not directly related to the firms' financial performance.

As a continuation of the former, one can argue that the responsibility in terms of ESG is implicitly in the hands of the shareholders. By deciding which companies to invest in, the shareholders simultaneously decide how much impact and contribution to place on ESG matters. The shareholder theory postulate that this is the best way to engage with responsible investing, rather than to place it as a duty on the corporations and make companies “waste” resources on ESG-related activities.

In contrast, the stakeholder theory argues that a company should not single-mindedly concern itself with maximizing the benefits for shareholders (Wijnberg, 2000). The stakeholder theory was first introduced by Freeman (1984) as a counterweight to the already established shareholder theory. A definition of the theory is stated by Crainer (1995): *"The theory that a firm should be run in the interests of all its stakeholders rather than just the shareholders."* Furthermore, the theory postulates two main responsibilities of the firm (in addition to maximizing shareholder value); firstly, to ensure that no ethical rights of its stakeholders are violated, and secondly, stakeholders' interests should be balanced in the decision-making processes.

The stakeholder theory emphasizes a positive relation between ESG performance and financial performance and argues that sustainable investments can potentially be value-creating for shareholders. Freeman (2010) states that engaging in nonfinancial activities can benefit both the company and its shareholders through positive side effects. One argument supporting this statement is that mismanaging other stakeholders' interests may cause bad reputational effects and boycotts, and followingly reduced revenues, market shares, and financial performance. Moreover, a study by Whysall (2000) found that a fallout with stakeholders can cause long-lasting and widespread effects that potentially reduce the long-term financial performance.

Having discussed both the shareholder- and stakeholder theory, it is evident that the theories have opposing views on corporations' purpose. One can argue that the shareholder theory, in most cases, does not support the thought of companies caring about ESG-related matters, as it is beyond the scope of financial performance. In contrast, the stakeholder theory indicates that companies should care about ESG. However, with the stakeholder theory being the older viewpoint, we are observing a trend where the stakeholder theory is gradually receiving more support from investors, politicians, and academia.

3.2 Bond pricing

The pricing of defaultable fixed income securities is a complex procedure, and several models and methodologies have been developed to estimate the securities' true value. We are not going to explain the details of these models, but we will elaborate on the practical application and rationale behind them to get an overview of the determinants of corporate bond pricing. Duffie and Singleton (2001) highlight different pricing models used by researchers and practitioners.

As with most assets, bond value is derived from the present value of the expected future cash flows. Due to the bonds' design, the cash flows (coupons and principal repayment) are known in advance, meaning that potential uncertainty revolves around the issuers ability to repay the promised cash flows. The uncertainty is referred to as credit risk. Increasing credit risk makes it less likely that the issuer is able to repay the promised cash flows (Duffie and Singleton, 2001). Merton (1974) is considered one of the first to synthesize a corporate debt pricing model. His paper highlights that the value of corporate debt depends on three factors: (1) the required rate of return on riskless assets. (2) the bond's characteristics (coupon rate, maturity, seniority, etc.), and (3) the probability of default. The paper states that in the case of no default, the coupon and principal will be repaid in accordance with the contractual agreement. However, in the case of default, the bondholder does not receive the promised cash flows but will instead receive a percentage of the promised payments. This percentage is referred to as the recovery rate. The recovery rate measures how much of the bond's par value is returned to bondholders after the company enters default. There are several determining factors to the recovery rate, such as seniority and industry class (Duffie and Singleton, 2001).

In a simplified two-period model for estimating the value of a defaultable bond, there are two future states; one in which the promised cash flow is repaid and one in which the issuer defaults and the recovery rate is returned to the bondholder. The value of the bond in the current period depends on the expected cash flow in the future states, the risk-neutral probability, and the risk-free interest rate (Duffie and Singleton, 2001). The risk-free interest rate is negatively related to bond prices, implying that greater interest rates result in lower bond prices due to higher discounting. In terms of expected cash flow, the probability of default is negatively related to bond prices, while the recovery rate is positively related to bond prices, implying that expected cash flow is positively related to the bond price. The key takeaway from this model is that higher credit risk (more uncertainty regarding the issuer's ability to repay its debt obligations and lower recovery rates) result in lower bond prices. As bond prices and bond yields are inversely related, lower bond prices results in higher bond yields. Chapter 3.1 argued that ESG-related matters may impact firms' profitability, meaning that firms with low ESG performance may be subject to higher credit risks, potentially leading to higher bond yields.

3.3 ESG and ESG risks

ESG is an abbreviation of the three words, environmental, social, and governance, and in the context of finance, ESG is to be understood as to how a company interacts with environmental-, social-, and governance-related issues. Over the last couple of years, the ESG term has also become a buzzword for sustainable business practice. Despite not becoming a commonly used term until recently, companies' interaction with ESG-related matters is by no means a new issue. CSR has been viewed as the predecessor for ESG, with ESG incorporating all aspects of CSR while adding the governance aspect. Hence, ESG is CSR plus governance (Gerard, 2019). In his publication Social Responsibilities of the Businessman, Howard Bowen coined the CSR abbreviation in 1953. Therefore, Bowen is often referred to as the father of CSR (Writer, 2019). Nowadays, ESG has gained increased momentum and has almost entirely replaced the use of CSR.

Today, every business is deeply intertwined with environmental, social, and governance concerns (Henisz et al., 2019). The E in ESG is the environmental aspect and includes all issues regarding carbon emission, pollution, consumption of energy and resources, and climate change. In short, it encapsulates how a company affects and is affected by the environment. S is the social aspect, which encompasses companies' labor relations, diversity, and inclusion, in addition to the reputation and general perception of how a company behaves socially. Lastly, G captures the importance of corporate governance and internal systems, which reduces agency problems and meet the needs of both external and internal stakeholders. The purpose of ESG is to highlight and emphasize the importance of ethical considerations and practices, giving sustainability and moral principles the same priority as profits (Gupta, 2021).

A fundamental aspect of this thesis is the assumption that poor ESG performance is associated with financial risk. In financial terms, risk is defined as deviation from an expected outcome, indicating that high risk makes it more likely that the outcome deviates largely from the expected outcome. Financial risk is usually quantified using measures such as variance or standard deviation. When discussing ESG risk, it should be interpreted as a deviation in expected financial performance directly or indirectly caused by environmental, social, or governance factors.

Environmental (or climate) risk is divided into two subgroups: physical and transitional risk. Physical risk is the risk caused by changes in the Earth's physical climate. It is generally agreed upon that pollution contributes to global warming, which in turn impacts our physical climate. For firms, these risks could materialize through the flooding of a factory or the loss of crops due to wildfires or droughts. Transitional risk includes all risks caused by severe regulatory and political changes adopted to prevent excess pollution and combat global warming and environmental devastation. The regulatory and political landscape plays an important role, where changes may impact crucial aspects of firms, such as factor prices or allowances to operate in their current business, thus causing uncertainty and risk of future financial performance.

Social risk stems from corporations' exposure and contribution towards social injustice. Social injustice is generally thought of as obeying society's standards, norms, and expectations. Examples of social injustice are gender inequality, social dumping, or health detrimental products. Firms that do not follow society's norms and expectations risk of facing regulatory or reputational losses, which in turn could be costly and harm firm value.

Governance risk includes all risks associated with a firm's governance matters. Governance is defined as the system by which entities are directed and controlled. A well-governed firm has appropriate and adequate controls and measures in place such that the firm can maximize shareholder/stakeholder value without agency problems. If such measures are absent, the firm risks of behaving suboptimal and thus destroying shareholder/stakeholder value. Suboptimal behavior occurs when a firm's governance body has incentives to misbehave at the expense of maximal shareholder/stakeholder value, commonly referred to as agency problems. Poor corporate governance is therefore value-destroying and imposes a risk to the firm.

It appears that ESG performance may indeed impact firms' financial performance. We recall the stakeholder theory, which suggests that firms may face reputational- and ultimately financial costs by, e.g., not behaving socially or polluting the environment. Subsequently, from a stakeholder-theory point of view, it is optimal for firms to behave in a pro-ESG way. Chapter 3.1 argued that in most cases, the shareholder theory does not support pro-ESG behavior, as it was not financially optimal to do so. However, what if governments threatened to impose taxes or other measures to reduce the profitability of firms behaving in a sub-ESG-optimally manner. Under this assumption, it becomes optimal, even from a shareholder theory point of view, to behave in a pro-ESG manner, as it is financially optimally to do so. Therefore, we argue that under certain circumstances, there exist situations where both the stakeholder- and shareholder theory agree upon poor ESG performance being associated with greater credit risk. Greater credit risk will, as previously explained, result in lower bond prices, and thus, a theoretical relationship between ESG performance and bond prices is established.

4 Hypotheses and methodology

So far, we have presented theory and relevant literature regarding our research question. In this section, we will reformulate our research question into suitable hypotheses and present our chosen research models. Ultimately, we will discuss the validity of our models and potential concerns.

We make use of a multi-step approach to investigate our research question by dividing the analysis into three different segments. First, we investigate the relationship between aggregated ESG performance and bond performance, using Refinitiv's ESG Score as the independent variable and estimated yield spread as the dependent variable. Secondly, we decompose the aggregated ESG Score into individual pillar scores (ESGE, ESGS, and ESGG) and analyze how each pillar is related to yield spread. At last, we analyze how sustainability impacts bond yield by investigating whether the yield spread on green bonds differs from their non-green counterparties.

4.1 Hypotheses

As discussed in chapter 2.1, the evidence on the relationship between ESG performance and yield spread is still unclear. However, most available research seems to support the view that ESG performance is negatively related to yield spreads. Moreover, we believe that there exists a theoretical justification as to why ESG performance should impact yield spread, as explained in chapter 3. To our knowledge, no empirical studies have been conducted on this topic that specifically focuses on the Norwegian bond market. We believe that Norway, and the Nordic area in general, provides an interesting case, given how the country(ies) ranks on sustainable engagement and awareness. Based on these views, we formulate the following hypothesis:

Hypothesis 1: Bonds issued by companies with higher ESG rating trade at lower yield spreads

The ESG Score contains information on a broad range of topics, covering companies' environmental (E), social (S), and governance (G) performance. As the score includes a variety of measures and features, a weighted aggregated score may not thoroughly display the true characteristics of a company. Subsequently, it is arguably more suitable to use models that incorporate the potential impact of each pillar separately. Therefore, we propose three models, each incorporating one of the three ESG pillars, to investigate how each pillar may be related to yield spreads. We utilize Refinitiv's segregation of the total ESG score into individual E-, S-, and G Scores and formulate the following sub-hypotheses:

Hypothesis 2. A: Bonds issued by companies with higher environmental rating trade at lower yield spreads

Hypothesis 2. B: Bonds issued by companies with higher social rating trade at lower yield spreads

Hypothesis 2. C: Bonds issued by companies with higher governance rating trade at lower yield spreads

The introduction of green bonds has allowed investors to easily find and access projects that have a positive or non-negative impact on the environment. Subsequently, it becomes easier to invest in assets that are low on environmental risk. Following the belief that environmental risk is financially material, green bonds should trade at lower yield spreads, ceteris paribus. We formulate the following hypothesis:

Hypothesis 3: Green bonds trade at lower yield spreads than their non-green counterparties

4.2 Methodology

The methodology used to analyze the relationship between ESG performance and yield spreads builds on a similar framework as used by Oikonomou et al. (2014). As the data sample contains observations both across time and bonds, we utilize panel data regression when performing our analysis. Note that the data sample is unbalanced as not all bonds have ESG ratings during the entire period. Most commonly, panel data regression analysis is conducted using fixed-effects- , random-effects- , or pooled OLS models. We have run a Hausman test to confirm that the fixed-effect model is the most suitable model for our panel data sample.

However, Thompson (2011) proposes a clustering method more suitable for analyzing financial data. The method is mostly similar to a fixed-effects model, and by performing the clustering method, the model is able to adjust for correlated residuals (Oikonomou et al., 2014). Bonds issued by the same company are assumed to correlate because they contain the same operating and financial risk while differing in bond-specific characteristics such as e.g., time to maturity or coupon rate. Oikonomou et al. (2014) argue that a time series consisting of multiple traded bonds issued by the same company will likely feature both company and time dependencies, and by using the clustering method, one overcomes these issues. Our proposed clustering method differs from a fixed-effects model in the sense that it relaxes the assumption of independent residuals within each cluster while assuming that they are independent across clusters, where we cluster at company level. In essence, the methodology produces robust standard errors which allow for autocorrelation and heteroskedasticity within each cluster. By imposing a clustering method with yearly- and industry-fixed effects, we estimate the impact of ESG performance on yield spreads. The same model will be used in the second analysis when using each ESG pillar as the dependent variable.

$$log(Yield\,Spread_{i,t}) = \\ f(ESG\,Score_{i,t},\ Company\,Characteristics_{i,t},\ Bond\,Characteristics_{i,t})$$

For the analysis of green bonds and yield spreads, we make use of a Linear Mixed Model (LMM). Mixed-effects models are desired because they give the opportunity to use fixed effects and random effects simultaneously. In this analysis, we consider random effects to capture the effects on yield spreads caused by the bond being issued by a certain company. Bonds issued by different companies trade at different yield spreads, as they have different financial risks or operate in different industries. By including random effects, we capture the observed variation across companies. Now the model can focus on its core activity: investigate whether green bonds trade at lower yield spreads than their non-green counterparties. We consider fixed effects to capture the effects of a bond being labeled green. By introducing a green bond dummy variable, the model will estimate the potential difference in yield spreads caused by a bond being green while controlling for other relevant bond characteristics and company-specific effects. In essence, we use non-green bonds as the control group and green bonds as the treatment group. In addition, we include robust standard errors to prevent any issues with heteroskedasticity. Note that the data sample is unbalanced as not all companies have outstanding green bonds throughout the sample period.

$$log(Yield\,Spread_{i,t}) = f(Green\,Bond_i,\ Company\,Characteristics_{i,t},\ Bond\,Characteristics_{i,t})$$

4.3 Model validity

It is of great importance to secure the validity of the panel data models to obtain correct results and avoid any data biases. In this section, we take a closer look at counter-specific issues of endogeneity, as well as multicollinearity and selection bias. Endogeneity problems are particularly severe in corporate finance and governance studies. There are three main sources of endogeneity problems: omitted variables, simultaneity, and measurement errors (Roberts and Whited, 2013).

4.3.1 Omitted variable

Omitted variable bias is a problem when an explanatory variable relevant to the regression is not included in the model (Roberts and Whited, 2013). When omitting such a variable, it will show up in the residual and cause endogeneity where the error term and independent variables are correlated. The inclusion of that variable would otherwise have changed both the dependent- and one or more of the independent variables. Such an issue will therefore cause biased and inconsistent coefficients and upward biased standard errors.

We include control variables to prevent the omitted variable issue. Variables utilized in our analysis are carefully selected based on previous academic research and economic intuition, with inspiration from Oikonomou et al. (2014). However, including too many variables is not a desired feature, as it may cause overcomplicated models with a high degree of freedom. Subsequently, there is a trade-off between omitting variables and including too many. Therefore, we have included control variables based on relevant financial theory and previously conducted research and believe that the variables included in the analyses give rise to reasonable results.

4.3.2 Simultaneity and reverse causality

Challenges occur in cases where two variables are influenced by the same third variable, or they influence each other simultaneously. This is the case of simultaneity, which in turn cause an endogeneity problem. One related issue is reverse causality, where one misjudges the causality of two variables. That is when X and Y are associated but not in the assumed direction. In our studies, we are testing whether ESG performance or sustainability influence financial performance, proxied through yield spread. However, there exist evidence that this causality goes the other way around; hence that large, steady, and good-performing firms are able to perform better in ESG enhancing activities. Also, some studies argue that causality goes in both directions. Among others, a paper by Waddock and Graves (1997) concludes that the relationship is a "virtues cycle" and that the causality runs in both directions.

If simultaneity or reverse causality is an issue, it will cause inconsistent and biased estimates. Dealing with that issue is out of the scope of this thesis, but it is a critical problem in the case of finding the true relationship between ESG performance, sustainability, and financial performance. Therefore, being aware of the potential issue is of great importance. One way of minimizing the causality issue is by lagging the independent variable. We are essentially using companies' lagged ESG performance to explain current yield spreads, as the ESG Score is based on the previous year's ESG performance. This, in turn makes it more likely that we capture the simultaneity in the desired direction, hence how last year's ESG performance impacts the current yield spread.

4.3.3 Measurement errors

The next possible source of endogeneity and potential pitfall for the validity of our analysis is measurement error. This is the case when one is measuring a variable, but there is a discrepancy between the true variable of interest and the proxy (Roberts and Whited, 2013). Usually, the issue is due to inaccurate reporting from the issuer of data or errors in the data collection process, leading to a biased data sample. We have retrieved data from four different providers, which all are solid and trustworthy actors in the market. To our knowledge, no measurement error exists in the data collection process or the variables.

However, we note a possible issue for the ESG Score variables, which we have retrieved from Thomson Reuters Refinitiv. There is no standardized way of measuring ESG performance across ESG rating agencies. Thus, ESG scores are based on different sources, estimated using different approaches, and bringing along some significant methodological challenges. Issues regarding ESG reporting and ESG Score estimation will be discussed in chapter 7.2.1. How to account for the differences in ESG measuring and estimation is out of the scope of this thesis. Subsequently, we conclude that our results are valid under the assumption that Refinitiv's ESG Score is a suitable proxy for companies' ESG performance.

4.3.4 Multicollinearity

Multicollinearity is an issue in regression analysis where explanatory variables are highly correlated (Brooks, 2008). Either perfect multicollinearity, where two independent variables are linear functions of each other, or near-perfect, where two independent variables move in a very similar pattern. The consequence of this feature is biased estimates, which can be detected by a high R^2, while individual coefficients have large standard errors and poor explanatory power. The regression model is also very sensitive to small changes in the variable composition.

Exclusion of the highly correlated variable is one of the mitigating tools used as a countermeasure (Brooks, 2008). Through early analysis, we detected a high correlation (around 0.8) between two of our control variables in the green bond data sample, namely between the Price to Book (P/B) ratio and Market Capitalization. The P/B ratio is consequently left out of the regression model for the analysis of green bonds. We observed no multicollinearity issues for the analyses on ESG performance, meaning both variables are included in the ESG analyses.

Further, we perform VIF tests to test and measure the correlation between explanatory variables in the regression model. If the VIF value is greater than five it indicates a potential problem with multicollinearity for any of the explanatory variables (Hair et al., 2010). None of our variables return values above the threshold, hence the tests suggest no further problem with multicollinearity in our regression models. We conclude that the correlation between our regression variables is not large enough to cause multicollinearity issues. Table 2 depicts the VIF-tests results on the regressors in our two data samples.

Variable	Sample 1	Sample 2
Duration	2.68	1.86
TTM	2.58	2.49
M.Cap.	1.69	2.69
Issued Amount	1.42	1.15
Current Ratio	1.23	2.63
D/E	1.23	2.38
RoA	1.21	2.07
P/B	1.15	
D/EBITDA	1.11	2.62
ESG	1.21	
Green Bond		1. 88
Mean VIF	**1.55**	**2.22**

Table 2: VIF-test

4.3.5 Selection bias

Our chosen market delimitation is the Norwegian corporate bond market. To ensure a valid sample from the population it is of great importance that data is collected in a randomized order. In this thesis, we are faced with an issue where the bonds included in our data samples are chosen based on the issuing company receiving an ESG score or the company having issued green bonds. Hence, we may face selection bias in the data samples. Complications stemming from this issue is biased and inconsistent estimators (Brooks, 2008). Therefore, we are not able to draw valid conclusions for the overall Norwegian corporate bond market, and the conclusions will only be valid for companies included in the analyses.

5 Data and descriptive statistics

The following section presents the data sources used in our analyses, the data collection process, and the data treatment process. We introduce the dependent, independent, and control variables before providing descriptive statistics.

5.1 Data sources

5.1.1 Nordic Bond Pricing

Nordic Bond Pricing (NBP) is the provider of estimated historical bond prices. NBP provides daily price estimates for Norwegian listed bonds, index services, and pricing of other NOK denominated fixed income instruments. NBP is a trusted and well-renowned provider of these services within the Norwegian market.

Regarding the estimation of the real-time value of corporate bonds, illiquidity is a well-known issue. Corporate bonds may not be traded for a considerable period, which in turn presents difficulties in assessing the actual real-time value of a bond. By using NBP, we overcome this issue as the bond value is estimated daily based on broker quotes and NBP's estimates. NBP has provided monthly price data for all Norwegian publicly listed corporate bonds, not including the financial sector, in the 2017-2022 period. The exclusion of the financial sector is consistent with previous studies. It is argued that the financial sector has large amounts of bonds, which would have dominated the sample and significantly decreased its cross-industrial variability (Oikonomou et al., 2014).

5.1.2 Stamdata

Stamdata is one of the Nordic region's most frequently used sources for fixed income information. The company provides infrastructure, data, and analyses for all market participants in the Nordic bond market. Both Stamdata and NBP are companies under the Nordic Trustee umbrella. We use Stamdata as the provider of descriptive bond characteristics, such as information on time to maturity, issued amount, and issue type (i.e., whether a bond is certified as green).

5.1.3 Bloomberg Terminal

Company-specific financial information is obtained from Bloomberg Terminal. Bloomberg Terminal is the market-leading provider of financial information and is used worldwide by the finance industry. The platform provides infrastructure, analyses, news, and data, on most assets and securities globally. We use Bloomberg Terminal because of its broad historical database on Norwegian publicly traded companies. Market value-based financials (e.g., market capitalization, price-to-book value) are observed monthly, while book-value metrics are updated whenever reported.

5.1.4 Refinitiv Eikon

Refinitiv Eikon is our chosen database for ESG rating on Norwegian publicly listed companies. Refinitiv is owned by Thomson Reuters and is a commonly used and acknowledged database serving market data and financial information on companies and securities globally. The ESG Score is computed by Refinitiv and ranges from 0-100 based on the company's performance on environmental, social, and governance criteria. In addition, Thomson Reuters provides separate ratings for the three pillars: Environmental pillar (ESGE), Social pillar (ESGS), and Governance pillar (ESGG), which further are divided into ten main themes. A comprehensive overview of the estimation is found in Appendix E.

There are several different providers of ESG rating and data, but we have chosen to use Refinitiv as it is one of the most comprehensive ESG databases in the industry covering over 10,000 public companies, across more than 400 different ESG metrics, with a history going back to 2002 (Reuters, 2022). As there are limitations on the availability of ESG information in the Norwegian market, especially going just a couple of years back, Refinitiv turned out to be the most comprehensive database for the Norwegian market overall. Despite being the provider covering most Norwegian companies, there are severe limitations to Refinitiv's coverage. However, we see a positive trend where more companies are receiving ESG ratings. The number of Oslo Stock Exchange (OSE) listed companies being assigned an ESG rating increased from 18 in 2017 to 82 in 2022. Figure 1 displays the Norwegian ESG rating development.

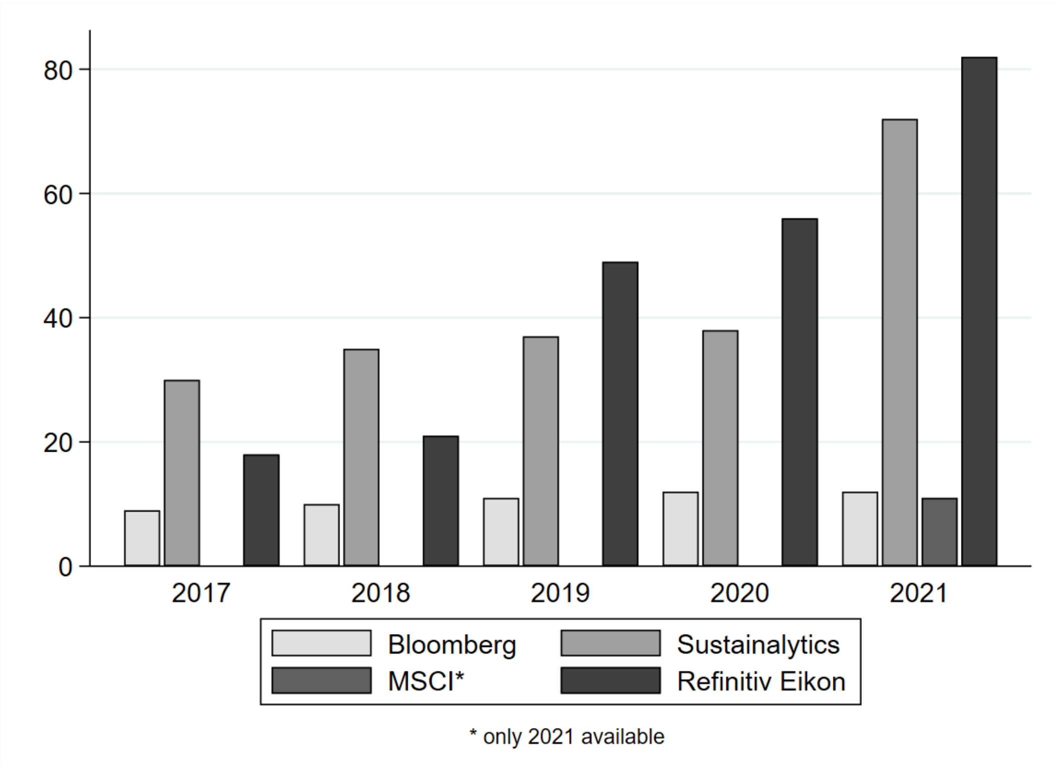


Figure 1: ESG rating development

5.2 Data treatment

As the data is gathered from four different providers of market information (NBP, Stamdata, Refinitiv, and Bloomberg), cleaning and merging of the datasets is needed. For the ESG performance analyses, NBP bond price data is merged with the ESG scores from Refinitiv, which then forms the foundation for the database used in the analyses. We only include bonds where the bond issuer is a company that also is assigned an ESG score from Refinitiv in the relevant time period. All bonds where the issuer is not assigned an ESG score are excluded from the database, with the same applying to companies that are assigned an ESG score but have not had any outstanding bonds during the period. Finally, we match the bond observations with financials from Bloomberg and bond characteristics from Stamdata. Table 3 presents a summary of the number of observations, unique bonds, companies, and industries that are included in the finalized data sample. Note that bonds issued by Norwegian Air Shuttle ASA (NAS) are intentionally excluded from the data sample due to the distressed situation the company experienced during the Covid-19 pandemic. NAS-issued bonds traded at abnormally high yield spreads, which in turn resulted in severe outliers in our data samples. The sample used in the analysis of ESG performance is denoted by sample 1.

Year	**Observations**	**Bonds**	**Companies**	**Industries**
2017	137	29	9	5
2018	280	38	10	6
2019	324	44	12	5
2020	558	84	20	7
2021	642	96	23	8
2022	107	101	26	8
Total	**2,048**	**147**	**29**	**8**

Table 3: Summary of sample 1

For the analysis covering green bonds, we create a separate data sample. The sample contains all bonds (both green and non-green) issued by firms that are listed on OSE and have or have had both green and non-green bonds outstanding in the 2017-2022 period. The filtering process was performed using bond characteristics retrieved from Stamdata. Historically estimated price data on the bonds is retrieved from NBP, and financials are retrieved from Bloomberg Terminal. Note that this sample does not include data on Refintiv's ESG Score. Table 4 presents a summary of the finalized data sample. We denote the sample used in the green bond analysis by sample 2.

Year	Observations	Bonds	Green Bonds	Companies	Industries
2017	200	42	2	5	5
2018	291	45	2	5	5
2019	295	50	4	5	5
2020	306	50	8	5	5
2021	350	55	19	5	5
2022	52	50	19	5	5
Total	**1,494**	**105**	**19**	**5**	**5**

Table 4: Summary of sample 2

5.3 Variables

Next, the various variables used in the regression analyses and their expected relation to the dependent variable will be presented. Appendix A provides a definition of the variables, a mathematical presentation, and a brief description of the variables. The variables have been identified and included as control variables in our regression models based on previous literature and research on corporate bonds. The control variables are categorized and assigned into two broad subcategories in accordance with Oikonomou et al. (2014); firm characteristic control variables and bond characteristic control variables. Table

5 displays the independent and control variables expected relation to yield spread.

The yield spread is the dependent variable for both the analysis on ESG performance and green bonds. The yield spread is estimated by NBP and measures the yield discrepancy between the bond in question and a risk-free government bond with matching time to maturity. If a bond is considered risky, it will trade at higher yields, resulting in higher yield spreads.

There are several determining characteristics of a company that influence bond yields. Larger firms, proxied through market capitalization, are believed to have a lower risk of default, meaning it is believed to be negatively related to yield spread. The same relationship is assumed for liquidity (proxied through current ratio), Return on Assets (RoA), and the P/B ratio. Higher leverage, proxied through Net Debt to Equity (D/E), is believed to increase a company's risk, implying a positive relationship between leverage and yield spreads. A similar relationship is assumed for the Net Debt to EBITDA (D/EBITDA) relationship.

Bond-specific characteristics also impact the riskiness of bonds. Interest rate risk, proxied through duration, estimates a bond's exposure to changing interest rates. Higher interest rate risk is assumed to be positively related to yield spreads. The same relationship is assumed for bond size, as higher outstanding amounts are believed to be more difficult to repay. Time to Maturity (TTM) is also believed to be positively related to yield spread. Lastly, we include a dummy variable for high yield bonds and a dummy variable for floating-rate bonds. Note that only fixed- and floating rate bonds are included in our data samples.

Relation to dependent variable: Yield spread		
Characteristics	**Proxy**	**Relation**
Independent Variable		
ESG performance	ESG Score	To be estimated
Environmental performance	ESGE Score	To be estimated
Social performance	ESGS Score	To be estimated
Governance performance	ESGG Score	To be estimated
Green Bond	Green Bond	To be estimated
Company characteristic control variables		
Firm size	Market Capitalization	-
Leverage	Net Debt to Equity	+
Distress factor	Price to Book	-
Asset efficiency	Return on Assets	-
Debt repayment capacity	Net Debt to EBITDA	+
Bond characteristic control variables		
Interest rate risk	Duration	+
Maturity	Time to Maturity	+
Bond size	Issued Amount	+
Bond type	Float / Fixed	- / +
Riskiness	High Yield / Investment Grade	+ / -

Table 5: Summary of variables

5.4 Summary statistics

In the following sections, we will present summary statistics for our data samples, including general descriptive statistics, correlation matrices, and other relevant metrics.

5.4.1 Sample distributions

A summary of observations from 2017 to 2022 for both samples is provided in Table 6. The total number of observations amounts to 2 048 for sample 1 and 1 494 for sample 2. The average number of observations per year in sample 1 (2) is 341 (249), while the minimum and the maximum number of observations per year are 107 (52) and 642 (350), respectively. We observe an increasing number of observations for both samples during our sample period. The increase in observations is caused by more companies receiving ESG rating and more green bonds being issued. As our data was retrieved at the end of February 2022, the number of observations for 2022 is consequently smaller.

Sample 1: ESG Score			
Year	**Mean Yield Spread**	**Observations (N)**	**%**
2017	153.25	137	6.69%
2018	125.17	280	13.67%
2019	137.73	324	15.82%
2020	193.77	558	27.25%
2021	124.70	642	31.35%
2022	115.12	107	5.22%
Total	**147.05**	**2,048**	**100.00%**
Sample 2: Green Bond			
Year	**Mean Yield Spread**	**Observations (N)**	**%**
2017	99.06	200	13.29%
2018	99.10	291	19.48%
2019	82.15	295	19.75%
2020	117.38	306	20.48%
2021	82.29	350	23.43%
2022	79.11	52	3.48%
Total	**94.86**	**1,494**	**100.00%**

Table 6: Sample distribution

5.4.2 Industry distribution

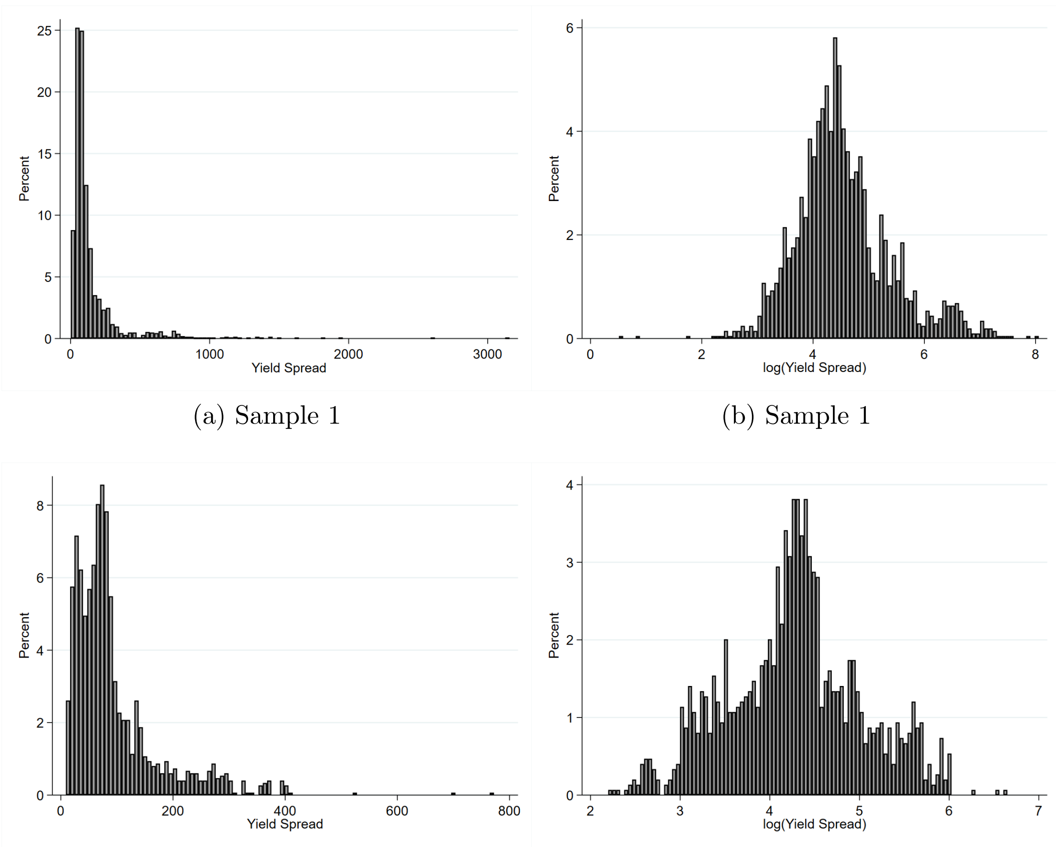
Table 7 illustrates the data samples' industry classification distribution. Each sample is divided into industry classifications according to the Standard Industrial Classification (SIC) system. We observe an unevenly distributed representation of the industries in our samples, where sample 1 bear an overweight of companies in the industrial sector (46%), while sample 2 has a significant overweight in the real estate sector (72%). Concurrently, some industries have a very low representation. The telecom/IT- and forestry industries each account for 1-2% of the observations in sample 1, while the oil and gas industry account for around 2% of the observations in sample 2. It is evident that the samples are not evenly distributed across industries, with some industries dominating the samples. The skewed sample distributions are an undesired feature that gives rise to potential sample biases. Of the 11 sectors included in the SIC system, sample 1 contains data from 8 different sectors, while sample 2 gas representation from five sectors. Note that the financial sector is intentionally excluded from our samples, as disclosed in chapter 5.2.

Sample 1: ESG Score			
Sector	**Mean Yield Spread**	**Observations (N)**	**%**
Convenience Goods	62.35	184	9.98%
Industry	145.16	942	46.00%
Media	95.57	291	14.21%
Oil and Gas	394.70	175	8.54%
Pulp, paper and forestry	265.96	39	1.90%
Real Estate	62.46	289	5.22%
Seafood	211.51	107	5.22%
Telecom/IT	238.51	21	1.03%
Total	**147.05**	**2,048**	**100.00%**
Sample 2: Green Bond			
Sector	**Mean Yield Spread**	**Observations (N)**	**%**
Convenience Goods	32.11	183	12.25%
Industry	276.27	139	9.30%
Oil and Gas	179.95	34	2.28%
Real Estate	70.06	1,082	72.42%
Seafood	179.10	56	3.75%
Total	**94.86**	**1,494**	**100.00%**

Table 7: Industy distribution

5.4.3 Dependent variable

Figure 2 depicts histograms with the distributions for both regular and logged values of the dependent variable, yield spread, for both samples. It is evident by graphical interpretation that the yield spread is not normally distributed, as both sample 1 and 2 is severely right-skewed. Subsequently, log normal yield spreads will be utilized in the analyses. Table 8 provides further measures of the distribution of yield spreads.



(a) Sample 1 (b) Sample 1

(c) Sample 2 (d) Sample 2

Figure 2: Yield spread distribution

Sample 1: ESG Score

Variable	**Mean**	**Min**	**25th**	**75th**	**Max**	**Std**	**N**
Yield Spread	147.05	1.67	55.30	138.35	3157.16	221.63	2,048
log(Yield Spread)	4.54	0.51	4.01	4.93	8.06	0.86	2,048

Sample 2: Green Bond

Variable	**Mean**	**Min**	**25th**	**75th**	**Max**	**Std**	**N**
Yield Spread	94.86	9.00	44.61	11.31	772.25	79.74	1,494
log(Yield Spread)	4.27	2.20	3.80	4.71	6.65	0.74	1,494

Table 8: Descriptive of yield spread

When analyzing table 8, it becomes evident that sample 2 contains bonds that on average trade at lower spreads compared to sample 1. The average yield spread for sample 1 is 147 bps with a standard deviation of 212 bps, while sample 2 has an average and a standard deviation of 95 bps and 80 bps, respectively. We argue that the different industry compositions cause the difference in the observed average yield spread across the two samples. Note that the real estate sector accounts for over 70% of the observations in sample 2, notably reducing the mean of sample 2 compared to sample 1.

5.4.4 Regression variables

Table 9 summarizes the descriptive statistics for the regression variables in the analyses. We observe an average ESG score of 57.09 with a standard deviation of 18.22. The ESG score varies from 13.35 for the least sustainable firm to a maximum score of 89.98 for the best performing firm, implying that the sample contains a variety of both high and poor-performing companies. For the independent variable in sample 2, we see that 16% of the observations are green bonds.

Sample 1: ESG Score							
Variable	**Mean**	**Min**	**25th**	**75th**	**Max**	**Std**	**N**
log (Yield Spread)	4.54	0.51	4.01	4.93	8.06	0.86	2,048
ESG Score	57.76	13.35	45.82	71.40	89.98	5.23	2,048
ESGE Score	56.97	1.08	38.55	76.77	97.04	23.87	2,048
ESGS Score	67.93	11.49	57.03	83.83	96.41	20.70	2,048
ESGG Score	58.55	6.11	41.50	76.21	94.20	20.97	2,048
M. Cap.	69,413	1.07	13,524	89,938	85,4328	113,208	2,048
Duration	1.89	-0.42	0.12	3.42	12.20	2.58	2,048
D/E	124.65	-124.89	16.23	68.52	18,825.00	1.243.42	2,048
P/B	2.68	-33.24	1.25	3.19	174.81	5.22	2,048
Current Ratio	3.32	0.19	1.24	2.11	100.74	11.78	2,048
RoA	4.32	-81.87	2.14	7.15	41.53	8.09	2,048
D/ EBITDA	3.35	-3.02	0.90	3.51	36.26	4.01	2,048
TTM	3.54	0.0028	1.68	4.74	16.39	2.60	2,048
Issued Amount	9.02e+08	3.50e+07	5.00e+08	1.10e+09	3.50e+09	5.68e+08	2,048
Sample 2: Green Bond							
Variable	**Mean**	**Min**	**25th**	**75th**	**Max**	**Std**	**N**
log (Yield Spread)	4.27	2.20	3.80	4.71	6.65	0.74	1,494
M. Cap.	28,017	3,104	7,804	34,240	125,244	27,414	1,494
Duration	1.40	-0.24	0.11	2.42	8.96	2.08	1,494
D/E	78.60	0.61	72.45	95.65	169.07	27.76	1,494
Current Ratio	0.81	0.083	0.28	1.31	3.70	0.79	1,494
RoA	6.29	-7.07	4.76	9.90	15.75	4.57	1,494
D/EBITDA	6.65	0.36	4.03	9.78	18.84	3.71	1,494
TTM	3.09	0.0028	1.15	4.63	9.97	2.16	1,494
Issued Amount	8.05e+08	1.50e+08	4.71e+09	1.20e+09	3.50e+09	4.64e+08	1,494
	Obseratvions				%		
Green bonds	241				16.13%		
Non-Green bonds	1.253				83.87%		

Table 9: Descriptive of variables

5.4.5 Correlation matrix

Table 10 and Table 11 contains the result from a Pearson correlation matrix for sample 1 and 2, respectively. The correlations are calculated against the dependent variable, log (Yield Spread), and the different independent- and control variables.

From the correlation matrix for sample 1, we notice that the ESG score is the variable that has the largest absolute correlation with the yield spread, with a correlation coefficient of -0.60. This suggests that bonds from companies with high ESG scores typically trade at lower yield spreads, which is consistent with our main hypothesis. Correspondingly, the pillar scores ESGE, ESGS, and ESGG are negatively correlated with the dependent variable. Furthermore, RoA and Market Capitalization are variables with a negative correlation with the yield spread. This is true for both samples, suggesting that bonds from large companies with high returns trade at lower yield spreads. Other similar observations between both samples are TTM, Duration and D/E, which are positively correlated with the yield spread. The findings are consistent with the expectations discussed in chapter 5.3. Despite providing insight into the relationship between variables, the correlation matrix is not a valid source for concluding the true relationship between the regression variables.

Most variables in the two correlation matrices have the same signs, indicating consistency between the two samples. However, Issued Amount, Current Ratio, and D/EBITDA, differs and have opposing signs in their correlation with the dependent variable. This is an unexpected and undesirable feature considering that the two subsamples are drawn from the same main population.

Lastly, we check the explanatory variables for high correlation with each other as a tool to prevent multicollinearity. In general, if one has a correlation coefficient with an absolute value greater than 0.7 between two predictor variables, it may indicate the presence of multicollinearity (Brooks, 2008). We observe a high correlation between the total ESG score and the different pillar scores. This is expected as the total ESG score is a weighted combination of the three pillars. Since we run regressions with only one of the four scores as an independent variable at a time, this will not cause any further issues. Furthermore, in both samples, we are experiencing one additional case of high correlation, namely between TTM and Duration in sample 1 and between Market Capitalization and D/E in sample 2, which is positively correlated with a coefficient of 0.78 and 0.70, respectively. In sample 2 there are in addition several cases where the absolute correlation coefficient is approaching the critical level. However, the VIF-tests conducted in chapter 4.3.4 indicates no multicollinearity between any of our control variables.

	Yield Spread	**ESG**	**ESGE**	**ESGS**	**ESGG**	**M.Cap.**	**Duration**	**D/E**	**P/B**	**Current Ratio**	**RoA**	**D/ EBITDA**	**TTM**	**Issued Amount**
Yield Spread	1.00													
ESG	-0.60	1.00												
ESGE	-0.54	0.83	1.00											
ESGS	-0.52	0.81	0.80	1.00										
ESGG	-0.43	0.69	0.75	0.72	1.00									
M.Cap.	-0.19	0.25	0.39	0.33	0.42	1.00								
Duration	0.08	0.16	0.25	0.19	0.28	0.52	1.00							
D/E	0.19	-0.08	-0.07	-0.12	-0.03	-0.04	0.00	1.00						
P/B	0.06	-0.07	-0.12	-0.12	-0.11	-0.08	-0.07	0.27	1.00					
Current Ratio	-0.08	0.02	-0.02	0.01	-0.03	-0.09	-0.07	-0.02	-0.02	1.00				
RoA	-0.38	0.18	0.12	0.09	0.05	-0.02	-0.03	-0.32	-0.07	0.04	1.00			
D/EBITDA	0.05	-0.09	-0.07	-0.26	-0.13	-0.21	-0.15	0.13	-0.06	-0.06	-0.15	1.00		
TTM	0.20	0.12	0.20	0.15	0.19	0.51	0.78	-0.02	-0.05	-0.08	0.01	-0.14	1.00	
Issued Amount	-0.28	0.27	0.44	0.36	0.34	0.30	0.09	-0.18	-0.20	-0.15	0.13	0.12	0.13	1.00

Table 10: Correlation matrix, sample 1

	Yield Spread	**Green Bond**	**M.Cap.**	**Duration**	**D/E**	**Current Ratio**	**R0A**	**D/ EBITDA**	**TTM**	**Issued Amount**
Yield Spread	1.00									
Green Bond	0.13	1.00								
M.Cap.	-0.14	0.13	1.00							
Duration	0.12	0.07	0.14	1.00						
D/E	0.03	0.08	-0.70	-0.15	1.00					
Current Ratio	0.51	-0.08	0.49	-0.08	-0.47	1.00				
RoA	-0.53	0.09	0.33	0.20	-0.14	-0.33	1.00			
D/EBITDA	-0.30	0.31	-0.35	-0.05	0.54	-0.61	0.05	1.00		
TTM	0.48	0.43	0.19	0.60	-0.18	0.11	0.14	-0.15	1.00	
Issued Amount	0.11	0.04	-0.23	0.12	0.06	-012	-0.19	0.00	0.09	1.00

Table 11: Correlation matrix, sample 2

6 Results

In this chapter, the findings and results from our regressions models will be presented. As discussed in chapter 4, we split our analysis into three sections. The first section seeks to analyze the relationship between ESG performance, proxied through Refinitv's ESG Score, and yield spreads. Sub-analyses will be conducted in the second section by studying how each pillar of the ESG Score is related to yield spread to shed additional light on the proposed relationship. The last section aims to analyze the relationship between green bonds and yield spreads. By comparing the yield spreads of green bonds to their nongreen counterparties, we seek to study if green bonds trade at lower spreads.

6.1 Section 1: ESG Score and yield spread

We impose four different models to explain the relationship between ESG performance and yield spreads in the Norwegian corporate bond market. The models are designed to analyze the proposed negative relationship between ESG performance and yield spreads, using ESG Score as the independent variable. Models (1)-(4) all include the same methodological design and approach but with varying inclusion of fixed effects. Model (1) is without fixed effects, Model (2) includes yearly fixed effects, Model (3) includes industry fixed effects, and Model (4) includes both yearly- and industry fixed effects. Table 12 presents the regression results for all four models. We argue that Model 4 is the better-suited model to explain the observed yield spread due to the varying spreads across industries (Longstaff and Schwartz, 1995) and the unique market conditions that the Norwegian bond market experienced during the Covid-19 pandemic. Subsequently, we will only comment on the results from Model 4. However, we want to highlight the fact that the introduction of yearly- and industry-fixed effects do not substantially alter the results, implying that similar conclusions can be drawn from all models.

We recall hypothesis 1: Bonds issued by companies with higher ESG scores trade at lower yield spreads. The results from Model 4 indicate that such a negative relationship does not exist, as the ESG Score is statistically insignificant in explaining yield spreads. The ESG Score's coefficient is estimated at 0.000315, suggesting that a higher ESG Score is associated with higher yield spreads. However, as the result is not significant, we find no support for our main hypothesis that ESG Score is negatively related to yield spreads. Thus, the result is inconsistent with previous findings of Oikonomou et al. (2014); Bhojraj and Sengupta (2003); Menz (2010).

Next, we assess the control variables and find that the majority are statistically significant in explaining yield spreads and return coefficients that are in line with economic theory. Of the company-specific control variables, we find that Market Capitalization, P/B ratio, and Current Ratio are all statistically significant at the 1% level, with coefficients of -0.508, -0.00167, and -0.0135. This suggests that bonds issued by large and liquid companies trade at lower yield spreads. The above-mentioned results are in line with the expectations from chapter 5.3. Also, D/E, RoA, and D/EBITDA return coefficients in line with the expectations, but no statistical significance is obtained from these variables.

Of the bond-specific characteristics, we observe that Issued Amount, TTM, and High Yield are all statistically significant in explaining yield spread. They return coefficients of 0.143, 0.156, and 1.026, respectively, at the 10%, 1%, and 1% significance levels. The results imply that high yield bonds, with longer time to maturity and higher issued amounts trade at larger yield spreads. Floating Rate bonds appear to trade at lower yield spreads, but the variable is not statistically significant from zero. Duration is the only variable with a coefficient not in line with our expectations, as higher duration seems to return lower yield spreads. However, the result is not statistically significant.

Appendix B displays the regression results from model 2, while simultaneously displaying the coefficients obtained from the dummy variables included in the yearly- and industry fixed effects estimation. We observe no statistically significant difference between the years, except for 2020. 2020 reports a coefficient of 0.184, significant at the 1% level. We recall the extraordinary market conditions that heavily impacted the observed yield spreads during the Covid-19 pandemic, providing an economic rationale for why 2020 saw higher yield spreads than usual. Furthermore, it is evident that the yield spreads vary across industries.

Variable	**Model (1)**	**Model (2)**	**Model (3)**	**Model (4)**
ESG	-0.0277	-0.00359	0.00123	0.000315
	(0.00296)	(0.00282)	(0.00448)	(0.00432)
M.Cap.	-0.162**	-0.156**	-0.539***	-0.508***
	(0.0723)	(0.0671)	(0.0777)	(0.0704)
Duration	-0.0575*	-0.0476	-0.0369	-0.0314
	(0.0294)	(0.0307)	(0.0318)	(0.0314)
D/E	0.00175***	0.00182***	-0.000101	0.0000865
	(0.000510)	(0.000464)	(0.000306)	(0.000304)
P/B	-0.00381	-0.00341	-0.00185***	-0.00167***
	(0.00232)	(0.00208)	(0.000656)	(0.000595)
Current Ratio	-0.00867***	-0.00831***	-0.0142***	-0.0135***
	(0.000991)	(0.000986)	(0.00108)	(0.00102)
RoA	-0.0122	-0.00965	-0.00332	-0.00202
	(0.00800)	(0.00773)	(0.00664)	(0.00633)
D/EBITDA	-0.00385	0.00287	-0.00560	0.00143
	(0.0101)	(0.00887)	(0.00900)	(0.00830)
TTM	0.183***	0.178***	0.158***	0.156***
	(0.0243)	(0.0253)	(0.0275)	(0.0258)
Issued Amount	0.183*	0.173*	0.163**	0.143*
	(0.0956)	(0.0995)	(0.0823)	(0.0805)
Floating Rate	-0.244	-0.182	-0.154	-0.114
	(0.152)	(0.157)	(0.148)	(0.143)
High Yield	1.619***	1.624***	1.021***	1.026***
	(0.213)	(0.222)	(0.238)	(0.245)
Constant	1.817	1.884	6.080***	6.127***
	(1.458)	(1.578)	(1.131)	(1.221)
Year FE	No	Yes	No	Yes
Industry FE	No	No	Yes	Yes
Observations (N)	2,048	2,048	2,048	2,048

This table reports the results from our main regression, Section 1. The logged yield spread is the dependent variable. ESG score is the independent variable of interest. Model (1)-(4) includes different levels of fixed effects. YearFE is a dummy variable controlling for the yearly variation, and Industry FE is a dummy variable controlling for industry specific variation, together making up our fixed effects. The standard errors are presented in parentheses. The statistical significance of the included variables is denoted as following: ***1% significance level, **5% significance level and *10% significance level.

Table 12: Regression Results, section 1

6.2 Section 2: ESG pillars and yield spread

We introduce three additional models, each incorporating one of the three ESG pillars, to investigate each pillar's relation to yield spreads. Table 13 displays the results for Model (4)-(7), where Model (4) stems from the primary analysis in chapter 6.1.

The independent variables of interest are ESGE Score, ESGS Score, and ESGG Score for Models (5), (6) and (7) respectively. The analysis is run with the same methodological approach as in Model (4). While Model (4) found no relation between ESG Score and yield spreads, the results obtained in Model (5)-(7) contradict hypotheses 2A, 2B, and 2C. The ESGE variable is positive with a coefficient estimated at 0.00653 and is statistically significant at the 5% level. Next, Model (6) estimates a coefficient for the social pillar of 0.0082, statistically significant at the 10% level. Thirdly, Model (7) returns a coefficient of 0.00753 for the ESGG variable, statistically significant at the 10% level. We observe that a one-unit increase in ESGE Score leads to a 0.6bps increase in yield spread, while a one-unit increase in ESGS- and ESGG Score leads to 0.8bps and 0.76bps increase in yield spread, respectively. Hence, the results indicate that a better Environmental-, Social-, or Governance Score is associated with higher yield spreads. Moreover, the Environmental Score seems to be the most influential with the highest significance, while the Social Score has the largest coefficient. While potentially providing better descriptions of companies, it appears that each pillar score is positively associated with yield spreads. The results indicate that firms increase their cost of capital by increasing the environmental, social, or governance performance. The results contradict the previous research of Oikonomou et al. (2014) and Bhojraj and Sengupta (2003), but are in line with the results from Menz (2010). Note that Menz (2010) only studied the environmental and social performance, not the governance pillar.

We observe that the most control variables stay similar across Model (4)-(7). For Model (4)-(7), the company-specific control variables return relatively equal coefficients with a similar level of statistical significance. The only notable difference is that the P/B ratio in Model (6) is statistically significant at the 10% level, compared to the 1% level in the other models.

The bond-specific control variables return relatively similar results across all models as well. However, we observe that the TTM coefficient is not statistically significant for Model (6), while being statistically significant at the 10% level for Model (4), (5), and (7). We recall that higher duration is believed to be associated with higher spreads due to the increased interest rate risk. Nevertheless, like in chapter 6.1, Model (4)-(7) indicates a negative and statistically insignificant relationship between Duration and Yield Spread. The rest of the not-already mentioned bond- and company-specific control variables return coefficients which's signs are in line with the expectations, but the coefficients are statistically insignificant.

Variable	Model (4)	Model (5)	Model (6)	Model (7)
ESG	0.000315			
	(0.00432)			
ESGE		0.00653**		
		(0.00315)		
ESGS			0.00820*	
			(0.0432)	
ESGG				0.00753*
				(0.00428)
M.Cap.	-0.508***	-0.578***	-0.583***	-0.566***
	(0.0704)	(0.0854)	(0.0863)	(0.0910)
Duration	-0.0314	-0.0330	-0.0373	-0.0356
	(0.0314)	(0.0311)	(0.0296)	(0.0318)
D/E	0.0000865	-0.0000994	0.000148	-0.000529
	(0.000304)	(0.000315)	(0.000296)	(0.000555)
P/B	-0.00167***	-0.00174***	-0.00126*	-0.00189***
	(0.000595)	(0.000477)	(0.000760)	(0.000628)
Current Ratio	-0.0135***	-0.0154***	-0.0150***	-0.0150***
	(0.00102)	(0.00163)	(0.00147)	(0.00172)
RoA	-0.00202	-0.000108	0.000127	-0.000567
	(0.00633)	(0.00621)	(0.00591)	(0.00550)
D/EBITDA	0.00143	-0.00269	-0.00383	-0.00348
	(0.00830)	(0.0101)	(0.0113)	(0.00858)
TTM	0.156***	0.169***	0.165***	0.170***
	(0.0258)	(0.0214)	(0.0219)	(0.0253)
Issued Amount	0.143*	0.110	0.121*	0.121*
	(0.0805)	(0.0682)	(0.0680)	(0.0701)
Floating Rate	-0.114	-0.0649	-0.0875	-0.0371
	(0.143)	(0.130)	(0.131)	(0.147)
High Yield	1.026***	1.170***	1.193***	1.204***
	(0.245)	(0.192)	(0.178)	(0.179)
Constant	6.127***	6.946***	6.710***	6.665***
	(1.221)	(1.021)	(1.097)	(1.121)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations (N)	2,048	2,048	2,048	2,048

This table reports the results from our main regression, Section 2. The dependent variable is the logged yield spread. The independent variable of interst in the regression models is ESG, ESGE, ESGS and ESGG for model (4) - (7) respectively. All four models, (4)-(7), includes fixed effects. YearFE is a dummy variable controlling for the yearly variation, and Industry FE is a dummy variable controlling for industry specific variation, together making up our fixed effects. The standard errors are presented in parentheses. The statistical significance of the included variables is illustrated as following: ***1% significance level, **5% significance level and *10% significance level.

Table 13: Regression results, section 2

6.3 Section 3: Green bonds and yield spread

In the third section, we shift focus towards sustainability by investigating the relationship between green bonds and yield spreads. We introduce a new data sample, previously described in chapter 5, and a LMM approach is imposed to explain the relationship. By only utilizing companies that have issued green bonds, can to compare the yield spread of green bonds to the yield spread of their non-green counterparties. Subsequently, we have designed a model which captures the effect of a bond being green while controlling for the company- and bond-specific variables. Table 14 reports the results from Model (8), with Green Bond being the independent variable.

Our result indicates a statistically significant and negative relationship between green bonds and yield spread, hence we obtain support for hypothesis 3. The Green Bond variable returns an estimated coefficient of -0.108 and is statistically significant at the 5% level. We observe green bonds on average trade at 10bps lower than their non-green counterparties. Hence, the results do indicate that green bonds trade at lower yield spreads when controlling for company- and bond-specific characteristics. The results are in line with the findings of Zerbib (2019) and the trend described by Karpf and Mandel (2018) and Bos et al. (2018). It appears that firms can achieve a cheaper cost of capital by investing in positive or non-negative projects.

Although the Green Bond variable identifies an interesting relationship, the model's control variables return results that, to a certain degree, violate the expectations discussed in chapter 5.3. Market Capitalization, TTM, and High Yield are all statistically significant at the 5% and 1% level, with coefficients estimated to -0.400, 0.1986, and 1.197, respectively. The results are thus in line with our expectations. The Current Ratio coefficient contravenes the expectations, indicating that greater liquidity is associated with higher yield spreads, as the coefficient is estimated at 0.0751, statistically significant at the 1% level. The Issued Amount, Duration, D/EBITDA, and RoA variables return signs that are in line with the expectations discussed in chapter 5.3, but their coefficients are not statistically significant in explaining yield spread. The D/E ratio returns a negative coefficient while floating-rate bonds seem to trade at higher yield spreads. These findings contradict the expectations of chapter 5.3, but the variables are not statistically significant.

Variable	**Model (8)**
Green Bond	-0.108**
	(0.0486)
M.Cap.	-0.400**
	(0.173)
Duration	0.0160
	(0.0336)
D/E	-0.0296
	(0.122)
Current Ratio	0.0751***
	(0.0277)
RoA	-0.00567
	(0.0277)
D/EBITDA	0.0119
	(0.0103)
TTM	0.198***
	(0.0102)
Issued Amount	0.00495
	(0.0290)
Floating Rate	0.152
	(0.123)
High Yield	1.197***
	(0.0279)
Constant	7.095***
	(1.440)
Year FE	Yes
Observations (N)	1,494

This table reports the results from our main regression, Section 3. The dependent variable is the logged yield spread. The green bond dummy-variable is the variable of interest. The standard errors are presented in parentheses. The statistical significance of the included variables is illustrated as following: ***1% significance level, **5% significance level and *10% significance level.

Table 14: Regression results, section 3

7 Robustness tests and data validity

In this section, we conduct robustness tests and comment on potential issues and limitations to our thesis. Model specification tests are applied to ensure that the appropriate panel data model is utilized. To prevent potential model bias, we run pooled OLS regressions to secure consistency in the results across different methodological approaches.

7.1 Robustness tests

We have conducted robustness tests to secure the validity of the results obtained in chapter 6. In this section, we display the results and discussions regarding these tests.

7.1.1 Model specification tests

As previously mentioned, there are three commonly applied models when working with panel data, namely pooled regression, random effects, and fixed-effects model. We run model-specific tests to ensure the suitability of our proposed models.

First, we run a fixed effect model where we simultaneously test for poolability to investigate whether there exist individual effects. The null hypothesis is rejected in all cases, which indicates that the fixed effect model is preferred to the pooled regression model. Next, the Breusch-Pegan test is conducted, which checks for heterogeneity in the data, and also, here the null hypothesis is being rejected, indicating that there exist random effects within the model. The test suggests that a random-effects model is more suited than a pooled regression. As both effects are present, the Hausmann test is conducted to test if the data samples are more exposed to random or fixed effects. Also here the null hypothesis is rejected, and the fixed effects model is deemed the most suitable model for our data samples. Lastly, we run the Wooldridge test, which indicates that our data samples indeed suffer from autocorrelation. We employ clustering robust standard errors to add robustness to the regression and to deal with the observed heterogeneity and autocorrelation.

Despite the results from the model-specific tests, we employ a clustering model (similar to Oikonomou et al. (2014)) for sample 1 and a linear mixed model for sample 2 in favor of the fixed-effect models. We argue that our model choice is equally suitable as we want to utilize bond- and company-specific dummies, which would otherwise be impossible in a fixed-effect model due to collinearity with the cross-section fixed effect.

Table 15 summarizes the results of the above-mentioned tests. Appendix C displays the hypotheses and detailed results from the model specification tests.

Independent Variable	Poolability Test	Breusch-Pegan	Hausenman	Model Choice	Wooldridge	Robust Std.
ESG_t	Reject H0	Reject H0	Reject H0	FE	Reject H0	Yes
$ESGE_t$	Reject H0	Reject H0	Reject H0	FE	Reject H0	Yes
$ESGS_t$	Reject H0	Reject H0	Reject H0	FE	Reject H0	Yes
$ESGG_t$	Reject H0	Reject H0	Reject H0	FE	Reject H0	Yes
Green Bond	Reject H0	Reject H0	Reject H0	FE	Reject H0	Yes

Table 15: Model specification tests

7.1.2 Pooled regression analyses

To test the robustness of our findings, an alternative panel data approach is applied to validate consistency in results across models. A pooled regression approach is hence utilized to study the effects between the dependent and independent variables while not accounting for time- or entity-specific effects (Brooks, 2008). However, we include year and sector dummies and robust standard errors to secure consistency and comparability to our clustering model. The pooled models mimic the methodology used by Bhojraj and Sengupta (2003).

Table 16 displays the results from the pooled OLS regression for section 1 and 2. The models are designed to investigate the relationship between ESG Score and yield spreads, and we run the pooled OLS models for both the aggregated ESG score and each ESG pillar separately, similarly to Models (4)-(7) in chapter 6.1 and 6.2. Model (4'), with ESG as the independent variable, returns a coefficient estimated to 0.003, which is equal to the coefficient in Model (4), with the variable being statistically insignificant in explaining yield spreads. Furthermore, the model returns similar coefficients and levels of statistical significance for the company- and bond-specific control variables. We observe that while the P/B ratio and Issued Amount are statistically significant in Model (4), the variables are not statistically significant in Model (4'). Simultaneously, Duration goes from being negative and not statistically significant in Model (4) to being negative and statistically significant at the 10% level in Model (4').

For Model (5')-(7'), most coefficients remain unchanged when changing from the clustering model to the pooled OLS model. The independent variables, ESGE, ESGS, and ESGG, all remain statistically significant, although with varying significance levels. The coefficients remain consistent across the models. The company- and bond-specific control variables remain unchanged with similar levels of statistical significance, except for Duration and the P/B ratio.

The pooled OLS models imposed on the relationship between ESG Score, ESG pillars, and yield spreads leads to similar results as obtained in chapter 6.1 and 6.2, providing consistency across varying methodological approaches. We argue that the observed consistency provides evidence of robust results, as similar results are obtained, regardless of methodological approach.

Variable	Model (4')	Model (5')	Model (6')	Model (7')
ESG	0.000319			
	(0.00490)			
ESGE		0.00544*		
		(0.00279)		
ESGS			0.0106*	
			(0.00296)	
ESGG				0.00627*
				(0.00306)
M.Cap	-0.428***	-0.459***	-0.551***	-0.466***
	(0.0588)	(0.0642)	(0.0647)	(0.0580)
Duration	-0.0509*	-0.0484	-0.0528*	-0.0450
	(0.0297)	(0.0305)	(0.0299)	(0.0300)
D/E	0.000588	0.000219	0.000137	-0.000171
	(0.0006649)	(0.000704)	(0.000775)	(0.000933)
P/B	-0.00275	-0.00279	-0.000664	-0.00249
	(0.00183)	(0.00184)	(0.00178)	(0.00147)
Current Ratio	-0.0117***	-0.0129***	-0.0139***	-0.0128***
	(0.00145)	(0.00130)	(0.00116)	(0.00123)
RoA	-0.00490	-0.00233	-0.00123	-0.00266
	(0.00499)	(0.00448)	(0.00412)	(0.00364)
D/EBITDA	-0.0129	-0.00971	-0.0108	-0.0760
	(0.0143)	(0.0127)	(0.0133)	(0.0137)
TTM	0.166***	0.166***	0.170***	0.164***
	(0.0160)	(0.0169)	(0.0157)	(0.0177)
Issued Amount	0.0640	0.0328	0.0411	0.0502
	(0.0560)	(0.0534)	(0.0544)	(0.0560)
Floating Rate	-0.189	-0.165	-0.173	-0.142
	(0.126)	(0.130)	(0.128)	(0.132)
High Yield	1.221***	1.270***	1.276***	1.281***
	(0.183)	(0.174)	(0.157)	(0.143)
Constant	6.817***	7.534***	7.974***	7.352***
	(1.025)	(0.876)	(0.992)	(0.945)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations (N)	2,048	2,048	2,048	2,048

This table reports the results from our pooled OLS regression. The dependent variable is the logged yield spread. The independent variable of interst in the regression models is ESG, ESGE, ESGS and ESGG for model (4') - (7') respectively. All four models, (4')-(7'), includes fixed effects. YearFE is a dummy variable controlling for the yearly variation, and Industry FE is a dummy variable controlling for industry specific variation, together making up our fixed effects. The standard errors are presented in parentheses. The statistical significance of the included variables is illustrated as following: ***1% significance level, **5% significance level and *10% significance level.

Table 16: Pooled OLS regression, ESG-scores

Next, we run a pooled OLS model to estimate the relationship between green bonds and yield spreads. Table 17 displays the regression results for Model (8'), with Green Bond being the independent variable of interest. Green Bond's coefficient is estimated at -0.106 while being statistically significant at the 5% level. The results imply that green bonds trade at lower spreads, which is consistent with the results from the LMM approach of chapter 6.3. Market Capitalization, Current Ratio, TTM and High Yield are all statistically significant in explaining yield spreads. They return coefficients estimated to -0.300, 0.133, 0.197, and 1.060, respectively, with Current Ratio being statistically significant at the 5% level and the rest at the 1% level. These results are similar to those of Model (8). Of the remaining control variables, Duration, D/E, and D/EBITDA all return coefficients which signs are in line with the expectations of chapter 5.3, but the variables are not statistically significant. The signs of RoA, Issued Amount, and Floating Rate contradict the expectations discussed in section 5.3, but neither of these variables are statistically significant. We note that when comparing Model (8) and (8'), the D/E ratio, RoA and Issued Amount have opposing signs.

The pooled OLS model yields largely similar results compared to the mixed-effects model imposed in chapter 6.3. The consistency across the different methodological approaches indicates that the results are robust, regardless of which model is being utilized. However, the estimated coefficients of some variables contradict our expectations, leaving the results from our analyses questionable.

Variable	Model (8')
Green Bond	-0.106**
	(0.0360)
M.Cap.	-0.300***
	(0.0334)
Duration	0.0169
	(0.0330)
D/E	0.00989
	(0.0912)
Current Ratio	0.133**
	(0.0353)
RoA	0.0000176
	(0.00698)
D/EBITDA	0.00740
	(0.00904)
TTM	0.197***
	(0.0113)
Issued Amount	-0.0192
	(0.0344)
Floating Rate	0.154
	(0.111)
High Yield	1.060***
	(0.0920)
Constant	6.482***
	(0.678)
Year FE	Yes
Observations (N)	1,494

This table reports the results from our pooled OLS regression. The dependent variable is the logged yield spread. The green bond dummy-variable is the variable of interest. The standard errors are presented in parentheses. The statistical significance of the included variables is illustrated as following: ***1% significance level, **5% significance level and *10% significance level.

Table 17: Pooled OLS regression, Green bond

7.2 Data validity

In this section, we highlight the weaknesses of our data samples, as data and measurement quality may significantly impact the conclusions that are drawn from regression analyses.

7.2.1 ESG scores

ESG scores continue to become increasingly widespread and publicly available. More companies are receiving ESG ratings, even in smaller markets that have traditionally been overlooked (such as OSE). However, there are substantial issues with how ESG ratings are being determined, as there exists no common standards or procedures amongst rating agencies. Which measures and factors that are included in the determination of the score can vary largely between agencies, and the use of different data sources may bring considerable methodological challenges. A study from Berg et al. (2019) compares the ESG scores between five of the largest providers of ESG data. They find that ESG ratings on average correlate 0.61, ranging from 0.42 to 0.73. In contrast, credit ratings from Moody's and Standard & Poor's have a correlation of 0.99. The discrepancy between the agencies is imbedded in both how ESG is defined and how each of the three ESG pillars is weighted. In addition, there are challenges in agreeing on which criteria to be applied to firms in various industries, as ESG materiality differs greatly across industries (Longstaff and Schwartz, 1995). Therefore, we emphasize that the use of different sources for ESG rating gives rise to potential misconceptions of companies' ESG performance. Using Refinitiv's ESG Score as a proxy for ESG performance is consequently problematic because the score may not perfectly reflect the companies' true ESG performance. Furthermore, the varying degree of rating coverage leaves investors with incomplete information, making it harder for them to distinguish the relative ESG performance between firms. This could in turn incentivize investors to overlook ESG ratings completely, as the rating provides no real comparison. Therefore, the uncertainty regarding ESG scores should be considered when interpreting the results from our regression models, as they act as a potential source of error.

7.2.2 Green bond data sample

Another potential weakness of our study is the data sample used in the green bond analysis. After filtering the data sample to exclusively contain bonds issued by OSE-listed companies, having both green and non-green bonds outstanding during our period of interest, only five companies were left in the sample. There are in total 105 different bonds in the sample, which in isolation is somewhat diverse. However, a vast majority of those are issued by the same company. Appendix D displays the companies included in our data samples. Furthermore, when sorting our observations based on sector classification, we observe that all five companies operate in different industries. The real estate sector, which only includes bonds from one company, accounts for over 70% of all observations in the data sample. This implies that the analysis is highly affected by that company and sector, which in turn is a potential source of sample selection bias, yielding biased and inconsistent estimators.

We emphasize that the Norwegian green bond market is in an early phase with a limited number of providers, contributing to the very limited sample. Also, a unique feature of the Norwegian bond market is that there are relatively few bond issuers outside the financial and public sectors, which are sectors excluded from this analysis. In addition, we see that a great number of companies that issues green bonds are not listed on OSE. The poor representation of the total population in our data sample makes any conclusion invalid.

8 Conclusion

Throughout this thesis, we have analyzed the relationship between ESG performance, sustainability, and yield spreads in the Norwegian corporate bond market. We have used both ESG scores and green bonds as proxies for ESG performance and sustainability with the intention to study how ESG performance and sustainability affect the yield spread. Previously conducted empirical research has not unanimously agreed upon whether sustainability and ESG performance is rewarded or penalized by investors or whether a relationship exists at all.

In the first analysis, with the aggregated ESG Score as the independent variable, we used a clustering method with industry- and yearly fixed effects to estimate the proposed relationship. The model found no evidence of such a relationship, as ESG Score was not statistically significant in explaining yield spread. A pooled OLS model was imposed to examine whether the results were model dependent. With both models yielding the same results, we consider the results robust. Subsequently, we conclude that investors neither penalize nor reward aggregated ESG performance in the Norwegian corporate bond market.

The second analysis studies each ESG pillar's relation to yield spread, using the same methodological approach as section 1. When running each pillar score separately, the model estimated a statistically significant positive relationship for each pillar, indicating that better environmental, social, or governance performance is associated with higher yield spreads. A pooled OLS model was applied to control for potential model dependency, and the pooled OLS model yielded similar results to the clustering method, indicating robust results. Our results are indicative of environmental, social, or governance performance being positively related to yield spreads in the Norwegian secondary bond market. Subsequently, it appears that firms can increase their cost of capital by boosting their ESG pillar performance. The findings contradict both our initial hypotheses and the majority of empirical research (Oikonomou et al., 2014; Bhojraj and Sengupta, 2003). However, the analysis supports the results obtained by Menz (2010), which additionally is the only study covering the European market. Note that Menz (2010) only covers the effects related to environmental and social performance. Furthermore, we believe that the discussion surrounding ESG performance estimation from chapter 7.2.1 provides a theoretical justification as to why an aggregated ESG Score may not be related to yield spread, while individual ESG pillars may. Recall that there are discrepancies in how ESG scores are estimated, and pillar-specific scores could potentially more accurately reflect companies' true ESG performance than an aggregated score.

The final section aimed to study the relationship between sustainability and yield spread. Using green bonds as a proxy for sustainability, the analysis examined whether the yield spread on green bonds was statistically significantly different from their non-green counterparties. By using a linear mixed model approach, we were able to identify a statistically significant negative relationship between green bonds and yield spreads, when controlling for company- and bond-specific variables. Once more, a pooled OLS model was imposed to investigate potential model dependency, and both the linear mixed model and the pooled OLS model yielded similar results. The results indicate that bonds with lower sustainability-related risks trade at lower yield spreads. Subsequently, firms can reduce their cost of capital by investing in positive or non-negative environmental projects. The findings obtained in this analysis are supportive of our hypothesis and the previous results obtained by Zerbib (2019) and the trend described by Karpf and Mandel (2018) and Bos et al. (2018).

While the main result from the green bond analysis indicates a negative relationship between sustainability and yield spreads, we find worrying attributes embedded in the data sample which potentially impact the results. The previously mentioned industry- and company composition is a potential source of error, as one single company accounts for over 70% of the total observations. Furthermore, bonds from only five different companies are included in the data sample, giving rise to significant sample selection bias. We argue that challenges related to the small sample become evident when assessing the model's control variables, as some coefficients contradict established economic theory. We believe that the small sample size significantly impacts the results from the regression model, rendering the estimated outcome questionable.

Following the discussion above, we conclude that higher environmental, social, or governance performance is related to higher yield spreads in the Norwegian corporate bond markets. The analysis of the relation between green bonds and yield spreads finds evidence of a negative relationship, but due to potential sample composition bias caused by the small sample size, we are reluctant to conclude on the estimated relationship.

While touching upon relevant and interesting issues, it appears that our study is somewhat premature. In order to more accurately estimate the effects of ESG performance on yield spreads, better ESG rating estimation is needed. As for the analysis of green bonds and yield spread, larger sample size is needed to achieve better statistical accuracy. For small and immature markets, such as the Norwegian bond market, this will hopefully continue to improve in the years to come, following the ongoing trend. Subsequently, we recommend future research to repeat these analyses when ESG scores are more accurate and broadly established in the Norwegian market, and with a bigger green bond market. Alternatively, the same analyses can be performed, using other readily available proxies for ESG performance and sustainability, to test whether similar conclusions are drawn.

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APPENDIX

A Appendix A

Yield Spread

Yield spread, also known as credit spread, measures the yield discrepancy between two different debt obligations of varying character. Varying character is to be understood as difference in issuer risk, credit rating, or other bond or issuer characterizations. Typically, yield spread measures the difference between the yield of a corporate bond and a risk-free government bond. As bond prices and bond yields are inversely related, a riskier bond is associated with higher yield, which, ceteris paribus, results in higher yield spread. Thus, the yield spread can be viewed upon as the additional risk premium creditors require to be willing to hold the specific bond.

NBP's historical estimated price database includes yield spread calculations. They utilize Norwegian government bonds of similar maturity as reference bonds when computing the yield spread measure. The yield spread is estimated by subtracting the observed risk-free government bond yield from the observed corporate bond yield.

$$Yield\,Spread_{i,t} = Bond\,Yield_{i,t} - Government\;Risk\;Free\,Yield_{i,t}$$

ESG Score

The ESG score measures a company's ESG performance during its latest fiscal year and is estimated annually by Thomson Reuters. The ESG score ranges from 0-100, where 0 is poor and 100 is excellent performance, based on the company's performance on a list of environmental, social and governance criteria. The score measures the company's relative ESG performance, commitment, and effectiveness, based on company-reported data. It captures and calculates over 500 company-level ESG measures and are further divided into 10 main themes or categories, which all represent one of the three pillars of ESG (Refinitiv, 2022). A comprehensive overview of the estimation is found in Appendix E.

In addition, Thomson Reuters provides separate ratings for the three pillars: environmental (E), social (S), and governance (G). When estimating the combined ESG Score, the pillars are weighted 44%, 31% and 26% respectively. The company's score in each category is the determining factor for the pillar scores.

$$ESG\ Score_{i,t} = f(E_{i,t},\ S_{i,t},\ G_{i,t})$$

Green Bond

Green bonds are defined as bonds which proceeds are earmarked to positive impacting climate or environmental projects. This paper utilizes the classification of green bonds provided by Stamdata, when determining whether a bond is green. The green bond variable is a dummy variable equal to zero if the bond is a non-green bond, and equal to one if the bond is a green bond.

$$Green\ Bond_i = \begin{cases} 1, & \text{if bond is characterized as "green"} \\ 0, & \text{otherwise} \end{cases}$$

Market Capitalization

Market Capitalization (market cap) is defined as the market value of a company's outstanding shares. Typically, market cap is computed by multiplying the company's number of outstanding shares with the latest traded stock price. The market cap is known also known as a company's market value since it is the stock market that determines the price of the company's shares. Subsequently, market cap tends to fluctuate following the stock market's perception of the company's financial state. A high market cap means that a company is valuable, while a low market cap means that the stock market deems the company less valuable.

$$Market\ Capitalization_{i,t} = Share\ Price_{i,t} * Number\ of\ Outstanding\ Shares_{i,t})$$

Net Debt-to-Equity Ratio

A company's financial leverage is measured by computing the ratio between the company's debt and shareholder equity. The debt-to-equity ratio, D/E ratio for short, is frequently used to measure a company's financial risk. Higher leverage (D/E ratio) is believed to be riskier, as the company has high debt obligations relative to the company's equity. The D/E ratio tends to differ significantly across different industries and time and needs to be assessed in the appropriate context if it is to be understood correctly.

In the context of this thesis, we have opted to utilize net debt measure instead of total debt, when computing the D/E ratio. A company with high amounts of debt and high amounts of cash or cash equivalents is not as risky as a company with high amounts of debt but low amounts of cash or cash equivalents. We therefore deem net debt to be a more appropriate measure when computing the D/E ratio.

$$\frac{D}{E}\ Ratio_{i,t} = \frac{Net\ Debt_{i,t}}{Shareholder\ Equity_{i,t}}$$

Price-to-Book Ratio

The price-to-book ratio (P/B) measures the ratio between the market price of a company's equity (i.e., the market cap) and the book value of a company's equity. The P/B ratio is commonly used when making value investments, but also a tell-tale sign of the stock market's perception of the value of a company's asset. If the P/B ratio is higher than 1, it means that the stock market believes that the true value of the company is greater than its book value. A low P/B is subsequently associated with financial distress and risk, as the stock market believes that the assets are worth less than its book value. As with the D/E ratio, the P/B ratio fluctuates severely across industries and time. E.g., tech companies notoriously have higher P/B ratios because most of their assets are intangible and the value is embedded in the company's operation, not within its physical assets.

$$\frac{P}{B}\,Ratio_{i,t} = \frac{Market\,Capitalization_{i,t}}{Book\,Value\,of\,Equity_{i,t}}$$

Net Debt-to-EBITDA

A commonly used measure to estimate a company's ability to repay its debt obligations is the net debt-to-EBITDA ratio. The ratio measures the relative proportion between a company's net debt and its earnings before interest, taxes, depreciation and amortization (EBITDA). A ratio over 1 means that the company's debt is higher than its current ability to repay debt (EBITDA) if it were to be repaid immediately.

There exist other commonly used debt repayment ability measures, but we found the net debt-to-EBITDA measure to be most frequently reported measure on Bloomberg Terminal. Other suitable measures include net debt-to-EBIT or interest coverage ratio. We assess all three measures to proxy the same type of debt repayment risk and chose net debt-to-EBITDA due to it being the most commonly reported on Bloomberg Terminal.

$$Net\,Debt\text{-}to\text{-}EBITDA\,Ratio_{i,t} = \frac{Market\,Capitalization_{i,t}}{Book\,Value\,of\,Equity_{i,t}}$$

Current Ratio

The current ratio estimates a company's short-term (obligations due within one year) debt and payables repayment capacity. The ratio takes the ratio between a company's current assets and its current liabilities and is thus a liquidity measure. Current items on a company's balance sheet are assets that can be turned into cash within one year, and it does therefore paint a picture of whether the company is able to obtain the necessary cash to repay its upcoming debt obligations and other payables. A low current ratio is associated with higher financial risk, as the company may face challenges repaying its current debt and other payables.

$$Current\ Ratio_{i,t} = \frac{Current\ Assets_{i,t}}{Current\ Liabilities_{i,t}}$$

Return on Assets

Return on assets (RoA) is a frequently used measure for estimating the efficiency of a company's asset. The measure takes the ratio between the company's net income and the company's total assets, and thus describe the company's profitability relative to its assets. As with most ratios and metrics, return on assets varies across industries and sectors. It does therefore only make sense to compare the RoA of companies within the same industry, as they share the same asset base. This does of course not apply to companies in different sectors as they may require widely different assets to operate. High RoA is associated with higher asset efficiency, and thus a desired feature for bond holders.

$$Return\ on\ Assets_{i,t} = \frac{Net\ Income_{i,t}}{Total\ Assets_{i,t}}$$

Industry Classifciation

It's a common reasoning that companies operating in different industries bear an industry specific risk which differs between sectors, in addition to some investors making investment decisions based on industry specific criteria. Empirical studies have also shown that companies operating in different industry sectors yields different risk premia in bond marked regardless their credit rating received by rating agencies (Longstaff and Schwartz, 1995).

$$Industry\ Dummy_{i,j} = D_{i,j}(industry_j,\ observation_i)$$

Time to Maturity

Time to maturity is a measure for number of years until a bond matures and the principal is fully repaid. Until the bond matures, the bond owner will (in the case of bullet bonds) receive coupon payments on the investment. Hence, as at number of years to maturity increases, it is likely that the premium increases due to greater uncertainty of the future financial condition of the company. Therefore, it is expected that bonds with longer maturities is riskier, and thus trade with a greater yield spread. We have calculated time to maturity for each bond by subtracting the maturity date from the observation date.

$$Time\ to\ Maturity_{i,t} = Maturity\ Date_{i,t} - Observation\ Date_{i,t}$$

Duration

A commonly used measure for bond volatility and interest rate risk is duration. The duration of a bond is the linear relationship between price and interest rate and measures a fixed income security's sensitivity to changes in interest rate, where if interest rates increase the price of the bond decrease. More specifically, duration is a measure of years until the interest payments generated form the bond investment will be sufficient to repay the bond principal. Hence, the expected total cash flow of the bond bears a risk of changes in interest rate, and that is essentially what duration captures. A higher duration indicates that the repayment of principal will happen later than otherwise, and consequently increases the interest rate risk of the bond.

$$Duration_{i,t} = \frac{\sum 1 * \frac{C_{i,1}}{1+r_{i,1}} + 2 * \frac{C_{i,2}}{1+r_{i,2}} + ... + T * \frac{C_{i,T}}{1+r_{i,T}}}{Bond\ Price_{i,t}}$$

Issued Amount

Issued amount reflects the monetary value of the bond's outstanding debt at the time of issuance. It is believed that higher amounts of issued amount should yield higher spreads, as the risk of failing to repay is larger when there is more debt to be repaid.

$$Issued\,Amount_i = Monetary\,Value\,of\,Debt\,Issue_i$$

High Yield

A bond is defined as high yield (also referred to as junk bond) if it is deemed above a certain threshold of riskiness. By assessing several factors such as, bond seniority, firm's financial risk, and collateral, a bond is deemed either high yield or investment grade. Bonds that are not deemed as risky as high yield bonds are deemed investment grade bonds. We use the classification provided by Stamdata when determining whether a bond is investment grade or high yield. As high yield bond is riskier than investment grade bonds, they should trade at higher yield spread.

$$High\,Yield_i = \begin{cases} 1, & \text{if bond is characterized as "high yield"} \\ 0, & \text{otherwise} \end{cases}$$

Floating Rate

Bonds which coupon payments are not fixed at point of issuance are known as floating rate bonds. Floating rate bonds differ from fixed rate bonds as the coupon payment is not determined at the time of issuance. Instead, the coupon payment is determined one period in advance, according to the current market (reference) rate. Floating rate bonds are believed to be less risky, due to the lower interest rate risk caused by the floating coupon payments. Subsequently, floating rate bonds are believed to have lower yield spreads.

$$Floating\ Rate_i = \begin{cases} 1, & \text{if coupon rate is floating rate} \\ 0, & \text{otherwise} \end{cases}$$

B Appendix B

Variable	Model (1)	Model (2)	Model (3)	Model (4)
ESG	-0.0277	-0.00359	0.00123	0.000315
	(0.00296)	(0.00282)	(0.00448)	(0.00432)
M.Cap.	-0.162**	-0.156**	-0.539***	-0.508***
	(0.0723)	(0.0671)	(0.0777)	(0.0704)
Duration	-0.0575*	-0.0476	-0.0369	-0.0314
	(0.0294)	(0.0307)	(0.0318)	(0.0314)
D/E	0.00175***	0.00182***	-0.000101	0.0000865
	(0.000510)	(0.000464)	(0.000306)	(0.000304)
P/B	-0.00381	-0.00341	-0.00185***	-0.00167***
	(0.00232)	(0.00208)	(0.000656)	(0.000595)
Current Ratio	-0.00867***	-0.00831***	-0.0142***	-0.0135***
	(0.000991)	(0.000986)	(0.00108)	(0.00102)
RoA	-0.0122	-0.00965	-0.00332	-0.00202
	(0.00800)	(0.00773)	(0.00664)	(0.00633)
D/EBITDA	-0.00385	0.00287	-0.00560	0.00143
	(0.0101)	(0.00887)	(0.00900)	(0.00830)
TTM	0.183***	0.178***	0.158***	0.156***
	(0.0243)	(0.0253)	(0.0275)	(0.0258)
Issued Amount	0.183*	0.173*	0.163**	0.143*
	(0.0956)	(0.0995)	(0.0823)	(0.0805)
Floating Rate	-0.244	-0.182	-0.154	-0.114
	(0.152)	(0.157)	(0.148)	(0.143)
High Yield	1.619***	1.624***	1.021***	1.026***
	(0.213)	(0.222)	(0.238)	(0.245)
Constant	1.817	1.884	6.080***	6.127***
	(1.458)	(1.578)	(1.131)	(1.221)
2018		0.0179		0.0338
		(0.0761)		(0.0723)
2019		0.0516		0.0562
		(0.0913)		(0.0804)
2020		0.184***		0.0145***
		(0.0628)		(0.0471)
2021		-0.0399		-0.0410
		(0.0606)		(0.0624)
2022		0.0222		0.0222
		(0.0523)		(0.0595)
Industry			0.245**	0.230**
			(0.0994)	(0.102)
Media			-4.290***	-4.043***
			(0.746)	(0.676)
Oil and gas			0.783***	0.749***
			(0.188)	(0.198)
Pulp, paper, forestry			-0.240	-0.248
			(0.274)	(0.298)
Real Estate			-0.296*	-0.352**
			(0.170)	(0.170)
Seafood			0.336	0.299
			(0.237)	(0.238)
Telecom/IT			-0.441	-0.425
			(0.398)	(0.448)
Observations (N)	2,048	2,048	2,048	2,048

Reference year is 2017 and reference industry is convenience goods. The standard errors are presented in parentheses. The statistical significance of the included variables is illustrated as following: ***1% significance level, **5% significance level and *10% significance level.

Table 18: Complete regression results, section 1

C Appendix C

Poolability test	
H0	Individual effects do not exist
HA	Individual effects do exist
Breusch-Pagan test	
H0	Individual-specific or time-specific error variance are zero
HA	Individual-specific or time-specific error variance are not zero
Hausman test	
H0	Both Fixed effects and Random effects model can be used
HA	Only Fixed effects model is suitable
Wooldridge test	
H0	No first-order autocorrelation
H1	First-order correlation is present

Table 19: Model specification tests, hypotheses

Sample	**F-stat/ X2-stat**	**P-Value**	**Reject H0**
Poolability test			
1	37.05	0.000	Yes
2	13.06	0.000	Yes
Breusch-Pagan test			
1	8.71	0.000	Yes
2	11.61	0.000	Yes
Hausman test			
1	226.29	0.000	Yes
2	146.77	0.000	Yes
Wooldridge test			
1	254.958	0.000	Yes
2	143.910	0.000	Yes

Table 20: Model specification tests, details

D Appendix D

List of companies

Sample 1	**Sample 2**
Aker ASA	Bonheur ASA
Austevoll Seafood ASA	Entra ASA
Bonheur ASA	Mowi ASA
Borregaard ASA	Norwegian Property ASA
Crayon Group Holding ASA	Orkla ASA
Aker BP ASA	
DNO ASA	
Elkem ASA	
Entra ASA	
Equinor ASA	
Grieg Seafood ASA	
Hexagon Composites ASA	
Kongsberg Gruppen ASA	
Link Mobility Group Holding ASA	
Mowi ASA	
Norsk Hydro ASA	
NRC Group ASA	
Norske Skog ASA	
Olav Thon Eiendomsselskap ASA	
Orkla ASA	
REC Silicon ASA	
SalMar ASA	
Scatec ASA	
Schibsted ASA	
Telenor ASA	
Tomra Systems ASA	
Veidekke ASA	
Yara International ASA	
Zalaris ASA	

Table 21: List of companies

E Appendix E

Thomson Reuters Refinitiv Pillar Score composition

Pillar	**Category**	**Weight**	**Sum of weights**
Environmental	Resource use	15%	44%
	Emissions	15%	
	Innovation	13%	
Social	Workforce	13%	31%
	Human rights	5%	
	Community	9%	
	Product responsibility	4%	
Governance	Management	17%	26%
	Shareholders	5%	
	CSR strategy	3%	

Table 22: ESG-score composition