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The impact of sustainable finance on corporate greenhouse gas emissions: Evidence from North American and European firms

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ABSTRACT:

This thesis examines the relationship between sustainable finance (i.e. sustainable investors' ownership and the amount of green bonds outstanding relative to a firm's total assets) and the North American and European firms' different scopes of greenhouse gas (GHG) emissions, both unscaled GHG emissions and GHG emission intensities. The results suggest that sustainable finance is generally related to lower GHG emissions. The findings are more consistent for direct than indirect or total emissions. However, when comparing the relationship between sustainable finance and GHG emissions of firms from the USA and firms from Europe and Canada, the results suggest that the sustainable finance relation to lower corporate GHG emissions is mainly present in European and Canadian firms, indicating that sustainable finance itself is not the main driving factor for lower GHG emissions. Furthermore, when only non-financial firms are included in the sample, the relationship between sustainable finance and lower GHG emissions weakens but is still present in some scopes of emissions.

KEYWORDS: Sustainable finance, Climate finance, Sustainable investing, Green bond, Greenhouse gas emissions, Ownership

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TIIVISTELMÄ:

Tämä tutkielma tarkastelee kestävän rahoituksen (eli kestävien sijoittajien omistusosuuden ja liikkeessä olevien vihreiden joukkovelkakirjalainojen määrän suhdetta yrityksen kokonaisvaroihin) ja pohjoisamerikkalaisten sekä eurooppalaisten yritysten eri laajuisten kasvihuonepäästöjen välistä suhdetta – sekä skaalaamattomien kasvihuonepäästöjen että kasvihuonepäästöintensiteettien osalta. Tulokset viittaavat siihen, että kestävä rahoitus on yleisesti ottaen yhteydessä matalampiin kasvihuonepäästöihin. Tulokset ovat johdonmukaisempia suorien päästöjen osalta kuin epäsuorien tai kokonaispäästöjen osalta. Kuitenkin kun verrataan kestävän rahoituksen ja yritysten kasvihuonepäästöjen välistä suhdetta yrityksiin Yhdysvalloista ja yrityksiin Euroopasta ja Kanadasta, tulokset viittaavat siihen, että kestävä rahoitus on yhteydessä matalampiin päästöihin pääasiassa eurooppalaisissa ja kanadalaisissa yrityksissä, mikä viittaa siihen, ettei kestävä rahoitus itsessään ole pääasiallinen tekijä alempien päästöjen takana. Lisäksi kun otokseen sisällytetään vain rahoitusalan ulkopuoliset yritykset, yhteys kestävän rahoituksen ja matalampien kasvihuonepäästöjen välillä heikentyy, mutta on yhä havaittavissa joissakin päästöluokissa.

AVAINSANAT: Sustainable finance, Climate finance, Sustainable investing, Green bond, Greenhouse gas emissions, Ownership

Contents

Figures

Tables

1 Introduction

Sustainable finance and investment have gained a significant amount of attention and capital due to increasing concerns and business opportunities linked to environmental, social, and governance (ESG) factors. However, in recent years, sustainable investing, particularly ESG, has lost some momentum. Nonetheless, numerous businesses are involved in solving sustainability-related challenges, and many investors are keen to invest in these solutions and innovations, with a particular focus on environmental issues, especially challenges such as climate change. A number of investors are investing in so-called green assets that are related to environmental sustainability, while some are divesting from and excluding certain assets they deem not sustainable enough. Additionally, some investors actively engage with less sustainable companies to make them more sustainable. Others are providing financing to corporations to finance their sustainable investments.

There are many approaches and instruments under the term sustainable finance, and some of them might be more effective than others. This study examines the effectiveness and relationship of sustainable finance in achieving its intended objective of enabling companies and the world to become more sustainable. If a company has sustainable or climate-oriented investors or debt classified as green, will the company become more sustainable over time? Furthermore, this study focuses on green and climate finance and sustainability impact measured by corporate greenhouse gas (GHG) emissions, both unscaled GHG emissions and GHG emission intensities. Climate change is arguably the most important sustainability challenge to be solved. GHG emissions are its key metric, and corporations are in a key position to execute the transformation to a low-carbon economy.

There are numerous studies in the finance literature related to corporate sustainability, sustainable investing, and even green bonds. Most of these studies focus on investors' returns or corporate profits and overall sustainability, which is measured by metrics like

ESG scores. Fewer studies seem to focus on environmental impacts, especially GHG emissions, even though it could be argued that GHG emissions are one of the most important or even the most critical variables regarding sustainability.

Furthermore, one of the mainstream approaches to sustainable investing, divesting, is criticised as it appears not to have a relevant sustainability impact. In a recently published study, Berk and Van Binsbergen (2025) find that divestments from businesses that are not sustainable do not seem to have a significant impact on the cost of capital of targeted companies. On the other hand, they and, similarly, De Angelis et al. (2023) note that if the number of divestments grows substantially, there could be a greater impact on the cost of capital and, consequently, on the firms' sustainability. However, this scenario seems very unlikely, and the authors suggest that a more efficient way to have a positive sustainability impact on companies would be to engage with them or directly finance companies to invest in projects with negative net present value but positive sustainability impact.

There is some existing literature examining the relationship between engagement and ownership of sustainable investors and sustainability. For instance, Azar et al. (2021) examine the relation of active engagement and ownership by three major institutional investors, BlackRock, Vanguard and State Street Global Advisors, on the firms' carbon emissions. They find that the ownership share of these three investors is negatively related to the carbon emissions of the firms they hold. Furthermore, these three institutions also seem to concentrate their engagements on large companies and companies that have high carbon emissions. Similarly, Dyck et al. (2019) find evidence that institutional investors' ownership is positively related to a firm's environmental and social performance and firms that experience successful engagements are also in better financial positions.

In contrast to the three major institutional investors, which mainly offer ETFs (Exchange-Traded Funds) and index funds that can be categorised as passive investments, Kim and

Yoon (2020) analyse the effect of active US mutual funds committing to the United Nations-supported Principles for Responsible Investing (UN PRI). They do not find any significant effects on ESG scores of funds' overall holdings or the funds' returns. In addition, the authors examine the effect of these UN PRI signatories' holdings on firms' ESG scores, concluding that there is no significant improvement in those scores either. The assets under management (AUM) and the number of signatories of the UN PRI have grown significantly since 2006. However, in recent years, the growth has slowed, and the number of signatories has even slightly started to decrease for the first time on record (Figure 1).

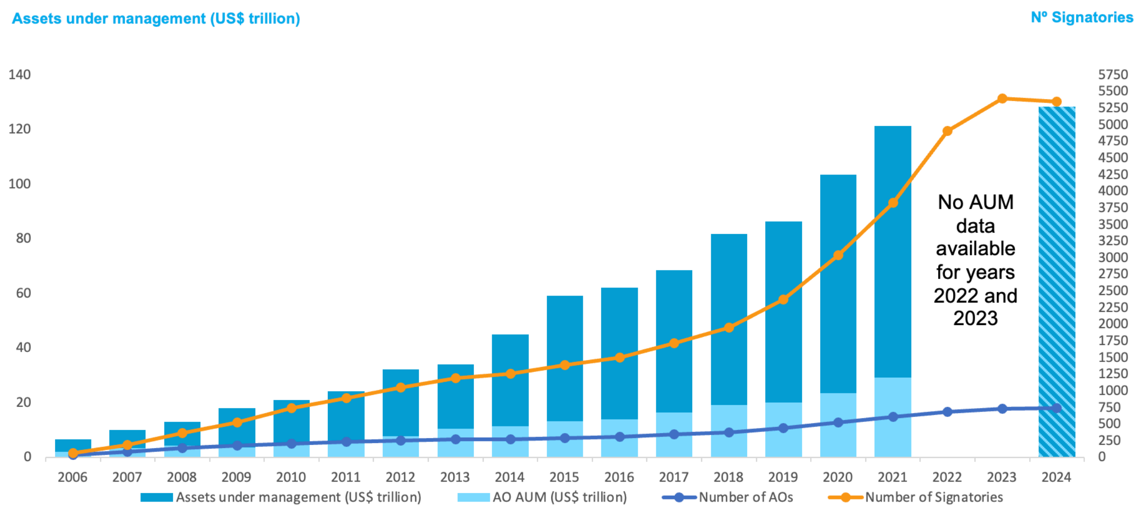

Figure 1. PRI growth 2006–2024 (adapted from Principles for Responsible Investment, n.d. -a). The original figure only includes the years 2006-2021. The data for the years 2022–2024, shown in the figure, are sourced from the respective year's annual reports of the UN PRI. The last column of the figure displays the total AUM (US$ trillion), which includes asset owners' (AO) AUM.

There is also some literature on sustainable fixed-income instruments' sustainability impacts. For instance, Flammer (2021) observes that corporate green bonds are associated with improvement in corporate environmental performance as companies that issue green bonds increase their environmental ratings and decrease their carbon emissions intensities post-issuance. However, she points out that corporate green bonds themselves do not necessarily affect firms' environmental performance because the issuances are not large enough. In the same way, Fatica and Panzica (2021) investigate the effects of corporate green bonds on firms' GHG emissions and conclude that total and scope 1 emission intensity decreases after a corporation issues a green bond. Like the UN PRI trends regarding AUM and signatories, corporate green bond issuances have plateaued in terms of the number of bonds and total amount issued (Figure 2). However, the total amount of green bonds outstanding has grown consistently.

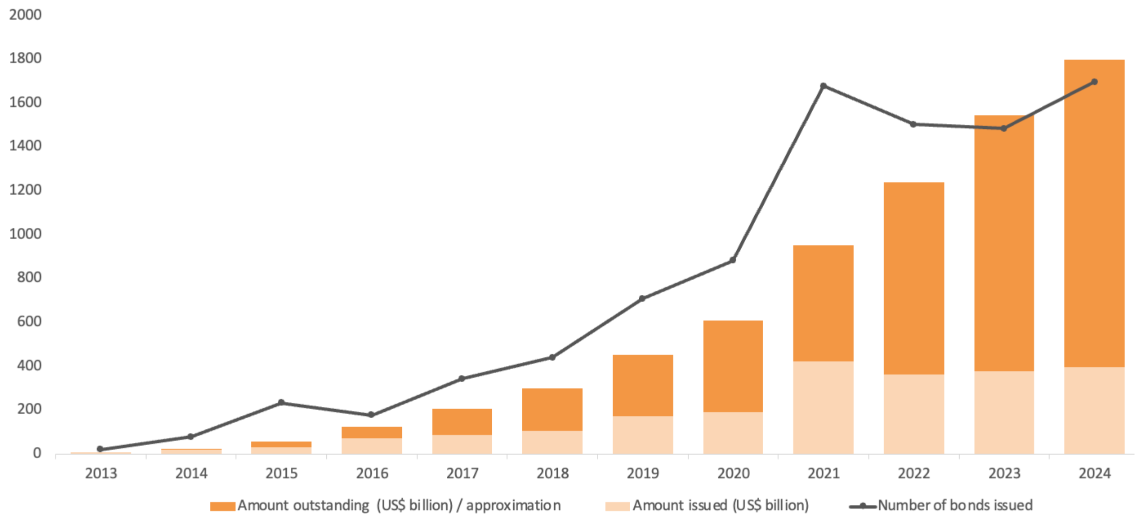

Figure 2. Corporate green bonds growth 2013–2024. Data source: Bloomberg. The figure shows a global sample of corporate bonds in which the Bloomberg "green instrument indicator" is positive. The sample includes government-related corporations. The amount outstanding is approximated using the issue year, maturity year and call year and issue amount. If the bond is perpetual, the maturity year is set to year 9999. Sinkable and puttable bonds are included in the sample as if they were "at maturity" types of bonds.

In order to measure something reliably, the data have to be at least somewhat accurate. Berg et al. (2022) find that six major ESG rating agencies' ESG ratings for the same companies only correlate on average 0.38-0.71. The highest average correlation (0.53) is between ratings of environmental factors. These are relatively low correlations. They note that the divergence of ESG ratings may cause difficulties in evaluating and following the development related to these factors and recommend that when researching something related to ESG, using raw data like GHG is a better option. This thesis uses GHG emissions due to a climate focus and better data availability regarding corporate GHG emissions. Busch et al. (2022) measure the correlations between different GHG emission data providers' emission data, including Bloomberg, Thompson Reuters (LSEG), Sustainalytics, Trucost, CDP and MSCI. The reported figures for scope 1 and 2 emissions are very consistent across data providers. However, according to the study, figures for scope 3 emissions differ substantially more among data providers compared to scope 1 and 2 GHG emissions figures. The GHG emissions data for this thesis are obtained from Bloomberg.

This thesis conducts the empirical part of this study using regression analysis. The data used in this thesis are yearly observations of variables from publicly traded large firms from North America and Europe. The sample contains approximately seven hundred companies, and it spans the period 2015 to 2023. The data are primarily sourced from Bloomberg, as well as directly from Norges Bank Investment Management regarding the Government Pension Fund Global. There are no data available about the sustainability preferences of every investor in the market. Therefore, this thesis uses ownership by certain funds that can be classified as sustainable investors as a proxy for sustainable investors' ownership.

The Norwegian Government Pension Fund Global is one of the world's largest sovereign wealth funds. The fund has set a goal for the companies it owns to achieve net zero emissions by 2050, and it uses a set of sustainable investment practices like engagement with companies, as well as some exclusion and divestment strategies (Norges Bank Investment Management, n.d.). Similarly, another fund, US-based TCW Transform Systems ETF (Ticker: NETZ / PWRD), is used as a proxy for sustainable investors. This fund has taken a rather opposite approach compared to certain ESG funds, which exclude specific industries or companies. This ETF (Exchange-Traded Fund) focuses its investments on companies like Exxon Mobil, which some ESG funds would certainly exclude because it operates in the fossil fuel industry. TCW Transform Systems' ETF follows active ownership and engagement strategies, and its goal is to benefit financially from energy transformation (TCW, n.d.). This thesis also studies the relationship between sustainable or green debt and corporate GHG emissions. Hence, another key variable is the amount of green bonds outstanding (issued by the company or its subsidiary) divided by the company's total assets. If Bloomberg has classified the corporate bond as a "green instrument", it is treated as a corporate green bond in this study.

1.1 Purpose of the thesis

What is the point of sustainable finance if it does not have any meaningful relation to or impact on sustainability? This study gathers evidence about the relation and effects of sustainable finance on the sustainability of the firms measured by corporate GHG emissions. This thesis provides information that could guide investors and companies to make better investments and manage their existing investments regarding sustainability. Furthermore, this study might also provide useful information for policymakers as sustainable finance is considered to be a tool to achieve sustainable development goals.

This thesis's empirical part largely excludes divestment, screening, and exclusion approaches in sustainable finance from its scope. This thesis focuses on the relationship and effect of two prominent sustainable finance approaches, active ownership or engagement and sustainable debt, more specifically, green bonds, on corporate GHG emissions. This thesis contributes to the growing literature regarding the impact of sustainable finance. Most studies, even recently published ones, usually use data up to the 2010s when ESG and sustainable finance started to gain substantial momentum, which has by now slowed significantly. This study uses data at least up until the end of 2023. In addition, unlike many studies in sustainable finance, this thesis uses GHG emissions instead of other sustainability metrics such as ESG scores. Furthermore, this thesis uses novel variables like the amount of green bonds outstanding relative to a firm's assets and the percentage of ownership by sustainable investors to capture the relation of sustainable finance to corporate GHG emissions.

This study's primary contribution is to provide evidence and information about the relationship between sustainable finance and corporate sustainability, measured as corporate GHG emissions. However, this thesis does not prove the causality of sustainable finance having a sustainable impact, but it does provide both supporting and non-supporting evidence about the possible causal effect. The secondary objective is to provide information about sustainable finance in general, such as returns, profitability, etc., mainly through a literature review.

1.2 Hypothesis

The key idea of this thesis is to examine and gather information about the relation and effectiveness of sustainable finance in achieving a sustainability impact, as measured by corporate GHG emissions. If a company has sustainable or climate-oriented investors or debt classified as green, will the company become more sustainable over time? Is sustainable finance associated with lower corporate GHG emissions? The hypotheses of this study are supported by literature (e.g., Azar et al., 2021; Dyck et al., 2019; Fatica & Panzica, 2021; Flammer, 2021). The hypotheses are the following:

Hypothesis 1: Sustainable investors’ ownership is associated with a positive sustainability impact on corporations, as measured by their GHG emissions.

Hypothesis 2: Green debt share is associated with a positive sustainability impact on corporations, as measured by their GHG emissions.

1.3 Structure of the thesis

This thesis is structured as six main chapters: introduction, theoretical framework, literature review, data and methodology, results, and finally, conclusions. This thesis begins with an introduction, including the purpose and motivation for the study and hypothesis.

The next chapter includes the theoretical framework for the thesis, including the basic economics of climate change and GHG emissions, the role of green finance, shareholder theory, and the efficient markets hypothesis. The third chapter reviews the existing literature relevant to this thesis, including perspectives on sustainability impact, profits, and returns. The fourth chapter concerns the data and methodology used in this thesis. First, the different datasets are introduced. Then, the methods and concerns regarding combining the datasets into one single dataset are addressed, variables are defined, and descriptive statistics about the data are presented. Next, the methodology and regression models of this thesis are outlined. The fifth chapter presents the empirical results of this thesis, and the sixth and final chapter draws conclusions regarding the thesis.

2 Theoretical framework

This chapter provides the relevant theoretical framework for this thesis. The framework includes the basic economics of climate change and GHG emissions, the role of green finance, shareholder theory, and the efficient markets hypothesis. The last subchapter draws conclusions based on the framework.

2.1 Economics of climate and the role of green finance

First of all, Nordhaus (2019) emphasises that greenhouse gas emissions represent a negative externality impacting the entire globe, requiring a global solution(s). Furthermore, from an economics perspective, the author states that the primary goal should be to internalise the cost of GHG emissions by establishing the pricing of these emissions. This would then enable the prices of goods and services to better reflect the true (social) cost of carbon, consequently incentivising innovators and investors to create and finance projects and products aimed at reducing emissions. On the contrary, currently, as Nordhaus (2019) points out, emissions are largely externalised to the public, and the emission savings spill over to the public, not generating incentives to lower emissions. In other words, firms that emit GHG emissions lack the incentives to reduce their emissions because emitting them is cheap or free of cost, and if they cut emissions, they might not benefit from it. The firms that voluntarily cut their emissions likely raise their costs and might give a financial advantage to their competitors, who might not care about their GHG emissions as much. Conversely, some other firms and people will likely experience climate risks and bear the costs.

Pedersen (2023) notes that nowadays, green finance is utilised significantly more than carbon pricing, but if carbon pricing would reflect the social cost of GHG emissions, green finance might become pointless and obsolete, in terms of green finance influencing the cost of capital. He states that in this case, green finance might even be counterproductive, as it could interfere with the price of carbon. Nevertheless, carbon prices are currently too low and, in most cases – zero (Nordhaus, 2019). In this kind of situation, green finance still might have a place, Pedersen (2023) notes, but at the same time acknowledges that green finance is unlikely to have a large enough impact on the cost of capital to have a significant enough sustainability impact, especially if the cost of capital should match the effect of carbon prices in the future, which are estimated to be much higher than today. Nevertheless, finance for green or more sustainable investments is necessary, but labelling or tagging parts of finance as green or sustainable might not be, as it is unlikely that finance is the main driving force for sustainable development.

2.2 Shareholder theory

Friedman (1970) argues that "the social responsibility of business is to increase its profits" and not to engage in activities that counter this goal. The same doctrine can be applied to financial institutions and perhaps to finance in general. It can be rephrased as follows: The responsibility of an investor is to increase their returns and not to engage with activities that counter this goal. However, some businesses, initiatives, and investments classified as responsible, sustainable or green might still be beneficial for firms and investors to achieve this goal, but in this case, action should be taken to increase profits and returns, not because of sustainability or some other responsible agenda.

On the other hand, Friedman (1970) notes that if a firm takes action to reduce its emissions beyond its best interests or legal requirements, the firm is lowering shareholders' returns, which is essentially a tax on emissions. He argues that taxes should be imposed by the government, not firms, even though it might be for a good reason and may prove considerably more difficult and time-consuming to achieve through the government and democratic processes. Furthermore, he describes an instance where some shareholders of a company attempt to engage with the firm to influence the firm to become more sustainable, which again may be against the interests of shareholders and other stakeholders if it is not in the best interests of the company or required by law, effectively imposing a tax on them. This is not necessarily the optimal means to achieve these sustainability goals. Although, he clearly states that individuals are free to use their money as they like and impose “a tax” on themselves.

Nevertheless, Friedman (1970) is rather sceptical about the potential outcomes of those who trade for the public good. This underscores his belief that the drive for self-interest by individuals is an essential, key, and fundamental component of an efficient and functioning free-market economy. Similarly to Friedman, Edmans (2023) argues that it is the responsibility of government(s) to regulate externalities, as they represent a “market failure”. However, he adds that companies could independently address externalities if governments fail to do so and if the shareholders of the company agree. This, however, would likely lead to a decrease in profits for the company and returns for its investors, as externalities, by definition, do not impact company profits, but addressing them will (if they don’t, they would not be externalities). Nevertheless, some shareholders may still be willing to sacrifice some profits for the common good (Edmans, 2023).

2.3 Efficient markets hypothesis

The efficient markets hypothesis developed by Fama (1970) argues that all the information available to market participants should already be priced into the assets. Furthermore, he states that the main function of the markets is to efficiently allocate resources and to achieve that, prices must be precise and contain all available information. However, this is not always the case; for example, investors tend to behave irrationally from time to time. Fama (1970) divides market efficiency into three categories, which are weak, semi-strong and strong forms, where the weak form prices in all historical trading data like prices and volumes, semi-strong prices include all publicly available information and the strong form all information including insider information.

According to the efficient markets hypothesis, if market efficiency is at least semi-strong, prices should include the effects of publicly available sustainability-related information if it impacts the value of a company. However, if information about different assets is unclear or inconsistent, it might be hard or even impossible to value its effect. This might be the case in ESG metrics and also, to some degree, in GHG emissions. On the other hand, GHG emissions are largely an externality, so corporations' own GHG emissions should not affect the prices of companies per se, but if, for example, the company is under carbon pricing or there is a risk (e.g. legislative risk) that it will have to pay for emitting greenhouse gases, the company's stock price should contain information about the possible effect of corporate GHG emissions too. Companies can also have physical climate risks. They might have to face prolonged droughts or other extreme weather phenomena, which might damage companies' businesses or assets. However, the physical climate risks are not usually directly attributable to corporations' own GHG emissions, but to the firms' other characteristics like their location and industry.

2.4 Theoretical conclusions and considerations

In other words, in theory, firms should maximise their shareholder value, investors maximise their returns, markets allocate resources efficiently, and the government set rules like carbon pricing system(s). However, reaching a global or even regional agreement on fair and functional carbon pricing is likely to be an enormous challenge, as Korhola (2014) demonstrates, the political process of dealing with climate change has been cumbersome. There is no guarantee that governments will agree and set such rules that enable climate change to be solved. Ideally, the cost of emitting a specific amount of GHG emissions should be the same for everyone and everywhere in the world. In addition, carbon pricing has hardly been successfully implemented on a large scale. However, the EU emissions trading system (ETS) may serve as an example of such a carbon pricing system.

One potential low-hanging apple is to make a greener monetary policy. Schoenmaker (2021) noticed that the European Central Bank (ECB) tends to hold corporate bonds issued by carbon-intensive firms. The author argues that the ECB could re-balance their portfolio without negative side-effects towards less carbon-intensive firms, which then could potentially lower the cost of capital of less carbon-intensive firms and raise the cost of capital of carbon-intensive firms, incentivising firms to go low carbon similar to a carbon tax. However, the cost of capital should rise quite significantly in favour of low-carbon companies to have a meaningful impact on sustainability (Berk & Van Binsbergen, 2025; Pedersen, 2023). It remains uncertain whether central banks' asset balancing toward greener assets could have a meaningful impact on the world; at least, it seems to be a low risk and quite certainly easier to implement compared to tools like carbon taxes.

On the other hand, most countries managed to agree to reduce their GHG emission by signing the Paris Agreement in 2015. Nevertheless, it remains uncertain whether the world will meet the targets set by the Paris Agreement. The private sector is undoubtedly in a key position to achieve the targets and execute the transformation to a carbon-neutral economy. Outsourcing the responsibility and having high expectations for the private sector and partly also for sustainable, green or climate finance offers an easier and more flexible route, but perhaps inefficient without additional government policies, to have a real sustainability impact. “Economics points to one inconvenient truth about climate-change policy: for any policy to be effective, it must raise the market price of CO2 and other GHG emissions.” (Nordhaus, 2019, p.2003).

3 Literature review

This chapter reviews the most relevant research literature on this thesis topic. It is further divided into five main parts, which are the overview of the literature, sustainable investing, returns and ESG, corporate green bonds, and ESG and GHG emission data.

3.1 Overview of the literature

Numerous studies examining corporate responsibility, sustainability and ESG have already been done and published, but mainly from the standpoint of examining if sustainability or ESG is related to profits for corporations and returns for investors. Almost two decades ago, Van Beurden and Gössling (2008) reviewed research literature regarding corporate financial performance and corporate responsibility. The result of this study is that, generally, more responsible firms seem to be in a stronger financial position. More recent analysis regarding the same subject come to similar conclusions. A meta-analysis by Whelan et al. (2021) examines unique studies and other meta-studies about the subject, altogether covering over a thousand unique studies related to ESG and financial performance. The result of the analysis is that the majority of existing research has concluded that there is a positive link between ESG and financial performance, both in studies focusing on corporations and on investment performance. Only a fraction of these studies find a negative link between profits and ESG. However, many studies find mixed or neutral correlations between ESG and profits.

Considerably less research has been done related to the sustainability outcomes and the real impact of sustainable finance on sustainability itself, even though sustainable finance and investing have grown significantly and have been advertised as, for example, sustainable or green and as a better option regarding our planet compared to conventional finance and investments without sustainability preferences. However, some research has been done regarding the impact of sustainable investing. Kölbel et al. (2020) review empirical literature regarding the impact of sustainable investing on sustainability. They conclude that shareholders' active engagement is the most promising and evidence-based way to have a real impact compared to capital allocation, i.e., divesting from unsustainable companies and investing in sustainable companies. Interestingly, they also note that investors' initiatives related to governance or social factors are more likely to be successful than those related to environmental factors, probably due to the higher average costs of implementing the latter. For example, in line with Kölbel et al.'s assessment of the investor's possible impact on environmental factors, Bolton and Kacperczyk (2025) note that multiple firms have indeed made commitments to reduce their emissions. However, if the firm has small emissions to begin with, they are more likely to commit to reducing them than is a firm with a lot of emissions. On top of this, 60% of firms that have made commitments seem to have fallen behind their target. However, they find that firms that commit to reducing their emission are likely to reduce them as well, which is encouraging.

3.2 Sustainable investing

This section is further divided into three sub-sections. Two of them discuss the main approaches to sustainable investing: active engagement and divesting, or, as Edmans (2023) puts it, "voice" and "exit." The third main part is about the behavioural finance aspect of sustainable investing and its impact.

To begin with, De Angelis et al. (2023) point out that the average GHG emission intensities of firms listed on major US stock exchanges have been decreasing while, at the same time, sustainable investing AUM has increased. They speculate that this might be driven, for example, by regulations, consumer behaviour and green investors. However, it is fair to speculate that this might also be due to increasing revenues in businesses and in the number of naturally low-carbon companies, such as internet-related companies. Furthermore, this highlights the need for and importance of industry and firm-fixed effects when researching the relation of sustainable or green finance on companies' environmental performance.

3.2.1 Active ownership

Active ownership or engagement is about investors or owners of a company using their power and voice as shareholders to transform the company from the inside to become better, for example, more profitable or sustainable in terms of GHG emissions. It is the opposite approach to exclusions and divestments and is viewed as a better approach by many studies (e.g. Berk & Van Binsbergen, 2025; Kölbel et al., 2020; Puttonen, 2025). Institutional investors have formed engagement coalitions to promote particular agendas like sustainability or climate, such as the UN PRI and the Climate Action 100+, to list a few of the most notable coalitions.

A study by Dyck et al. (2019) finds evidence that institutional investors' ownership is positively related to a firm's environmental and social performance. Remarkably, they observe that these positive company changes seem to be driven by institutional investors from countries with higher environmental and social norms. The study classifies many European countries as having high norms. In addition, Dimson et al. (2015) find abnormal stock returns on companies related to successful investor engagements related to ESG aspects and, more specifically, engagements related to climate change. However, they note that these results may vary over time and by the investor.

For small retail investors, making change by owning a few stocks of major companies can certainly be challenging and even impossible. It might be more efficient to pick an index fund representing, for example, the world's equity markets from a fund provider with a track record of engaging successfully with companies on a topic important to the investors. Picking the right fund management company can be a meaningful and impactful decision. In other words, investing in an ESG fund excluding specific industries or companies might be less effective and more expensive than investing in a low-cost index fund. There is some existing literature to support this viewpoint.

Azar et al. (2021) examine the effects of three major institutional investors' (BlackRock, Vanguard and State Street Global Advisors) active engagement and ownership on firms' carbon emissions. They find that the ownership share of these three investors is negatively related to the carbon emissions of the firms they hold. Furthermore, these three institutions also seem to concentrate their engagements on large companies that usually have higher carbon emissions. According to the research, BlackRock is the most active in engaging with the companies in which they invest. The negative relationship between carbon emissions and ownership share is also the largest and the most statistically significant for BlackRock's ownership. It is worth noting that these three institutions hold shares in many of the same companies because they offer similar investment products to their customers. This suggests that it is possible to be a free rider. In other words, investors who are passive owners who do not actively engage with their holdings might also have their ownership associated with lowering GHG emissions due to other investors actively engaging with the same companies.

Furthermore, there might be a quite simple reason behind the fact that these three major institutional investors have decided to engage with their investments and not divest from them. The reason is that they are mostly passive investors, as they offer many index funds that do not have any exclusion criteria. Appel et al. (2016) study the effect of passive institutional investors on firms. They point out that passive investors are less likely to divest from companies, which might make them more likely to engage with them. One of their findings supporting this argument is that while ownership of passive investors increases, the probability of activism by hedge funds decreases, suggesting the need to engage with companies decreases due to passive investors' ownership. Furthermore, long-term ownership by passive investors is also related to positive financial performance. The overall conclusion drawn from the results is that passive investors are not passive owners but seem to effectively use their influence and engage with the companies to create value.

3.2.2 Divesting, screening, exit

One of the traditional views and practices of sustainable investing is that investors should invest in businesses that are sustainable regarding factors such as the environment, and not invest in companies that are not sustainable (Puttonen, 2025). Institutional investors who actively manage investments usually have the possibility to sell an asset altogether. In contrast, index fund providers do not usually have the luxury to pass down the problematic asset. Given the above, Gibson Brandon et al. (2022) find that, on average, institutional investors improve their portfolio's ESG scores after signing the UN PRI. However, this does not apply to US-based institutional investors. This is confirmed by Kim and Yoon (2020), as they do not find any significant effects on ESG scores of funds' overall holdings after active US mutual funds have signed the UN PRI. However, they observe an increasing inflow of capital into the funds after the fund has signed the UN PRI.

The institutional investors who join the Climate Action 100+ engagement coalition or climate disclosure project (CDP) seem to sell their "dirty" assets to other investors rather than engage with the companies, Atta-Darkua et al. (2023) notice. They conclude that this will make investors' portfolios cleaner but probably has minimal effect on the world and on the companies. They also point out that investors based in countries that have or have stronger carbon pricing systems are more likely to sell their dirty assets compared to investors based in countries where there is no carbon pricing or less carbon pricing.

Some publicly traded companies are selling assets that are not compatible with their sustainability goals to private companies, Puttonen (2025) notes and argues that this makes publicly traded companies more sustainable, private companies less sustainable, and that the overall sustainability impact of this on the world might be negative. He stresses that private companies usually have fewer resources and capabilities, like capital and technological talent, than larger public companies do to make the assets more sustainable. For instance, Cohen et al. (2020) emphasise that energy firms are key innovators when it comes to green innovations and patents, as they have been contributing greatly to green innovations in their field. They argue that traditional energy firms have a goal to stay in the energy business even after the use of fossil fuels. At the very core of climate change and GHG emissions are fossil fuels and energy questions. Energy corporations, most of which are also in the fossil fuel industry, hold great potential to develop and reduce GHG emissions. Despite this, energy companies producing fossil fuels have been excluded by many sustainable and climate-oriented investors and investments in these companies have been sold to other investors, who might have less enthusiasm for clean energy and energy transformation.

In addition, Puttonen (2025) states that these private companies which are buying less sustainable assets from larger public corporations tend not to experience the same amount of pressure from stakeholders like sustainable investors to change their business to be more sustainable compared to larger, well-known publicly traded companies. The author stresses that the result of sustainable investing in a traditional mainstream way (buy green, sell brown) might be negative when it comes to the overall sustainability of the world.

De Angelis et al. (2023) focus their research on investors' climate screening their investments and show that increasing amounts under the management of these green investors and their increasing sensitivity to GHG emissions seem to push corporations to decrease their GHG emissions, although by a relatively small percentage. They also model that corporate GHG emissions decrease faster if investors expect tighter regulation or new climate-related technologies. Similarly, Pástor et al. (2021) model the effects of sustainable investing and find that green firms have higher market value and lower cost of capital, which increases green firms' real investment compared to brown firms.

On the other hand, Hartzmark and Shue (2023) note that firms that are in high GHG emission intensity industries usually have more potential to reduce their emissions in terms of their absolute emissions, which has a greater impact on the world than high percentage reductions by firms which are already relatively green and operate in low GHG emission intensity industries. Furthermore, they argue that if a firm is in financial distress or has a higher cost of capital, it is likely to result in the firm favouring its current way of doing business as the firm is more unlikely to make the necessary investments to transform its business in a more environmentally friendly direction and because the existing business provides revenue sooner than the new investments. While brown firms could need more financing to transform their operations, green companies already seem to enjoy sustainable finance, even though they do not seem to need as much funding to change their operations because they are already relatively green. The authors observe that a lower cost of capital for green firms does not seem to create a significant positive sustainability impact in terms of GHG emission intensity reductions. On the contrary, they find that a higher cost of capital for brown firms seems to increase their GHG emission intensity. To counter this counterproductive phenomenon, their research suggests that investors with environmental sustainability preferences should focus on and engage with brown companies and incentivise them to reduce GHG emissions, for example, by providing them with finance or engaging with them as active owners. However, the authors notice that sustainability-oriented investors tend to underweight brown companies even though there is most work to be done regarding GHG emissions and, consequently, a more significant potential impact regarding the emissions.

The goal of sustainable finance should not be to make existing "dirty" businesses more profitable than new investments for more efficiency, for example, in terms of the environment. Tools like green bonds might be useful in these kinds of situations. However, making the firm's old business less profitable may drive the firm into financial distress, making it even harder to get funding to address its environmental impacts. (Hartzmark & Shue 2023). Naturally, in the transformation to a low carbon economy, some companies that do not take into account the transformation and hence find themselves in financial distress might eventually go bankrupt and lose their market share to their competitors.

3.2.3 Behavioural finance aspects of sustainable investing and impact

Giglio et al. (2025) analyse US retail investors' survey results from the years 2021-2023 and find that, on average, these investors expect approximately two percent lower return annually over ten years from ESG investments compared to a market index. Furthermore, about half of the respondents do not seem to have any reasons for ESG investing, about a quarter of respondents view it just as the right thing to do, about the same portion view it as a hedge against climate-related risk, and only six percent of the respondents answered that their reason for ESG investing is that they believe it will outperform.

Correspondingly, Heeb et al. (2023) find that investors are willing to pay for sustainable investment with some sustainability impact measured as CO2 emissions when compared with conventional investment. However, the relationship between willingness to pay and impact is not linear. When the impact of an investment is set to be ten times higher, the willingness to pay for it grows but substantially less than ten times, research shows and suggests that this phenomenon is most likely due to investors' emotions, which drive them to invest sustainably in the first place. The authors note that this might incentivise financial product providers to build products that fulfil the investor's internal need for positive emotions but that provide only a limited actual amount of sustainability impact. The result might be that investors feel good, and fund managers have more profits, but the sustainability problems remain unaffected or only slightly affected. Based on their results, the authors stress that there is a substantial risk of greenwashing by financial product providers.

3.3 Returns and ESG

As noted earlier, a meta-analysis conducted by Whelan et al. (2021) covers over a thousand unique studies related to ESG and financial performance. Based on the studies they review, the authors conclude that responsible firms seem to be generally in a better financial position, protected against economic, social and other types of crises. Lins et al.'s (2017) research related to the Great Financial Crisis (GFC) also supports the finding that more sustainable firms are better protected against market downfalls. Firms that are measured to be more responsible were better protected against GFC as their value dropped less in the crisis than firms that were not as responsible based on corporate social responsibility metrics. Similarly, Pástor et al. (2021) conclude that in unexpected circumstances related to ESG, for example, resulting in climate concerns growing rapidly, green stocks outperform the market.

A more recent study by Alves et al. (2024) uses a global dataset of over 16,000 companies to uncover the relationship between ESG ratings and stock returns. The result of the study is that there is no significant relation between these two variables. This suggests that ESG ratings have no positive or negative significant effect on stock returns. Edmans (2023) sees that the ESG is a combination of value drivers for the long run, which makes it important but nothing special compared to other non-ESG value drivers. A company that has a poor ESG rating might still be a great investment. Correspondingly, Hong and Kacperczyk (2009) study companies that operate in industries that are commonly considered irresponsible. These include companies in the tobacco, alcohol and gambling industries. According to the study, the shares of these companies have a higher expected return than similar companies operating in other industries. The study deducts that this difference is because institutional investors, particularly, avoid companies that operate in the tobacco, alcohol and gambling industries.

3.3.1 Returns and emissions

Bolton and Kacperczyk (2021) analyses firms' carbon dioxide emissions and returns of the firms' stocks in the US market. They conclude that firms emitting more carbon emissions have higher stock returns than firms that emit less. Their research indicates that investors already seem to take into account the carbon risk of investments and demand compensation for it. They call this phenomenon the "carbon premium". So, markets seem to price in carbon risks. Given the above, investing in firms that emit either less or more carbon does not matter return-wise because carbon emissions and risks related to them are already taken into account in the prices of these assets. As the fundamental principle in finance states, risks are rewarded. Bolton and Kacperczyk (2023) continue to research the effects of carbon emissions on stock returns globally. They observe that the carbon premium is a global phenomenon, positively related to the absolute level of corporate carbon emissions (long-term carbon risk) and their annual growth (short-term carbon risk). Furthermore, they observe that carbon premiums exist both in companies' direct (scope 1) and indirect (scope 2 & 3) emissions. However, they find that the carbon intensity of companies does not seem to have a significant effect on stock returns and point out that, "the increasing cost of equity for companies with higher emissions can be seen as a form of taxation through capital markets." (Bolton & Kacperczyk, 2023, p. 3752).

In addition to the carbon premium observed by previous studies, Garel et al. (2024) observe an emerging biodiversity premium in stock returns. This premium is observable from October 2021, after an important UN biodiversity conference. However, the corporate biodiversity footprint used in the study is related to GHG emissions as it is a combination of a set of variables: greenhouse gas emissions, land use, and air and water pollution. Similar to later studies, Hsu et al. (2023) find significant premiums on stocks of companies that pollute toxic substances, implying that by investing in these firms, investors can achieve excess returns. However, the authors argue that the key factors explaining the premium are likely the risk of regulation and potential expenses related to litigation, which could result in lower profits for firms and returns for investors.

Bolton and Kacperczyk (2023) explain that carbon intensity is not the best measure because even though carbon intensity (emissions divided by revenue, for example) can decrease, the absolute level of emissions might increase and vice versa. They argue that the goal for the world is to achieve zero emissions in a few decades, and carbon efficiency is secondary to this goal, although they are related. Aswani et al. (2024) criticise the use of unscaled firm-level emissions. Instead, they prefer using emission intensity, when researching the relationship between emissions and stock returns. This is due foremost to the observation that unscaled emissions are highly related to the size of the firm. In addition, they note that part of the corporate GHG emission figures provided by some data vendors are estimations by third parties. The authors find no relationship between emissions and stock returns using firm-disclosed data. The observed result is the opposite when using emission data provided by the data vendor containing third-party estimations. Additionally, like Bolton and Kacperczyk (2021, 2023), Aswani et al. (2024) find no relationship between carbon intensity and stock returns. However, they recommend using carbon intensity rather than unscaled emission data.

3.3.2 Returns and climate risks

On the other hand, Hong et al. (2019) show that stock markets likely underestimate the effects of climate change as the authors find that they can predict poor profits and stock returns for food companies by using data about drought trends within the country where the companies are located.

Stroebel and Wurgler's (2021) research further gathers supporting evidence for the underpricing of climate risks in the markets as they surveyed academics, professionals and regulators in the field of finance on climate finance and risks. The majority of these people believe that climate risks are not fully priced into the assets. They think the most important risks in the short term are regulatory, and for the long-term physical risks. When asked about the best tools to have an impact on companies to reduce their climate risk and GHG emissions, the two most popular selections from among pre-designated answers were institutional investors and carbon taxes. In addition, many respondents find that the real effects of responsible investing and green finance, like green bonds, are important research topics.

3.4 Corporate green bonds

There has been a relatively rapid growth of corporate green bond issuances. A large number of these bonds have been issued by companies in industries like energy and utilities, which are known to be capital intensive and also key industries regarding environment and climate. However, companies in the financial industry have issued the largest number of green bonds, likely to re-lend the funds forward. Furthermore, corporate green bonds are issued mostly in euros, United States dollars and Chinese yuan (Table 1).

Table 1. Corporate green bonds issued 2007-2024 by industry (Bloomberg industry classification system) and currency. Data source: Bloomberg. The table shows a global sample of corporate bonds for which the Bloomberg's "green instrument indicator" is positive.

Industry	Amount issued (US$ billion)	Number of bonds issued	Currency	Amount issued (US$ billion)	Number of bonds issued
Financials	1115	4904	EUR	931	2400
Utilities	568	1826	USD	583	1534
Consumer Discretionary	150	531	CNY	369	1542
Industrials	107	685	SEK	74	908
Materials	94	305	GBP	45	122
Energy	80	703	JPY	44	483
Communications	52	79	NOK	29	342
Technology	34	90	CHF	29	163
Consumer Staples	25	104	CAD	25	87
Health Care	6	24	Others	102	1670

3.4.1 Corporate green bonds sustainability impact

Flammer (2021) observes that corporate green bonds are associated with improvement in corporate environmental performance as companies that issue green bonds increase their environmental ratings and decrease their carbon emissions intensities post-issuance. This phenomenon is pronounced in green bonds certified by third parties. However, she notes that corporate green bonds per se do not necessarily affect firms' environmental performance because the issuances are not large enough. The author notes that green bond issues are relatively small compared to the average-size corporate bond issuance, which implies that other factors likely explain the positive environmental effects created by corporations issuing green bonds. One possible explanation is called the signalling argument. It is easier and cheaper to issue non-green bonds as they have no environmental requirements, and by issuing a green bond, companies credibly signal that they take the environment seriously and show commitment towards the environment. There are a lot more green bonds in the market than before, and in reality, some of them might not be that green. However, it is generally less expensive and more convenient to issue non-green bonds as there are usually fewer requirements. Given that green bond issuers seem to decrease their emissions, greenwashing does not seem to occur with green bonds.

On the other hand, Bongaerts and Schoenmaker (2019) stress that a considerable portion of green bonds seems to go towards refinancing projects and operations previously financed by normal bonds without a green label. In practice, this means that some green bonds do not add any finance for environmental or climate investment; hence, they probably do not have as much real impact on the environment or climate compared to green bonds issued for non-refinancing purposes. Fatica and Panzica (2021) investigate the effects of corporate green bonds on firms' GHG emissions and conclude that total and scope 1 emission intensity decreases after a corporation issues a green bond, and this phenomenon seems to be even stronger when excluding green bonds issued for refinancing. Furthermore, they notice that a significant majority of the green bonds issued are for climate-related objectives. The authors' findings also support the argument that when third parties have verified the green bond, its environmental impact seems to be larger.

3.4.2 Greenium

A higher price for a corporate green bond at issuance means a lower cost of capital for the company. If a green bond sells at a higher price than an otherwise similar conventional bond, the difference between these two prices is called a green premium, or greenium. A similar premium can be present or emerge in the secondary market, but it has a smaller implication for the company itself compared to the primary market greenium. Corporate green bonds do not seem to trade at a premium or discount compared to non-green bonds. However, some previous studies using different models have found a small premium, while others have not.

By precisely matching green bonds with ordinary non-green bonds, which are otherwise similar, and observing their yields at issuance, Flammer (2021) does not find a premium in green bonds. She notes that the green bond market is relatively new and speculates that if investors want to buy more green bonds and profitable green projects become scarce, buyers might have to settle for a lower yield, which would create a situation where green bonds trade at a premium compared to non-green bonds.

Tang and Zhang (2020) find that green bond issuances yield positive stock returns for stockholders right after the issuance announcements. However, they deduce that this is likely due to increasing publicity for the firms immediately after the issuance announcement and the signalling effect of committing to environmental factors, mainly because they see an increase in the liquidity and institutional ownership in companies issuing green bonds. They do not find consistent evidence about the existence of a lower cost of capital or, in other words, a premium in green bonds at issuance because, with only country fixed effects, there is a statistically significant observable premium, but when other fixed effects are added to the analysis, the results are no longer statistically significant. So, the lower cost of capital likely has not contributed significantly to observed higher stock returns after green bond issuance announcements.

Contrary to later studies, Pietsch and Salakhova (2022) observe a significant premium on green bonds in the euro area if they are certified by third parties or are issued by firms that operate in the green industry or by banks that are part of the United Nations Environment Programme Finance Initiative (UNEP FI). It appears that green bonds issued as a whole do not seem to provide a lower cost of capital for the issuer, but if they are certified by third parties or issued by companies in the green sector, there seem to be significant positive financial implications for the issuer in the form of a lower cost of capital, at least in the euro area.

3.5 ESG and GHG emission data

In order to measure something reliably, the data have to be accurate. Berg et al. (2022) find that the ESG ratings of the same companies by six major ESG rating agencies correlate only on average 0.38-0.71. They find that the highest average correlation (0.53) is between ratings of environmental factors. Alves et al. (2024) find similar results on average correlations of ESG ratings by different rating agencies on the same companies. These are relatively low correlations. Berg et al. (2022) find that the most significant factor behind the divergence of the ratings is the agencies' different methods of measuring the factors contributing to the ratings. Similarly, the different scope of the measured factors substantially contributes to the divergence. However, they notice that the weights that agencies give to a specific factor or sub-factor have the smallest contribution to the differences in ratings. Researchers stress that the divergence of ESG ratings may cause difficulties in evaluating and following the development related to these factors in firms and recommend that when researching something related to ESG, using a combination of ratings from multiple agencies to give a better picture of the sustainability of the firm or raw data like GHG emissions is a better option.

Remarkably, more ESG data seem to result in even more divergence, as Christensen et al. (2022) find that if a firm discloses more of its ESG information, the ESG agencies have even greater differences in their ratings. Edmans (2023) noticed that ESG ratings for the same companies tend to differ by different ESG rating agencies. However, he argues that ESG ratings naturally do so as they are more like educated opinions about the companies than hard and quantitative facts. He compares ESG ratings to stock analysts' reports on companies and their buy and sell recommendations rather than credit ratings.

This thesis uses GHG emissions due to a climate focus and better data availability regarding corporate GHG emissions. Busch et al. (2022) measure the correlations between

GHG emission data providers' emission data, including Bloomberg, Thompson Reuters (LSEG), Sustainalytics, Trucost, CDP and MSCI. The reported figures for scope 1 and 2 emissions are remarkably consistent across data providers. However, according to their study, figures for scope 3 emissions differ substantially more among data providers compared to scope 1 and 2 GHG emissions figures. This is because some data providers use third-party estimations when they do not get the data directly from the company, as the research shows that third-party estimated figures have lower correlations among data providers than figures reported by firms.

However, not every company reports its greenhouse gas emissions even though it is a central figure in terms of sustainability. Additionally, some companies misreport their emission figures, and the figures are not always certified by credible third parties, as Puttonen (2025) shows. Furthermore, he notes that databases contain notable errors due to faulty reporting by companies. There seems to be a risk that companies can manipulate their GHG emissions figures. In addition, Aswani et al. (2024) note that more emission data are available than before, but this is mainly due to increasing data vendor estimations rather than firms disclosing more data by themselves.

4 Data and methodology

This chapter reviews the data and methodology used in this thesis. First, the data samples are introduced, including the primary firm-level data, sustainable investors' proxy data, and corporate green bond data. Then, the methods and concerns related to combining the datasets into a single dataset are addressed; dependent, explanatory independent, and control variables are defined; and various tables describe the merged data. Finally, the methodology and regression models of this thesis are outlined.

4.1 Data sample

The raw sample of this thesis has yearly data for approximately a thousand of the most valuable companies by market cap as of the end of 2014 from North America and Europe. The raw sample spans the period 2014 to 2023 and includes approximately ten thousand firm-year observations. However, due to missing values and the use of lagged independent variables, the number of companies, years, and consequently the number of firm-year observations is smaller in the regressions conducted. The standardised sample used for regressions has data from 703 companies from 2015 to 2023 and includes a total of 3829 firm-year observations. Data for this thesis are mainly sourced from Bloomberg. In addition, data are sourced from Norges Bank Investment Management, which manages Government Pension Fund Global, which is used as a proxy for sustainable investors in this study.

4.1.1 Firm-level data

The primary dataset includes the main firm-level data and is sourced from Bloomberg to Excel using the "BDH" (Bloomberg Data History) function. The dataset has GHG emission data and relevant financial data about the sample firms. Data are yearly data from years 2015 to 2023 from companies in North America and Europe. The companies are chosen by their market cap as it was at the end of 2014. Hence, the sample contains the most valuable publicly traded companies from North America and Europe at the end of 2014, more specifically from the USA, Canada, twenty-seven EU countries, the UK, Switzerland, Norway and Iceland. Naturally, some of these countries have no representation in the sample due to the fact that they had none of the top companies by market cap. Most of these figures represent end-of-year values, but some are measured during the year or otherwise "close" to the end of the year. There is some variation, especially if the company's financial year differs from the calendar year, even though Bloomberg specifies the data as calendar year data, not financial year data. However, this variation will introduce some noise into the sample.

The reason for selecting the companies by market cap is that they are among the most relevant companies in the countries selected, and since they are publicly traded, data are easily available about them. About a thousand companies were selected, foremost due to the monthly data amount exporting limit in Bloomberg terminals. The sample companies are limited to Europe and North America to limit the scope of the study, make comparisons between North America and Europe, and due to the assumption that GHG data are more available and more reliable from these areas.

4.1.2 Sustainable investors’ proxy data

There are no data available about the sustainability preferences of every investor in the market. Therefore, this thesis uses ownership by certain funds that can be classified as sustainable investors as a proxy for sustainable investors’ ownership. The Norwegian Government Pension Fund Global is one of the world’s largest sovereign wealth funds. The fund has set a goal for the companies that it owns to achieve net zero emissions by 2050, and it uses a certain set of sustainable investment practices like engagement with companies, as well as some exclusion and divestment strategies (Norges Bank Investment Management, n.d.). Furthermore, Government Pension Fund Global is one of the first signatories of the UN PRI (Principles for Responsible Investment, n.d.-b). Similarly, another fund, TCW Transform Systems ETF (Ticker: NETZ / PWRD), is used as a proxy for sustainable investors. This fund has taken a rather opposite approach compared to certain ESG funds, which exclude specific industries or companies. This ETF (Exchange-Traded Fund) focuses its investments on companies like Exxon Mobil, which some ESG funds would certainly exclude because it operates in the fossil fuel industry. TCW Transform Systems' ETF follows active ownership and engagement strategies, and its goal is to benefit financially from energy transformation (TCW, n.d.). Norges Bank Investment Management publishes Government Pension Fund Global's yearly ownership shares of the companies it owns in percentages and additionally as USD. Data regarding TCW Transform Systems' ETF holdings are in USD and sourced from Bloomberg separately from the firm-level dataset. The data are the end of year values.

4.1.3 Corporate green bond data

Corporate green bond data includes variables like issue amount, issue year, call year and maturity year. The data are sourced from the Bloomberg fixed income database separately from firm-level data. More specifically, in Bloomberg fixed income search, the "instruments" is set to "corporates", "security status" to "all", and the "green instrument" variable is set to "yes". Further, making sure that the sample has only corporate green bonds, using Bloomberg industry classification standards, issuers that are "government" are excluded. The sample includes government-related corporations. The presumption is that the Bloomberg database includes all or almost all corporate green bonds that are issued worldwide. The variable used in the key variable of this thesis is the yearly amount of green bonds outstanding in a company. It is estimated using the issue year, maturity year and call year and issue amount of the green bond. If the bond is perpetual, the maturity year is set to year 9999. Sinkable and puttable bonds are included in the sample as if they were "at maturity" types of bonds. The data are the end of year values.

4.1.4 Merging the datasets

The data regarding these sustainable investors' proxy data and corporate green bond data are sourced separately from firm-level data. Hence, the relevant data from those datasets concerning this study must be combined with the firm-level dataset. The data regarding sustainable investors' proxies' ownership shares and approximated amounts of green bonds outstanding are merged with the primary firm-level dataset. Due to the lack of proper identification numbers like ISIN codes for companies and issuers in datasets regarding sustainable investors' proxies' ownership shares and green bonds, the combining of the data is primarily done by using the names of the companies, names of the issuers and issuers' ultimate parents' names. Furthermore, the companies' tickers, Bloomberg tickers and industry information are utilised to find the correct matches. A fuzzy-matching algorithm, which uses the Jaccard similarity index, is used in the process to match the data to the correct firms. In some unclear instances, manual matching and verification are used. In most cases, the names fully match between datasets.

4.1.5 Robustness of combined dataset

Due to fuzzy-matching and manual verification and matching, some values regarding sustainable investors' proxy data and green bond variables may be missing from the combined dataset. In the case of green bonds and TCW Transform Systems ETF, it is presumed that all of the data were successfully combined. This means that if the name or ticker of the company is drastically different from the name and ticker in the firm-level dataset, the data are not likely in the combined dataset, and if there is no indication about green bonds or ownership by TCW Transform Systems ETF, the value is set to zero.

In the dataset regarding Government Pension Fund Global, in some instances, there are multiple names for the same company, as the names can slightly or more drastically change from year to year. If a company has more than one name in the dataset regarding the Government Pension Fund Global, the other less similar names for the same companies, compared to the names in the firm-level dataset, are disregarded because the method used in combining data only recognises one matching name per company. To make the data more robust, if the fund has owned a part of a sample company at some point during the sample period, and if, for some reason, the value went to zero – very likely due to the name change the value is interpreted as a missing value instead of zero.

4.1.6 Dependent variables

A series of dependent variables are included to explore the relationship between GHG emissions and sustainable finance. First, all the GHG emissions figures are in thousands of metric tonnes of carbon dioxide equivalent (CO2e) and include the following greenhouse gases: carbon dioxide (CO2), methane, nitrous oxide, and possibly other GHGs, depending on the firm and its reporting. The GHG emission figures are disclosed by firms. Log (Scope 1 GHG) is the natural logarithm of the firm's annual direct GHG emissions. Log (Scope 2 GHG) is the natural logarithm of the firm's annual indirect GHG emissions emitted due to the activities of the firm but that are emitted by sources not owned or controlled by the firm. The main source of Scope 2 GHG emissions is purchased energy. The figure is calculated using a location-based method, which means that it is calculated using the GHG emission intensity of the energy grid used for the energy consumed. Log (Scope 3 GHG) is the natural logarithm of the firm's annual indirect GHG emissions not captured by the Scope 2 GHG emission figure. Log (Total GHG) is the natural logarithm of the total annual GHG emissions (scope 1 + scope 2 + scope 3) of the firm. GHG intensity (Int.) variables Log (Scope 1 GHG Intensity), Log (Scope 2 GHG Intensity), Log (Scope 3 GHG Intensity), and Log (Total GHG Intensity) are defined as the natural logarithms of the ratio of the equivalent scope's annual GHG emissions divided by the firm's annual revenue in millions of USD.

4.1.7 Main explanatory independent variables

This study includes a group of independent variables for regressions. Green Bonds % is defined as the amount of green bonds outstanding (issued by the company or its subsidiary) in a company divided by the company's total assets. NETZ % is defined as the ownership share of the company by the TCW Transform Systems ETF (Ticker: NETZ / PWRD), which is calculated using the USD value of the holding divided by the company's market cap in USD. Norway % is defined as the ownership share of the company by the Government Pension Fund Global, the sovereign wealth fund of Norway. The variables above represent either the percentage of a company owned by a sustainable or climate-oriented investor or the share of a company's sustainable or green financing at each year's end.

4.1.8 Control variables

Regression analyses include a set of company-level control variables. The Log (Size) is the natural logarithm of total assets, and it controls for the company's size. Larger firms tend to have higher GHG emissions than smaller firms. Log (BM) is the natural logarithm of the book-to-market ratio, and it controls for a company's growth aspects and valuation. Firms with low valuation levels tend to be more traditional, low-growth, and carbon-intensive, while highly valued firms tend to be the opposite. Leverage is defined as short and long-term debt divided by total assets, and it controls for a firm's financial risk and credit constraints. A company with a lot of debt has limited possibilities to invest in sustainability or climate-related investments. Return on assets (ROA) is net income divided by total assets and controls for the firm's financial performance. Firms with higher ROA are usually in a better position to invest in lowering their GHG emissions. PPE is net property, plant and equipment value divided by the firm's total assets, and it controls for the firm's assets' tangibility and capital intensity. Companies that have a lot of PPE assets are also more likely to have a higher environmental impact. The study by Azar et al. (2021) uses the same or at least a very similar set of control variables.

4.2 Descriptive statistics

The unstandardised sample spans the period 2014 to 2023 and includes five thousand to nine thousand firm-year observations, depending on the variable. However, due to missing values and the use of lagged independent variables, the number of companies, years, and consequently, the number of firm-year observations is smaller in the regressions conducted. The standardised sample that is used in the following regression has data from 703 companies from 2015 to 2023 and includes a total of 3829 firm-year observations. Both the unstandardised and standardised samples are shown in the following descriptive statistics tables (Tables 2 and 3). The standardised sample is further described in Table 4.

The dependent and control variables are winsorised at the 1st and 99th percentiles to combat outliers in the data. Independent variables Green bond %, NETZ %, and Norway % are not winsorised as they are the main explanatory variables and carry meaningful information. If NETZ % is winsorised at the 1st and 99th percentiles, all of its values will be zero and information related to it is lost. Furthermore, if these three variables are winsorised, the coefficients related to Green bond % and Norway % seem to be generally larger and statistically more significant. This effect is more pronounced in coefficients related to Green bond % than in Norway %. However, the results are fairly similar even if the three variables are winsorised.

Table 2. Descriptive statistics for the key variables of the unstandardised sample. The dependent and control variables are winsorised at the 1st and 99th percentiles, while green bond %, NETZ %, and Norway % are not winsorised.

	Obs	SD	Min	p25	Mean	Median	p75	Max
Log (Scope 1 GHG)	6928	2.978	-2.0402	2.8535	4.9935	4.7707	7.0707	11.23
Log (Scope 2 GHG)	6676	1.9806	-1.0272	3.8215	5.0574	5.1335	6.4358	9.1848
Log (Scope3 GHG)	5975	3.2062	-0.4201	4.2491	6.8389	7.0361	9.4047	13.2177
Log (Total GHG)	5610	2.6909	1.6728	5.665	7.743	7.7352	9.908	13.1658
Log (Scope 1 GHG Int.)	6917	2.7994	-10.9448	-6.7524	-4.5715	-4.853	-2.5704	1.4486
Log (Scope 2 GHG Int.)	6666	1.6985	-10.0844	-5.467	-4.5188	-4.4786	-3.4646	-.591
Log (Scope 3 GHG Int.)	5963	2.9106	-9.2181	-5.2667	-2.8078	-2.3833	-.4674	2.7264
Log (Total GHG Int.)	5600	2.4094	-7.2418	-3.7563	-1.9206	-1.7827	-.0005	2.8072
Norway %	7947	.0092	0.0000	.0069	.0114	.0093	.0138	.1486
NETZ %	8943	0	0.0000	0	0	0	0	.0002
Green Bonds %	9101	.011	0.0000	0	.0016	0	0	.3443
Log (Size)	9101	1.4563	7.5555	9.2293	10.2887	10.0865	11.1084	14.4265
Log (BM)	8692	.9727	-3.9935	-1.5127	-.9464	-.8541	-.2701	1.1032
Leverage	9099	.1786	0.0000	.1565	.2878	.2722	.3964	.8807
ROA	9085	.0688	-0.1637	.011	.0527	.0432	.0841	.2836
PPE	8977	.2522	0.0003	.0518	.2533	.1602	.4018	.9016

Table 3. Descriptive statistics for the key variables of the standardised sample. The dependent and control variables are winsorised at the 1st and 99th percentiles, while the independent variables Green bond %, NETZ %, and Norway % are not winsorised.

	Obs	SD	Min	p25	Mean	Median	p75	Max
Log (Scope 1 GHG)	3829	2.902	-2.0402	2.723	4.8047	4.5123	6.7236	11.23
Log (Scope 2 GHG)	3829	1.9307	-1.0272	3.8347	5.0644	5.124	6.4043	9.1848
Log (Scope3 GHG)	3829	3.0826	-0.4201	4.5895	7.0466	7.299	9.4648	13.2177
Log (Total GHG)	3829	2.6232	1.6728	5.749	7.7803	7.7772	9.8534	13.1658
Log (Scope 1 GHG Int.)	3829	2.6902	-10.9448	-7.0432	-4.9087	-5.1694	-3.1786	1.4486
Log (Scope 2 GHG Int.)	3829	1.6214	-10.0844	-5.561	-4.6533	-4.6319	-3.6161	-.591
Log (Scope 3 GHG Int.)	3829	2.8105	-9.2181	-4.9386	-2.6674	-2.2191	-.4655	2.7264
Log (Total GHG Int.)	3829	2.3392	-7.2418	-3.7065	-1.9339	-1.7715	-.0442	2.8072
Norway %	3829	.0099	0.0000	.0074	.0125	.0097	.016	.146
NETZ %	3829	0	0.0000	0	0	0	0	.0002
Green bond %	3829	.0106	0.0000	0	.0018	0	0	.2396
Log (Size)	3829	1.4997	7.5555	9.5315	10.6369	10.4264	11.5701	14.4265
Log (BM)	3829	.9779	-3.9935	-1.5475	-.9692	-.8541	-.2784	1.1032
ROA	3829	.065	-0.1637	.0114	.0547	.0436	.0836	.2836
Leverage	3829	.1535	0.0000	.1624	.2754	.2681	.3855	.7678
PPE	3829	.2335	0.0003	.0449	.2317	.1424	.3625	.9016

Table 4. Sample distribution by country, industry (GICS / Global Industry Classification Standard), and year.

Country	Obs	%
Austria	17	0.44
Belgium	35	0.91
Canada	238	6.22
Croatia	4	0.10
Czech Republic	4	0.10
Denmark	51	1.33
Finland	61	1.59
France	259	6.76
Germany	257	6.71
Greece	4	0.10
Ireland	50	1.31
Italy	72	1.88
Luxembourg	19	0.50
Netherlands	85	2.22
Norway	53	1.38
Poland	13	0.34
Portugal	18	0.47
Spain	106	2.77
Sweden	92	2.40
Switzerland	168	4.39
United Kingdom	411	10.73
United States	1812	47.32

Industry	Obs	%
Communication Services	257	6.71
Consumer Discretionary	407	10.63
Consumer Staples	352	9.20
Energy	149	3.89
Financials	812	21.21
Health Care	330	8.62
Industrials	588	15.36
Information Technology	309	8.07
Materials	321	8.39
Real Estate	26	0.68
Utilities	277	7.24

Year	Obs	%
2015	264	6.89
2016	331	8.64
2017	355	9.27
2018	388	10.13
2019	426	11.13
2020	502	13.11
2021	536	14.00
2022	560	14.63
2023	467	12.20

Most of the variables seem to be stationary. However, the NETZ % and Green Bond variables seem to be non-stationary. Moreover, the inverse normal metric indicates that also Log (BM) and PPE are non-stationary (Table 5). The panel data are highly unbalanced, as some firms have only one or a few observations, while others have observations for nearly all years of the sample period. Due to the unbalanced panel data, the cross-dependency tests cannot be conducted.

Table 5. Unit root test results (Fisher-type unit-root tests).

	Modified inv. chi-squared	P-Value	Inverse normal (Z)	Z-PValue
Log (Scope 1 GHG)	28.6913	0.0000	-9.6798	0.0000
Log (Scope 2 GHG)	26.6425	0.0000	-8.0034	0.0000
Log (Scope 3 GHG)	37.8471	0.0000	-11.6300	0.0000
Log (Total GHG)	32.4507	0.0000	-9.6254	0.0000
Log (Scope 1 GHG I..)	35.5163	0.0000	-10.9447	0.0000
Log (Scope 2 GHG I..)	19.5336	0.0000	-7.8253	0.0000
Log (Scope 3 GHG I..)	38.2091	0.0000	-11.3275	0.0000
Log (Total GHG Int.)	36.3267	0.0000	-9.9125	0.0000
Norway %	32.0263	0.0000	-11.5575	0.0000
NETZ %	-21.9773	1.0000	.	.
Green bond %	-18.0949	1.0000	4.2701	1.0000
Log (Size)	28.8367	0.0000	-10.9265	0.0000
Log (BM)	12.2616	0.0000	-0.0844	0.4664
ROA	21.849	0.0000	-9.5537	0.0000
Leverage	22.389	0.0000	-7.5387	0.0000
PPE	3.3276	0.0004	0.5827	0.7199

GHG emission variables seem highly correlated with each other (Figure 3). However, this is not a problem in regression analysis, as the GHG emissions figures are used separately in each regression. In addition, the variable PPE (net property, plant, and equipment value divided by the firm's total assets) has elevated correlations with the GHG emission variables, particularly with the logarithm of Scope 1 GHG emission intensity. However, the variance inflation factors (VIFs) indicate that there is no significant multicollinearity among non-GHG variables as the mean VIF is only approximately 1.3 and the highest VIF is only approximately 2.0 (Table 6).

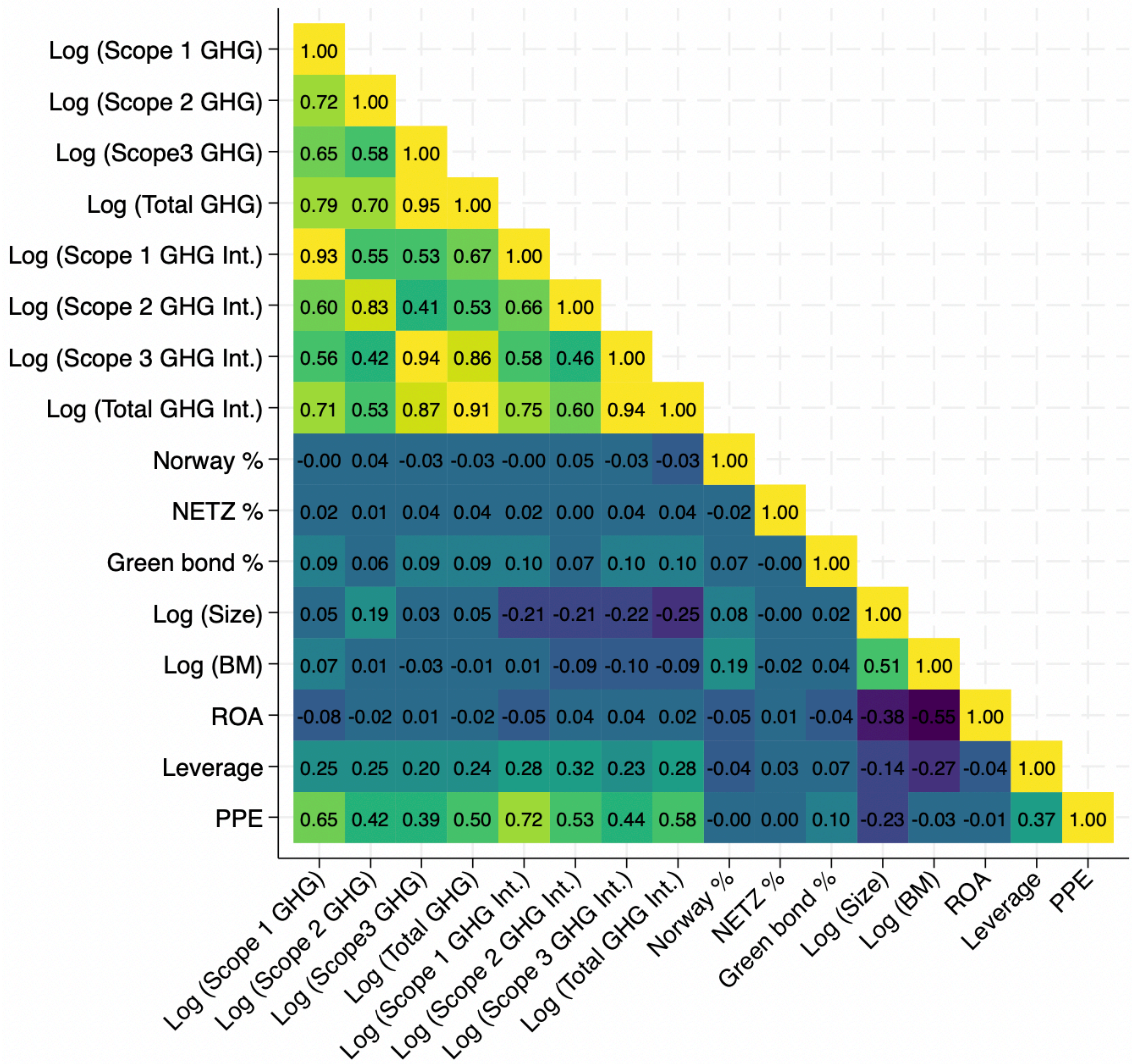

Figure 3. Correlation matrix of the key variables (Pearson correlations).

Table 6. Variance inflation factors of the key independent variables.

	VIF	1/VIF
Norway %	1.047	0.955
Green bond %	1.019	0.981
NETZ %	1.001	0.999
Log (BM)	2.008	0.498
ROA	1.556	0.643
Log (Size)	1.482	0.675
Leverage	1.346	0.743
PPE	1.268	0.789
Mean VIF	1.341	

4.3 Methodology

This thesis conducts the empirical part using regression analyses, more specifically, using fixed effects (FE) regressions. A few prior studies have used similar methodologies for similar research questions. For instance, Azar et al. (2021) examine the relation of active engagement and ownership by three major institutional investors (BlackRock, Vanguard and State Street Global Advisors) on firms' carbon emissions. Similarly, Dyck et al. (2019) studied institutional investors' ownership relation to firms' environmental and social performance. In the same way, Kim and Yoon (2020) analyse the effect of active US mutual funds committing to the United Nations-supported Principles for Responsible Investing (UN PRI) and the relation of these UN PRI signatories' ownership shares on firms' ESG scores.

All of the later studies use forms of regression analyses with fixed effects – usually industry, country, year and firm fixed effects as their research methodology. That suggests that they use least squares dummy variable (LSDV) regressions, not a fixed effect (FE) regression analysis. Also, a relatively high R^2 of the studies' regression results indicates that a fixed effects (FE) regression was not used. The main differences between the three are that Kim and Yoon (2020) and Dyck et al. (2019) use either combined ESG scores or sub-factors as dependent variables, for example, scores representing the environmental or social performance of the firms. Instead, Azar et al. (2021) use corporate GHG emissions like this thesis.

4.3.1 Model specification and setup

The fixed effects model is determined to be the best option compared to the random effects and pooled OLS models. The Breusch and Pagan Lagrangian multiplier tests for random effects indicate that the random effects model is better than the pooled OLS model (Table 7). The Hausman tests compare the fixed effects model and random effects model, and the test results show that the fixed effects model is the better option than the random effects model (Table 7). Due to the heteroscedasticity observed through modified Wald tests (for groupwise heteroskedasticity in the fixed effect regression model), all the regressions' standard errors are robust and clustered at the firm level (Table 7).

Table 7. The results of the Breusch and Pagan Lagrangian multiplier tests, the Hausman tests and the modified Wald tests. Models are named based on their dependent variables and run using the control variables and using the standardised sample.

	Breusch and Pagan		Hausman		Modified Wald	
Model	Chibar2	P-Value	Chi2	P-Value	Chi2	P-Value
Log (Scope 1 GHG)	8934.7548	0.0000	796.1083	0.0000	1.540e+08	0.0000
Log (Scope 2 GHG)	7498.1885	0.0000	268.0728	0.0000	67830909	0.0000
Log (Scope 3 GHG)	5908.1188	0.0000	42.3493	0.0000	4.115e+08	0.0000
Log (Total GHG)	7342.2936	0.0000	97.7294	0.0000	3.878e+10	0.0000
Log (Scope 1 GHG I..)	8433.9792	0.0000	652.5193	0.0000	12257461	0.0000
Log (Scope 2 GHG I..)	6411.6697	0.0000	126.0788	0.0000	62666782	0.0000
Log (Scope 3 GHG I..)	5006.7203	0.0000	34.1632	0.0000	29023649	0.0000
Log (Total GHG Int.)	6340.1295	0.0000	81.0982	0.0000	5.909e+08	0.0000

Independent variables, including control variables, are lagged by one year to avoid simultaneity bias and better estimate sustainable finance's possible impact on corporate GHG emissions. For example, Azar et al. (2021) and Kim and Yoon (2020) also use lagged variables or lead variables. It is assumed that the changes caused by sustainable finance in companies will not happen instantly but require some time to emerge. The general main fixed effects regression model of this thesis is the following:

$$(GHG\ emission\ figure)_{it} = \beta_1 Norway\ \%_{it-1} + \beta_2 NETZ\ \%_{it-1} + \beta_3 Green\ bond\ \%_{it-1} + Controls_{it-1} + \alpha_i + \gamma_t + \varepsilon_{it}\ , \quad (1)$$

where the GHG emission figure represents the set of different GHG emissions variables used in this thesis, including logged GHG emissions and GHG emission intensities. α_i represents the firm-specific effects, γ_t the year-fixed effects, and ε_{it} the error term. Subindex i refers to the firm, and t refers to the year. All the other variables are defined in previous sections of this thesis. Firm-fixed effects are included in fixed effects (FE) regressions by default; however, some regressions also have year-fixed effects. Another regression model used in this thesis aims to compare US firms with non-US firms i.e. US firms with European and Canadian firms. This is achieved by using interaction terms. Canadian firms are grouped with European firms because Canada is regarded as closer to Europe in terms of norms related to sustainability and climate. The general model is the following:

$$(GHG\ emission\ figure)_{it} = \beta_1 Norway\ \%_{it-1} + \beta_2 NETZ\ \%_{it-1} + \beta_3 Green\ bond\ \%_{it-1} + \beta_4 (US_i \times Norway\ \%_{it-1}) + \beta_5 (US_i \times NETZ\ \%_{it-1}) + \beta_6 (US_i \times Green\ bond\ \%_{it-1}) + Controls_{it-1} + \alpha_i + \gamma_t + \varepsilon_{it}\ , \quad (2)$$

where the US dummy variable indicates if the firm is from the United States (it takes a value of 1 if the firm is from the USA). β coefficients from 1 to 3 indicate the sustainable finances relation to European and Canadian firms' GHG emissions, and β coefficients from 4 to 6 indicate the sustainable finances relation to firms' GHG emissions for firms from the USA. All the other variables are as defined previously.

5 Results

This chapter reviews the results of the regression analyses of this thesis, both regarding the unscaled GHG emissions and GHG emission intensities. First, the main regressions are reviewed, then regressions that compare the relationship between sustainable finance and the GHG emissions of US and non-US firms. As a robustness test, the regression analyses are run with NETZ and Green bond dummies instead of ratios. Finally, the regression analyses are run with a sample excluding firms whose industry is classified as financial. Then the results are summarised.

5.1.1 Main regressions

Ownership by the two sustainable investors' proxies, the Government Pension Fund Global, the sovereign wealth fund of Norway (Norway %), and the TCW Transform Systems ETF (NETZ %) and the amount of green bonds outstanding relative to the firm's assets (Green bond %) seem to be generally associated with lower corporate GHG emissions (Table 8). If coefficients are statistically significant, they tend to be negative. However, there is one exception to this as Norway % coefficient for scope 2 GHG emissions is positive, although it is only marginally statistically significant and only so if year-fixed effects are applied.

The ownership by Government Pension Fund Global (Norway %) is comparable to the ownership by BlackRock, Vanguard and State Street Global Advisors, as all of the above owners have extensive coverage of the market and tend to be passive investors. Although Government Pension Fund Global might be categorised as less passive than others as its hands are not as strongly tied to the companies it owns as it does not offer any index funds like the other three institutions, let alone any index funds without any exclusion criteria. However, regarding the sample of this thesis, the Government Pension Fund Global is an owner in almost every sample company during the sample period. One factor contributing to this is likely the selection of the sample companies by their market cap. The results of Azar et al. (2021) related to ownership by the “big three” BlackRock, Vanguard and State Street Global Advisors and the firms’ total carbon emissions align with the results of this thesis as the ownership by Government Pension Fund Global (Norway %) is associated with lower firms’ total GHG emissions like the ownership by BlackRock, Vanguard and State Street Global Advisors.

The coefficient sizes for NETZ % (TCW Transform Systems ETF) seem to be in a different category compared to Norway % and Green bond % coefficients. The large negative coefficients for NETZ % indicate that it is associated with much larger GHG emissions reductions. A likely explanation is that the fund tends to invest in companies emitting a high amount of GHG emissions to begin with, and therefore, companies have more potential to lower their emissions, and when they do reduce them, that likely explains the high coefficient. In other words, the fund owns only a handful of companies compared to Government Pension Fund Global. A larger number of companies have also issued green bonds than the TCW Transform Systems ETF has invested in. However, the statistical significance is not very consistent among different emissions scopes and regressions with time-fixed and non-time-fixed effects, unlike the coefficients for Norway %, which show fairly consistent results. Similar inconsistencies are also observable with the Green bond % variable, as it seems to have a statistically significant relationship only with scope 1 GHG emissions and scope 2 GHG emissions, without year-fixed effects.

Table 8. Fixed effects (FE) regressions regarding Log (GHG emissions). Robust standard errors, clustered at the firm level, are shown in parentheses. Statistical significance is denoted using p-values: *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Log (Scope 1 GHG)	Log (Scope 1 GHG)	Log (Scope 2 GHG)	Log (Scope 2 GHG)	Log (Scope3 GHG)	Log (Scope3 GHG)	Log (Total GHG)	Log (Total GHG)
Norway %	-2.648**	-3.335**	4.086*	3.246	-13.56**	-11.32**	-9.625**	-8.467**
	(1.296)	(1.456)	(2.462)	(2.810)	(5.959)	(5.760)	(4.087)	(3.925)
NETZ %	-328.9	-1,338***	-115.6	-1,895***	-4,365**	-1,871	-2,486*	-1,672
	(303.1)	(287.5)	(660.1)	(585.6)	(1,990)	(2,043)	(1,288)	(1,254)
Green bond %	-2.825*	-5.290***	-0.842	-5.109**	1.012	8.396	-0.337	3.086
	(1.529)	(1.966)	(1.942)	(2.395)	(7.250)	(5.667)	(5.038)	(4.384)
Log (Size)	0.520***	0.229***	0.545***	0.0434	0.678***	1.564***	0.632***	1.052***
	(0.0728)	(0.0686)	(0.0773)	(0.0777)	(0.240)	(0.225)	(0.197)	(0.165)
Log (BM)	-0.0788***	-0.0664**	-0.0967***	-0.0728**	-0.210*	-0.211*	-0.141*	-0.144**
	(0.0304)	(0.0310)	(0.0282)	(0.0311)	(0.114)	(0.110)	(0.0748)	(0.0700)
ROA	-0.0738	-0.255	0.0344	-0.308	-0.549	0.459	-0.380	0.0807
	(0.233)	(0.240)	(0.212)	(0.241)	(0.693)	(0.713)	(0.430)	(0.434)
Leverage	-0.312*	-0.645***	-0.247	-0.710***	-0.0149	0.867	-0.452	-0.0334
	(0.169)	(0.176)	(0.220)	(0.224)	(0.795)	(0.857)	(0.511)	(0.529)
PPE	0.861***	0.409	0.559	0.0688	1.955*	2.527**	2.012***	2.263***
	(0.312)	(0.322)	(0.413)	(0.421)	(1.094)	(1.156)	(0.588)	(0.609)
Constant	-0.707	2.456***	-0.632	4.698***	-1.461	-10.51***	0.326	-3.967**
	(0.742)	(0.701)	(0.808)	(0.827)	(2.542)	(2.383)	(2.081)	(1.740)
Observations	3,829	3,829	3,829	3,829	3,829	3,829	3,829	3,829
R-squared	0.111	0.033	0.150	0.019	0.132	0.073	0.106	0.071
No. of firms	703	703	703	703	703	703	703	703
Year FE	YES	NO	YES	NO	YES	NO	YES	NO

The results are quite similar for GHG emission intensities (Table 9) compared to unscaled GHG emissions. Ownership by the two sustainable investors' proxies, the Government Pension Fund Global, the sovereign wealth fund of Norway (Norway %), and the TCW Transform Systems ETF (NETZ %), and the amount of green bonds outstanding relative to the firm's assets (Green bond %) seem to be associated with lower corporate GHG emission intensities. If coefficients are statistically significant, they are also negative. There are no positive relations which are statistically significant for variables related to sustainable finance. Still, all of the explanatory variables have some scopes of emission intensities (with or without year-fixed effects) that do not have a statistically significant relation to GHG emission intensities, and some of the coefficients have positive values. Remarkably, the NETZ % and Norway % coefficients are negative and statistically significant for total GHG emission intensities, whereas the Green bond % is consistently negative and statistically significant only for scope 1 emission intensity.

Flammer (2021) finds that the total GHG emission intensity decreases after a company has issued a green bond. She uses a ratio of total emissions divided by total assets, which differs from this thesis as the emissions are divided by revenues. She also uses a dummy variable to indicate the issuance of a green bond, which differs from this thesis. However, the regression results suggest that the amount of green bonds outstanding relative to the firm's assets is not related to lower total GHG emission intensity, which does not align with the result of Flammer (2021), although admittedly, the research setting is somewhat different. On the other hand, Fatica and Panzica (2021) investigate the effects of corporate green bonds on firms' GHG emissions and conclude that total and scope 1 emission intensities decrease after corporations issue a green bond. The finding that scope 1 emission intensity decreases following green bond issuance aligns with the results of this thesis.

Table 9. Fixed effects (FE) regressions regarding Log (GHG emission intensities). Robust standard errors, clustered at the firm level, are shown in parentheses. Statistical significance is denoted using p-values: *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Log (Scope 1 GHG Int.)	Log (Scope 1 GHG Int.)	Log (Scope 2 GHG Int.)	Log (Scope 2 GHG Int.)	Log (Scope 3 GHG Int.)	Log (Scope 3 GHG Int.)	Log (Total GHG Int.)	Log (Total GHG Int.)
Norway %	-3.437***	-4.092***	3.174	2.395	-14.64**	-12.32**	-10.68***	-9.472**
	(1.295)	(1.582)	(2.419)	(2.926)	(5.894)	(5.647)	(4.023)	(3.851)
NETZ %	-410.1	-2,627***	-186.0	-3,177***	-4,567**	-3,325*	-2,843**	-3,236***
	(339.5)	(484.0)	(726.4)	(721.6)	(2,025)	(1,966)	(1,315)	(1,171)
Green bond %	-2.699*	-6.326***	-0.611	-5.991***	1.305	7.511	-0.0304	2.234
	(1.563)	(2.070)	(1.798)	(2.208)	(6.886)	(5.516)	(4.780)	(4.297)
Log (Size)	0.0234	-0.374***	0.0374	-0.563***	0.192	0.973***	0.133	0.450***
	(0.0644)	(0.0648)	(0.0643)	(0.0753)	(0.224)	(0.213)	(0.174)	(0.149)
Log (BM)	0.0360	0.0456	0.0193	0.0403	-0.101	-0.105	-0.0270	-0.0317
	(0.0292)	(0.0299)	(0.0302)	(0.0331)	(0.115)	(0.112)	(0.0766)	(0.0722)
ROA	-0.478**	-0.741***	-0.339	-0.754***	-0.952	-0.0195	-0.730*	-0.342
	(0.227)	(0.235)	(0.221)	(0.251)	(0.698)	(0.714)	(0.436)	(0.435)
Leverage	-0.0826	-0.446**	-0.00471	-0.488**	0.197	1.056	-0.187	0.202
	(0.171)	(0.186)	(0.218)	(0.233)	(0.791)	(0.844)	(0.496)	(0.505)
PPE	0.747**	0.395	0.363	-0.0146	1.785	2.469**	1.851***	2.202***
	(0.289)	(0.285)	(0.394)	(0.399)	(1.094)	(1.151)	(0.569)	(0.590)
Constant	-4.954***	-0.756	-4.752***	1.533*	-5.809**	-13.84***	-3.902**	-7.180***
	(0.672)	(0.674)	(0.683)	(0.804)	(2.384)	(2.265)	(1.847)	(1.578)
Observations	3,829	3,829	3,829	3,829	3,829	3,829	3,829	3,829
R-squared	0.188	0.077	0.255	0.086	0.091	0.039	0.052	0.025
No. of firms	703	703	703	703	703	703	703	703
Year FE	YES	NO	YES	NO	YES	NO	YES	NO

5.1.2 Interaction term models

Ownership by the two sustainable investors' proxies, the Government Pension Fund Global, the sovereign wealth fund of Norway (Norway %), and the TCW Transform Systems ETF (NETZ %) and the amount of green bonds outstanding relative to the firm's assets (Green bond %) are associated with considerably lower corporate GHG emissions if firms are from Europe or Canada compared to those from the USA (Tables 10 and 11). Furthermore, results are much more statistically significant for non-US firms.

The above applies both to unscaled GHG emissions and GHG emission intensities. For example, the US x Green bond % coefficients for total GHG emissions and GHG emission intensities are positive, quite large, and statistically significant, indicating that sustainable finance is more related to higher GHG emissions in the US than in Europe and Canada. This suggests that sustainable finance itself is unlikely to be the main driving force behind GHG emission reductions. The differences might be due to carbon pricing, such as the EU emissions trading system (ETS), carbon taxes, differences in legislation and norms related to the environment, or likely some sort of combination of the listed factors.

There are similar results pointing in the same direction. For example, Atta-Darkua et al. (2023) point out that investors based in countries with stronger carbon pricing systems are more likely to sell their dirty assets compared to investors based in countries without carbon pricing or with weaker carbon pricing. Also, Pietsch and Salakhova (2022) observe a significant premium on green bonds in the euro area if they are certified by third parties, issued by firms operating in the green industry, or provided by banks that are part of the United Nations Environment Programme Finance Initiative (UNEP FI). Dyck et al. (2019) also find evidence that institutional investors' ownership is positively related to a firm's environmental and social performance and is driven by institutional investors from countries with higher environmental and social norms. Furthermore, the study classifies many European countries as having high norms, which aligns with the results of this thesis and is a probable contributor to the difference in GHG emissions reductions in US firms compared to European and Canadian firms.

Table 10. Fixed effects (FE) regressions comparing the USA with Europe and Canada regarding Log (GHG emissions). Robust standard errors, clustered at the firm level, are shown in parentheses. Statistical significance is denoted using p-values: *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Log (Scope 1 GHG)	Log (Scope 1 GHG)	Log (Scope 2 GHG)	Log (Scope 2 GHG)	Log (Scope 3 GHG)	Log (Scope 3 GHG)	Log (Total GHG)	Log (Total GHG)
Norway % (non-US)	-2.971**	-3.602**	4.446	3.666	-14.92**	-13.42**	-10.07**	-9.252**
	(1.315)	(1.617)	(2.771)	(3.231)	(6.910)	(6.450)	(4.583)	(4.253)
US x Norway %	-0.306	-1.236	3.465	2.345	-4.089	1.293	-3.939	-1.329
	(3.711)	(3.010)	(5.028)	(5.014)	(8.750)	(11.63)	(6.722)	(8.159)
NETZ % (non-US)	-1,461**	-4,278***	979.8	-3,637***	-8,926***	-2,783**	-4,647***	-2,702**
	(730.0)	(291.7)	(658.5)	(803.6)	(2,466)	(1,224)	(1,774)	(1,304)
US x NETZ %	-282.9	-1,109***	-302.0	-1,786***	-4,161*	-2,077	-2,549*	-1,881
	(305.7)	(234.5)	(705.6)	(668.1)	(2,176)	(2,191)	(1,360)	(1,304)
Green bond % (non-US)	-3.948**	-6.409***	-1.924	-6.125**	-3.232	4.036	-4.760	-1.407
	(1.879)	(2.478)	(2.498)	(3.118)	(8.462)	(6.500)	(4.981)	(4.075)
US x Green bond %	1.156	-1.357	2.773	-1.774	16.11	24.11***	15.07*	18.78**
	(2.010)	(2.475)	(2.395)	(2.255)	(11.56)	(8.890)	(8.682)	(7.400)
Log (Size)	0.516***	0.225***	0.545***	0.0426	0.663***	1.545***	0.621***	1.038***
	(0.0729)	(0.0692)	(0.0777)	(0.0788)	(0.238)	(0.225)	(0.197)	(0.166)
Log (BM)	-0.0761**	-0.0640**	-0.0952***	-0.0713**	-0.199*	-0.201*	-0.132*	-0.134*
	(0.0305)	(0.0312)	(0.0282)	(0.0311)	(0.114)	(0.110)	(0.0748)	(0.0699)
ROA	-0.0654	-0.248	0.0397	-0.306	-0.516	0.501	-0.351	0.113
	(0.233)	(0.240)	(0.212)	(0.241)	(0.692)	(0.712)	(0.429)	(0.432)
Leverage	-0.308*	-0.642***	-0.250	-0.714***	0.00347	0.892	-0.444	-0.0216
	(0.170)	(0.176)	(0.218)	(0.221)	(0.793)	(0.854)	(0.508)	(0.526)
PPE	0.840***	0.388	0.545	0.0555	1.873*	2.442**	1.936***	2.187***
	(0.312)	(0.321)	(0.410)	(0.419)	(1.095)	(1.156)	(0.585)	(0.607)
Constant	-0.666	2.496***	-0.624	4.712***	-1.301	-10.33***	0.447	-3.823**
	(0.743)	(0.707)	(0.814)	(0.838)	(2.528)	(2.379)	(2.076)	(1.742)
Observations	3,829	3,829	3,829	3,829	3,829	3,829	3,829	3,829
R-squared	0.114	0.035	0.152	0.020	0.135	0.075	0.111	0.077
No. of firms	703	703	703	703	703	703	703	703
Year FE	YES	NO	YES	NO	YES	NO	YES	NO

Table 11. Fixed effects (FE) regressions comparing the USA with Europe and Canada regarding Log (GHG emission intensities). Robust standard errors, clustered at the firm level, are shown in parentheses. Statistical significance is denoted using p-values: *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Log (Scope 1 GHG Int.)	Log (Scope 1 GHG Int.)	Log (Scope 2 GHG Int.)	Log (Scope 2 GHG Int.)	Log (Scope 3 GHG Int.)	Log (Scope 3 GHG Int.)	Log (Total GHG Int.)	Log (Total GHG Int.)
Norway % (non-US)	-3.933***	-4.499**	3.478	2.778	-16.14**	-14.56**	-11.23**	-10.34**
	(1.427)	(1.762)	(2.810)	(3.357)	(6.856)	(6.435)	(4.576)	(4.315)
US x Norway %	-0.472	-1.573	2.651	1.455	-4.692	0.667	-4.660	-2.139
	(3.207)	(3.401)	(4.495)	(5.612)	(8.348)	(10.24)	(6.003)	(6.742)
NETZ % (non-US)	-1,611	-7,160***	830.0	-6,522***	-11,120**	-7,801*	-8,093*	-8,870**
	(987.5)	(174.6)	(899.1)	(728.2)	(5,375)	(4,154)	(4,543)	(4,104)
US x NETZ %	-346.8	-2,215***	-352.8	-2,883***	-4,149*	-3,141	-2,579*	-2,947**
	(351.4)	(321.7)	(768.7)	(736.5)	(2,171)	(2,137)	(1,360)	(1,206)
Green bond % (non-US)	-3.687**	-7.234***	-1.526	-6.760**	-2.805	3.370	-4.327	-2.051
	(1.849)	(2.527)	(2.257)	(2.807)	(7.845)	(6.159)	(4.394)	(3.765)
US x Green bond %	0.880	-3.068	2.444	-3.491	15.98	22.52**	14.96*	17.24**
	(2.034)	(3.019)	(2.168)	(2.491)	(11.70)	(9.433)	(8.827)	(7.963)
Log (Size)	0.0190	-0.378***	0.0371	-0.563***	0.176	0.954***	0.122	0.436***
	(0.0651)	(0.0658)	(0.0651)	(0.0768)	(0.222)	(0.213)	(0.173)	(0.149)
Log (BM)	0.0386	0.0478	0.0206	0.0414	-0.0906	-0.0945	-0.0180	-0.0226
	(0.0292)	(0.0301)	(0.0304)	(0.0333)	(0.115)	(0.112)	(0.0764)	(0.0720)
ROA	-0.469**	-0.736***	-0.334	-0.754***	-0.921	0.0191	-0.702	-0.313
	(0.227)	(0.235)	(0.221)	(0.250)	(0.697)	(0.713)	(0.435)	(0.433)
Leverage	-0.0762	-0.442**	-0.00743	-0.492**	0.216	1.081	-0.178	0.214
	(0.173)	(0.187)	(0.216)	(0.231)	(0.788)	(0.841)	(0.493)	(0.502)
PPE	0.726**	0.375	0.351	-0.0253	1.703	2.384**	1.774***	2.126***
	(0.289)	(0.284)	(0.392)	(0.399)	(1.095)	(1.151)	(0.566)	(0.588)
Constant	-4.909***	-0.714	-4.746***	1.543*	-5.643**	-13.65***	-3.774**	-7.035***
	(0.679)	(0.682)	(0.694)	(0.819)	(2.367)	(2.259)	(1.836)	(1.576)
Observations	3,829	3,829	3,829	3,829	3,829	3,829	3,829	3,829
R-squared	0.189	0.079	0.256	0.087	0.093	0.042	0.058	0.030
No. of firms	703	703	703	703	703	703	703	703
Year FE	YES	NO	YES	NO	YES	NO	YES	NO

5.1.3 Green bonds and NETZ as dummies

As noted earlier, the Green bond % and NETZ % are not stationary according to the unit root tests. Furthermore, these variables tend to have a value of zero, as shown in descriptive statistics, which might explain the unit root results. These variables might be better characterised using dummy variables instead of ratios. If a firm has green bond(s) outstanding, the Green bond dummy variable will take a value of one and otherwise zero, and if a company is at least partly owned by the TCW Transform Systems ETF, the NETZ dummy variable will take a value of one and otherwise zero. Also, Fatica and Panzica (2021) and Flammer (2021) use dummy variables in their research regarding green bonds. Norway % variable is dropped as it is stationary according to the unit root test. The regression model is otherwise similar to the main model presented previously. The results of the regressions are presented in the following tables (Tables 12 and 13). The results are, on average, less statistically significant, and there is more variation in the results compared to the main regressions. For example, there are more statistically significant positive coefficients. However, the overall results of these regressions point in the same direction as the main regressions.

Table 12. Fixed effects (FE) regressions using dummy variables regarding Log (GHG emissions). Robust standard errors, clustered at the firm level, are shown in parentheses. Statistical significance is denoted using p-values: *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Log (Scope 1 GHG)	Log (Scope 1 GHG)	Log (Scope 2 GHG)	Log (Scope 2 GHG)	Log (Scope 3 GHG)	Log (Scope 3 GHG)	Log (Total GHG)	Log (Total GHG)
NETZ dummy	0.0691	-0.0309	0.112**	-0.0575	-0.112	0.140	-0.105	-0.0145
	(0.0442)	(0.0369)	(0.0559)	(0.0419)	(0.218)	(0.208)	(0.106)	(0.0935)
Green bond dummy	-0.0705	-0.225***	0.00760	-0.254***	-0.453***	0.0564	-0.336***	-0.0855
	(0.0462)	(0.0457)	(0.0881)	(0.0925)	(0.170)	(0.155)	(0.121)	(0.111)
Log (Size)	0.516***	0.239***	0.555***	0.0688	0.614***	1.558***	0.587***	1.057***
	(0.0724)	(0.0683)	(0.0776)	(0.0752)	(0.234)	(0.225)	(0.193)	(0.166)
Log (BM)	-0.0748**	-0.0580*	-0.0959***	-0.0623**	-0.194*	-0.221**	-0.130*	-0.145**
	(0.0303)	(0.0308)	(0.0288)	(0.0313)	(0.116)	(0.112)	(0.0767)	(0.0714)
ROA	-0.0890	-0.249	0.0440	-0.272	-0.587	0.439	-0.407	0.0827
	(0.234)	(0.239)	(0.210)	(0.237)	(0.693)	(0.717)	(0.432)	(0.435)
Leverage	-0.325*	-0.657***	-0.255	-0.717***	-0.0418	0.915	-0.475	-0.00254
	(0.170)	(0.174)	(0.223)	(0.220)	(0.790)	(0.856)	(0.504)	(0.526)
PPE	0.863***	0.426	0.586	0.122	1.827*	2.434**	1.928***	2.212***
	(0.313)	(0.322)	(0.421)	(0.425)	(1.084)	(1.151)	(0.579)	(0.602)
Constant	-0.693	2.327***	-0.686	4.483***	-0.896	-10.58***	0.713	-4.115**
	(0.741)	(0.701)	(0.817)	(0.796)	(2.495)	(2.389)	(2.043)	(1.751)
Observations	3,829	3,829	3,829	3,829	3,829	3,829	3,829	3,829
R-squared	0.108	0.035	0.148	0.023	0.134	0.069	0.108	0.068
No. of firms	703	703	703	703	703	703	703	703
Year FE	YES	NO	YES	NO	YES	NO	YES	NO

Table 13. Fixed effects (FE) regressions using dummy variables regarding Log (GHG emission intensities). Robust standard errors, clustered at the firm level, are shown in parentheses. Statistical significance is denoted using p-values: *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Log (Scope 1 GHG Int.)	Log (Scope 1 GHG Int.)	Log (Scope 2 GHG Int.)	Log (Scope 2 GHG Int.)	Log (Scope 3 GHG Int.)	Log (Scope 3 GHG Int.)	Log (Total GHG Int.)	Log (Total GHG Int.)
NETZ dummy	0.0925*	-0.125***	0.136**	-0.152***	-0.0701	0.0590	-0.0761	-0.103
	(0.0495)	(0.0421)	(0.0562)	(0.0392)	(0.214)	(0.203)	(0.110)	(0.0970)
Green bond dummy	-0.0399	-0.255***	0.0453	-0.274***	-0.410**	0.0366	-0.301**	-0.111
	(0.0538)	(0.0525)	(0.0834)	(0.0868)	(0.169)	(0.155)	(0.122)	(0.114)
Log (Size)	0.0210	-0.363***	0.0481	-0.538***	0.129	0.965***	0.0894	0.455***
	(0.0643)	(0.0651)	(0.0641)	(0.0730)	(0.219)	(0.213)	(0.170)	(0.150)
Log (BM)	0.0388	0.0554*	0.0188	0.0518	-0.0867	-0.113	-0.0166	-0.0323
	(0.0291)	(0.0298)	(0.0304)	(0.0332)	(0.118)	(0.114)	(0.0786)	(0.0738)
ROA	-0.498**	-0.732***	-0.335	-0.716***	-0.998	-0.0395	-0.763*	-0.339
	(0.228)	(0.235)	(0.219)	(0.247)	(0.698)	(0.718)	(0.438)	(0.437)
Leverage	-0.0916	-0.459**	-0.00779	-0.497**	0.176	1.101	-0.204	0.232
	(0.174)	(0.185)	(0.221)	(0.229)	(0.785)	(0.844)	(0.490)	(0.502)
PPE	0.748**	0.409	0.389	0.0335	1.657	2.370**	1.765***	2.146***
	(0.291)	(0.286)	(0.401)	(0.405)	(1.085)	(1.147)	(0.560)	(0.584)
Constant	-4.963***	-0.895	-4.833***	1.317*	-5.273**	-13.90***	-3.535*	-7.333***
	(0.674)	(0.678)	(0.687)	(0.776)	(2.344)	(2.273)	(1.811)	(1.591)
Observations	3,829	3,829	3,829	3,829	3,829	3,829	3,829	3,829
R-squared	0.184	0.078	0.255	0.090	0.092	0.035	0.053	0.022
No. of firms	703	703	703	703	703	703	703	703
Year FE	YES	NO	YES	NO	YES	NO	YES	NO

5.1.4 Excluding firms in the financial industry

If the firm's industry is classified by the Global Industry Classification Standard (GICS) as "financial", it is excluded from the sample. The non-financial firm's sample is described in the following table (Table 14).

Table 14. Descriptive statistics for the key variables of the standardised sample, which excludes firms classified as "financial" by GICS. The dependent and control variables are winsorised at the 1st and 99th percentiles, while the independent variables Green bond %, NETZ %, and Norway % are not winsorised.

	Obs	SD	Min	p25	Mean	Median	p75	Max
Log (Scope 1 GHG)	3017	2.7022	-2.0402	3.6507	5.5588	5.4523	7.5756	11.23
Log (Scope 2 GHG)	3017	1.7534	-1.0272	4.1806	5.4883	5.5572	6.6846	9.1848
Log (Scope3 GHG)	3017	2.7946	-0.4201	5.8554	7.8202	8.1439	9.8521	13.2177
Log (Total GHG)	3017	2.3003	1.6728	6.7701	8.506	8.6884	10.2158	13.1658
Log (Scope 1 GHG Int.)	3017	2.4547	-10.9448	-5.9069	-4.1383	-4.4807	-2.2386	1.4486
Log (Scope 2 GHG Int.)	3017	1.3868	-10.0844	-5.0699	-4.2108	-4.2728	-3.3624	-.591
Log (Scope 3 GHG Int.)	3017	2.4312	-9.2181	-3.4285	-1.8777	-1.418	-.1267	2.7264
Log (Total GHG Int.)	3017	1.9074	-7.2418	-2.6689	-1.1905	-.9989	.246	2.8072
Norway %	3017	.0098	0.0000	.0074	.0122	.0097	.0155	.146
NETZ %	3017	0	0.0000	0	0	0	0	.0002
Green bond %	3017	.0117	0.0000	0	.0021	0	0	.2396
Log (Size)	3017	1.0947	7.5555	9.3702	10.1706	10.0829	10.8701	13.3227
Log (BM)	3017	.912	-3.9935	-1.7144	-1.1721	-1.0614	-.542	1.1032
ROA	3017	.0655	-0.1637	.0272	.0627	.0553	.0919	.2836
Leverage	3017	.1435	0.0000	.2029	.3064	.3	.4106	.7678
PPE	3017	.2293	0.0014	.1019	.2908	.216	.446	.9016

The regression results (Tables 15 and 16) using the sample excluding firms whose industry is classified as "financial" by GICS are statistically less significant compared to the sample, including financial firms. This applies both to unscaled GHG emissions and GHG emission intensities. This phenomenon is the strongest in the coefficients related to Norway %. It has only two statistically significant coefficients related to unscaled GHG emissions. However, these two coefficients, which are for scope 2 GHG emissions, are positive, similar to the sample, including financial firms. However, this time, the coefficients are larger and more statistically significant, indicating that the ownership by Government Pension Fund Global is associated with larger indirect (scope 2) GHG emissions rather than lower.

Table 15. Fixed effects (FE) regressions regarding Log (GHG emissions) excluding firms whose industry is classified as "financial" by GICS. Robust standard errors, clustered at the firm level, are shown in parentheses. Statistical significance is denoted using p-values: *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Log (Scope 1 GHG)	Log (Scope 1 GHG)	Log (Scope 2 GHG)	Log (Scope 2 GHG)	Log (Scope 3 GHG)	Log (Scope 3 GHG)	Log (Total GHG)	Log (Total GHG)
Norway %	-0.0726	-0.168	5.265**	5.222*	-9.172	-7.679	-7.402	-6.611
	(1.509)	(1.602)	(2.524)	(2.963)	(7.202)	(7.012)	(4.882)	(4.649)
NETZ %	-468.1	-1,402***	-244.7	-1,957***	-4,522**	-2,270	-2,833**	-1,983
	(336.6)	(307.2)	(681.1)	(591.7)	(2,020)	(2,062)	(1,303)	(1,263)
Green bond %	-2.967*	-5.088**	-1.198	-4.825**	-0.0506	7.188	-0.849	2.316
	(1.598)	(1.977)	(1.970)	(2.386)	(7.642)	(5.963)	(5.198)	(4.519)
Log (Size)	0.558***	0.280***	0.569***	0.0983	0.856***	1.855***	0.844***	1.289***
	(0.0868)	(0.0814)	(0.0922)	(0.0867)	(0.222)	(0.231)	(0.158)	(0.160)
Log (BM)	-0.0798**	-0.0595*	-0.110***	-0.0782**	-0.255**	-0.290**	-0.202***	-0.213***
	(0.0336)	(0.0339)	(0.0297)	(0.0316)	(0.121)	(0.117)	(0.0756)	(0.0717)
ROA	-0.137	-0.315	-0.0234	-0.372	-0.823	0.223	-0.678	-0.156
	(0.244)	(0.250)	(0.221)	(0.256)	(0.731)	(0.747)	(0.455)	(0.449)
Leverage	-0.432**	-0.788***	-0.434*	-0.946***	-1.018	0.190	-1.179**	-0.661
	(0.184)	(0.193)	(0.231)	(0.239)	(0.847)	(0.920)	(0.553)	(0.557)
PPE	0.867***	0.474	0.605	0.187	2.016*	2.817**	2.196***	2.502***
	(0.312)	(0.321)	(0.419)	(0.420)	(1.093)	(1.163)	(0.579)	(0.613)
Constant	-0.160	2.780***	-0.233	4.603***	-2.282	-12.19***	-0.916	-5.292***
	(0.838)	(0.788)	(0.915)	(0.873)	(2.267)	(2.353)	(1.600)	(1.621)
Observations	3,017	3,017	3,017	3,017	3,017	3,017	3,017	3,017
R-squared	0.107	0.041	0.142	0.028	0.169	0.097	0.144	0.104
No. of firms	563	563	563	563	563	563	563	563
Year FE	YES	NO	YES	NO	YES	NO	YES	NO

Table 16. Fixed effects (FE) regressions regarding Log (GHG emission intensities) excluding firms whose industry is classified as "financial" by GICS. Robust standard errors, clustered at the firm level, are shown in parentheses. Statistical significance is denoted using p-values: *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Log (Scope 1 GHG Int.)	Log (Scope 1 GHG Int.)	Log (Scope 2 GHG Int.)	Log (Scope 2 GHG Int.)	Log (Scope 3 GHG Int.)	Log (Scope 3 GHG Int.)	Log (Total GHG Int.)	Log (Total GHG Int.)
Norway %	-1.581	-1.267	3.868	4.237	-10.71	-8.771	-9.076*	-7.857*
	(1.530)	(1.725)	(2.547)	(3.072)	(7.215)	(6.999)	(4.939)	(4.706)
NETZ %	-947.8***	-2,669***	-753.4	-3,225***	-5,151**	-3,701*	-3,600***	-3,529***
	(345.4)	(537.3)	(707.1)	(770.6)	(2,029)	(1,967)	(1,277)	(1,148)
Green bond %	-2.937*	-5.807***	-1.028	-5.340**	0.167	6.675	-0.624	1.803
	(1.646)	(2.032)	(1.817)	(2.139)	(7.300)	(5.749)	(4.954)	(4.383)
Log (Size)	0.00405	-0.349***	0.00656	-0.529***	0.308	1.237***	0.293*	0.666***
	(0.0732)	(0.0696)	(0.0730)	(0.0741)	(0.221)	(0.227)	(0.150)	(0.151)
Log (BM)	0.0520*	0.0782**	0.0220	0.0595*	-0.135	-0.163	-0.0759	-0.0814
	(0.0310)	(0.0312)	(0.0314)	(0.0331)	(0.124)	(0.120)	(0.0794)	(0.0753)
ROA	-0.460*	-0.706***	-0.315	-0.720***	-1.168	-0.180	-0.991**	-0.527
	(0.235)	(0.241)	(0.224)	(0.259)	(0.735)	(0.748)	(0.462)	(0.451)
Leverage	-0.117	-0.470**	-0.136	-0.633***	-0.746	0.473	-0.870	-0.346
	(0.179)	(0.190)	(0.223)	(0.232)	(0.837)	(0.910)	(0.536)	(0.538)
PPE	0.676**	0.440	0.346	0.0933	1.774	2.741**	1.965***	2.429***
	(0.291)	(0.285)	(0.402)	(0.401)	(1.098)	(1.161)	(0.570)	(0.599)
Constant	-4.015***	-0.412	-3.996***	1.407*	-6.188***	-15.49***	-4.794***	-8.538***
	(0.731)	(0.691)	(0.741)	(0.759)	(2.273)	(2.327)	(1.536)	(1.549)
Observations	3,017	3,017	3,017	3,017	3,017	3,017	3,017	3,017
R-squared	0.177	0.088	0.240	0.099	0.126	0.055	0.081	0.041
No. of firms	563	563	563	563	563	563	563	563
Year FE	YES	NO	YES	NO	YES	NO	YES	NO

5.1.5 Summary of the results

The results suggest that sustainable finance is generally related to lower GHG emissions. However, the association is not consistently present in every scope of emissions and differs by the sustainable finance variable. The findings are more consistent for direct than indirect or total emissions. This applies especially to corporate green bonds. The results are similar both for unscaled GHG emissions and GHG emission intensities. The association is supportive evidence for a causal relationship between sustainable finance and sustainability impact. However, when comparing the relationship between sustainable finance and GHG emissions of firms from the USA with those from Europe and Canada, the results suggest that the connection between sustainable finance and lower corporate GHG emissions is mainly present in European and Canadian firms. This implies a non-causal relationship between sustainable finance and sustainability impact.

In addition, if the amount of green bonds outstanding and ownership by the TCW Transform Systems ETF are presented as a dummy variable instead of a ratio, the regressions yield similar but weaker results regarding the association than the main regressions. Furthermore, if only non-financial firms are included in the sample, the relation of sustainable finance to lower GHG emissions weakens but is still present in some scopes of emissions. In other words, the results are mixed, and sustainable finance is only generally related to lower GHG emissions. This thesis's hypotheses can be either accepted or rejected depending on how strictly the results are interpreted. However, the results provide support for both hypotheses:

Hypothesis 1: Sustainable investors' ownership is associated with a positive sustainability impact on corporations, as measured by their GHG emissions.

Hypothesis 2: Green debt share is associated with a positive sustainability impact on corporations, as measured by their GHG emissions.

In addition, the previous finance literature aligns with this thesis's general findings. The results of this thesis are similar to findings by Azar et al. (2021), Dyck et al. (2019), Fatica and Panzica (2021) and Flammer (2021), but there are some differences too, which are explained in the prior sections of this thesis. The findings of this thesis also seem to align with the theoretical framework of this thesis, especially with the shareholder theory. The firms seem to lower their emissions, but only to a certain point, most likely maximising their shareholder value. This might also support the explanation of why firms from Europe and Canada lower their emissions more than firms from the USA. The differences might be due to carbon pricing, like the EU emissions trading system (ETS), carbon taxes, differences in legislation and norms related to the environment or likely some combination of the listed factors. The economics of climate also support these explanations. If the price for emitting is higher or increases, the emissions should be lower and decrease.

6 Conclusions

This thesis examines the relationship between sustainable finance (i.e. sustainable investors' ownership and the amount of green bonds outstanding relative to a firm's total assets) and the North American and European firms' different scopes of GHG emissions, both unscaled GHG emissions and GHG emission intensities. Sustainable investors' ownership is represented by the holdings of the Government Pension Fund Global, the sovereign wealth fund of Norway, and the TCW Transform Systems ETF. This thesis's empirical part largely excludes divestment, screening, and exclusion approaches in sustainable finance from its scope. This thesis focuses on the relationship and effect of two prominent sustainable finance approaches, active ownership or engagement and sustainable debt, more specifically, green bonds, on corporate GHG emissions. If a company has sustainable or climate-oriented investors or debt classified as green, will the company become more sustainable over time? Is sustainable finance associated with lower corporate GHG emissions?

The results suggest that sustainable finance is generally related to lower GHG emissions. However, the association is not consistently present in every scope of emissions and differs by the sustainable finance variable. The findings are more consistent for direct than indirect or total emissions. The results are similar both for unscaled GHG emissions and GHG emission intensities. However, when comparing the relationship between sustainable finance and GHG emissions of firms from the USA with those from Europe and Canada, the results suggest that the connection between sustainable finance and lower corporate GHG emissions is mainly present in European and Canadian firms, indicating that sustainable finance itself is not the main driving factor for lower GHG emissions.

Furthermore, the association is weaker in the sample, that includes only non-financial firms. Also, the replacement of ratio variables with dummy variables regarding outstanding green bonds and ownership by the TCW Transform Systems ETF yields similar but weaker results regarding the association. The relation of sustainable finance to lower GHG emissions weakens but is still present in some scopes of emissions, indicating that the finding that sustainable finance is generally associated with lower GHG emissions is somewhat robust. Previous studies related to sustainable finance and sustainability also indicate that sustainable finance and sustainability have been associated with higher profits for companies and returns for investors. However, more recent studies show that the relationship between sustainability and returns has weakened and might not be present anymore.

6.1.1 Practical implications

While sustainable finance likely has a role in making companies and the world more sustainable, the results of this thesis imply that sustainable finance is not the main driving factor for lower GHG emissions, even though, in general, sustainable finance is associated with lower corporate GHG emissions. The findings of this thesis seem to align with the theoretical framework of this thesis: the economics of climate, shareholder theory and the efficient markets hypothesis. The theoretical framework that the results of this thesis support implies that firms should maximise their shareholder value, investors maximise their returns, markets allocate resources efficiently, and governments set rules like carbon pricing systems. The results of this thesis support the argument that sustainable finance itself is not going to solve the sustainability challenges but requires additional policy measures by governments.

6.1.2 Limitations

This thesis also has limitations. The most notable limitation is that this thesis does not prove the causality of sustainable finance as having an impact on improving the sustainability of firms or the world, even in terms of lower GHG emissions. There are also a few limitations regarding the sample of this thesis. The sample includes only large firms from North America and Europe, which report their GHG emissions figures. In addition, there might be a bias in the sample. The companies that report their GHG emissions figures might take the climate change challenge more seriously and, on average, use sustainable financing and reduce their emissions more compared to firms that do not report their GHG emission figures.

Furthermore, variables used in this thesis to represent sustainable finance (i.e. sustainable investors' ownership and the amount of green bonds outstanding relative to a firm's total assets) might not fully represent all of the sustainable finance. In this thesis, sustainable investors' ownership is represented by the holdings of the Government Pension Fund Global, the sovereign wealth fund of Norway, and the TCW Transform Systems ETF. However, there are no data available about every investor's or owner's sustainability preferences. In addition, the independent variables of this thesis were lagged by one year. The results might differ if the independent variables are not lagged, lagged by two years or only by half a year, for example.

6.1.3 Future research

It is somewhat challenging to research the causality between sustainable finance and sustainability impact. Future research might be able to make progress on this front. In addition, similar research to this thesis could be done using a more representative sample, including smaller companies from all around the world. However, data availability might become an obstacle. New reporting obligations for companies might provide more representative data for future research. Different variables used to represent sustainable finance might also be relevant to study in the future.

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