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Assessing the state of Scope 3 Greenhouse gas emissions reporting in Norway

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Contents

Executive Summary

This thesis aims to assess the state of Scope 3 greenhouse gas (GHG) emission reporting in Norway, using data from 2020 to 2022 for the top 100 listed companies as defined by Position Green's 'ESG100' 2022; and which factors explain the variation in reporting among companies. Scope 3 is a company's indirect emissions related to value chain activity. The state of Scope 3 reporting is important for two reasons, the first being that it will become mandatory for many firms to report Scope 3 emissions for the first time under new CSRD (Corporate Sustainability Reporting Directive) legislation from the EU. Secondly, many firms are facing increasing pressure from stakeholders, including investors, to become more transparent about their impact on the planet and their exposure to climate related risks. As Scope 3 emissions often make up the largest share of a firm's total carbon footprint, firms that measure them well by mapping out their entire value chain and reporting on material Scope 3 categories can be considered to take a pro-active approach to their climate risk management, especially regulatory risk.

A logistic model was used to assess if firm and industry level variables could predict whether a firm reports on Scope 3 or not. Results suggest several significant variables that increased the odds of a firm reporting on Scope 3 emissions, including firm value and setting a Scope 3 emissions target. One model, also considering industry level effects, was able to correctly predict which firms reported Scope 3 with an accuracy rate of 85%.

A tobit random effects model was used to assess which firm and industry level variables effect the quality of a firm's Scope 3 performance, measured by a 'Scope 3 score'. This score gives points to firms based on how many Scope 3 categories they report on, and how many categories deemed 'material' to the sector they report on. Results suggest that smaller firms are linked to a higher Scope 3 reporting performance, while newer firms are linked to a lower reporting performance compared with older firms. While the value of the firm significantly increased the odds of a firm reporting, it did not significantly affect the firm's Scope 3 reporting performance.

The number of companies reporting on Scope 3 emissions increased year on year from 2020 to 2022, as did the average quality of the firms' Scope 3 reporting. Despite this, the majority of companies have a lot of work to do in terms of improving their Scope 3 reporting if they are to fulfil the requirements of reporting Scope 3 emissions through the lens of 'double

materiality' that will be required when the CSRD and subsequent ESRS (European Sustainability Reporting Standards) become mandatory.

List of Abbreviations

GHG	Greenhouse Gas
ESG	Environmental, Social, Governance
EU	European Union
ESRS	European Sustainability Reporting Standards
CSRD	Corporate Sustainability Reporting Directive
UN	United Nations
NFRD	Non-Financial Reporting Directive
EFRAG	European Financial Reporting Advisory Group
PCAF	Partnership for Carbon Accounting Financials
TCFD	Task Force on Climate-related Financial Disclosures
SDGs	Sustainable Development Goals
CDP	Carbon Disclosure Project
GRI	Global Reporting Initiative
SASB	Sustainability Accounting Standards Board
ISSB	International Sustainability Standards Board
SBTi	Science Based Targets Initiative

List of Tables

List of Figures

1. Introduction

It is now widely accepted that greenhouse gases (GHG) emitted from human activity since the start of the industrial revolution are the leading cause of our planet's changing climate. If global emissions do not begin to fall soon, we run the risk of crossing critical tipping points which will lead to irreversible changes in our planet's climate systems and rising temperatures that will threaten the survival of humanity.

Businesses are responsible for a large share of GHG emissions and are increasingly facing pressure from stakeholders to measure and manage their carbon footprints. ESG investing, where investors incorporate Environmental, Social and Governance factors into their investment decisions, is becoming an increasingly popular as a way to protect financial portfolios from climate risks. At the same time, a tsunami of environmental regulation for businesses is on the horizon, specifically within the EU. The EU's 'Green Deal' aims to decouple economic growth from resource use, with the goal to make Europe the world's first climate neutral continent by 2050.

In response to investor and regulatory pressures, many large companies have started to disclose their GHG emissions to be transparent about the impact the company has on the environment, and as a way to signal to investors that the company is serious about managing and mitigating climate risk. However, whilst the disclosure of Scope 1 and Scope 2 emissions, direct emissions from the firm's activity and indirect emissions from purchased electricity respectively, is now quite common among listed companies, the same cannot be said for Scope 3 emissions. Scope 3 emissions are a company's indirect emissions related to value chain activity and although they are much more difficult to measure and therefore manage, they usually account for a large part of a firm's total emissions. The materiality of Scope 3 emissions also varies among firms and industries, meaning that absolute emissions figures for Scope 3 should not be used to compare firms with one another in terms of environmental performance.

The European Sustainability Reporting Standards (ESRS), that will become compulsory to report with under the new Corporate Sustainability Reporting Directive (CSRD) from the EU as part of the Green Deal, will make the disclosure of Scope 3 emissions mandatory for the first time for many companies in Norway.

1.1 Objectives

The aim of this thesis is to assess the current state of Scope 3 GHG emissions reporting by the 100 largest listed companies in Norway, as defined by Position Green's ESG 100 for 2021.

Firm level data will be used to see if it is possible to predict whether or not a firm reports on Scope 3 emissions, and time series data from 2020 to 2022 will be used to assess the improvement, if any, in Scope 3 reporting level performance over the time period.

I will aim to identify firm and industry level factors that can be linked to an improved Scope 3 reporting performance, as well as investigate where a firm's financial performance influences their Scope 3 disclosure efforts. I will also examine whether the materiality of Scope 3 emissions to the firm are linked to Scope 3 reporting performance, and whether setting emissions reductions targets improves Scope 3 reporting performance.

At this stage it is important to note that the main aim of this project is to assess Scope 3 *reporting performance* and not to measure *emissions reductions* within Scope 3. This is due to Scope 3 reporting being in its early phase with many firms currently reporting incomplete information that does not provide a full picture of their Scope 3 emissions inventory. Until Scope 3 emissions are effectively measured by firms, we cannot get an idea of how they are being managed and thus we can reasonably expect (reported) Scope 3 emissions to grow over the next few years as they become more accurately measured.

Reporting performance will be measured by a 'Scope 3 score', calculated by me, which takes into account the number of Scope 3 categories the firm reports on and how many of those categories are material to their industry.

1.2 Overview

I will now present the research questions that have been formulated to help achieve the objectives of this thesis. Chapter 2 will provide some background surrounding climate change and the EU legislation involving businesses that attempts to address it. Chapter 3 will focus on the theories and concepts of Scope 3 emissions, sustainability reporting and climate risk management, whilst chapter 4 outlines the methods and data used in this thesis. Chapter 5 presents the results and relevant discussion, finishing with the conclusions in chapter 6.

1.3 Research Questions

1. **Can firm level data predict <u>whether or not a firm reports</u> on Scope 3 emissions for each year?**

   Hypothesis 1: Firm characteristics can be used to predict whether the firm reports on Scope 3 or not.

2. **Is Scope 3 <u>reporting performance linked to the materiality</u> of Scope 3 emissions?**

   Hypothesis 2: The more material scope 3 emissions are to a firm, the more comprehensive their scope 3 reporting is.

3. **Is Scope 3 <u>reporting performance</u> linked to certain firm level characteristics?**

   Hypothesis 3: The age of a firm is positively related with Scope 3 reporting performance.

   Hypothesis 4: Firm size and Scope 3 reporting performance are positively related.

   Hypothesis 5: We can expect performance to vary by sector due to industry, and literature suggests the financial sector as well as the oil and gas sector will have higher scores whilst the transport sector will have the lowest scores.

4. **Does <u>setting targets</u> lead to improved Scope 3 performance?**

   Hypothesis 6: Setting a Net-zero target leads to an improved Scope 3 performance.

   Hypothesis 7: Setting Science Based Targets leads to an improved Scope 3 performance.

   Hypothesis 8: Setting a Scope 3 target leads to an improved Scope 3 performance.

5. **Is Scope 3 emissions reporting performance linked to <u>financial performance</u>?**

   Hypothesis 9: Scope 3 emissions reporting performance increases with the value of the firm.

   Hypothesis 10: Firms with a better Scope 3 score saw a more stable share price between 2020 and 2022.

6. **Have Scope 3 emissions <u>reporting efforts by firms improved</u> from 2020 to 2022?**

   Hypothesis 11: The number of firms reporting on Scope 3 emissions has increased from 2020 to 2022.

   Hypothesis 12: The quality of Scope 3 reporting by firms has improved from 2020 to 2022.

2. Background

2.1 Climate Change and the Emissions Gap

Climate change is the biggest threat facing humanity in the 21st century (Feulner, 2017). In 2015 at the UN Climate Change Conference 194 Parties (193 countries and the EU) signed the Paris Agreement, a binding internationally treated that aimed to 'substantially reduce global greenhouse gas emissions to limit the global temperature increase in this century to 2 degrees Celsius while pursuing efforts to limit the increase even further to 1.5 degrees (UN FCCC, 2015). To reach this target, global greenhouse gas emissions need to be reduced by 45% by 2030 and reach net zero by 2050.

Yet current reports show that nations are not doing enough to reach these crucial targets. According to the United Nations Environment Program (UNEP), current policies in place by governments are projected to result in a 2.8°c rise in global temperatures by the end of the twenty-first century compared to pre-industrial levels (UNEP, 2022).

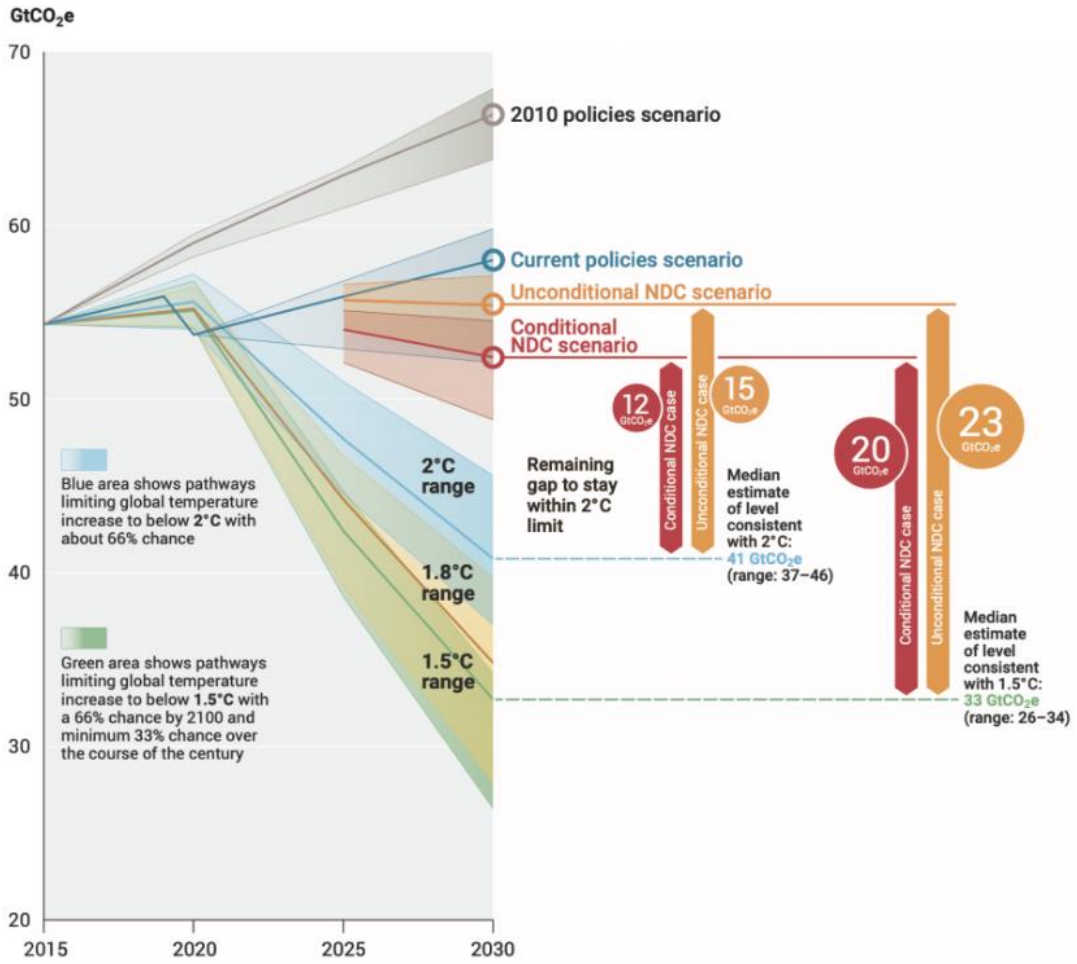

Figure 2.1 Global GHG emissions under different scenarios and the emissions gap in 2030, (UNEP, 2022)

Figure 2.1 shows the emissions gap under current policies, with both conditional and unconditional nationally determined contributions taken into account, for 2030. For a target of 2°c warming we see an emissions gap of between 12-15 GtCO2e, and for a target of 1.5°c warming this increase to between 20-23 GtCO2e.

Perhaps even more worryingly is that GHG emissions for 2021 are preliminary estimated to be around 58 GtCO2e globally. If this estimate proves to be correct, it means that 2021 will be a record breaking year for CO2e levels, surpassing emissions for the current top year of 2019 (UNEP, 2022).

2.2 EU Green Deal

In response to the world's failure to curb GHG emissions the EU has looked to strengthen its legislation and regulations concerning climate action and economic growth .The European Green Deal was approved in 2020, with the aim to raise urgency, narrow the emissions gap and become the world's first net-zero emissions continent by 2050 (Dolge & Blumberga, 2021). To achieve this goal, the EU needs to reduce is GHG emissions by 55%, compared to 1990 levels, by 2030 (European Comission, 2020).

To help facilitate the flow of money towards the sustainable activities that are needed to achieve net-zero by 2025, in 2021 the European Commission adopted the Sustainable Finance package. Consisting primarily of the EU Taxonomy, CSRD and Delegated Acts on sustainability preferences, fiduciary duties and product governance, these proposals will enable investors to 're-orient investments towards more sustainable technologies and businesses (and) will be instrumental in making Europe climate neutral by 2050' (European Comission, 2021b).

Figure 2.2 The ESRS and CSRD as part of the EU green deal and sustainable finance package, (PWC Norge, 2022)

2.2.1 The Corporate Sustainability Reporting Directive

On 10th November 2022, the European Parliament voted with 525 votes, 60 against and 28 abstentions, to adopt the Corporate Sustainability Reporting Directive, making it mandatory for certain businesses across the EU and Norway to disclose a wide range of information regarding their impacts on society and the environment over the coming years (European Parliament, 2022).

The CSRD replaces the Non-Financial Reporting Directive (NFRD) and expands the number of companies who must report on their sustainability impacts from 11,700 today to over 50,000 by 2025 (European Parliament, 2022). As part of this legislation, the European Financial Reporting Advisory Group (EFRAG) has been tasked with developing the European Sustainability Reporting Standards, a standardised set of reporting requirements that companies will be obliged to report on, ensuring that all relevant sustainability data and information is comparable and disclosed. The first draft of the ESRS standards was published in April 2022, and after a period for public consultation the final version was submitted to the European Commission on 23rd November 2022.

One of the biggest changes facing companies from the implementation of the CSRD and subsequent ESRS is that Scope 3 emissions reporting, indirect emissions resulting from corporate value chain activities, will become mandatory. Scope 3 emissions are often difficult to measure and therefore manage, as they cover all indirect emissions excluding emissions from purchased energy – Scope 2.

It is important to note that the CSRD and subsequent ESRS do not directly task firms with reducing their GHG emissions. One of the aims of the Sustainable Finance package is to require investors to 'make allocative decisions based on sustainable considerations, in order to steer economic activity towards sustainable outcomes' (Chiu, 2022, p. 87).

It is hoped that by forcing companies to become more transparent and report on their sustainability risks, opportunities and impacts, the standardised ESRS will allow companies' sustainability efforts to become more comparable in the eyes of investors. This transparency will lead to greater competition, with investors ultimately choosing the most 'future-proof' companies to invest in, thus leading to firms actively working towards reducing their GHG emissions to remain competitive.

A CDP report from 2017 estimated that 32% of historic emissions come from publicly listed investor-owned companies (Griffin & Heede, 2017). Given that the CSRD will cover all

publicly listed companies by the end of its rollout in 2026, there is tremendous potential for the EU to reduce its overall GHG emissions by regulating businesses through mandatory sustainability reporting and climate disclosures.

3. Theoretical and Conceptual Frameworks

3.1 Scope 3 Emissions

In 2001 the GHG accounting scheme, the GHG Protocol, was created by the World Resources Institute and the World Business Council on Sustainable Development, after extensive consultation with government agencies, private firms and non-governmental organizations (Green, 2010), and resulted in the *Greenhouse Gas Protocol Corporate Accounting and Reporting Standard* being published. The purpose of the standard was to 'develop internationally accepted greenhouse gas (GHG) accounting and reporting standards' (GHG Protocol, 2001), filling a regulatory gap in global climate policy-making by providing the corporate sector with the means to systematically account and report their GHGs (Hickmann, 2017).

The standard was the first time GHG emissions were broken down into the now familiar *Scope 1*, *Scope 2* and *Scope 3* emissions categories. It mandated that all companies reporting the GHG emissions using the standard must report their Scope 1 and Scope 2 emissions, with Scope 3 emissions reporting being optional.

Table 3.1 An overview of the different GHG emissions scopes

Emissions Category	Description	Mandatory to Report on
Scope 1	Direct GHG emissions that occur from sources that are owned or controlled by the company	Yes
Scope 2	Indirect GHG emissions from the generation of purchased electricity consumed by the company	Yes
Scope 3	Indirect emissions that are a consequence of the activities of the company, but occur from sources not owned or controlled by the company	No

(GHG Protocol, 2001)

Although Scope 3 emissions reporting was optional, the standard suggests companies could focus on reporting on activities that were relevant to their business and goals, and could

provide the opportunity to be innovative in their GHG management (GHG Protocol, 2001). To help with this, Scope 3 emissions were broken down into six further categories:

- Extraction and production of purchased materials and fuels
- Transport-related activities
- Electricity-related activities (not included in scope 2)
- Leased assets, franchises, and outsourced activities
- Use of sold products and services
- Waste disposal

It is important to note that as firms could pick and choose which Scope 3 categories they reported on, comparisons of emissions quantities in this category would not be a good measure of the companies true GHG inventory.

3.1.1 GHG Protocol Corporate Value Chain Accounting and Reporting Standard

The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard was introduced in 2011 to provide further guidance for companies who wanted to prepare and publicly report emissions from their value chain activities in their GHG emissions inventory (GHG Protocol, 2011).

'The primary goal of this standard is to provide a standardized step-by-step approach to help companies understand their full value chain emissions impact in order to focus company efforts on the greatest GHG reduction opportunities, leading to more sustainable decisions about companies' activities and the products they buy, sell, and produce.' (p. 4, GHG Protocol, 2011)

Scope 3 Categories

The updated standard for Scope 3 emissions increased the number of sub-categories from six to 15 and divides them into upstream and downstream emissions. Upstream emissions are defined as emissions that occur up to the point of receipt by the reporting company related to purchased or acquired goods and services, and downstream emissions occur up to the point of receipt by the reporting company to another entity such as consumers or businesses further along in the supply chain and relate to sold goods and services (GHG Protocol, 2011).

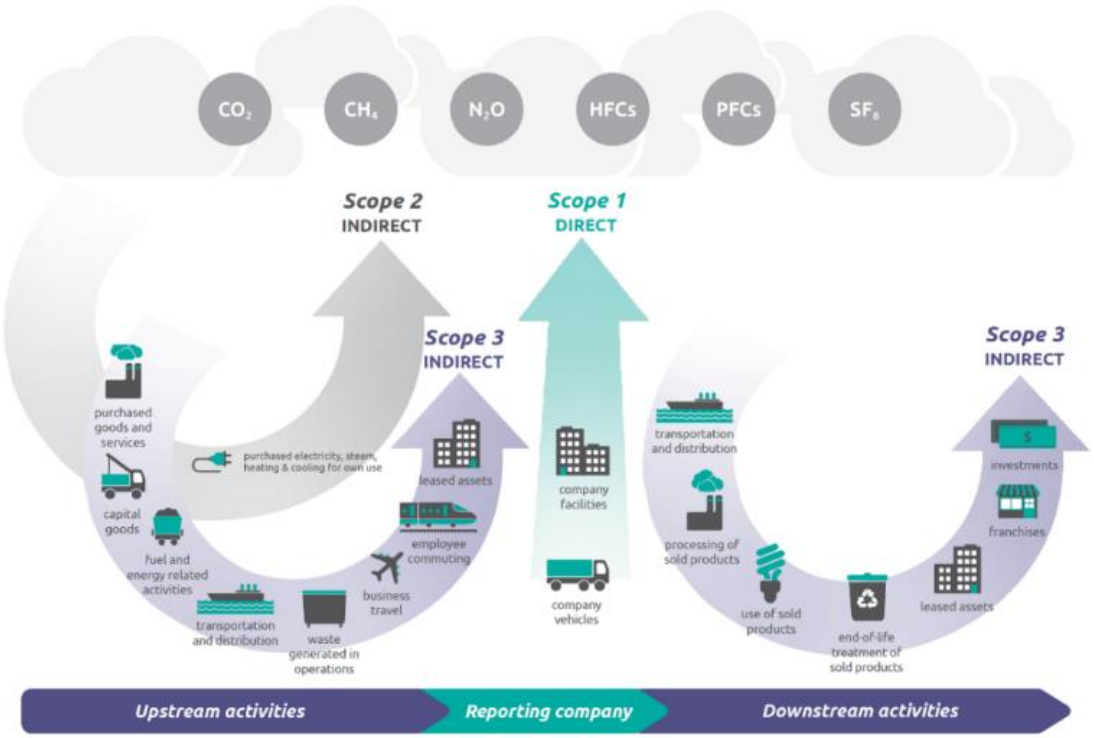

Figure 3.1 Scope 3 upstream and downstream categories, (GHG Protocol, 2011)

Table 3.2 An overview of the 15 Scope 3 categories divided by upstream and downstream emissions

Emissions Activity	Category
Upstream	1. Purchased goods and services
	2. Capital goods
	3. Fuel- and energy-related activities (not included in scope 1 or scope 2)
	4. Upstream transportation and distribution
	5. Waste generated in operations
	6. Business travel
	7. Employee commuting
	8. Upstream leased assets
Downstream	9. Downstream transportation and distribution
	10. Processing of sold products
	11. Use of sold products
	12. End-of-life treatment of sold products
	13. Downstream leased assets
	14. Franchises
	15. Investments

(GHG Protocol, 2011)

Category Relevance

The standard also sets out how companies should identify which of the 15 Scope 3 categories are relevant for their business. Firms should start by mapping out their value chain to help them assess which categories are material and which categories can be excluded from the Scope 3 disclosures on the basis that they are not relevant.

Table 3.3 Criteria for identifying relevant Scope 3 activities

Criteria	Description
Size	They contribute significantly to the company's total anticipated scope 3 emissions.
Influence	There are potential emissions reductions that could be undertaken or influenced by the company.
Risk	They contribute to the company's risk exposure (e.g., climate change related risks such as financial, regulatory, supply chain, product and customer, litigation, and reputational risks).
Stakeholders	They are deemed critical by key stakeholders (e.g., customers, suppliers, investors, or civil society).
Outsourcing	They are outsourced activities previously performed in-house or activities outsourced by the reporting company that are typically performed in-house by other companies in the reporting company's sector.
Sector guidance	They have been identified as significant by sector-specific guidance.
Other	They meet any additional criteria for determining relevance developed by the company or industry sector.

(GHG Protocol, 2011)

When selecting which Scope 3 categories to report on, companies should ensure that the Scope 3 inventory appropriately and accurately reflects their carbon footprint, and that it serves the decision making needs of internal and external stakeholders.

It is important that company justifies the exclusion of any category from the Scope 3 inventory, and that no activity that is expected to significantly contribute towards the firm's total Scope 3 emissions is excluded (p. 60, GHG Protocol, 2011).

Consolidation Approaches

One important thing to note when a company is disclosing Scope 3 emissions is the organizational boundary with which it chooses to report with. Companies should use a consistent consolidation approach across the Scope 1, Scope 2, and Scope 3 inventories to avoid any overlap or double counting of emissions.

A company has three options for defining its organizational boundaries as first defined in the *Greenhouse Gas Protocol Corporate Accounting and Reporting Standard*.

Table 3.4 Consolidation approaches to emissions disclosures

Consolidation Approach	Description
Equity share	Under the equity share approach, a company accounts for GHG emissions from operations according to its share of equity in the operation. The equity share reflects economic interest, which is the extent of rights a company has to the risks and rewards flowing from an operation.
Financial control	Under the financial control approach, a company accounts for 100 percent of the GHG emissions over which it has financial control. It does not account for GHG emissions from operations in which it owns an interest but does not have financial control.
Operational control	Under the operational control approach, a company accounts for 100 percent of the GHG emissions over which it has operational control. It does not account for GHG emissions from operations in which it owns an interest but does not have operational control.

(GHG Protocol, 2011)

The consolidation approach selected by the firm affects which activities in the company's value chain are categorized as direct emissions and indirect emissions (p. 28, GHG Protocol, 2011), as explained by the following example from the GHG Protocol:

'If a company selects the equity share approach, emissions from any asset the company partially or wholly owns are included in its direct emissions (Scope 1), but emissions from any asset the company controls but does not partially or wholly own (e.g., a leased asset) are excluded from its direct emissions and should be included in its Scope 3 inventory. Similarly, if a company selects the operational control approach, emissions from any asset the company controls are included in its direct emissions (i.e., Scope 1), but emissions from any asset the

company wholly or partially owns but does not control (e.g., investments) are excluded from its direct emissions and should be included in its Scope 3 inventory' (p. 29, GHG Protocol, 2011).

The GHG Protocol Corporate Value Chain Accounting and Reporting Standard was designed to be used across industries, independent of which Scope 3 categories are relevant to the various industries. However, in the case of financial institutions, a further industry specific standard has been developed to assist firms in accounting for Scope 3 emissions from category 15 – Investments.

3.1.2 PCAF

The Partnership for Carbon Accounting Financials (PCAF) is an industry-led initiative that was created in 2015 in response to strong demand for a standardised GHG accounting and reporting approach from the financial industry (PCAF, 2022). The Global GHG Accounting and Reporting Standard for the Financial Industry was established to allow financial institutions to consistently measure and disclose their Scope 3 emissions, otherwise known as financed emissions or Scope 3 emissions from category 15 – Investments.

The Financed Emissions Standard provides detailed methodological guidance for assisting in the measurement and disclosure of GHG emissions associated with seven different asset classes (PCAF, 2022):

Figure 3.2 The seven asset classes the standard assists in measuring, (PCAF, 2022)

3.1.3 Challenges in Measuring and Managing Scope 3 Emissions

Many companies are at the beginning stages of mapping out the emissions from their supply chain, and it is therefore less common to see Scope 3 reduction targets from companies compared with Scope 1 or Scope 2 targets (Ecovadis, 2022). Measuring and managing Scope 3 emissions requires great effort and coordination among all actors in the value chain (Patchell, 2018). Six interdependent factors that inhibit the successful measurement and management of Scope 3 emissions have been identified; transaction costs, power, responsibility allocation, uncertainty, location contingency and economic performance (Patchell, 2018).

To measure their Scope 3 emissions firms must essentially perform a value chain audit, measuring emissions from all upstream and downstream channels. To do this effectively, firms must collect information from actors, such as suppliers and consumers, that are outside of their operational control. Collecting complex, high-quality information across the value chain requires coordination from all parties involved is a demanding and complex task which requires substantial resources, meaning that obtaining the information comes with high transaction costs (Patchell, 2018). Even if the firm is willing to absorb the costs of obtaining the information, they may not have sufficient leverage over the other actors in the value chain to mandate that they do the same. Strong buyer power is needed for firms to elicit emissions reporting from firms throughout their value chain, and it has been found that such power is limited to firms in oligopolistic sectors with strong brands that are exposed to public opinion (Mayer & Gereffi, 2010). However, this presents an opportunity for industry actors to work together to improve the disclosure rates of their suppliers to achieve their shared supply chain emission reduction goals. Data has shown that if two companies request a supplier to disclose to CDP, there is a 68% probability that the supplier will respond, and if that increases to three companies there is a 76% likelihood they will respond (Farsan et al., 2018).

The challenge of responsibility allocation refers to the fact that indirect emissions are often double or even triple counted due to significant overlap in firms' value chain. For example, both a supplier and a buyer will count the emissions of their logistics company in their Scope 3 accounting, and that logistics company will also report those same emissions in their Scope 1 disclosure. This double counting is justified on the premise that it encourages each firm to take some responsibility for reducing emissions (Patchell, 2018). However, the confusion over who is responsible for the shared value chain emissions can also be used as an excuse for inaction over the reduction of emissions (Farsan et al., 2018).

For a long time, businesses could use the uncertainty of climate change assessments as an excuse not to undertake mitigation practices (Esty & Winston, 2006), and although climate change and its consequences for humanity are now widely accepted, firms must now deal with the uncertainty and complexity of how to best mitigate their emissions (Patchell, 2018). Companies must decide how to best modify their value chains in order to manage and mitigate Scope 3 emissions, and their decisions on how to respond to increasing regulatory requirements may not align with those of other firms in the value chain, potentially leading to tension and uncertainty between them. This can be especially true when taking into account the geographical location of firms in the supply chain. Collecting information on GHG emissions requires broad and diverse efforts at the local level, a task which the vast majority of locations are unable to undertake (Patchell, 2018).

The final challenge of measuring and managing Scope 3 emissions is related to its effect on economic performance. Transforming the value chain to become more sustainable can involve costly changes in capital equipment, human resources and organizational structure and procedures. Whilst the necessity of building sustainable supply chain has been widely documented, the literature struggles to put forward a financial case for doing so (Patchell, 2018). One study did find there to be financial returns for firms when changes are made in response to customer environmental demands, but did not find beneficial returns to environmental collaboration with suppliers (Laari et al., 2016). The issue of financial performance and emissions disclosure will be further explored later in this paper.

3.2 Sustainability Reporting

In 1987, Brundtland famously defined sustainable development as ‘development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs’ (Brundtland, 1987). But how do we take this concept of sustainable development and give it a more precise meaning in terms of business context? The International Institute for Sustainable Development defined sustainability in business as ‘adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future’ (IISD, 1992).

But why should businesses care about sustainability at all? It was Milton Friedman and his shareholder theory framework that said the only social responsibility a business had was to increase profits for its shareholders (Friedman, 1970). Fortunately, there has been a shift in

the attitude of businesses in terms of their corporate social responsibility in recent years, and many firms now voluntarily use environmental accounting alongside traditional financial reporting to examine their impacts on society. Regulations aside, two explanations can be attributed for this shift in attitude; increasing pressure from stakeholders concerned about the impact of corporate activities on the environment, and the increase in the cost of environmental impacts, alongside a decrease in the cost of information management, means that environmental information has become economically relevant to accountability and decision making in business (Schaltegger & Burritt, 2017).

In order to gauge how well a company is doing with respect to sustainability, there is a common understanding that progress should be measurable (Özdemir et al., 2011). Until now, sustainability reporting by companies has mostly been on a voluntary basis, and has been increasingly adopted by companies worldwide due to stakeholder demand for greater transparency on the environmental as well as social impacts of the company (Siew, 2015). I will now explore the key drivers behind sustainability reporting and review the literature around which type of companies are performing the best in this area.

3.2.1 Drivers of Sustainability Reporting

This paper will assess if there is a link between the level or Scope 3 emissions reporting and certain firm characteristics such as the size of the firm and the industry the firm belongs to. As studies looking specifically at Scope 3 are few and far between, I will look at the relationship between firm characteristics and overall sustainability disclosure to gain insight into the direction of the relationship.

Firm Size

Theory suggests a positive link between firm size and sustainability disclosure. Stakeholder theory (Freeman, 1984) states that a business has a responsibility to all of its stakeholders, and not just its shareholders, and it is argued that firms use sustainability reporting as a broad form of justification to their stakeholders (Drempetic et al., 2020). Larger firms have a wider range of external stakeholders, thus can be considered to face more pressure from society at large over their sustainability impacts and are therefore more likely to disclose sustainability data.

A study by Drempetic et al looked at over 3000 firms around the world to test for a link between their size and their corporate sustainability performance. They found that company size, as measured by the number of employees, positively influences a firm's ESG score

(Drempetic et al., 2020). Another study by Ecovadis, a business sustainability ratings provider, in 2021 looked at the sustainability scores of 27 EU companies based on the number of employees each firm has. The results showed that larger firms consistently scored higher than medium and small sized firms on environmental and overall sustainability scores (Ecovadis, 2021).

Similar results have also been found when firm size is measured by variables other than the number of employees. A study of the largest US firms between 2002 and 2006 found that firm size, when measured as the market cap of the firm, was an important determinant of corporate sustainability performance, with the largest firms in each industry leading in terms of sustainability disclosures (Artiach et al., 2010). Also using market cap as a proxy for the size of a firm, a study of 339 listed Australian firms in 2006 found a positive and significant relationship between firm size and sustainability disclosures (Herbohn et al., 2014).

However, a study that looked at the corporate sustainability disclosures of 100 largest companies in Norway for the financial year 2004 did not find a concentration of high scores among the larger companies (Vormedal & Ruud, 2009). No clear link between firm size, when measured in terms of annual turnover, and high sustainability reporting scores was found, with a relatively even distribution of the scores across all firms and some of the smaller firms achieving scores as high as the largest firms (Vormedal & Ruud, 2009).

Industry

Sustainability disclosure performance has also been found to be related to the industry to which the firm belongs to. A study from Kolk et al using sustainability disclosure data from 1998 for 250 international companies identified a link between the degree of environmental reporting and sectors with a direct environmental impact (Kolk et al., 2001). They also found that non-industrial sectors such as finance, telecommunications, retail and services disclosed on sustainability issues less than the sample average (Kolk et al., 2001). The previously mentioned Norwegian study by Vormedal and Ruud found that petroleum and energy sectors firms obtained ‘notably higher’ average disclosure scores than other sectors (Vormedal & Ruud, 2009), but outside of this did not find any other link between sector and disclosure performance.

The more recent Ecovadis study found the sectors with the highest sustainability scores for the 27 EU countries were finance and consulting (56.1), heavy manufacturing (55.4) and construction (54.4). The lowest performing sectors were advanced manufacturing (40.9,

transport (50.7) and wholesales services (51.0) (Ecovadis, 2021). The difference in performance for the financial industry between the studies from the early 2000s and 2020 could possibly be explained by the increase in sector specific legislation over time and evolving stakeholder expectations.

Age of Firm

When examining whether the age of a firm affects their sustainability disclosures, the literature is somewhat mixed. Cantele et al suggest that firm age can be considered 'a proxy for organizational experience, and this can be beneficial to firm survival and firm (sustainability) performance' (p. 5, Cantele et al., 2022). Older firms can be considered to have more experience and resources to put into sustainability disclosure practices, yet they may also be bound by the existing rules, routines and practices that prevents them from taking advantage of sustainability opportunities stemming from the changing business environment (Cantele et al., 2022).

For newer firms, it can be argued that their inexperience means they may not have established routines in place to guarantee efficient and effective sustainability management, leading to a lower performance. Yet newer firms may also have been founded with a mission of improving sustainability impacts at their core. Firms who are B-Corp certified, those who demonstrate high levels of social and environmental performance, exhibit transparency and make legal commitments to be accountable to all shareholder (B-Corps), have been found to be younger than average firms (Parker et al., 2019).

Older firms are also more likely to be larger firms, so we can perhaps expect some correlations between the 'firm size' relationship to sustainability disclosure and the age of the firm.

3.2.2 Materiality

Materiality is a key concept in non-financial reporting and can broadly be defined in three ways: financial materiality, impact materiality and double materiality.

The concept of materiality has its origins within financial reporting. The International Financial Reporting Standards Foundation definition of materiality has been widely endorsed, and states that 'information is material if omitting, misstating or obscuring it could reasonably be expected to influence the decisions that the primary users of general purpose financial statements make on the basis of those financial statements' (IFRS, 2018). Financial

materiality has been applied to the concept of sustainability reporting in terms of financial related climate risks, with the Task Force on Climate-related Financial Disclosures (TCFD) providing a framework with which firms can improve their reporting of climate related risks and opportunities that are considered financially material to other financial and non-financial stakeholders through ESG disclosures. This is known as the 'outside-in' perspective of materiality – how the impacts of sustainable issues in the outside world affect the performance of the company.

Impact materiality is almost the opposite of financial materiality and focuses on how a firm impacts the outside world and environment through the internal and value chain decisions it makes, also known as the 'inside-out' perspective of materiality. It can be argued that businesses have a responsibility to advance global sustainability issues as they have benefitted financially from their contribution of negative externalities in to society and the natural environment (Montiel et al., 2021), and can work towards this by using the impact materiality perspective in their sustainability reporting.

Given that the aim of the EU's Green Deal is to help facilitate the flow of money towards sustainable activities, it is obvious that taking only one of these materiality perspectives would lead to failure. In response to this, the concept of 'double-materiality' was first formally proposed by the European Commission in 2019 (European Comission, 2019).

3.2.2.1 Double Materiality

The concept of double materiality combines traditional financial materiality with sustainability impact materiality. Firms must not only consider their vulnerability to physical climate and transition risks, but also their contribution towards these risks.

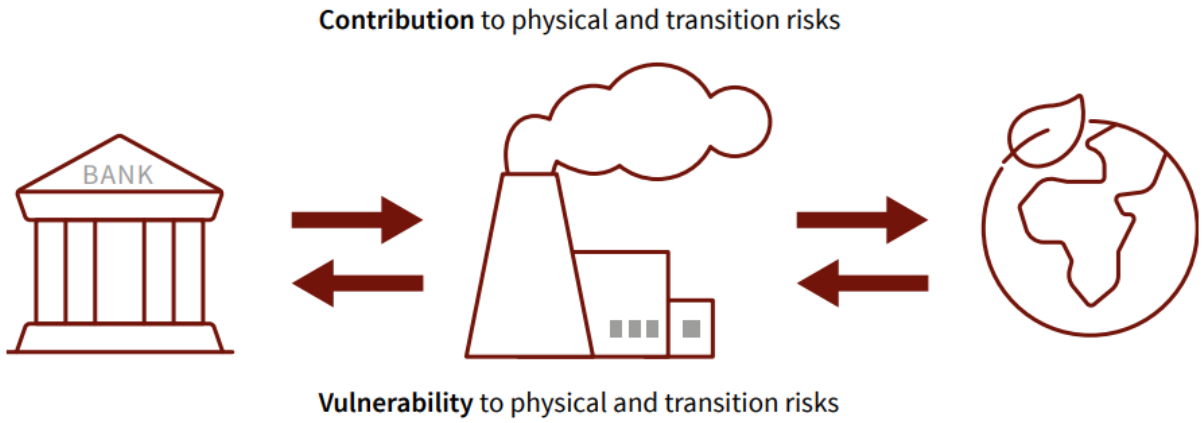

Figure 3.3 The concept of double materiality, (Oman & Svartzman, 2021)

Three different approaches to the use of double materiality have been identified: an idiosyncratic perspective, a systemic risk perspective, and a transformative perspective (Boissinot et al., 2022). The idiosyncratic approach to double materiality is closely linked to dynamic materiality – that firms must be forward looking as what is considered immaterial today may become material in the future. It is also closely aligned with the concept of traditional financial materiality in that it rationalizes that firms should report on their environmental impacts because they could later translate into financial risks (Boissinot et al., 2022). This is a similar approach we see today with firms who use the TCFD framework to report on climate on climate related risks and opportunities. Yet the main criticism of this approach is that a firm's contribution to an environmental problem does not always equal their vulnerability to the same issue, especially when taking into account the different time horizons being considered. A 2015 speech by the Governor of the Bank of England Mark Carney suggested that the horizon of materiality for a financial institution does not always naturally align with the time horizon needed to fully appreciate the impact of environmental issues (Carney, 2015). Thus, a double materiality approach that focuses solely on the financially material climate issues is not sufficient if we are to avoid the most serious climate impacts in the future.

A second approach to double materiality is the systematic risk perspective, where it is not assumed that an institutions' contribution to environmental degradation is always mirrored by its own vulnerability to future risks (Boissinot et al., 2022). By funding climate change activities today, firms and financial institutions contribute towards the build-up of future physical climate risks which could become systemic and, in some cases, irreversible. This is closely linked to the endogeneity of climate risks for firms – that expectations concerning future climate risks affects the actions they take today, thus potentially influencing the realization of such risk (Gourdel et al., 2022). This approach to double materiality requires firms to take a more extensive approach when assessing material climate impacts and the financial risk they pose to the firm than the idiosyncratic approach requires.

The final approach to double materiality is the transformative perspective which can be defined as an approach 'seeking to reshape financial and corporate practices and values in order to make them more inclusive of different stakeholders' interests and compatible with the actions needed for an ecological transition' (p.1, Boissinot et al., 2022). Under this approach, reporting on environmental impacts has merit in itself as a way to support ecological transformation rather than because they inform us about future financial climate

risks. This ‘strong’ version of double materiality allows firms to increase stakeholder engagement through ESG integration, whilst also facilitating discussions on sustainable development and contributing towards the Sustainable Development Goals (Delgado-Ceballos et al., 2023; Förster, 2022).

It is this transformative approach to double materiality that firms will need to report with under the CSRD through the requirements in the ESRS. Guidelines from EFRAG states that:

‘A sustainability topic or information meets… the criteria of double materiality if it is material from the impact perspective or from the financial perspective or from both of these two perspectives’
(EFRAG, 2022b).

Switching from a financially focused concept of double materiality to a transformative approach is not without its challenges, and few firms currently complete their materiality assessment through this lens. A study was conducted by De Cristofaro & Gulluscio with the aim to map exisiting double materiality approaches in non-financial reporting using firm level data from 2019-2021. They found that only a limitied number of European companies operating in the service industries showed a proactive attitude towards double materiality, largely for 2021 reports (De Cristofaro & Gulluscio, 2023). If firms are to embrace a true double materiality perspective that will be required under the CSRD, they require new mindsets, resources and processes for measurement and evaluation (Chiu, 2022), which will undoubtedly result in increases challenges and costs to the firm (Baumüller & Sopp, 2021).

3.2.2.2 Materiality of Scope 3 Emissions

Scope 3 emissions can be deemed material to companies in several different ways. On a sector level, the materiality of Scope 3 emissions can be defined by looking at how large a share of total emissions they account for – the larger the share, the more material Scope 3 emissions can be deemed to be. Figure 3.4 from the Carbon Disclosure Project (CDP) uses firm level data to estimate the share of total Scope 1, 2 and 3 emissions across different sectors of the economy.

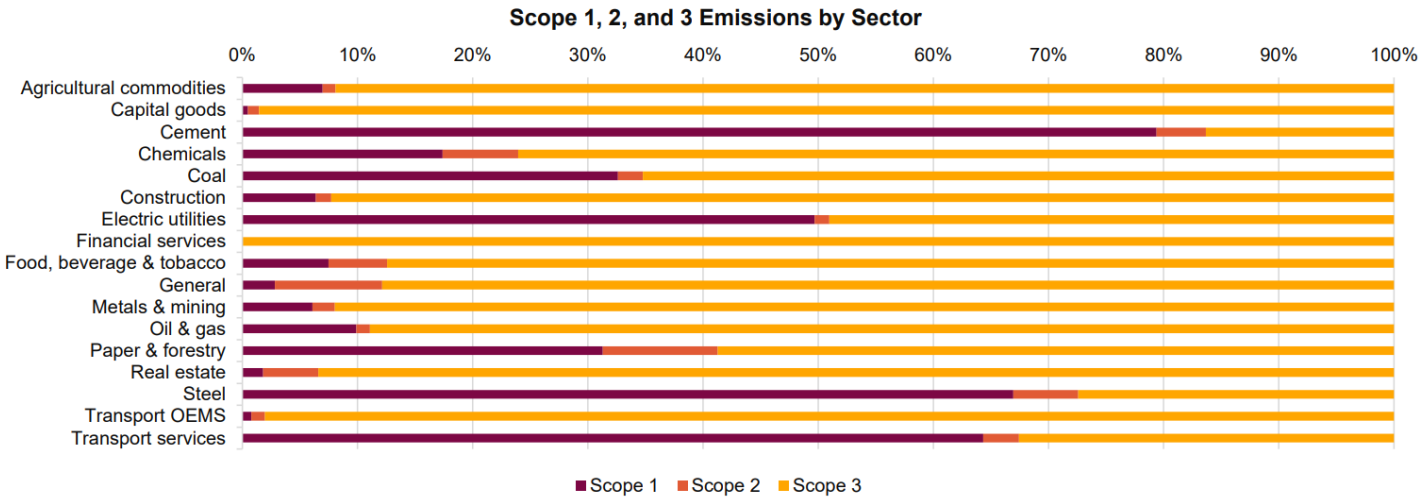

Figure 3.4 Scope 1, 3 and 3 emissions by sector, (CDP, 2022b)

Across all sectors, Scope 3 emissions account for around 75% of total Scope 1+2+3 emissions (CDP, 2022b). Yet we can see that the materiality of Scope 3 emissions varies drastically between industries, accounting for over 99% of emissions in the financial sectors but only 16% of total emissions in the cement sector. The Scope 3 categories that are deemed relevant and thus material to the firm also differs by sector. For example, category 11 'use of sold products' can account for the vast majority of Scope 3 emissions for an oil and gas firms, but it is not a category that would be considered relevant to a service type firm that does not produce any goods.

It is important to distinguish the difference between the materiality of Scope 3 emissions in general, and the materiality of each Scope 3 category on a sector specific level. Even though the cement industry can claim that Scope 3 emissions are not particularly material to their industry, they still have relevant and material Scope 3 categories that they can measure and manage. The ESRS will require all firms to identify and measure all Scope 3 categories deemed relevant and material to the firm, and full explanations must be given for why a certain category has not been deemed relevant and thus not calculated.

Scope 3 emissions grew by 84% globally between 1995 and 2015 (Hertwich & Wood, 2018), which is perhaps unsurprising as Scope 3 emissions are simply a cumulation of other firms Scope 1 and 2 emissions across the value chain. It is important to considered the entire value chain if we want to sufficiently capture the carbon footprint of a firm (Anquetin et al., 2022). The sheer size of Scope 3 emissions means that they can be seen as material through the lens of 'double materiality' – from an impact material and a financial material perspective.

If a retail firm puts pressure on one of its logistics partners to reduce their emissions from transportation, the resulting decrease in emissions for the logistics firm, their Scope 1 emissions, would result in a reduction in Scope 3 emissions not only for the retail firm but for all other firms using the same logistics company. Therefore, the more firms can put pressure on their value chain partners to measure and manage their emissions, the greater the opportunity for impacting Scope 3 emissions across different firms and sectors.

We can also use the interconnectivity of the different emissions scopes to argue that Scope 3 emissions can also be considered financially material to firms. In the EU, carbon taxes are applied to the Scope 1 emissions of firms in certain industries. Even if you are a firm not covered by the carbon tax, it is likely that a firm in your value chain is, meaning the larger your Scope 3 emissions, the more exposed you are to increases in the carbon tax through your value chain activity. Better knowledge of Scope 3 footprints can allow firms to pursue mitigation projects across the supply chain, which could lead to a reduction in costs through the more efficient use of resources (Huang et al., 2009). Scope 3 emissions can also be considered financially material from the investor perspective as they allow for a full understanding of a firm's carbon footprint, which is needed to accurately understand what kind of climate transition risk they face (DNV, 2022b).

Despite the clear importance of Scope 3 emissions for firms across a wide range of sectors, voluntary disclosure remains relatively low. Only 41% of companies responding to the CDP Climate Change Questionnaire in 2022 reported emissions for at least one Scope 3 category (CDP, 2023). When firms do report on Scope 3, the categories they choose to report on are not necessarily the categories deemed material to them, but the ones that are 'easiest' to report on. Figure 3.5 from CDP shows the percentage of companies reporting each Scope 3 category compared with size of the emissions from that category.

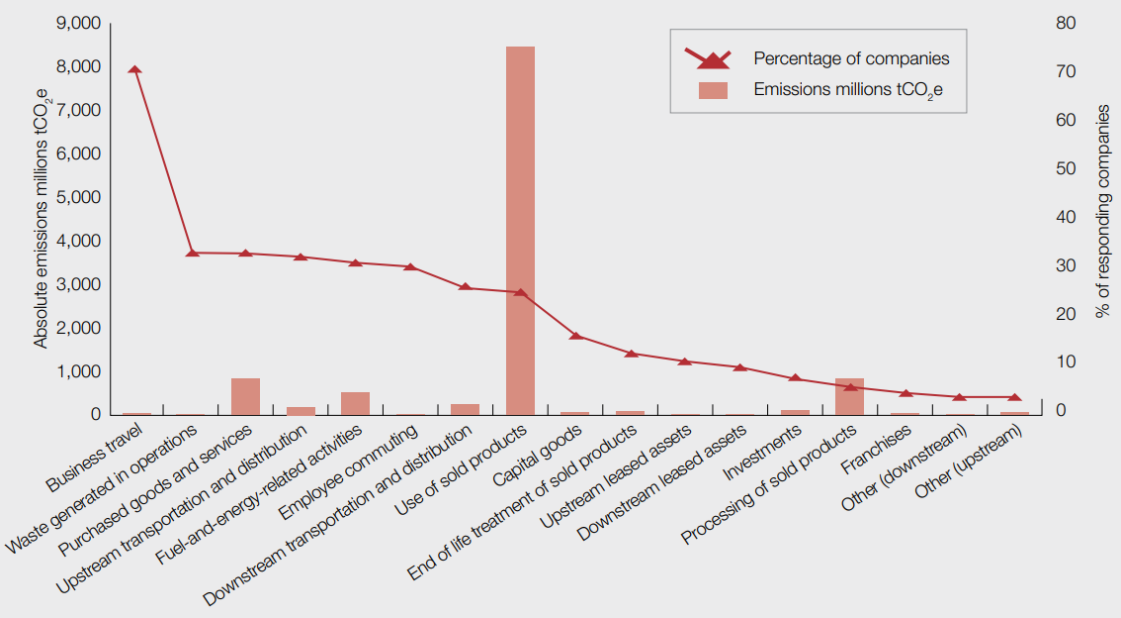

Figure 3.5 Percentage of firms reporting each category vs emissions reported, (CDP, 2013)

A perfect example of this is Category 6 – Business travel. Whilst around 70 percent of firms that reported Scope 3 calculated emissions for this category, the actual emissions attributed to this category are miniscule. With Category 11 – Use of sold products we see that the opposite occurs: the emissions attributed to this category are very high, yet the percentage of firms reporting on this category is less than 30 percent. So whilst the number of companies reporting Scope 3 remains low, the ones that do report are not necessarily reporting on the relevant and material categories.

It is perhaps this failure of the private market to fully map their entire carbon footprint that has led the EU to include mandatory Scope 3 disclosure in the new ESRS.

3.2.3 Sustainability Reporting Standards

Until now, no set of sustainability reporting standards has been mandatory for any firms to report with. Yet other standards have been used on a voluntary basis by firms in order to improve the transparency of their sustainability practices, both from an impact and financial perspective.

The Global Reporting Initiative (GRI) sustainability reporting standards have been widely used in Europe, and their aim is to provide transparency and comparability on how an organization reports on its sustainability impacts and contributes towards sustainable development (GRI, 2021). The main focus of the GRI standards is to assess sustainability from an impact materiality perspective, although impact on stakeholders is also taken into account some of whom may take a financial materiality view.

Other popular standards take a financial materiality standpoint, including the TCFD standards and the Sustainability Accounting Standards Board (SASB) standards. New standards currently being developed by the International Sustainability Standards Board (ISSB) will also have a financial materiality focus. Figure 3.6 gives an overview of popular sustainability standards and the materiality perspective they take.

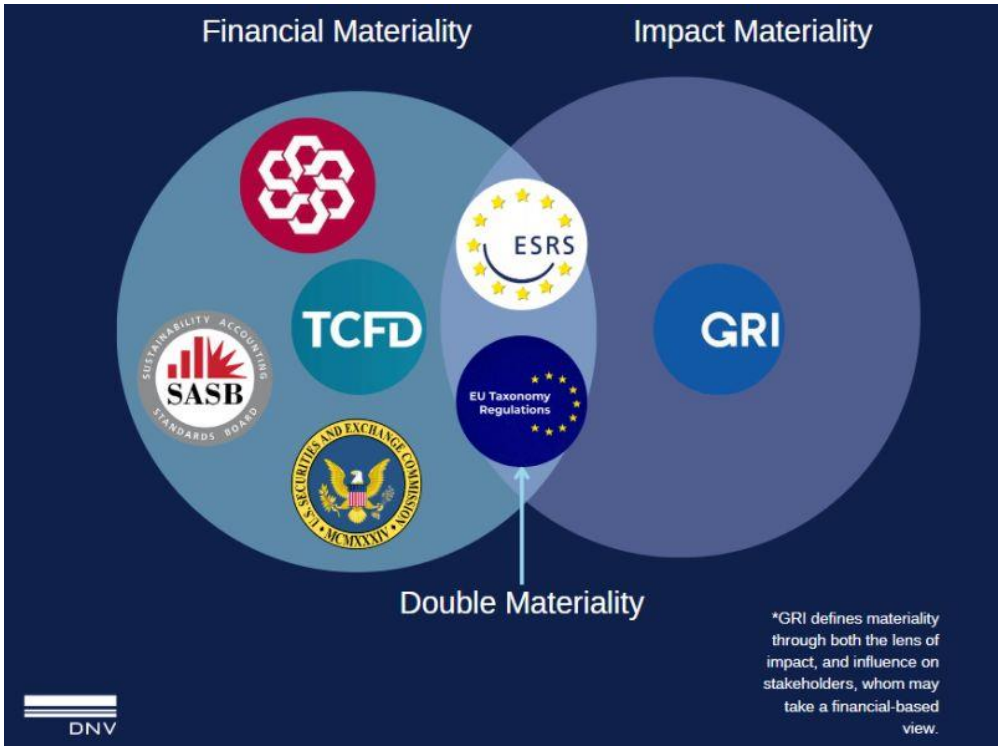

Figure 3.6 Materiality scope of different sustainability reporting standards, (DNV, 2022a)

The ESRS represents the first set of standards where firms must take both an impact and a financial materiality view when reporting on sustainability issues.

3.2.3.1 ESRS

The ESRS are the sustainability reporting standards that all companies covered by the CSRD regulations must report with. The were developed by EFRAG in co-operation with leading international sustainability reporting initiatives, with the goal to align with current initiatives whilst taking into account European specificities (European Comission, 2021a, p. 4). The ESRS focus on the concept of 'double materiality', bringing together impact materiality and financial materiality in order to create long term value for the company whilst working towards achieving the objectives of the Green Deal.

The CSRD legislation will cover all listed companies on regulated markets within the EU, including small and medium-sized enterprises (excluding micro-enterprises). It also applies to all large non-listed companies if they meet at least two of the following three criteria:

- Balance sheet total of more than EUR 20m
- Net turnover of more than EUR 40m
- The average number of employees during the financial year of more than 250

Non-EU undertakings with turnover above EUR 150 million in the EU if they have at least one subsidiary or branch in the EU exceeding the above thresholds are also covered by the new regulations.

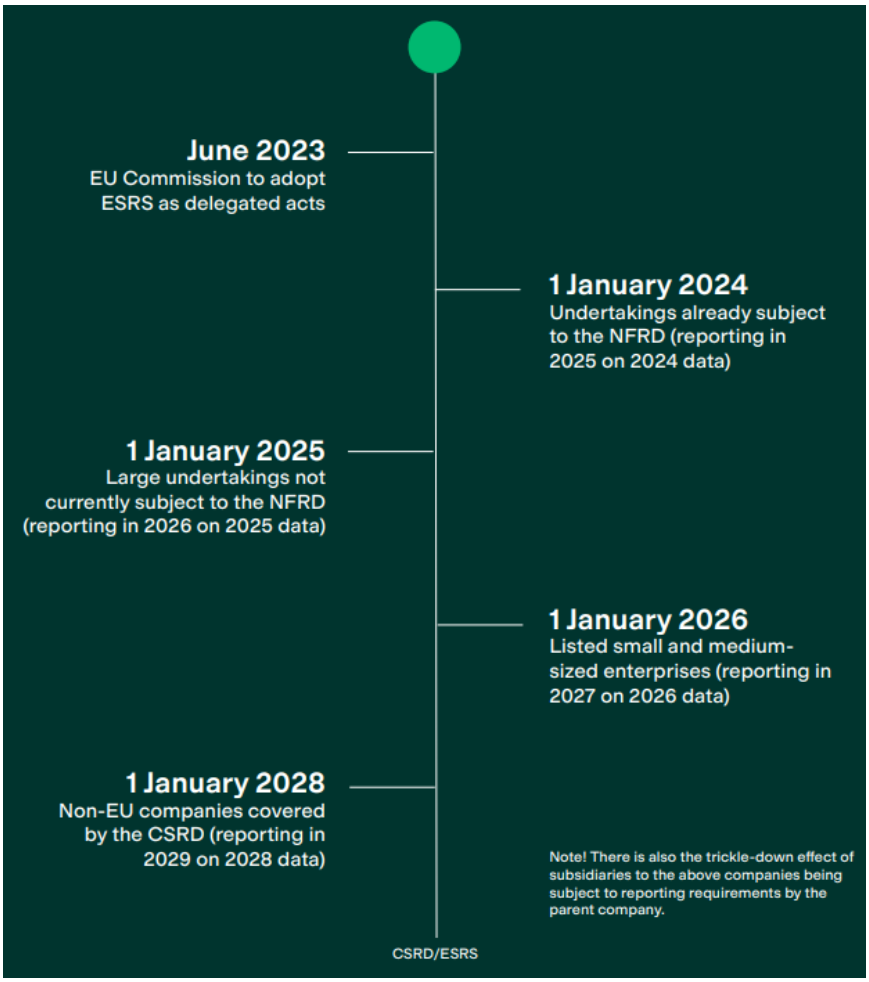

Figure 3.7 Timeline of the CSRD/ESRS adoption, (Position Green, 2023)

The draft ESRS consist of twelve standards, two cross-cutting standards and ten topical standards divided under environment, social and governance categories.

Table 3.5 ESRS draft standards

Cross-cutting standards:	▪ Draft ESRS 1 *General requirements* ▪ Draft ESRS 2 *General disclosures*
Topical standards: **Environment:**	▪ Draft ESRS E1 *Climate change* ▪ Draft ESRS E2 *Pollution* ▪ Draft ESRS E3 *Water and marine resources* ▪ Draft ESRS E4 *Biodiversity and ecosystems* ▪ Draft ESRS E5 *Resources and circular economy*
Social:	▪ Draft ESRS S1 *Own workforce* ▪ Draft ESRS S2 *Workers in the value chain* ▪ Draft ESRS S3 *Affected communities* ▪ Draft ESRS S4 *Customers and end-users*
Governance:	▪ Draft ESRS G1 *Business conduct*

(EFRAG, 2022c)

Following the submission of the first set of the draft standards to the European Commission on 23rd November 2022, EFRAG will now begin work on the second set of drafts. The second set of drafts will be sector-specific standards, with the first five covering the sectors that currently have GRI specific standards: *agriculture, coal mining, mining, oil and gas (upstream), oil and gas (mid-to downstream),* and the second five covering high impact sectors: *energy production, road transport, motor vehicle production, food/beverages, textiles*. Under the ESRS SMEs will have their own dedicated standards which will also be included in the second set of drafts (EFRAG, 2022c).

Draft ESRS E1 – Climate Change, contains the rules and guidance on Scope 3 emissions reporting and target setting disclosure.

Scope 3 Emissions Targets

Information on Scope 3 emissions reduction targets can be found in *Disclosure Requirement E1-4 Targets related to climate change mitigation and adaptation* (EFRAG, 2022a).

Under this disclosure requirement it is not mandatory to adopt any Scope 3 emissions reductions targets. However, if the company has already set any targets in this area, certain requirements regarding disclosure and detail of such targets shall apply. The specific

requirements surrounding Scope 3 target setting from ESRS E1 for this can be found in appendix I of this paper.

Scope 3 Emissions Reporting

Information on Scope 3 emissions reporting can be found under *Disclosure Requirement E1-6 Gross Scopes 1, 2, 3 and Total GHG emissions (EFRAG, 2022a).*

Here it is stated that 'The undertaking shall disclose its gross Scope 3 GHG emissions' (EFRAG, 2022a, Paragraph 41c) with the objective to 'to provide an understanding of the GHG emissions that occur in the undertaking's value chain beyond its Scope 1 and 2 GHG emissions. For many undertakings, Scope 3 GHG emissions may be the main component of the GHG inventory and are an important driver of the undertaking's transition risks.' (EFRAG, 2022a, Paragraph 42c)

The disclosure of gross Scope 3 GHG emissions required shall include GHG emissions in metric tonnes of CO2eq from each significant Scope 3 category (i.e., each Scope 3 category that is a priority for the undertaking) (EFRAG, 2022a, Paragraph 48).

Further information is given in *Appendix B: Application Requirements* of ESRS E1, which states exactly which frameworks must be used to identify relevant Scope 3 categories, how to report on Scope 3 emissions, as well as guidance on disclosing reporting boundaries and calculation methods used. It is stated that companies should report using the 15 Scope 3 categories set out in the GHG Protocol Corporate Value Chain Accounting and Reporting Standard. Condensing the 15 Scope 3 emissions categories into five overarching categories will also be acceptable. If the business is a financial institution, it should use the PCAF Global GHG Accounting and Reporting Standard for the Financial Industry to calculate Category 15 – Investments.

Framework from the GHG Protocol Corporate Value Chain Accounting and Reporting Standard should also be used when identifying which Scope 3 categories are relevant and material to report on for the business, with any excluded categories being fully explained.

Specific requirements regarding how the companies must prepare the information on gross Scope 3 GHG emissions from ESRS E1 can be found in appendix II of this paper.

3.2.4 Target Setting

Setting emission reduction targets in becoming more common place as part of a firm's sustainability reporting, with net-zero GHG emissions targets being pledged by thousands of businesses (Lin, 2022). In theory, setting a net-zero emission target should be the first step for a firm in measuring and managing their GHG emissions, it is often uncertain how net-zero pledges, which sets targets years or even decades in the future, will actually be met (Lin, 2022). Sun et al suggest that firms supplement net-zero targets with interim milestones to ensure that early action is taken for emissions reduction in order to meet such targets (Sun et al., 2021). However, net-zero targets set by firms are often voluntary, and there is no way to check if the firm is on track to meet them.

To counter this problem, the Science Based Targets Initiative (SBTi) was set up in 2015 as a partnership between CDP, The UN Global Compact, the World Resources Institute, and the World Wildlife Fund, to offer guidance, evaluate and approve firm's emissions reduction targets in line with climate science and Paris Agreement goals (SBTi). Having an SBTi approved emissions reduction targets has become somewhat of a 'gold standard' for firms who wish to show their commitment to sustainability and managing their climate risk.

SBT adoption is accelerating in larger, more visible companies in high income countries, and evidence from Bjørn et al suggests that science based target adoption corresponds to increased climate action by a firm (Bjørn et al., 2022).

3.3 Climate Risk Management

Climate change can be viewed as a 'double-material' issue for firms; the corporate sector has been identified as a key contributor to climate change as one of the main emitters of GHG, whilst at the same time it also causes serious risks to firms which will require them to implement adequate risk response measures (Kolk et al., 2008). Businesses are under increasing pressure from investors and other stakeholders to disclose environmental data, both from an impact material and a financial material viewpoint, with a focus on information related to their GHG emissions (Kolk et al., 2008).

From the financial viewpoint, climate risks have potentially large effects on individual firms and investor portfolios. Increasing evidence shows that institutional investors should consider climate risks in their investment decisions (Krueger et al., 2019), and by managing climate risks successfully, firms can provide attractive investment opportunities and protect their business for the future. As we have seen from the literature, value chain emissions often

make up the largest share of emissions for most companies, hence their consideration appears natural for both impact- and risk-management motivated investors (Ducoulombier, 2021).

Climate risks can be broadly categorised into three types: physical, market and regulatory.

3.3.1 Physical Climate Risk

Physical climate risk can be defined a risk that occurs directly from the result of climate-induced changes in the natural eco-systems of the planet, such as droughts, floods, changes in sea-level and storms (Sakhel, 2017). Extreme weather events resulting from human-induced climate change are already causing direct and indirect negative impacts on firm's operations, such as damaging assets and disrupting global supply chains (Sanderson et al., 2019). In a globalised economy, many firms have large and fragmented supply chains that stretch across different countries and regions around the globe. As a result of this many firms may be indirectly exposed to physical climate risk through their supply chains, and production of goods often takes place in parts of the world that are the most vulnerable to the physical impacts of climate change (Pankratz & Schiller, 2021). By reporting on their Scope 3 emissions, firms can get a better understanding of their exposure to physical climate risks, allowing them to better manage those risks to protect the value of the firm.

Yet the impact of physical climate risk to a firm is still plagued by uncertainty. The first type of uncertainty relates to the uncertainty to which physical climate events will affect future cash flows. The nature of human-induced climate change means that we do not have sufficient historical data that would allow us to predict exactly where and when extreme weather events may occur. This means that firms may not be able to accurately account for costs related to physical climate, events such as clean-up costs or legal costs related to accidental spills, in future cash-flows (Chen & Silva Gao, 2012). Uncertainty from lack of information over a firm's ability to react to physical climte risk may also have a negative affect on the value of the firms. Information uncertainty can hinder investor's abilities to accurately value the firm's future performance, and can lead to further discounting in the valuation of the firm (Chen & Silva Gao, 2012). However, risk from information uncertainty can be mitigated through corporate environmental disclosures. A company that has fully mapped its Scope 3 emissions has an excellent overview of its entire supply chain, allowing them to have a good understanding of the physical climate risks they may face in the future and how to best incorporate management of these risks into their business model.

3.3.2 Market Risk

Market risk can be defined as risk that emerges 'from (potential) climate change induced shifts in consumer and financial markets' (p. 103, Sakhel, 2017). Investors and other stakeholders such as consumers are increasingly concerned about the environmental impact of the companies they invest in or do business with. On the consumer side, changing attitudes as consumers become more environmentally aware can lead to a change in demand for products and services. Research has shown that certain consumers are willing to pay a higher price for goods that are more environmentally friendly (Tait et al., 2016). By reporting Scope 3 emissions voluntarily, the company can gain a competitive advantage over their peers who have not yet done so. It enables the company to differentiate itself as a leader in sustainability, enhance their reputation and brand value, and potentially attract environmentally conscious customers.

Market risk related to climate change can also affect how investors feel about investing their money in firms. As the world aims to move to a net-zero emissions economy, the pressure on fossil fuel companies and carbon-intensive industries to put in place transition plans grows. Investors in these firms face two choices, to divest entirely or to pursue active ownership (Linnenluecke et al., 2015). By reporting well on Scope 3 emissions, the company can signal to investors that is taking steps to measure and manage their impact on the environment, and also demonstrate that the company is forward-thinking and aware of the potential risks and opportunities associated with climate change. This in turn may stop investors divesting from the company, if it is currently heavily reliant on fossil fuels, whilst also attracting new environmentally aware investors who are looking to create long term sustainable value through active ownership.

3.3.3 Regulatory Risk

Regulatory risk refers to risk that stems from potential changes in regulation that is implemented in response to climate change (Sakhel, 2017). The Paris Climate Agreement stipulates that the targets for reducing GHG emissions will be strengthened over time, in terms of both scope and ambition (Rogelj et al., 2016). Given this, companies can expect further legislation that is aimed at mitigating their negative impacts on the climate, which constitutes a financial risk to the firm as it is likely to increase the cost of compliance. Now that Scope 3 emissions reporting will be made mandatory under the CSRD, European and international firms affected by the legislation will face increased costs related to data

collection, mapping out their supply chain and having their environmental data externally assured.

Firms that have proactively chosen to report on their Scope 3 emissions without having been mandated to do so now have an advantage over firms that have not, they have less work to do in a short time space. Measuring and reporting emissions is the first step needed to be able to manage and reduce emissions, and although it is difficult to predict what requirements future legislation will mandate, it is not unthinkable that Scope 3 emissions may one day be taxed in the same way as Scope 1 emissions for certain industries are now.

Regulatory risk is the type of risk related to climate change that firms and investors are most concerned about at this present time. A study of 126 European based companies by Sakhel showed that firms felt more exposed to regulatory climate risk that physical and markets risk, as they believed physical risks were expected to materialize in the more distant future and that the realization of market risk was rather unlikely (Sakhel, 2017). A survey by Krueger et al showed that institutional investors believe that climate risks, particularly regulatory risks, have already begun to materialise and will have financial implications for their portfolio (Krueger et al., 2019).

3.3.4 Emissions Disclosure and Financial Performance

There is evidence that disclosing GHG emissions can be considered good climate risk management and is subsequently reflected in the performance of the firm. As there has been no legislation that mandates reporting Scope 3 emissions in Norway, doing so can be considered as a voluntary disclosure until the first year the CSRD comes into force. I will therefor focus on studies that examine the effect between voluntary carbon disclosures and a firm's financial performance. As Scope 3 data is currently very limited, particularly outside of Europe, many of the studies look at the voluntary disclosure of Scope 1 and Scope 2 emissions in regions where it is not yet mandatory to do so.

A study that examined 500 listed US firms from 2006 to 2008 found that the median value of firms that disclose their carbon emissions was around $2.3 billion USD higher than that of comparable non-disclosing firms (Matsumura et al., 2014). Another study that looked at 300 listed companies in China between 2017 and 2020 found that voluntarily disclosing carbon emissions had a positive impact on firm value (Sun et al., 2022). Their conclusion cited signalling theory as the main reason for this, as voluntarily disclosing carbon emissions sends

a signal to investors over the company's commitment to social responsibility, boosting investor confidence and thus increasing the company's valuation (Sun et al., 2022).

Whilst many studies have shown a negative correlation between the size of a firm's emissions and the value of the firm (Aggarwal & Dow, 2011), several studies have shown that this negative effect can be somewhat mitigated by transparency and signalling through voluntary carbon disclosure. A study using CDP data from 2009 to 2015 for firms located in the US, Brazil, Russia, India and China found that firms with greater voluntary carbon disclosure had higher firm value, with a stronger positive association found for firms in developing countries (Jiang et al., 2021). Furthermore, they found that even large emitters, who are normally penalised for the size of their carbon emissions, with sufficient carbon disclosures experienced a less negative valuation than similar firms with inadequate carbon disclosures (Jiang et al., 2021). A study that examined over 1000 Japanese firms found similar results. Saka and Oshika found that whilst 'corporate carbon emissions have a negative relation with the market value of equity, the disclosure of carbon management has a positive relation with the market value of equity' (p. 22, Saka & Oshika, 2014). Interestingly, they also found that the positive relationship between voluntary carbon management and firm value was stronger for those firms with a large volume of carbon emissions (Saka & Oshika, 2014).

Despite the evidence that voluntary disclosing carbon emissions is beneficial to the firm's financial performance, there are many firms who chose not to, and this is particularly true of Scope 3 emissions.

4. Data and Methodology

4.1 Sample

For this thesis project I will use the top 100 publicly listed Norwegian companies, in accordance with the 2022 'ESG 100' (for 2021 data) report by Position Green (Position Green, 2022).

I chose a purposive sample, rather than conducting a random sample, because there are only a small number of companies that face mandatory sustainability disclosures under the current NFRD, limiting the data available for this project. Under this legislation, Scope 3 reporting is not mandatory, which again limits the available data.

As the reporting requirements vary vastly between Norwegian firm's at this time, my aim with this project is not to generate insights that can be generalised across the entire population, thus making a purposive sample acceptable in this case (Etikan et al., 2016).

Table 4.1 Number of observations in the sample

Year	Number of Observations	Explanation
2020	98	Two of the firms from the 2021 ESG 100 did not exist in 2020. A further four firms existed but were not listed, therefore variable regarding firm value and change in share price have been computed using 2021 data.
2021	100	Sample taken from 2021 ESG100.
2022	97	At the time of publishing, 3 of the firms (all in the transport sector) had not published their ESG/sustainability reports so emissions data was unavailable. Two firms in the data set were taken over by a third firm during 2022 so ESG data from the new parent company was used.

4.2 Data

All the data used in this project has been collected from publicly available sources. The primary source of the data is the firm's own annual or sustainability reports for the years 2020, 2021 and 2022.

The reporting data is taken from the report from the corresponding year. When data has been revised using new methodologies and updated in future reports, these figures have not been used as the purpose of this thesis is to assess how companies report each year, and the progress they have made with their Scope 3 reporting.

It is important to note that a certain level of objectivity has been used when recording some of the data points, as there is no standardized format used by all companies to present their emissions data and information on any targets they may have.

For example, when one figure is reported as emissions from 'transport' without any further detail of whether it is 'category 4 upstream transport' or 'category 9 downstream transport', both categories have been logged as reported and the emissions figure has been divided evenly among the two categories. If a company has simply stated a figure for 'Scope 3' without any further explanation as to which categories the data refers to, only 1 (non-material) Scope 3 category has been registered.

Further detailed information on the variables used in the models can be found in the methodology section 4.2.2.

Materiality

The materiality variable, which represents the materiality of Scope 3 emissions to each industry, has been computed by me based on information from the CDP Technical Note concerning the relevance of Scope 3 categories by sector (p.6, CDP, 2022b), see figure 3.4.

- **Material_1** (very material) – Scope 3 emissions account for between 50% - 100% of a sector's total GHG emissions.
- **Material_2** (somewhat material) – Scope 3 emissions account for between 30% - 49% of a sector's total GHG emissions.
- **Material_3** (not material) – Scope 3 emissions account for between 0% - 29% of a sector's total GHG emissions.

Direct information that firms have registered with CDP has been used to classify 43 of the firms into sectors, and the remaining 57 have been classified by me using detailed information from the CDP'S Activity Classification System (CDP, 2022a).

Table 4.2 Overview of the materiality of Scope 3 emissions to each sector

Sector	Scope 3 Share of Total Emissions	material_1 (1 = yes, 0 = no)	material_2 (1 = yes, 0 = no)	material_3 (1 = yes, 0 = no)	Number of Companies in Data set
General	88.00%	1	0	0	**28**
Financial services	99.98%	1	0	0	**20**
Transport services	32.56%	0	1	0	**12**
Agricultural commodities	91.91%	1	0	0	**9**
Oil and gas	88.93%	1	0	0	**8**
Capital goods	98.54%	1	0	0	**6**
Electric utilities	49.04%	0	1	0	**5**
Chemicals	76.05%	1	0	0	**3**
Real estate	93.41%	1	0	0	**3**
Construction	92.28%	1	0	0	**2**
Food, beverage and tobacco	87.43%	1	0	0	**2**
Metals and mining	91.97%	1	0	0	**1**
Paper and forestry	58.72%	1	0	0	**1**
Cement	16.34%	0	0	1	**0**
Coal	65.10%	1	0	0	**0**
Steel	27.41%	0	0	1	**0**
Transport OEMS	98.04%	1	0	0	**0**

Based on information from CDP, (p.6, CDP, 2022b)

4.3 Methodology

4.3.1 Scope 3 Score

A 'Scope 3 score' has been calculated for each firm and corresponding year. This score represents how well the firm reports on their Scope 3 emissions and will be the dependent variable for the regression model to answer research question 2, 3, 4 and 5. The score is based

on the number or Scope 3 categories reported by each firm and the materiality of those categories for the industry, as defined in the CDP Technical Note: Relevance of Scope 3 Categories by Sector (CDP, 2022b). The technical note aims to identify the Scope 3 categories that 'are most likely to be relevant and represent the bulk of Scope 3 emissions for the majority of companies in the sector' (p. 7, CDP, 2022b).

Material categories for the 'general' industries are not defined in the CDP technical note. For these companies, categories identified in the SBTI paper on best practices in Scope 3 emission management (p. 16, Farsan et al., 2018) have been used to allocate material categories for each sub-sector.

The identification of sector specific material Scope3 categories is in line with the guidance from the GHG Protocol on identifying relevant Scope 3 categories; a category is considered material and relevant if the size of the emissions from that category 'contribute significantly to the company's total anticipated scope 3 emissions' (p. 61, GHG Protocol, 2011).

Table 4.3 Material Scope 3 categories for each sector and sub-sector

Sector	Scope 3 Share of Total Emissions	Material Scope 3 Categories	Number of Material Categories
Agricultural commodities	91.91%	1, 10, 11	**3**
Capital goods	98.54%	11, 1	**2**
Cement	16.34%	1, 3, 4, 9	**4**
Chemicals	76.05%	1, 11, 12, 4, 3, 2, 9	**7**
Coal	65.10%	11	**1**
Construction:	92.28%		
Building developers		11, 4, 12, 2, 3	**5**
Construction contractors		1, 2	**2**
Electric utilities:	49.04%		
Renewable		3, 1, 4	**3**
Gas		11, 3, 15, 1, 4	**5**
Financial services	99.98%	15	**1**
Food, beverage and tobacco	87.43%	1, 9, 4	**3**
General:	88.00%		
Software & services		1, 2, 5, 7	**4**
Industrial support services		1, 2, 4, 7	**4**

Pharmaceuticals & biotech		1, 4, 2	**3**
Retail		1, 4, 2, 9	**4**
Telecommunication		1, 2, 11, 3	**4**
Light manufacturing & print		11, 1, 9	**3**
Metals and mining:	91.97%		
Mining		10	**1**
Processing metals		1	**1**
Oil and gas	88.93%	11, 1	**2**
Paper and forestry:	58.72%		
Forestry		1, 10, 12, 9	**4**
Processors		1, 9, 4	**3**
Real estate:	93.41%		
Building developers		2, 3, 11, 4, 12	**5**
Building Owners		2, 13, 1, 3	**4**
REITs		15	**1**
Steel	27.41%	1, 11, 10, 12	**4**
Transport OEMS	98.04%	11, 1	**2**
Transport services	32.56%	4, 3, 1	**3**

Calculation

The aim of the Scope 3 score is to measure the firm's performance on Scope 3 emissions reporting. It is based on the number of Scope 3 categories each firm reports on and is weighted to reward firms who report on categories deemed material to their sector.

Three different 'Scope 3 scores' have been calculated, with different weightings given to number of material Scope 3 categories reported.

Table 4.4 Calculation method for each Scope 3 score

Scope 3 Score	Weighting (categories/material categories)	Calculation
Score_1	50/50	[(number of scope 3 categories reported/15) * 0.5)] + [(number of material scope 3 categories reported/number of sector specific material categories) * 0.5]
Score_2	60/40	[(number of scope 3 categories reported/15) * 0.4)] + [(number of material scope 3 categories reported/number of sector specific material categories) * 0.6]
Score_3	70/30	[(number of scope 3 categories reported/15) * 0.3)] + [(number of material scope 3 categories reported/number of sector specific material categories) * 0.7]

If a firm states that they have fully mapped their Scope 3 emissions, they receive the highest score of 1 i.e. they report on all 15 categories and thus all categories deemed material to the industry. The definition of 'fully mapped' has been applied in the strictest sense here, and only applies when the company had given explanations as to why missing Scope 3 categories have been excluded as per the GHG Protocol.

Example

Company: Firm number 27 Sector: Electric Utilities (Renewables)
Relevant Scope 3 Categories: 3, 1, 4 (3)

Table 4.5 Example of Scope 3 score calculation

Year	Scope 3 Categories Reported	Number of Material Categories Reported	Scope 3 Score_1 *(50/50)*	Scope 3 Score_2 *(40/60)*	Scope 3 Score_3 *(30/70)*
2020	**1**, 6	1	((2/15) * 0.5) + ((1/3) * 0.5) = **0.23**	((2/15) * 0.4) + ((1/3) * 0.6) = **0.25**	((2/15) * 0.3) + ((1/3) * 0 .7) = **0.27**

2021	**1**, 5, 6, 15	1	((4/15) * 0.5) + ((1/3) * 0.5) = **0.30**	((4/15) * 0.4) + ((1/3) * 0.6) = **0.31**	((4/15) * 0.3) + ((1/3) * 0.7) = **0.31**
2022	**1**, 2, **3**, 5, 6, 15	2	((6/15) * 0.5) + ((2/3) * 0.5) = **0.53**	((6/15) * 0.4) + ((2/3) * 0.6) = **0.56**	((6/15) * 0.3) + ((2/3) * 0.7) = **0.59**

From the example you can see that the firm's scope 3 score improved slightly from 2020 to 2021 as they added two more Scope 3 categories to their reporting, only one of which was deemed material. The Score improved substantially from 2021 to 2022 as the firm added a further two categories to their reporting, one of which was deemed material to the sector, meaning the reported on a total of six out of 15 Scope 3 categories, two of which are classed as material.

Firms that focus on reporting material categories will receive a higher score under 'Score_3' than 'Score_2' and 'Score_1' respectively, as this score give more weighting to the materiality of the categories reported. Firms that report on a lot of categories, none of which have been deemed material will receive the highest score under 'Score_1'.

I have chosen to use *'Score_2'*, which gives a 40% weighting to the number of categories reported and a 60% weighting to the number of material categories reported, as the dependent variable in my regression models. There are two main reasons for this decision.

As previously explained, the CSRD mandates that companies should report on Scope 3 emissions with the GHG Protocol, which states that firms should identify and report on all relevant categories. Firms can easily increase the number of Scope 3 categories they report on by adding easy to measure but of little relevance categories such as Category 6 – Business travel or Category 5 – Waste, but this is not in the spirit of what the CSRD and GHG Protocol are trying to achieve. That is why I have chosen a Scope 3 score that gives more emphasis to reporting on material categories than simple the number of categories reported on.

The reason for not choosing 'Score_3', which give a 70% weighting to the number of material categories reported on is because the sector specific material categories identified in the literature are generalised for the entire sector. It is possible that individual firms within the sector have different business models and therefore the actual material categories may differ for firms within the same sector. Given this, I feel that is it important to acknowledge

the overall number of categories reported on and giving them only a 30% weighting as with 'Score_3' may not truly reflect the firm's efforts to improve their Scope 3 reporting performance.

A sensitivity analysis will be performed on the preferred models, to see if the choice of Scope 3 score makes a significant difference to the results of the analysis.

4.3.2 Models

Logistic Model

The first two models relate to research question 1 and will attempt to predict whether a company reports Scope 3 emissions or not using a logistic model. In this case the dependent variable, report_scope3, is either 1 for does report or 0 for does not report, so a logit model will be used to model the odds of a firm reporting Scope 3 emissions as a function of independent variables.

I will predict the residuals from each model and classify them as '1' (does report) if the predicted value is greater than 0.5, and as '0' (does not report) if the predicted value is less than 0.5. A confusion matrix will then be developed to assess the accuracy of the predictive model.

Model 1 consists of 13 independent variables that will be used in all of the models in this thesis. In model 2, dummy variables for each industry will be added to assess whether any insights from model 1 still hold after accounting for sector specific influences.

Model 1: Logistic model for predicting whether a firm reports on Scope 3 emissions.

report_scope3 ~ $\beta 0$ + $\beta 1$small_frim + $\beta 2$medium_firm + $\beta 3$new_firm + $\beta 4$firm_value + $\beta 5$change_share_price + $\beta 6$material_1 + $\beta 7$csrd_2024 + $\beta 8$csrd_2025 + $\beta 9$net_zero + $\beta 10$scope3_target + $\beta 11$sbti + $\beta 12$_2021 + $\beta 13$_2022

Model 2: Logistic model for predicting if a firm reports Scope 3 or not, dummy variables for industry.

report_scope3 ~ $\beta 0$ + $\beta 1$small_frim + $\beta 2$medium_firm + $\beta 3$new_firm + $\beta 4$firm_value + β5change_share_price + $\beta 6$material_1 + $\beta 7$csrd_2024 + $\beta 8$csrd_2025 + $\beta 9$net_zero + $\beta 10$scope3_target + $\beta 11$sbti + $\beta 12$_2021 + $\beta 13$_2022 + INDUSTRY DUMMIES

Panel Data Models

I will test several different panel data models in order to answer research question 2, 3, 4 and 5, to see which variables have an influence on a firm's Scope 3 reporting performance. The models tested will be a pooled OLS model, a fixed effects model, random effects model and a tobit random effects model.

Model 3: Panel data model

score_2 ~ $\beta 0$ + $\beta 1$small_frim + $\beta 2$medium_firm + $\beta 3$new_firm + $\beta 4$firm_value + β5change_share_price + $\beta 6$material_1 + $\beta 7$csrd_2024 + $\beta 8$csrd_2025 + $\beta 9$net_zero + $\beta 10$scope3_target + $\beta 11$sbti + $\beta 12$_2021 + $\beta 13$_2022

Model 4: Panel data models including dummy variables for industry.

score_2 ~ $\beta 0$ + $\beta 0$ + $\beta 1$small_frim + $\beta 2$medium_firm + $\beta 3$new_firm + $\beta 4$firm_value + $\beta 5$change_share_price + $\beta 6$material_1 + $\beta 7$csrd_2024 + $\beta 8$csrd_2025 + $\beta 9$net_zero + $\beta 10$scope3_target + $\beta 11$sbti + $\beta 12$_2021 + $\beta 13$_2022 + INDUSTRY DUMMIES

A detailed description of the variables used in the models can be found in table 4.6, and descriptions of the industry dummy variables in table 4.7, whilst a correlation heat map of all the variables can be found in appendix III.

Table 4.6 Description of variables

Variable	Overview	Detail
report_scope3	If the firms reports any Scope 3 emissions 1 = yes, 0 = no	If the firms reports any Scope 3 emissions, an absolute value measured in terms of C02 equivalents.
score_2	The Scope 3 score that reflects the firm's level of Scope 3 reporting	Reflects the number of Scope 3 categories and material categories reported on with a 40/60 weighting respectively. See section 4.3.1 for full details on how the score was calculated.
small_firm	Firms with 0-99 number of employees	Total number of people employed by the firm as stated in their corresponding annual/sustainability report or full-time equivalents when stated.

medium_firm	Firms with 100-5999 number of employees	Total number of people employed by the firm as stated in their corresponding annual/sustainability report or full-time equivalents when stated.
large_firm	Firms with 6000 or more number of employees	Reference variable – omitted from the model due to multicollinearity with small_firm and medium_firm.
new_firm	If a firm was founded in 2000 or later 1 = yes, 0 = no	Dummy variable to distinguish the very youngest firms from older firms.
value_firm	The average value of the firm between 2020-2021 in billions NOK	The mean of the market cap of the firm for the year end 2020, 2021 and 2022.
change_share_price	The percentage change in share price from the end 2020 to end of 2022	Variable to reflects how the firm has performed financially over the last 3 years.
material_1	Scope 3 emissions are very material to the firm 1 = yes, 0 = no	See section 4.2 for how the materiality of Scope 3 emissions has been defined for each sector.
material_2	Scope 3 emissions are somewhat material to the firm 1 = yes, 0 = no	Reference variable – omitted from the model due to multicollinearity with material_1.
csrd_2024	Firm obligated to report scope 3 in 2025 using 2024 data 1 = yes, 0 = no	Firms that must reported Scope 3 under the CSRD legislation in its first year of implementation.
csrd_2025	Firm obligated to report scope 3 in 2026 using 2025 data 1 = yes, 0 = no	Firms that must reported Scope 3 under the CSRD legislation in its second year of implementation.
csrd_2026	Firm obligated to report scope 3 in 2027 using 2026 data 1 = yes, 0 = no	Firms that must reported Scope 3 under the CSRD legislation in its third year of implementation. Reference variable – omitted from the model

		due to multicollinearity with csrd_2024 and csrd_2025.
net_zero	If the firm has committed to achieving net-zero emissions 1 = yes, 0 = no	If the firm states in its annual or sustainability report that it has a goal to reach net-zero emissions (carbon-neutral is not included).
sbti	If the firm set SBTI targets 1 = yes, 0 = no	If the firm has had emissions targets approved and verified by the Science Based Targets Initiative. This may or may not include a Scope 3 target.
scope_3_target	If the firm has set a Scope 3 emissions target 1 = yes, 0 = no	If the firm has stated in the annual/sustainability report that they have a specific Scope 3 emissions reduction target.
2020	Time variable, year	Data from 2020 reports. Reference variable – omitted from the model due to multicollinearity 2021 and 2022.
2021	Time variable, year	Data from 2021 reports
2022	Time variable, year	Data from 2022 reports

Table 4.7 Industry dummy variables

Variable	Overview	Detail
agriculture	All firm classified under the 'agricultural commodities' sector according to the CDP Questionnaire Allocation.	-
capital_goods	All firm classified under the 'capital goods' sector according to the CDP Questionnaire Allocation.	-
chemicals	All firm classified under the 'chemicals' sector according to the CDP Questionnaire Allocation.	-
construction	All firm classified under the 'construction' sector according to the CDP Questionnaire Allocation.	-

electric_utilities	All firm classified under the 'electric utilities' sector according to the CDP Questionnaire Allocation.	-
financial	All firm classified under the 'financial services' sector according to the CDP Questionnaire Allocation.	-
food_beverage	All firm classified under the 'food, beverage and tobacco' sector according to the CDP Questionnaire Allocation.	-
general	All firm classified under the 'general' sector according to the CDP Questionnaire Allocation.	Reference variable – omitted from the model due to multicollinearity with the other industry dummies.
metals_mining	All firm classified under the 'metals and mining' sector according to the CDP Questionnaire Allocation.	-
oil_gas	All firm classified under the 'oil and gas' sector according to the CDP Questionnaire Allocation.	-
paper_forestry	All firm classified under the 'paper and forestry sector according to the CDP Questionnaire Allocation.	-
real_estate	All firm classified under the 'real estate' sector according to the CDP Questionnaire Allocation.	-
transport	All firm classified under the 'transport services' sector according to the CDP Questionnaire Allocation.	-

5. Results and Discussion

5.1 RQ1

Can firm level data predict whether or not a firm reports on Scope 3 emissions for each year?

H1: Firm characteristics can be used to predict whether the firm reports on Scope 3 or not.

Two logistic models were used to predict whether or not a firm reports Scope 3 emissions for each year. Model 1 contains firm level data as explained in section 4.3.2 and model 2 contains the same dependent variables with dummy variables for each industry added. A summary of the two logistic models can be found below in table 5.1 and full regression results can be found in appendix IV.

Table 5.1 Logistic regression results summary

	Logit Model 1		Logit Model 2	
report_scope3				
small_firm	1.514	(0.827)	0.924	(1.024)
medium_firm	0.509	(0.585)	0.180	(0.688)
new_firm	-0.527	(0.382)	-0.799	(0.427)
firm_value	0.0165*	(0.00789)	0.0234*	(0.0115)
change_share_price	-0.728**	(0.239)	-0.670*	(0.289)
material_1	-0.0927	(0.471)	-1.222	(1.455)
csrd_2024	1.222*	(0.560)	1.311*	(0.638)
csrd_2025	0.804	(0.665)	-0.0711	(0.755)
net_zero	0.586	(0.548)	0.813	(0.591)
scope3_target	2.810***	(0.613)	2.137**	(0.704)
sbti	0.635	(1.160)	0.806	(1.212)
year_2021	0.681	(0.384)	0.977*	(0.426)
year_2022	0.842	(0.447)	1.204*	(0.491)
agriculture			-0.400	(0.753)
capital_goods			0.266	(0.877)
chemicals			-1.071	(1.694)
construction			0	(.)
electric_utilities			1.061	(1.468)
financial			2.138**	(0.705)
food_beverage			-2.412	(1.502)
metals_mining			-2.809	(2.069)
oil_gas			-0.788	(0.687)
paper_forestry			0	(.)
real_estate			2.054	(1.212)
transport			-1.572	(1.505)
_cons	-1.679	(0.865)	-0.482	(1.671)
N	295		286	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5.2 Logit posit-estimation statistics

Statistic	Model 1	Model 2
Pseudo r-squared	0.333	0.414
Hosmer–Lemeshow goodness-of-fit test: Pearson chi2 P value	 227.56 0.9915	 217.59 0.9789
AIC	256.6937	245.4991
BIC	308.3114	333.2429
Area under ROC curve	0.8691	0.9047

Several post-estimation test statistics were computed to assess which model provided the best 'goodness of fit' for the data. As this was a logistic model and not a linear model, a pseudo r-squared was calculated, rather than a regular or adjusted r-squared. Although pseudo r-squared can give an indication over the goodness of fit of the model, the value cannot be compared directly with a regular r-squared, and for a logistic model, a pseudo r-squared value of between 0.2 and 0.4 represent excellent fir (MCFADDEN, 1979). Both model 1 and model 2 have high pseudo r-squared values, with the higher value for model 2 telling us that it is the preferred model.

The high p-value in the Hosmer–Lemeshow goodness-of-fit test also tells us that both models are well fitted, and the lower 'AIC' and higher 'area under ROC curve' values for model 2 confirm that this is the preferred model for predicting whether or not a firm reports Scope 3.

In Model 2 we have seven variables that are significant at the 5% level in predicting whether or not a firm reports on Scope 3 emissions: 'firm_value', 'change_share_price', 'csrd_2024', 'scope3_target', 'year_2021', 'year_2022' and 'financial'. To interpret the meaning of these variables we must first calculate the odds ratio for each one.

Table 5.3 Interpretation of logit model 2

Variable	Beta	Odds Ratio	Interpretation
firm_value	0.0234	$e^{0.0234} = 1.02$	A 1 billion NOK increase in the average value of the firm from 2020 – 2022 is associated with an increase of 2% in the odds of reporting Scope 3 emissions.

change_share_price	-0.670	$e^{-0.670} = 0.51$	A one percent increase in the change in share price of a firm between 2020 – 2022, the odds of that firm reporting Scope 3 decrease by a factor of 0.51.
csrd_2024	1.311	$e^{1.311} = 3.71$	Firms who must report under the CSRD using 2024 data in 2025 have 3.71 times the odds of reporting on Scope 3 emissions those firms who do not have to report using 2024 data in 2025.
scope3_target	2.137	$e^{2.137} = 8.47$	Firms who have set a Scope 3 targets have 8.47 times the odds of reporting on Scope 3 emissions than those firms who have not set a target.
year_2021	0.977	$e^{0.977} = 2.66$	In 2021, firms have 2.66 times the odds of reporting on Scope 3 emissions than firms do in 2020.
year_2022	1.204	$e^{1.204} = 3.33$	In 2022, firms have 3.33 times the odds of reporting on Scope 3 emissions than firms do in 2020.
financial	2.138	$e^{2.138} = 8.48$	Firms in the 'financial' sector have 8.48 times the odds of reporting on Scope 3 emissions than firms in the 'general' sector.

To verify that model 2 represents the better model for the data, the residuals were predicted for each observation in each model and categorized as 'does report Scope 3' (1) if the value were greater than 0.5, and as 'does not report Scope 3' (0) if the value was less than 0.5 for both models. A confusion matrix was then created to see how well each model was able to predict the outcome variable.

Table 5.4 Confusion matrix – model 1

Actual Values	0	True Neg **43** 14.58%	False Pos **36** 12.20%
	1	False Neg **22** 7.46%	True Pos **194** 65.76%
		0	1
		Predicted Values	

Model Accuracy: 80.34%

Table 5.5 Confusion matrix – model 2

Actual Values	0	True Neg **57** 19.32%	False Pos **22** 7.46%
	1	False Neg **22** 7.46%	True Pos **194** 65.76%
		0	1
		Predicted Values	

Model Accuracy: 85.08%

We can see that both models perform well with an 80.34% and 85.08% accuracy rate for model 1 and model 2 respectively. Both models predicted the same number 'true positives' and 'false negatives'. Model 2, which included the industry dummy variables, was better at predicting when a firm does not report Scope 3 emissions, with 57 'true negatives' (compared with 43 in Model 1) and only 22 'false positives' (compared with 36 in Model 1).

This suggests that there are certain industries that perform particularly badly when it comes to whether they report any Scope 3 emissions, and the second model was able to capture this due to the industry dummy variables being added, although only the 'financial' industry was statistically significant in the model.

Overall, we can say that the evidence supports H1 as both logistic models were fairly accurate in predicting the outcome of whether or not a firm reports Scope 3 emissions or not. Model 2, which accounted for industry levels effects, was better at predicting when firms did not report Scope 3, suggesting that there are some sectors that are generally not as good at reporting Scope 3 emissions as others are.

5.2 Panel Data Models

A panel data model will be used to assess RQ2-5. Several models were tested to find the best model for assessing the effect of the variables on Scope 3 score. Full regression results for each model can be found in appendix V.

Firstly a pooled OLS model was run, with an r-squared value of 0.3958 for model 3 and 0.5194 for model 4. A random effects model was then run for both models, and a Breusch Pagan Lagrange Multiplier test for random effects was performed to test the best performing model, pooled OLS or random effects. For model 3 the chibar2 statistic was 60.14 with a p-

value of 0.00, and for model 4 the chibar2 statistic was 32.80 with a p-value of 0.00. The low p-values for both model 3 and model 4 suggests that we should reject the null hypothesis that there are no random effects present and conclude that the random effects model is the preferred model over the pooled OLS.

A fixed effects model was then run for model 3 and model 4, followed by a Hausman test. For model 3 the chi2 statistic was 6.26 with a p-value of 0.5095 and for model 4 the chi2 statistic was 2.81 with a p-value of 0.9018. The high p-values in both tests suggest that we cannot reject the null hypothesis that there is no correlation between random effects and fixed effects models, and thus conclude that the preferred model is the random effects model.

As the dependent variable, scope 3 score is a variable that takes on values between 0 and 100, it was decided that a tobit random effects model would be the most appropriate model to assess RQ3-6. A full summary table of all four models for model 3 and model 4 can be found in appendix VI.

Results from the preferred Tobit models can be found in table 5.6 below, and these results will be used to assess the remaining hypothesis in RQ 2 – 5.

Table 5.6 Regression results from tobit model 3 and tobit model 4

	Model 3 Tobit		Model 4 Tobit	
score_2				
small_firm	22.71*	(11.39)	24.43*	(10.39)
medium_firm	6.705	(7.253)	12.45	(6.743)
new_firm	-18.58**	(6.904)	-15.92**	(5.780)
firm_value	0.0215	(0.0337)	0.0463	(0.0293)
change_share_price	-10.32*	(4.145)	-7.557	(3.975)
material_1	1.982	(8.147)	-26.25	(14.40)
csrd_2024	13.70	(10.14)	9.778	(8.807)
csrd_2025	1.739	(12.11)	-5.219	(10.33)
net_zero	2.001	(4.851)	1.421	(4.606)
scope3_target	22.10***	(4.579)	18.47***	(4.439)
sbti	8.091	(5.096)	8.321	(5.019)
year_2021	10.69**	(3.493)	11.76***	(3.464)
year_2022	24.00***	(3.989)	25.35***	(3.937)
agriculture			0.326	(8.758)
capital_goods			10.07	(10.10)
chemicals			57.74***	(14.76)
construction			35.78*	(16.47)
electric_utilities			-14.81	(15.90)
financial			15.91*	(6.980)
food_beverage			-9.050	(16.43)
metals_mining			21.29	(23.09)

oil_gas			-15.18	(10.55)
paper_forestry			68.28**	(24.35)
real_estate			1.187	(14.14)
transport			-30.70	(16.22)
_cons	-13.86	(14.31)	7.252	(17.37)
/				
sigma_u	23.60***	(2.578)	18.05***	(2.241)
sigma_e	20.22***	(1.250)	20.12***	(1.234)
N	295		295	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As the tobit model is used to assess dependent variables that have a limited range, in this case Scope 3 score which is limited to values between 0 and 100, an adjusted r-squared value was not calculated to assess goodness of fit as it does not take into account the censored nature of the data and the presence of random effects. Table 5.7 contains some post-estimation statistics that can help us to understand the goodness of fit of the tobit models.

Table 5.7 Tobit posit-estimation statistics

Statistic/Model	Tobit model 3	Tobit model 4
AIC	2084.793	2071.414
BIC	2136.41	2174.649
rho	0.5822724	0.4459217

We can see that results from model 3 and model 4 are fairly similar, with model 4 having a slightly lower AIC and model 3 having a lower BIC. The value of rho can be interpreted as the variance explained by the random effects component of the model. As we are trying to estimate the average effect of the predictor variables on the dependent variable, the lower value of rho in model 4 indicates a better goodness of fit, suggesting that there is less variation in the dependent variable that is due to unobserved heterogeneity across individuals.

One thing to note at this stage is the high value of the standard errors for many of the variables in the models. As mentioned in section 4.1 the aim of this project is not to generate insights that can be generalised across the entire population, thus a purposive sample was chosen. A small, non- random sample could be the cause of the large standard errors in the model, as it is highly likely that variance seen in the model does not accurate reflect the true population variance.

Both tobit model 3 and tobit model 4 will be used to answer the following research questions, as we can compare the two to see if any effects still hold whilst taking industry factors into account.

5.3 RQ2

Is Scope 3 reporting performance linked to the materiality of Scope 3 emissions?

H2:The more material scope 3 emissions are to a firm, the more comprehensive their scope 3 reporting is.

The data set contains 17 firms where Scope 3 emissions have been deemed 'somewhat material' – their Scope 3 emissions account for between 30% - 49% of the sector's total emissions. For the remaining 83 firms, Scope 3 emissions are 'very material' – they account for 50% or more of the sector's total emissions. These 83 firms are represented under the independent variable 'material_1' in model 3 and model 4, with the other 17 firms under 'material_2', which is omitted from the model due to multicollinearity with 'material_1'. The variable 'material_1' was not found to be significant at the 5% level in either model 3 or model 4.

As we can see from figures 5.1 and 5.2 below, firms under 'material_1' did have higher average Scope 3 scores than firms under 'material_2' in each of the three years.

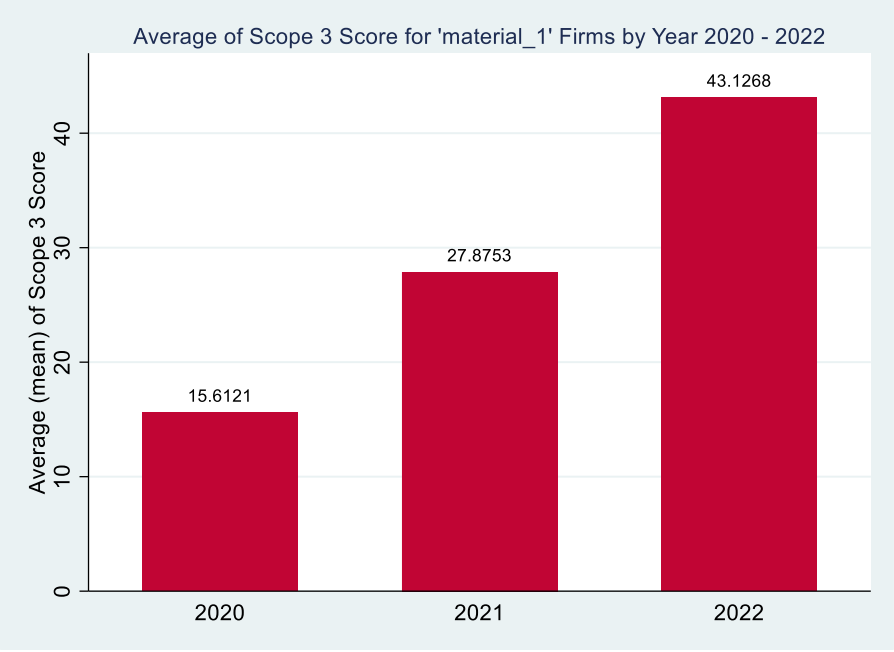

Figure 5.1 The average Scope 3 score for 'material_1' firms from 2020 – 2022

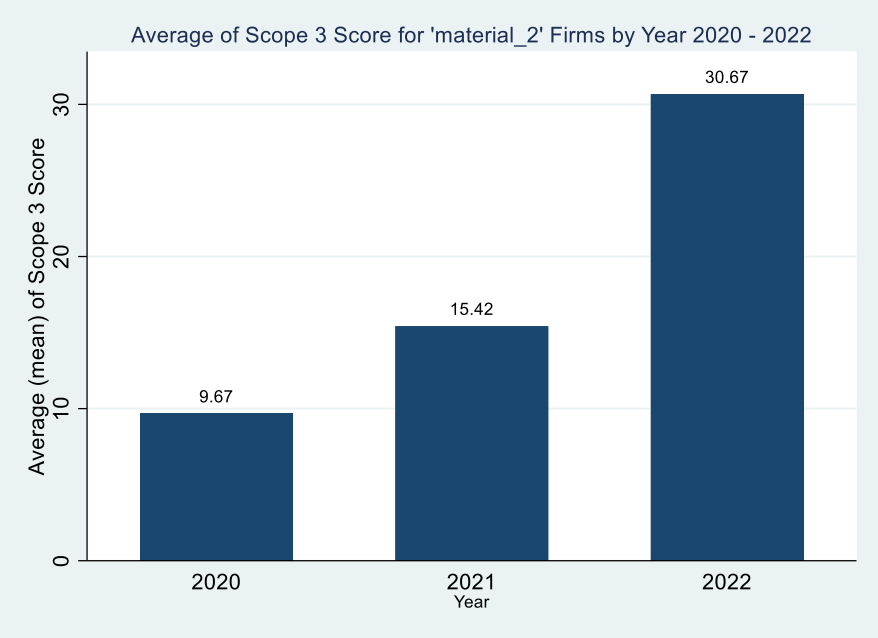

Figure 5.2 The average Scope 3 score for 'material_2' firms from 2020 - 2022

As the 'material_1' variable was not found to be significant at the 5% level, it means that the difference in the average score between the two groups is explained by other factors from the model, and Scope 3 emissions being 'very material' to a firm is not a significant factor for having a higher Scope 3 score.

Thus, no evidence was found to support H2. There are two ways to frame this finding. First, in terms of the requirements on Scope 3 reporting coming into force from the CSRD. Many of the companies in the data set will have to start reporting at the same time, so whether Scope 3 emissions are deemed material or not to their sector is irrelevant in terms of preparations to fulfill regulatory requirements, although those with larger more fragmented value chains may have a bigger job to do to adequately prepare. On the other hand, if firms were looking to effectively manage their climate risks, we could expect firms that have Scope 3 emissions as a large share of their total emissions to perform better than those firms where Scope 3 is not as material to the firm. My results indicate that firms are not sufficiently mapping their value chain climate risks, meaning that they have a lot of work to do to prepare for the upcoming Scope 3 reporting requirements in the ESRS.

5.4 RQ3

Is Scope 3 reporting performance linked to certain firm level characteristics?

H3: The age of a firm is positively related with Scope 3 reporting performance.

To test this hypothesis the dummy variable 'new_firm' was created , to distinguish between firms founded before and after the year 2000. The continuous variable 'age_firm' was not used due to the distribution being highly skewed towards younger firms.

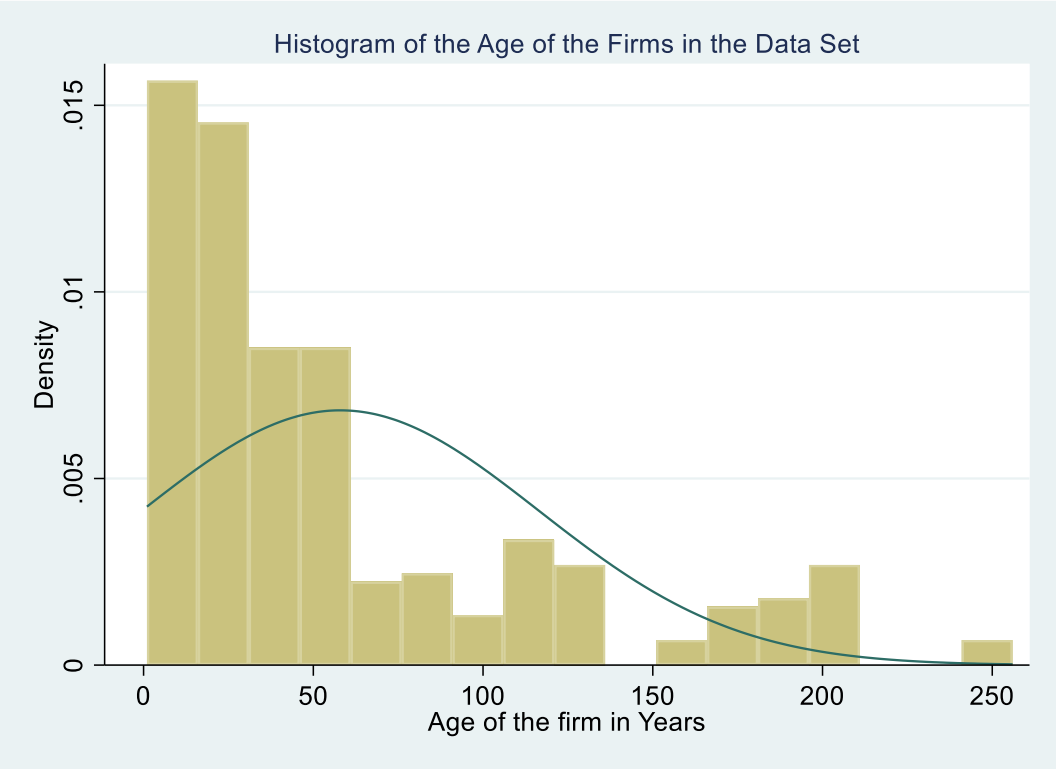

Figure 5.3 Histogram of the age of the firms in the data set

Model 3 and Model 4 showed quite similar results for the variable 'new_firm', with coefficients of -18.58 and -15.92 respectively with both found to be significant at the 1% level. This can be interpreted as firms that were founded in or after the year 2000 have an average of 18.58 and 15.92 lower Scope 3 score than firms founded before the year 2000 keep everything else constant, from model 3 and model 4 respectively.

Similar results from model 3 and model 4 mean that this effect still holds even when the sector a firm belongs to is taken into account.

In this case, no evidence was found to support H3 and we can say that younger firms perform statistically less well on Scope 3 performance than older firms do. From the literature we can assume that this is down to older firms having more established organizational practices that

can be exploited to increase sustainability disclosure performance in terms of their Scope 3 reporting.

H4: Firm size and Scope 3 reporting performance are positively related.

To test this hypothesis, the dummy variables 'small_firm' and 'medium_firm' were created to represent firms with between 0 – 99 employees and 100 – 5999 employees respectively. The continuous variable 'employees' was not used due to the highly skewed distribution of the variable towards smaller firms.

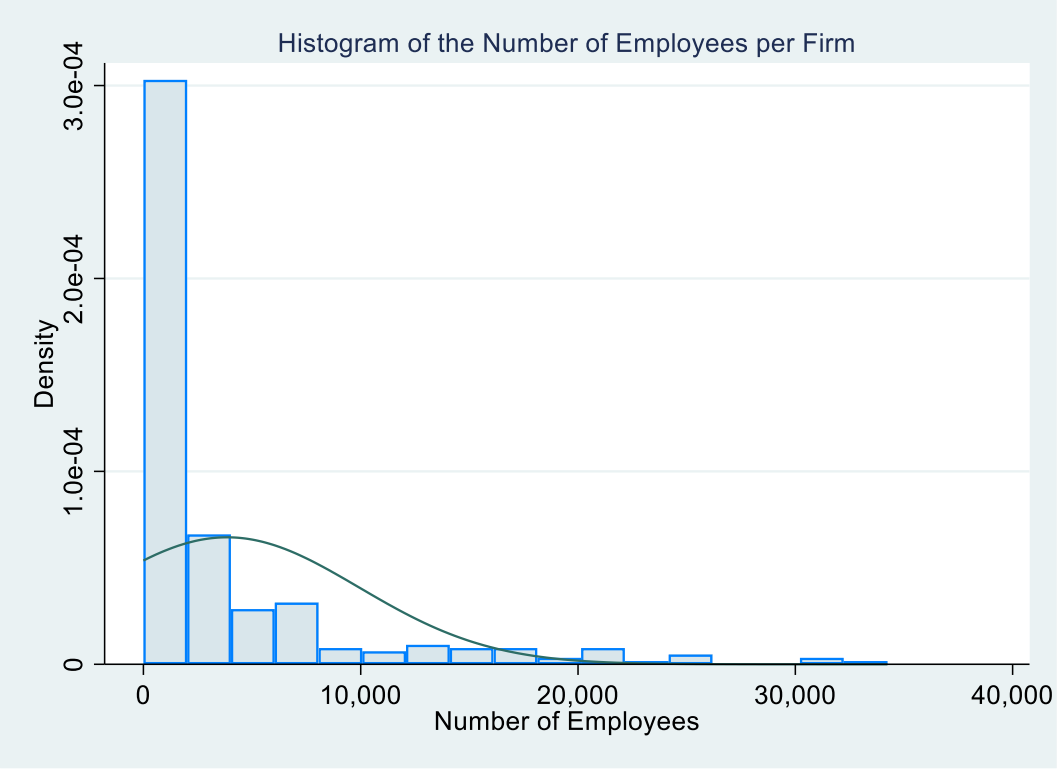

Figure 5.4 Histogram of the age of the firms in the data set

The variable 'small_firm' was found to be statistically significant at the 5% level in model 3 and model 4, with similar positive coefficients of 22.71 and 24.43 respectively. In model 3 this can be interpreted as a small firm with less than 100 employees has an average of a 22.71 point higher Scope 3 score than large firms with over 6000 employees when all else remains constant and the sector the firms belongs to is not taken into account.

From model 4 we can say that small firms have on average a 24.43 point higher Scope 3 score than large firms, even after the industry the firm belongs to is taken into account.

The variable ‘medium_firm’ was not found to be significant at the 5% level in either of the models.

No evidence was found to support H4. In this sample, it can be said that smaller firms perform better on Scope 3 disclosure than larger firms. Although this finding goes against most of the literature regarding firm size and sustainability disclosure performance, previous evidence from Norway also found that larger firms did not outperform smaller firms in terms of sustainability reporting performance. The 2009 study from Vormedal & Ruud found a relatively even distribution of sustainability reporting scores across all firm sizes, however their measure of firm size was annual turnover rather than the number of employees (Vormedal & Ruud, 2009).

Given the evidence from my project and the findings from Vormedal & Ruud differ from most of the other literature that has looked at firm size and sustainability disclosure performance, it is plausible to say that large firms performing worse than, or in the case of Vormedal & Rudd not better than, smaller firms is something that is seen specifically in the Norwegian market.

One possible explanation for this finding is that as Norway is a small country, larger firms may face less domestic competition and do not feel that they must perform well on sustainability disclosure in order to stay competitive and differentiate themselves from others in the market.

H5: We can expect performance to vary by sector due to industry, and literature suggests the financial sector as well as the oil and gas sector will have higher scores whilst the transport sector will have the lowest scores.

To test this hypothesis, we can look at the results from model 4 which includes dummy variables for each of the 13 industries in the sample (the ‘general’ industry was omitted for multicollinearity reasons and will serve as a comparison for the remaining sectors).

From this model, four of the industries were found to have a positive, statistically significant effect on the Scope 3 score at the 5% level when compared to the ‘general’ industry: ‘paper & forestry’, ‘chemicals’, ‘construction’ and ‘financial’.

The ‘paper & forestry’ sector had a coefficient of 68.28, which can be interpreted as firms in that sector score on average 68.28 points higher in their scope 3 score than firms in the ‘general’ industry. The same can be said for the ‘chemicals’ sector (57.74), ‘construction’ sector (35.78) and ‘financial’ sector (15.91).

It is important to note that three of these industries had very few observations in the data set – ‘paper & forestry’ 1, ‘chemicals’ 3 and ‘construction’ 2, which may have influenced the outcome. If the same study was performed with a larger data set, it is possible that we could see different sectors with statistically significant results.

Evidence to support H5 was mixed. The ‘financial’ sector did have a positive, statistically significant coefficient of 15.91, which fits with the most recent literature from Ecovadis of the sector performing well in terms of disclosure. The ‘transport’ sector was found to have a coefficient of -30.70, fitting in with the expectation that this sector performs badly on sustainability disclosure performance, and with a p-value of 0.058 only just missed out on being significant at the 5% level. The ‘oil and gas’ sector was found to have a coefficient of -15.18, going against previous literature that suggests they would score highly on sustainability disclosure, but this would only be considered significant at the 15% level as the p-value was 0.150.

One thing that is important to note when discussing H3, H4 and H5 is that previous literature focuses on a general sustainability disclosure performance and firm characteristics. This paper is specifically measuring the Scope 3 performance, so it is possible that whilst some firms perform well on overall sustainability disclosures, their Scope 3 disclosures may not contribute much to those scores. As Scope 3 becomes more important over time due to the imminent reporting requirements from the CSRD and as investors expectation over supply chain transparency grow, it can be expected that more studies will look at Scope 3 performance, especially as more data becomes available.

5.5 RQ4

Does setting targets lead to improved Scope 3 performance?

H6: Setting a Net-zero target leads to an improved Scope 3 performance.

To test this hypothesis the dummy variable 'net_zero' was added to model 3 and model 4, coded 1 when the company has committed to achieving net-zero in their annual or sustainability report and 0 if they have not.

The variable was found to be not significant at the 5% level in either of the models, thus no evidence to support H6 was found.

I suggest that this is because net-zero targets are something that are easily promised by the firm, but information on how the company will achieve this target is rarely given. For one firm in the data set, a net-zero target was set in 2020 but then taken back in a later report once they had decided to work towards setting a SBTi, which shows the ad hoc nature of unrealistic net-zero targets. In many cases when a company sets a net-zero target, it excludes Scope 3 emissions and only includes its Scope 1 and Scope 2 emissions, which may also explain why it was not have a significant effect on Scope 3 performance.

H7: Setting Science Based Targets leads to an improved Scope 3 performance.

To test this hypothesis the dummy variable 'sbti' was created to represent if a firm has had emissions reduction targets verified by the Science Based Targets Initiative, 1 if yes and 0 if no.

This variable was found not to be significant at the 5% level in either of the models. Although in model 4 in could be considered significant at the 10% level with a p-value of 0.097 and a beta coefficient of 8.321, interpreted as firms that set an SBT had a higher Scope 3 score by 8.321 points than firms who did not, all else remaining equal.

From the figure below we can see that the number of firms setting SBTs has increased from just 4 in 2020 to 33 in 2022, an astonishing 825% increase.

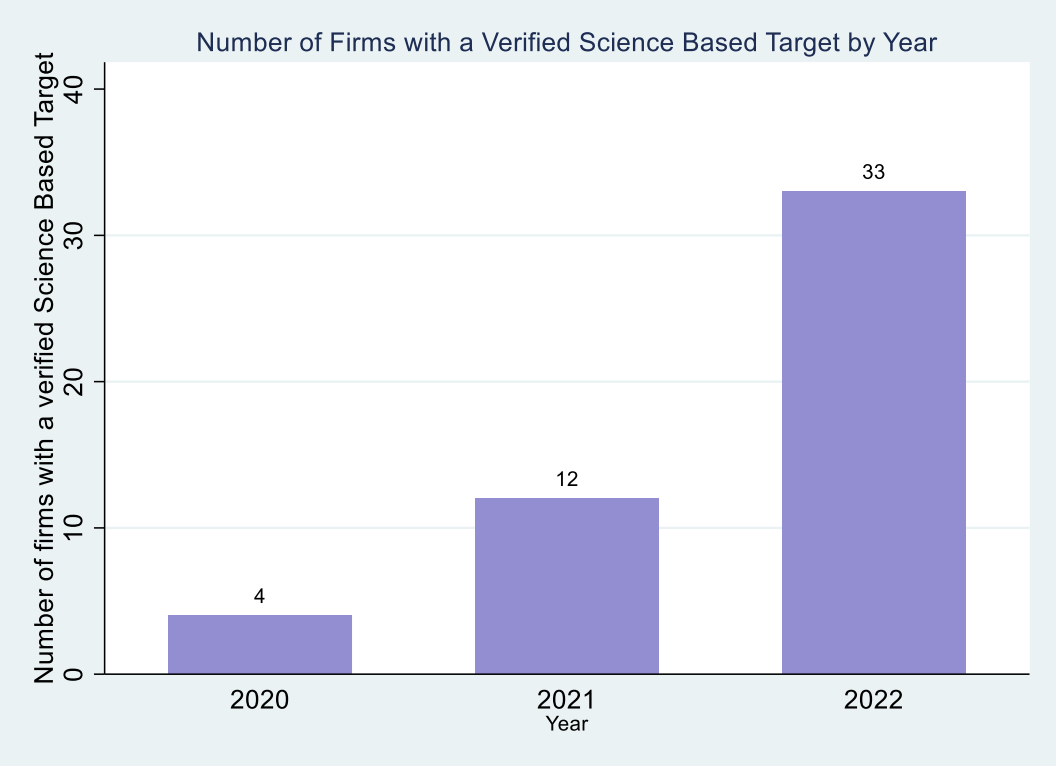

Figure 5.5 Number of firms with a verified science based target by year 2020 – 2022

As with net-zero targets, many firm's SBTs do not include targets for Scope 3 emissions, which is probably why this variable was not found to have a significant effect on the Scope 3 score. As more companies set SBTs with SBTI new methodology which states that Scope 3 targets must be set if the emissions from Scope 3 exceed 40% of the firm's total emissions, it is likely that this variable could become significant to the outcome on Scope 3 score. As it is now, I conclude that no strong evidence was found to support H7.

H8: Setting a Scope 3 target leads to an improved Scope 3 performance.

The variable 'scope3_target' was used to test this hypothesis, a dummy variable created if a firm had set an emissions reduction target for their scope 3 emissions, 1 for yes and 0 for no.

The variable was found to be significant at the 0.1% level in both model 3 and model 4, with a beta coefficient of 22.10 and 18.47 respectively, with an interpretation that setting a Scope 3 target for emissions leads to a 22.10 and 18.47 point increase in Scope 3 score.

This result is the most interesting out of all of the 'target' hypothesis, and is also the least surprising. For firms to set a Scope 3 target, they must already be working towards measuring and managing their Scope 3 emissions in order to have a baseline for emission reduction. But

as with net-zero targets, Scope 3 targets are generally not verified by any third party organization at the moment, so setting them does not necessarily mean that a firm is doing well in terms of their Scope 3 performance. This could possibly be why we do not see a larger beta coefficient for this variable.

Strong evidence was found to support H8. Given this evidence, I suggest that EFRAG make Scope 3 target setting mandatory in future versions of the ESRS, once Scope 3 reporting becomes more established. This would lead to firms better managing their Scope 3 emissions and help to achieve the CSRD's aim of funneling money into sustainable activities.

5.6 RQ5

Is Scope 3 emissions reporting performance linked to financial performance?

H9: Scope 3 emissions reporting performance increases with the value of the firm.

The variable 'firm_value' represents an average value of the market capitalization (in billions of NOK) of the firm at the year end of 2020, 2021 and 2022. The reason that an average value was used to test this hypothesis, rather than the firms yearly market cap was because the data set only spans 3 years, and I do not believe changes in the value of the firm from year to year would have a significant influence on the firms Scope 3 performance. This is because actions to map the firms value chain and the measure Scope 3 emissions are complex and take time to complete and I do not believe one 'bad' financial performance for a year would significant impact the firms plan to measure Scope 3.

This variable had a very low coefficient value, and while it was positive it was not statistically significant in either model 3 or model 4.

Therefore, no evidence was found to support H9. It is possible that other measures of financial performance, such as turnover or profit, may give more interesting results when looking at financial performance and Scope 3 performance, and could be an area of interest to explore further in subsequent studies.

H10: Firms with a better Scope 3 score saw a more stable share price from 2020 to 2022.

To test this hypothesis, the variable 'change_share_price' was used, which represents the average percentage change in share price for the firm from 31st December 2020 to 31st December 2022.

As which the 'firm_value' variable, it was decided to use an average change rather than a year change in share price, as I believe a firm's Scope 3 reporting plans would not be drastically affected by yearly changes.

Model 3 identified this variable as statistically significant at the 5% level, with a coefficient value of -10.32. The value of 'change_share_price' can be both positive or negative, we must be careful when interpreting the meaning. A one unit change in 'change_share_price' i.e. a one percentage change in share price, positive or negative, leads to a -10.32 point reduction in Scope 3 score, compared with the 'general' industry. If the percentage change in share price is negative, then it will lead to an increased Scope 3 score and if the percentage change in share price is positive it will lead to a decrease in Scope 3 score.

However, when we look at model 4 which includes industry level dummy variables, we see that the coefficient size of 'change_share_price' changes from -10.32 in model 3 to -7.557, and it is no longer considered significant at the 5% level.

We can interpret this to mean that industry level factors can explain the average change in share price over time, rather than the average change in share price affecting the Scope 3 score.

The table below shows the average percentage change in share price from 2020 – 2022 by industry.

Table 5.8 The average percentage change in share price from 2020 – 2022 by industry

Industry	Average Percentage Change in Share Price from 2020 - 2022	Industry	Average Percentage Change in Share Price from 2020 - 2022
transport	+107%	capital_goods	-12%
metals_mining	+84%	construction	-15%
oil_gas	+67%	food_beverage	-22%
financial	+26%	electric_utilities	-23%
chemicals	+17%	agriculture	-24%
paper_forestry	-7%	real_estate	-32%
general	-10%		

If there were no industry effects that affected the average change in share price, we could expect to see the figures in this table to be closer to zero, as performance by firms within the industry, both positive and negative, would be balance out once the industry average was taken. Yet we can see very high positive and negative values for the different industries.

The transport sector, metal and mining sector and the oil and gas sector all performed very well between 2020 – 2022, seeing a very high increase in share prices. Similarly, the food and beverage sector, electric utilities sector, agriculture sector and real estate sector all saw shares price decrease by over 20% over the same time period.

Therefore, I believe that although model 3 saw 'change_share_price' to be significant at the 5% level, we have no evidence to support H10, as this significance disappears in model 4 when taking industry level factors into account.

5.7 RQ6

Have Scope 3 emissions reporting efforts by firms improved from 2020 to 2022?

H11: The number of firms reporting on Scope 3 emissions has increased from 2020 to 2022.

The data showed that in 2020 only 58.16% of companies in the sample reported on Scope 3 emissions. This rose to 77% in 2021 and to 84.54% in 2022.

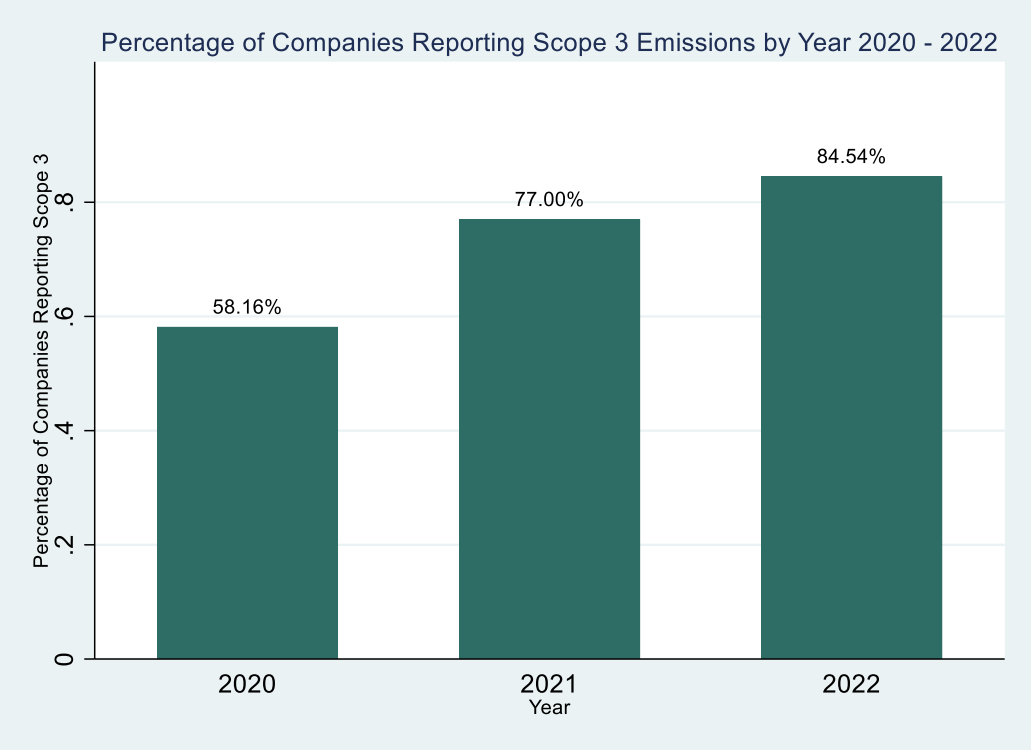

Figure 5.6 The percentage of companies reporting Scope 3 emissions by year from 2020 – 2022.

When looking at the data on the industry level, we can see that all sectors apart from one saw an increase in the number of companies reporting from 2020 to 2022.

In the case of the 'agricultural commodities' sector, one firm only reported one category(category 5 – Waste) each year in both tons of waste and in tons of C02e, apart from in the year 2022 when the emissions figure was not reported. This is the reason they were not recorded as reporting any Scope 3 emissions in the year 2022 and why the number of companies reporting Scope 3 in this sector decreased.

For the year 2022, there were eight sectors where every firm in the sector reported on Scope 3 emissions: capital goods, chemicals, construction, electric utilities, metals and mining, real estate, food and beverage and paper and forestry. These are the eight categories with the fewest firms in, so it is not surprising that the five most populus sectors in the sample (general, financial, oil and gas, agricultural and transport) were the ones that contained firms who have not yet reported Scope 3.

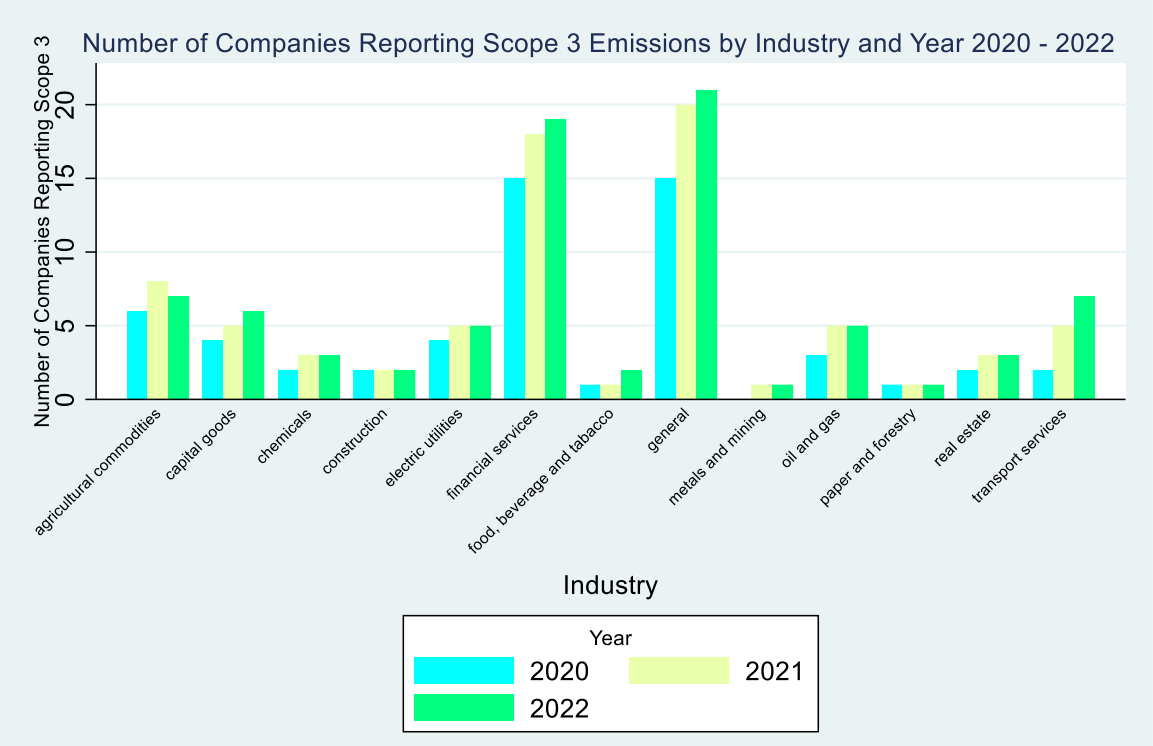

Figure 5.7 The number of companies reporting Scope 3 emissions by industry for the years 2020 – 2022.

If we go back to look at logistic model 2 from research question 1, we see that both year_2021 and year_2022 are positive and significant at the 5% significance level. A Wald test for joint significance of these two variables in model 2 showed a p-value of 0.0198,

meaning that their effect on the prediction of whether or not a firm reports Scope 3 emissions is significantly different from zero at the 5% significance level. As both coefficients are positive and the coefficient for 2022 is higher than for 2021, we can infer that the number of companies reporting Scope 3 emissions is increasing from year to year,

Data supports H11 and it is found that the number of companies reporting Scope 3 emissions did increase from year to year.

H12: The quality of Scope 3 reporting by firms has improved between 2020 and 2022.

There are two ways in which I have measured the quality of Scope 3 reporting, the first is by looking at the number of Scope 3 categories reported on each year. We can see from the graph below that the average number of Scope 3 categories reported on increase each year in the data set, from 1.74 categories per firm in 2020, to 2.79 categories per firm in 2021 (an increase of 60.34%). From 2021 to 2022 the average number of categories reported on rose by 48.75% to 4.15 categories per firm. When a firm adds a category to their Scope 3 inventory, they are mapping more of their value chain and get a better understanding of where their indirect emissions are coming from.

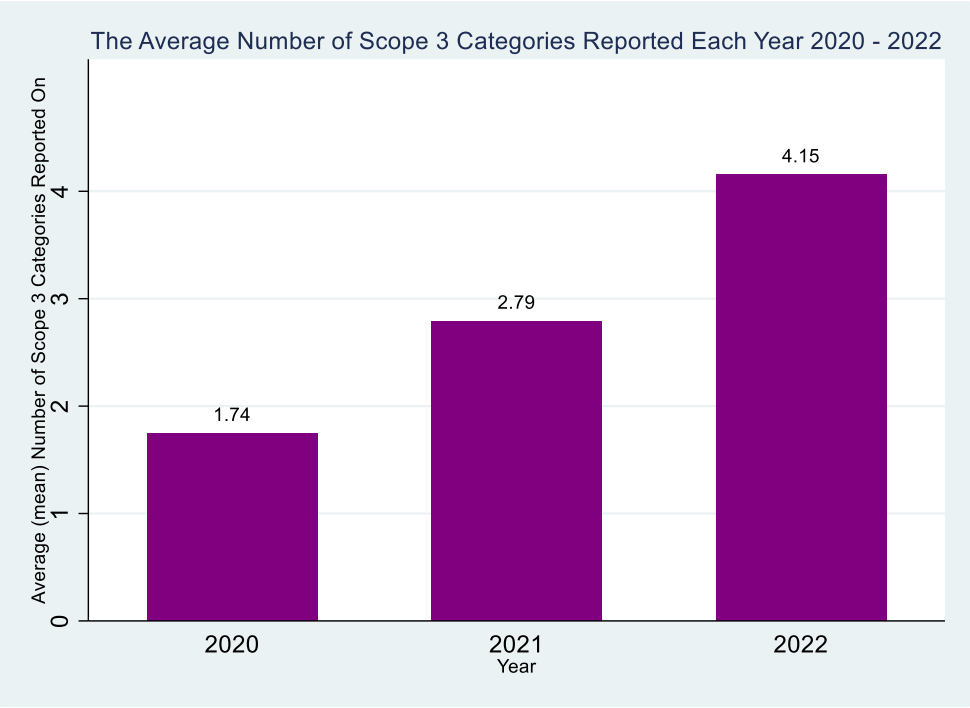

Figure 5.8 The average number of Scope 3 categories reported per firm per year from 2020 – 2022.

The second way to measure how the quality in Scope 3 reporting has changed is by using the Scope 3 score that has been specifically created for this paper. The score builds on the number of categories reported but is also weighted to reward firms that report on categories that have been deemed material to their industry. As you can see from the table below, the average Scope 3 score increases from year to year in the data set. The average score for 2020 is 14.64 and we see a 76.78% increase from this in 2021 to 25.88. In 2022 we see an even higher average score of 41.22, which represents a 59.27% increase from 2021.

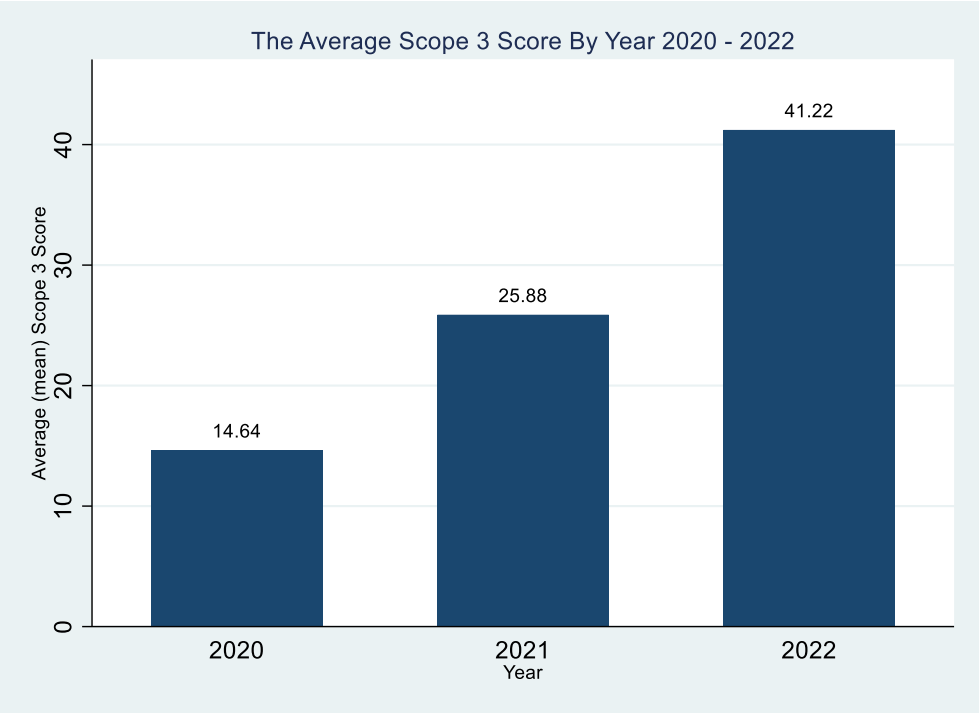

Figure 5.9 The average Scope 3 score by year from 2020 – 2022.

As the rate of increase is greater for the Scope 3 score than it is for the average number of categories reported from 2020 to 2021 and from 2021 to 2022, this shows that firms are not only increasing their Scope 3 reporting by adding the 'easiest' categories, but that they are adding categories that are material to their industry.

A Wald test for joint significance of 'year_2021' and 'year_2022' in the tobit random effects model showed a p-value of 0.00, for both model 3 and model 4. As both of the coefficients are positive, with 2022 having a high coefficient value that 2021, we can infer that the year has a significant effect on a firms scope 3 performance, with performance level increasing year on year. Thus, there is strong evidence to support H12.

However, whilst Scope 3 reporting performance is moving in the right direction, many firms are still a long way off from reaching the Scope 3 reporting level that will be mandated in the ESRS.

5.8 Sensitivity Analysis

When comparing results using the three different Scope 3 scores that were calculated in section 4.3.1, no interesting significant differences were found in model 3 or in model 4. All the same variables from the main regression model with 'score_2' remained at the same significance level, and 'score_2' provided the medium value in terms of coefficient value across all variables. See appendix VII for full model comparison results.

6. Conclusion

The objective of this thesis is to assess the current state of Scope 3 emissions reporting in Norway in light of new EU regulations that will make Scope 3 reporting mandatory for many businesses for the first time. As Scope 3 emissions reporting is currently voluntary, a firm that reports well on Scope 3 can be considered to be pro-active in their approach to identifying and managing climate risks, as well as pre-emptively preparing themselves for future regulations.

Overall, it was found that the number of firm reporting on Scope 3 emissions has risen year to year from 2020 to 2022. A logistic model containing firm and industry level data was able to correctly predict whether or not a firm reports on Scope 3 with a model accuracy level of 85.05%.

The quality of Scope 3 reporting was measured with a 'Scope 3 score' which takes into account how many of the 15 Scope 3 categories a firm reports on, and how many of those categories have been deemed to be material to their sector. The average Scope 3 score increased each year from 2020 to 2022, meaning that firm are not only increasing the number of categories they report on, but also focusing on reporting the most material categories for their sector, something that the CSRD legislation mandates that firms do.

Several variables were found to have a significant influence on a firm's Scope 3 score, as determined by a tobit random effects model. Smaller firms were linked with an improved Scope 3 reporting performance compared with the largest firms, but newer firms were found to have a negative link with Scope 3 reporting performance when compared to older firms.

Firms that had set scope 3 target were on average expected to have a 20 point higher Scope 3 score than firms who had not set any targets for Scope 3 emissions. Certain sectors were linked to an improved Scope 3 reporting performance, with the chemical, financial and paper & forestry sectors all expecting to have higher scores than the 'general' sector.

No evidence was found to suggest that Scope 3 reporting performance was positively linked to the materiality of Scope 3 emissions to a firm, possibly signifying a lack of climate risk management by firms in failing to fully map out their value chain emissions. Thus, firms with large complex value chains can expected to have more work to do in order to prepare themselves for the Scope 3 reporting requirements in the ESRS.

Whilst firm value was found to increase the odds that a firm reports on Scope 3 emissions, it was not found to significantly effect a firms' Scope 3 performance. The percentage change in a firms' share price from 2020 to 2002 was also not found to be significant once industry levels factors were taken into account.

Overall, it can be said that the level of Scope 3 reporting by firms in Norway is improving and moving in the right direction, but the majority of firms have a lot of work ahead of them if they are to meet the requirements set out in the ESRS once their implementation beings.

6.1 Limitations and Recommendations

The main limitation of this study is the small, non-random sample that was used to assess the dependent variables in the logistic and tobit models. The aim of this thesis was not to generate insights into Scope 3 reporting that could be generalised across the entire population, but the purposive sample may have biased the results of the regression models.

The Scope 3 score that was created by me to indicate a firms' performance on Scope 3 reporting may also indicate bias results. Although sensitivity analysis was performed and did not find results to be significantly different, the way in which the materiality of the different Scope 3 categories has been defined for each industry could lead to some firms scoring better or worse than their actual performance indicates. This is because Scope 3 categories that are material to individual firms may vary within a sector, something that is only partially taken into account in the Scope 3 score by giving points to the overall number of categories reported on. Several firms also 'attempted' to fully map their Scope 3 emissions but were not given credit for doing so under my scoring system as they did not provide full explanations as

to why some Scope 3 categories were not included, something which is mandated under the GHG Protocol which is recommended to use under the ESRS.

In terms of recommendations for future studies on the issue of Scope 3 reporting, it would be interesting to run the same study in 2024 once firms' have had one more year to prepare for the implementation of the CSRD. I would expect to find that the number of firms reporting Scope 3 to increase, and for the overall Scope 3 score to also increase as more firms start to measure their most material Scope 3 categories.

This thesis lays the basis for measuring a firms' Scope 3 reporting performance, but in time once more data becomes available, it would be beneficial to look at whether Scope 3 reporting performance is linked to a *reduction* in Scope 3 emissions. At the moment this is not possible, as Scope 3 emissions figures are generally increasing as more of the firm's value chain gets mapped and measured. But once the ESRS have been used by businesses for several years in a row, good quality standardized data should be available to evaluate this relationship.

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Appendix

Appendix I. CSRD Guidance for Scope 3 emissions targets

Paragraph	Requirement
32 (a)	GHG emission reduction targets shall be disclosed in absolute value (either in tonnes of CO2 equivalent or as a percentage of the emissions of a base year) and, if deemed meaningful, in intensity value.
32 (b)	GHG emission reduction targets shall be disclosed for Scope 1, 2, and 3 GHG emissions. The undertaking shall explain how the consistency of these targets with the GHG inventory boundaries is ensured (as required by Disclosure Requirement E1-6). The undertaking shall not include GHG removals, carbon credits or avoided emissions as a means of achieving the GHG emission reduction targets.
32 (c)	The undertaking shall disclose its current base year and baseline value, and from 2030 onwards, update the base year for its GHG emission reduction targets after every five-year period thereafter. The undertaking may disclose the past progress made in meeting its targets before its current base year provided that this information is consistent with the requirements of this [draft] Standard.
32 (d)	GHG emission reduction targets shall at least include target values for the year 2030 and, if available, for the year 2050. From 2030, target values shall be set after every five-year period hereafter.
32 (e)	The undertaking shall state whether the GHG emission reduction targets are science based and compatible with limiting global warming to 1.5°C. The undertaking shall state which guidance or framework has been used to determine these targets including the underlying climate and policy scenarios. As part of the critical assumptions for setting GHG emission reduction targets, the undertaking shall briefly explain how it has considered future developments (e.g., changes in sales volumes, shifts in customer preferences and demand, regulatory factors, and new technologies) and how these will potentially impact both its GHG emissions and emissions reductions.

32 (f)	The undertaking shall describe the expected decarbonisation levers and their overall quantitative contributions to achieve the GHG emission reduction targets (e.g., energy or material efficiency and consumption reduction, fuel switching, use of renewable energy, phase out or substitution of product and process).

(EFRAG, 2022a)

Appendix II. CSRD Requirements for reporting Scope 3 emissions

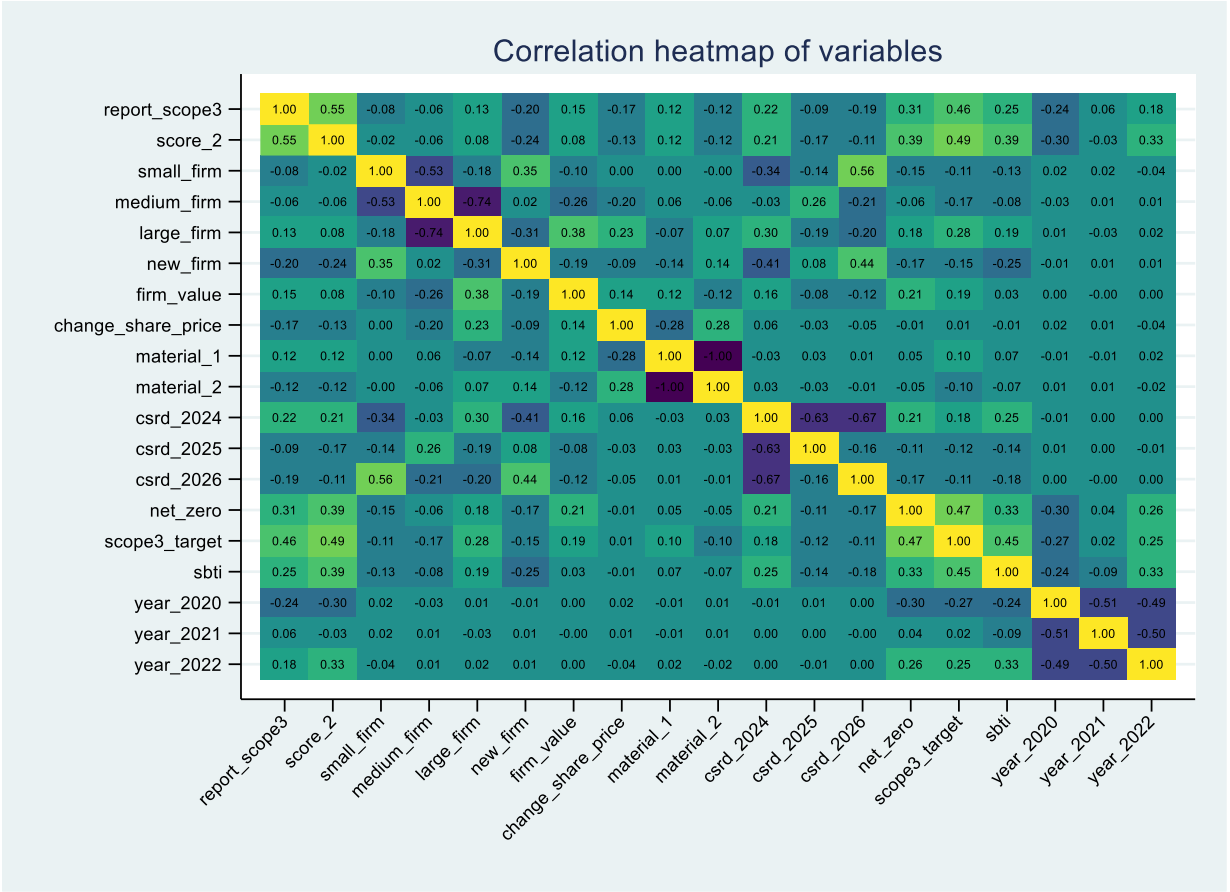
Paragraph	Requirement
AR 44. (a)	Consider the principles and provisions of the GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (Version 2011 or latest one); and it may consider the corresponding requirements for the quantification of indirect GHG emissions from ISO 14068:2018.
AR 44. (b)	If it is a financial institution, consider the GHG Accounting and Reporting Standard for the Financial Industry from the Partnership for Carbon Accounting Financial (PCAF).
AR 44. (c)	Screen its total Scope 3 GHG emissions based on the 15 Scope 3 categories identified by the GHG Protocol Corporate Standard and GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (Version 2011) using appropriate estimates. Alternatively, it may screen its indirect GHG emissions based on the categories provided by ISO 14064:2018 clause 5.2.4 (excluding indirect GHG emissions from imported energy).
AR 44. (d)	Identify its significant Scope 3 categories based on the magnitude of their estimated GHG emissions and other criteria provided by GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (Version 2011, p. 63 and 65-68) or ISO 14064-1:2018 Annex H.3.2, such as financial spend, influence, related transition risks and opportunities or stakeholder views.
AR 44. (e)	Calculate or estimate GHG emissions in significant Scope 3 categories using emissions factors recommended by the GHG protocol such as IPPC,

	ASHRAE Standard 34 / World Resources Institute and The Climate Registry.
AR 44. (f)	At least update the Scope 3 inventory every three years and in case of major changes (Explanatory note: Scope 3 GHG emissions need to be disclosed every year, but a full update of the underlying inventory is only expected every three years unless major changes occur).
AR 44. (g)	Disclose the percentage of emissions calculated using primary data obtained from suppliers or other value chain partners.
AR 44. (h)	For each significant Scope 3 GHG emissions category, disclose the reporting boundaries considered, the calculation methods for estimating the GHG emissions as well as if and which calculation tools were applied. The Scope 3 categories should be consistent with the GHGP and include: i. indirect Scope 3 GHG emissions from the consolidated accounting group (the parent and its subsidiaries), ii. indirect Scope 3 GHG emissions from associates, joint ventures, and unconsolidated subsidiaries for which the undertaking has the ability to control the operational activities and relationships (i.e., operational control), iii. Scope 1, 2 and 3 GHG emissions from associates, joint ventures, unconsolidated subsidiaries (investment entities) and joint arrangements for which the undertaking does not have operational control and when these entities are part of the undertaking's value chain.
AR 44. (i)	Disclose a list of Scope 3 GHG emissions categories included in and excluded from the inventory with a justification for excluded Scope 3 categories.
AR 44. (j)	Disclose biogenic emissions of carbon from the combustion or biodegradation of biomass that occur in its value chain separately from the gross Scope 3 GHG emissions, and include emissions of other types of GHG (such as N2O), and emissions of CO2 that occur in the life cycle of biomass other than from combustion or biodegradation (such as GHG emissions from

	processing or transporting biomass) in the calculation of Scope 3 GHG emissions.
AR 44. (k)	Exclude any purchased, sold or transferred carbon credits or GHG allowances from the calculation of Scope 3 GHG emissions.
AR 44. (l)	Disclose carbon uptakes and emissions (CO2, CO, CH4) from land use and land use change in its value chain separately from the Scope 3 GHG emissions, but include emissions of other types of GHG when applicable.
AR 48.	The Scope 3 GHG emissions may also be presented by overarching Scope 3 categories of the GHG Protocol to highlight the major sources of emissions in the value chain: (a) Upstream purchasing: "purchased goods and services", "capital goods", "fuel- and energy-related activities (not included in Scope 1 or Scope 2)", "upstream leased assets" and "waste generated in operations"; (b) Downstream sold products: "processing of sold products"; "use of sold products", "end-of-life treatment of sold products", "Downstream leased assets", "Franchises"; (c) Goods transportation: "upstream transportation and distribution" and "downstream transportation and distribution"; (d) Travels: "business travels" and "employee commuting"; (e) Financial investments.
AR 49.	If it is material for the undertaking's Scope 3 emissions, it shall disclose the GHG emissions from purchased cloud computing and data centre services as a subset of the overarching Scope 3 category "upstream purchased goods and services".

(EFRAG, 2022a)

Appendix III. Correlation heatmap of variables



Appendix IV. Logistic model regression results

Logistic Model 1

Logistic regression — Number of obs = 295; LR chi2(13) = 114.13; Prob > chi2 = 0.0000; Log likelihood = -114.34687; Pseudo R2 = 0.3329

report_scope3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
small_firm	1.514162	.8271902	1.83	0.067	-.1071013	3.135425
medium_firm	.5088098	.584638	0.87	0.384	-.6370596	1.654679
new_firm	-.527074	.3822057	-1.38	0.168	-1.276183	.2220355
firm_value	.0164617	.0078895	2.09	0.037	.0009986	.0319248
change_share_price	-.7279893	.2393181	-3.04	0.002	-1.197044	-.2589344
material_1	-.0926963	.4705289	-0.20	0.844	-1.014916	.8295234
csrd_2024	1.222399	.5599448	2.18	0.029	.1249277	2.319871
csrd_2025	.8038738	.665377	1.21	0.227	-.5002413	2.107989
net_zero	.5855983	.5478262	1.07	0.285	-.4881214	1.659318
scope3_target	2.810145	.6132224	4.58	0.000	1.608251	4.012038
sbti	.6347511	1.160404	0.55	0.584	-1.639599	2.909101
year_2021	.6805211	.3841638	1.77	0.076	-.072426	1.433468
year_2022	.8422502	.4473765	1.88	0.060	-.0345916	1.719092
_cons	-1.678805	.864611	-1.94	0.052	-3.373411	.0158015

Logistic Model 2

Logistic regression — Number of obs = 286; LR chi2(23) = 139.61; Prob > chi2 = 0.0000; Log likelihood = -98.74955; Pseudo R2 = 0.4141

report_scope3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
small_firm	.9244548	1.023672	0.90	0.366	-1.081905	2.930815
medium_firm	.1803286	.6878342	0.26	0.793	-1.167802	1.528459
new_firm	-.7990104	.4265954	-1.87	0.061	-1.635122	.0371011
firm_value	.0234395	.0114532	2.05	0.041	.0009917	.0458874
change_share_price	-.6699792	.288989	-2.32	0.020	-1.236387	-.1035711
material_1	-1.222466	1.454717	-0.84	0.401	-4.073658	1.628727
csrd_2024	1.310763	.6379874	2.05	0.040	.0603304	2.561195
csrd_2025	-.0711267	.7552044	-0.09	0.925	-1.5513	1.409047
net_zero	.8130044	.5906253	1.38	0.169	-.3445999	1.970609
scope3_target	2.137134	.7038402	3.04	0.002	.7576329	3.516636
sbti	.8057492	1.212158	0.66	0.506	-1.570037	3.181535
year_2021	.9771587	.4262512	2.29	0.022	.1417216	1.812596
year_2022	1.204043	.4906912	2.45	0.014	.2423058	2.16578
agriculture	-.4001906	.7530099	-0.53	0.595	-1.876063	1.075682
capital_goods	.2661797	.8772242	0.30	0.762	-1.453148	1.985507
chemicals	-1.070603	1.693624	-0.63	0.527	-4.390045	2.248838
construction	0	(omitted)				
electric_utilities	1.061027	1.468031	0.72	0.470	-1.81626	3.938314
financial	2.137983	.7051653	3.03	0.002	.755884	3.520081
food_beverage	-2.412318	1.502292	-1.61	0.108	-5.356756	.5321194
metals_mining	-2.809471	2.069305	-1.36	0.175	-6.865234	1.246292
oil_gas	-.7880524	.6869582	-1.15	0.251	-2.134466	.5583609
paper_forestry	0	(omitted)				
real_estate	2.053767	1.211531	1.70	0.090	-.3207909	4.428325
transport	-1.572001	1.505209	-1.04	0.296	-4.522156	1.378154
_cons	-.4819751	1.670902	-0.29	0.773	-3.756883	2.792933

Note: 0 failures and 3 successes completely determined.

Appendix V. Panel model regression results

Pooled OLS

Model 3

Linear regression

Number of obs	=	295	
F(13, 99)	=	15.67	
Prob > F	=	0.0000	
R-squared	=	0.3958	
Root MSE	=	23.972	

(Std. Err. adjusted for 100 clusters in firm)

score_2	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
small_firm	19.60181	9.560761	2.05	0.043	.6311852	38.57243
medium_firm	7.332848	6.852005	1.07	0.287	-6.263017	20.92871
new_firm	-12.88372	3.848336	-3.35	0.001	-20.51966	-5.247787
firm_value	.0033497	.0176312	0.19	0.850	-.0316345	.0383339
change_share_price	-5.438913	2.473037	-2.20	0.030	-10.34596	-.5318706
material_1	.2203428	5.509254	0.04	0.968	-10.71121	11.1519
csrd_2024	4.750948	8.785209	0.54	0.590	-12.68081	22.18271
csrd_2025	-3.663236	9.418451	-0.39	0.698	-22.35149	15.02501
net_zero	7.50713	4.425441	1.70	0.093	-1.273905	16.28816
scope3_target	19.87712	3.766333	5.28	0.000	12.4039	27.35035
sbti	7.902161	6.113693	1.29	0.199	-4.228733	20.03305
year_2021	4.753482	2.569062	1.85	0.067	-.3440944	9.851059
year_2022	14.73174	4.019283	3.67	0.000	6.756613	22.70687
_cons	3.461426	12.23868	0.28	0.778	-20.82278	27.74563

Model 4 Pooled OLS

Linear regression

Number of obs	=	295
F(23, 99)	=	.
Prob > F	=	.
R-squared	=	0.5194
Root MSE	=	21.852

(Std. Err. adjusted for 100 clusters in firm)

score_2	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
small_firm	22.08125	8.947024	2.47	0.015	4.328409	39.83408
medium_firm	12.25007	5.300343	2.31	0.023	1.733044	22.76711
new_firm	-11.61814	3.463814	-3.35	0.001	-18.4911	-4.745181
firm_value	.0274078	.0163757	1.67	0.097	-.0050851	.0599006
change_share_price	-4.551905	2.509555	-1.81	0.073	-9.531405	.4275959
material_1	-23.02302	8.461489	-2.72	0.008	-39.81245	-6.23359
csrd_2024	1.527506	8.237742	0.19	0.853	-14.81796	17.87297
csrd_2025	-8.473271	8.811356	-0.96	0.339	-25.95691	9.01037
net_zero	4.805967	4.164649	1.15	0.251	-3.4576	13.06953
scope3_target	15.26357	4.017723	3.80	0.000	7.291531	23.2356
sbti	8.231414	4.718408	1.74	0.084	-1.130932	17.59376
year_2021	6.042116	2.441582	2.47	0.015	1.197488	10.88674
year_2022	16.7958	3.594494	4.67	0.000	9.663546	23.92806
agriculture	-.8724632	5.550355	-0.16	0.875	-11.88557	10.14065
capital_goods	4.742664	7.118827	0.67	0.507	-9.382634	18.86796
chemicals	40.76281	7.536956	5.41	0.000	25.80786	55.71777
construction	24.23659	32.92121	0.74	0.463	-41.08623	89.55941
electric_utilities	-20.30364	8.231109	-2.47	0.015	-36.63595	-3.971336
financial	9.568498	5.968212	1.60	0.112	-2.273729	21.41073
food_beverage	-7.585395	4.516321	-1.68	0.096	-16.54676	1.375966
metals_mining	18.20214	5.747126	3.17	0.002	6.798599	29.60569
oil_gas	-10.11161	6.36555	-1.59	0.115	-22.74224	2.519024
paper_forestry	46.09407	4.788424	9.63	0.000	36.5928	55.59534
real_estate	-10.5038	7.538454	-1.39	0.167	-25.46173	4.45413
transport	-23.42291	10.40633	-2.25	0.027	-44.07133	-2.774496
_cons	23.08984	11.85061	1.95	0.054	-.4243358	46.60402

Random Effects

Model 3 Random Effects

```
Random-effects GLS regression                   Number of obs     =        295
Group variable: firm                            Number of groups  =        100

R-sq:                                           Obs per group:
     within  = 0.3981                                         min =          2
     between = 0.3985                                         avg =        3.0
     overall = 0.3901                                         max =          3

                                                Wald chi2(13)     =     182.96
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000
```

score_2	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
small_firm	18.31119	8.333902	2.20	0.028	1.977038	34.64533
medium_firm	7.035311	5.470093	1.29	0.198	-3.685876	17.7565
new_firm	-12.37835	4.97503	-2.49	0.013	-22.12923	-2.627472
firm_value	.009434	.0252859	0.37	0.709	-.0401254	.0589933
change_share_price	-5.403691	2.895934	-1.87	0.062	-11.07962	.2722367
material_1	.7480315	5.927396	0.13	0.900	-10.86945	12.36551
csrd_2024	5.888668	7.166141	0.82	0.411	-8.156709	19.93405
csrd_2025	-3.405948	8.579467	-0.40	0.691	-20.2214	13.4095
net_zero	2.556724	3.705666	0.69	0.490	-4.706249	9.819697
scope3_target	17.68531	3.547641	4.99	0.000	10.73206	24.63856
sbti	8.52753	4.073775	2.09	0.036	.5430771	16.51198
year_2021	5.946241	2.605961	2.28	0.023	.8386514	11.05383
year_2022	16.76076	2.977619	5.63	0.000	10.92473	22.59678
_cons	3.510957	10.31359	0.34	0.734	-16.7033	23.72521
sigma_u	17.080942					
sigma_e	17.157932					
rho	.49775138	(fraction of variance due to u_i)				

Model 4 Random Effects

```
Random-effects GLS regression                   Number of obs     =       295
Group variable: firm                            Number of groups  =       100

R-sq:                                           Obs per group:
     within  = 0.4022                                         min =         2
     between = 0.5838                                         avg =       3.0
     overall = 0.5176                                         max =         3

                                                Wald chi2(25)     =    237.58
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =    0.0000
```

score_2	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
small_firm	21.60113	8.090893	2.67	0.008	5.743273	37.45899
medium_firm	12.00926	5.373711	2.23	0.025	1.476985	22.54154
new_firm	-11.18351	4.52554	-2.47	0.013	-20.05341	-2.313619
firm_value	.0294009	.0237907	1.24	0.217	-.0172281	.07603
change_share_price	-4.355016	3.018695	-1.44	0.149	-10.27155	1.561518
material_1	-22.60245	11.45794	-1.97	0.049	-45.05961	-.1452975
csrd_2024	2.502003	6.719192	0.37	0.710	-10.66737	15.67138
csrd_2025	-7.950098	7.98605	-1.00	0.319	-23.60247	7.702273
net_zero	1.660007	3.643354	0.46	0.649	-5.480835	8.80085
scope3_target	15.08292	3.590768	4.20	0.000	8.04514	22.12069
sbti	8.319794	4.063401	2.05	0.041	.3556751	16.28391
year_2021	6.546722	2.588272	2.53	0.011	1.473801	11.61964
year_2022	17.86492	2.965301	6.02	0.000	12.05304	23.6768
agriculture	-.5668905	6.997758	-0.08	0.935	-14.28224	13.14846
capital_goods	5.289568	8.19775	0.65	0.519	-10.77773	21.35686
chemicals	42.68495	11.27007	3.79	0.000	20.59602	64.77387
construction	24.53134	13.1654	1.86	0.062	-1.272364	50.33505
electric_utilities	-19.02929	12.67847	-1.50	0.133	-43.87864	5.820057
financial	10.24849	5.57512	1.84	0.066	-.678545	21.17553
food_beverage	-6.806438	13.19973	-0.52	0.606	-32.67742	19.06455
metals_mining	18.99648	18.73164	1.01	0.311	-17.71686	55.70982
oil_gas	-9.624634	7.926191	-1.21	0.225	-25.15968	5.910415
paper_forestry	47.60671	18.34877	2.59	0.009	11.64378	83.56963
real_estate	-9.464388	11.39245	-0.83	0.406	-31.79319	12.86441
transport	-23.26911	12.80063	-1.82	0.069	-48.35788	1.819662
_cons	22.11697	13.67107	1.62	0.106	-4.67784	48.91177
sigma_u	14.765622					
sigma_e	17.157932					
rho	.42547975	(fraction of variance due to u_i)				

Fixed Effects

Model 3 Fixed Effects

```
Fixed-effects (within) regression               Number of obs      =       295
Group variable: firm                            Number of groups   =       100

R-sq:                                           Obs per group:
     within  = 0.4046                                         min =         2
     between = 0.2053                                         avg =       3.0
     overall = 0.2565                                         max =         3

                                                F(7,188)           =     18.25
corr(u_i, Xb)  = 0.0668                         Prob > F           =    0.0000
```

score_2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
small_firm	21.30729	16.31264	1.31	0.193	-10.87206	53.48663
medium_firm	11.70081	12.25898	0.95	0.341	-12.48203	35.88366
new_firm	0	(omitted)				
firm_value	0	(omitted)				
change_share_price	0	(omitted)				
material_1	0	(omitted)				
csrd_2024	0	(omitted)				
csrd_2025	0	(omitted)				
net_zero	-1.966056	4.630378	-0.42	0.672	-11.10023	7.168118
scope3_target	14.83659	4.438154	3.34	0.001	6.081605	23.59157
sbti	8.94835	4.641168	1.93	0.055	-.2071096	18.10381
year_2021	7.213511	2.668749	2.70	0.008	1.94897	12.47805
year_2022	19.02061	3.196587	5.95	0.000	12.71483	25.3264
_cons	.9873985	10.06133	0.10	0.922	-18.8602	20.835
sigma_u	22.15269					
sigma_e	17.157932					
rho	.62504008	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(99, 188) = 4.21                     Prob > F = 0.0000
```

Model 4 Fixed Effects

```
Fixed-effects (within) regression               Number of obs      =       295
Group variable: firm                            Number of groups   =       100

R-sq:                                           Obs per group:
     within  = 0.4046                                         min =         2
     between = 0.2053                                         avg =       3.0
     overall = 0.2565                                         max =         3

                                                F(7,188)           =     18.25
corr(u_i, Xb)  = 0.0668                         Prob > F           =    0.0000
```

score_2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
small_firm	21.30729	16.31264	1.31	0.193	-10.87206	53.48663
medium_firm	11.70081	12.25898	0.95	0.341	-12.48203	35.88366
new_firm	0	(omitted)				
firm_value	0	(omitted)				
change_share_price	0	(omitted)				
material_1	0	(omitted)				
csrd_2024	0	(omitted)				
csrd_2025	0	(omitted)				
net_zero	-1.966056	4.630378	-0.42	0.672	-11.10023	7.168118
scope3_target	14.83659	4.438154	3.34	0.001	6.081605	23.59157
sbti	8.94835	4.641168	1.93	0.055	-.2071096	18.10381
year_2021	7.213511	2.668749	2.70	0.008	1.94897	12.47805
year_2022	19.02061	3.196587	5.95	0.000	12.71483	25.3264
agriculture	0	(omitted)				
capital_goods	0	(omitted)				
chemicals	0	(omitted)				
construction	0	(omitted)				
electric_utilities	0	(omitted)				
financial	0	(omitted)				
food_beverage	0	(omitted)				
metals_mining	0	(omitted)				
oil_gas	0	(omitted)				
paper_forestry	0	(omitted)				
real_estate	0	(omitted)				
transport	0	(omitted)				
_cons	.9873985	10.06133	0.10	0.922	-18.8602	20.835
sigma_u	22.15269					
sigma_e	17.157932					
rho	.62504008	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(99, 188) = 4.21                     Prob > F = 0.0000
```

Tobit Random Effects

Model 3 Tobit

```
Random-effects tobit regression                 Number of obs      =       295
                                                  Uncensored       =       206
Limits: lower = 0                                 Left-censored    =        79
        upper = 100                               Right-censored   =        10

Group variable: firm                            Number of groups   =       100
Random effects u_i ~ Gaussian                   Obs per group:
                                                              min =         2
                                                              avg =       3.0
                                                              max =         3

Integration method: mvaghermite                 Integration pts.   =        12

                                                Wald chi2(13)      =    177.98
Log likelihood  = -1026.8053                    Prob > chi2        =    0.0000
```

score_2	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
small_firm	22.70861	11.39096	1.99	0.046	.3827453	45.03447
medium_firm	6.7055	7.253072	0.92	0.355	-7.51026	20.92126
new_firm	-18.58024	6.904384	-2.69	0.007	-32.11258	-5.047894
firm_value	.0214535	.0337176	0.64	0.525	-.0446317	.0875388
change_share_price	-10.32406	4.145059	-2.49	0.013	-18.44823	-2.199897
material_1	1.982483	8.146505	0.24	0.808	-13.98437	17.94934
csrd_2024	13.69969	10.13662	1.35	0.177	-6.167723	33.56711
csrd_2025	1.739466	12.10843	0.14	0.886	-21.99263	25.47156
net_zero	2.001107	4.850989	0.41	0.680	-7.506657	11.50887
scope3_target	22.09905	4.579355	4.83	0.000	13.12368	31.07442
sbti	8.09059	5.0957	1.59	0.112	-1.896798	18.07798
year_2021	10.68645	3.492774	3.06	0.002	3.840741	17.53216
year_2022	23.99627	3.989211	6.02	0.000	16.17756	31.81498
_cons	-13.85736	14.31365	-0.97	0.333	-41.91159	14.19687
/sigma_u	23.59849	2.578136	9.15	0.000	18.54544	28.65155
/sigma_e	20.22355	1.249941	16.18	0.000	17.77371	22.67339
rho	.5765606	.0640787			.4492191	.6963179

LR test of sigma_u=0: chibar2(01) = 63.94 Prob >= chibar2 = 0.000

Model 4 Tobit

```
Random-effects tobit regression                 Number of obs     =        295
                                                  Uncensored      =        206
Limits: lower = 0                                 Left-censored   =         79
        upper = 100                               Right-censored  =         10

Group variable: firm                            Number of groups  =        100
Random effects u_i ~ Gaussian                   Obs per group:
                                                              min =          2
                                                              avg =        3.0
                                                              max =          3

Integration method: mvaghermite                 Integration pts.  =         12

                                                Wald chi2(25)     =     233.86
Log likelihood  = -1007.7069                    Prob > chi2       =     0.0000
```

score_2	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
small_firm	24.43316	10.38894	2.35	0.019	4.071218	44.7951
medium_firm	12.45363	6.743165	1.85	0.065	-.7627314	25.66999
new_firm	-15.92293	5.779838	-2.75	0.006	-27.2512	-4.594653
firm_value	.0463007	.0293286	1.58	0.114	-.0111823	.1037837
change_share_price	-7.556634	3.974972	-1.90	0.057	-15.34744	.2341669
material_1	-26.24649	14.39795	-1.82	0.068	-54.46596	1.972987
csrd_2024	9.778398	8.806534	1.11	0.267	-7.482091	27.03889
csrd_2025	-5.218861	10.3271	-0.51	0.613	-25.4596	15.02188
net_zero	1.420542	4.606448	0.31	0.758	-7.607931	10.44902
scope3_target	18.46507	4.439218	4.16	0.000	9.764366	27.16578
sbti	8.32054	5.018939	1.66	0.097	-1.516399	18.15748
year_2021	11.75922	3.464484	3.39	0.001	4.968953	18.54948
year_2022	25.35292	3.937454	6.44	0.000	17.63565	33.07019
agriculture	.3256269	8.757796	0.04	0.970	-16.83934	17.49059
capital_goods	10.06817	10.10174	1.00	0.319	-9.730882	29.86722
chemicals	57.74436	14.75573	3.91	0.000	28.82365	86.66506
construction	35.77621	16.47468	2.17	0.030	3.486418	68.06599
electric_utilities	-14.81417	15.90177	-0.93	0.352	-45.98108	16.35273
financial	15.90565	6.979931	2.28	0.023	2.22524	29.58607
food_beverage	-9.049874	16.43283	-0.55	0.582	-41.25763	23.15788
metals_mining	21.28517	23.09465	0.92	0.357	-23.9795	66.54984
oil_gas	-15.17521	10.55029	-1.44	0.150	-35.85341	5.502984
paper_forestry	68.27976	24.34932	2.80	0.005	20.55598	116.0035
real_estate	1.186855	14.14351	0.08	0.933	-26.53392	28.90763
transport	-30.6984	16.21554	-1.89	0.058	-62.48027	1.083479
_cons	7.252257	17.36673	0.42	0.676	-26.78591	41.29042
/sigma_u	18.04677	2.240715	8.05	0.000	13.65505	22.43849
/sigma_e	20.11666	1.233862	16.30	0.000	17.69833	22.53498
rho	.4459217	.0727646			.3096731	.5889455

```
LR test of sigma_u=0: chibar2(01) = 37.21            Prob >= chibar2 = 0.000
```

Appendix VI. Panel data models summary

Model 3:

	Pooled OLS		Random Effects		Fixed Effects		Tobit RE	
score_2								
small_firm	19.60*	(9.561)	18.31*	(8.334)	21.31	(16.31)	22.71*	(11.39)
medium_firm	7.333	(6.852)	7.035	(5.470)	11.70	(12.26)	6.705	(7.253)
new_firm	-12.88**	(3.848)	-12.38*	(4.975)	0	(.)	-18.58**	(6.904)
firm_value	0.00335	(0.0176)	0.00943	(0.0253)	0	(.)	0.0215	(0.0337)
change_share_price	-5.439*	(2.473)	-5.404	(2.896)	0	(.)	-10.32*	(4.145)
material_1	0.220	(5.509)	0.748	(5.927)	0	(.)	1.982	(8.147)
csrd_2024	4.751	(8.785)	5.889	(7.166)	0	(.)	13.70	(10.14)
csrd_2025	-3.663	(9.418)	-3.406	(8.579)	0	(.)	1.739	(12.11)
net_zero	7.507	(4.425)	2.557	(3.706)	-1.966	(4.630)	2.001	(4.851)
scope3_target	19.88***	(3.766)	17.69***	(3.548)	14.84**	(4.438)	22.10***	(4.579)
sbti	7.902	(6.114)	8.528*	(4.074)	8.948	(4.641)	8.091	(5.096)
year_2021	4.753	(2.569)	5.946*	(2.606)	7.214**	(2.669)	10.69**	(3.493)
year_2022	14.73***	(4.019)	16.76***	(2.978)	19.02***	(3.197)	24.00***	(3.989)
_cons	3.461	(12.24)	3.511	(10.31)	0.987	(10.06)	-13.86	(14.31)
/								
sigma_u							23.60***	(2.578)
sigma_e							20.22***	(1.250)
N	295		295		295		295	
r2	0.3874		0.3814		0.2565		-	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Model 4 Summary

	Pooled OLS		Random Effects		Fixed Effects		Tobit RE	
score_2								
small_firm	22.08*	(8.947)	21.60**	(8.091)	21.31	(16.31)	24.43*	(10.39)
medium_firm	12.25*	(5.300)	12.01*	(5.374)	11.70	(12.26)	12.45	(6.743)
new_firm	-11.62**	(3.464)	-11.18*	(4.526)	0	(.)	-15.92**	(5.780)
firm_value	0.0274	(0.0164)	0.0294	(0.0238)	0	(.)	0.0463	(0.0293)
change_share_price	-4.552	(2.510)	-4.355	(3.019)	0	(.)	-7.557	(3.975)
material_1	-23.02**	(8.461)	-22.60*	(11.46)	0	(.)	-26.25	(14.40)
csrd_2024	1.528	(8.238)	2.502	(6.719)	0	(.)	9.778	(8.807)
csrd_2025	-8.473	(8.811)	-7.950	(7.986)	0	(.)	-5.219	(10.33)
net_zero	4.806	(4.165)	1.660	(3.643)	-1.966	(4.630)	1.421	(4.606)
scope3_target	15.26***	(4.018)	15.08***	(3.591)	14.84**	(4.438)	18.47***	(4.439)
sbti	8.231	(4.718)	8.320*	(4.063)	8.948	(4.641)	8.321	(5.019)
year_2021	6.042*	(2.442)	6.547*	(2.588)	7.214**	(2.669)	11.76***	(3.464)
year_2022	16.80***	(3.594)	17.86***	(2.965)	19.02** *	(3.197)	25.35***	(3.937)
agriculture	-0.872	(5.550)	-0.567	(6.998)	0	(.)	0.326	(8.758)
capital_goods	4.743	(7.119)	5.290	(8.198)	0	(.)	10.07	(10.10)
chemicals	40.76***	(7.537)	42.68***	(11.27)	0	(.)	57.74***	(14.76)
construction	24.24	(32.92)	24.53	(13.17)	0	(.)	35.78*	(16.47)
electric_utilities	-20.30*	(8.231)	-19.03	(12.68)	0	(.)	-14.81	(15.90)
financial	9.568	(5.968)	10.25	(5.575)	0	(.)	15.91*	(6.980)
food_beverage	-7.585	(4.516)	-6.806	(13.20)	0	(.)	-9.050	(16.43)
metals_mining	18.20**	(5.747)	19.00	(18.73)	0	(.)	21.29	(23.09)
oil_gas	-10.11	(6.366)	-9.625	(7.926)	0	(.)	-15.18	(10.55)
paper_forestry	46.09***	(4.788)	47.61**	(18.35)	0	(.)	68.28**	(24.35)
real_estate	-10.50	(7.538)	-9.464	(11.39)	0	(.)	1.187	(14.14)
transport	-23.42*	(10.41)	-23.27	(12.80)	0	(.)	-30.70	(16.22)
_cons	23.09	(11.85)	22.12	(13.67)	0.987	(10.06)	7.252	(17.37)
/								
sigma_u							18.05***	(2.241)
sigma_e							20.12***	(1.234)
N	295		295		295		295	
r2	0.5194		0.5176		0.2565		-	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix VII. Sensitivity analysis

Model 3 Sensitivity Analysis:

	Tobit Panel Model 3 **Score_1**		Tobit Panel Model 3 **Score_2**		Tobit Panel Model 3 **Score_3**	
small_firm	20.77*	(10.58)	22.71*	(11.39)	24.68*	(12.28)
medium_firm	5.881	(6.737)	6.705	(7.253)	7.524	(7.819)
new_firm	-17.78**	(6.419)	-18.58**	(6.904)	-19.42**	(7.436)
firm_value	0.0205	(0.0314)	0.0215	(0.0337)	0.0224	(0.0363)
change_share_price	-9.779*	(3.854)	-10.32*	(4.145)	-10.90*	(4.464)
material_1	2.154	(7.574)	1.982	(8.147)	1.816	(8.773)
csrd_2024	12.89	(9.425)	13.70	(10.14)	14.57	(10.92)
csrd_2025	2.288	(11.25)	1.739	(12.11)	1.236	(13.04)
net_zero	1.900	(4.501)	2.001	(4.851)	2.118	(5.236)
scope3_target	20.78***	(4.243)	22.10***	(4.579)	23.48***	(4.949)
sbti	8.423	(4.718)	8.091	(5.096)	7.765	(5.512)
year_2021	9.956**	(3.233)	10.69**	(3.493)	11.45**	(3.779)
year_2022	22.12***	(3.696)	24.00***	(3.989)	25.90***	(4.312)
_cons	-12.35	(13.31)	-13.86	(14.31)	-15.51	(15.42)
/						
sigma_u	21.97***	(2.397)	23.60***	(2.578)	25.38***	(2.775)
sigma_e	18.73***	(1.160)	20.22***	(1.250)	21.87***	(1.349)
N	295		295		295	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Model 4 Sensitivity Analysis:

	Tobit Panel Model 4 **Score_1**		Tobit Panel Model 4 **Score_2**		Tobit Panel Model 4 **Score_3**	
small_firm	22.95*	(9.597)	24.43*	(10.39)	25.93*	(11.24)
medium_firm	11.49	(6.229)	12.45	(6.743)	13.41	(7.296)
new_firm	-14.95**	(5.338)	-15.92**	(5.780)	-16.92**	(6.252)
firm_value	0.0438	(0.0271)	0.0463	(0.0293)	0.0489	(0.0317)
change_share_price	-6.854	(3.670)	-7.557	(3.975)	-8.279	(4.301)
material_1	-23.13	(13.29)	-26.25	(14.40)	-29.38	(15.58)
csrd_2024	9.535	(8.133)	9.778	(8.807)	10.06	(9.527)
csrd_2025	-3.813	(9.536)	-5.219	(10.33)	-6.608	(11.17)
net_zero	1.323	(4.259)	1.421	(4.606)	1.545	(4.984)
scope3_target	17.42***	(4.102)	18.47***	(4.439)	19.55***	(4.807)

sbti	8.438	(4.636)	8.321	(5.019)	8.222	(5.438)
year_2021	10.94***	(3.202)	11.76***	(3.464)	12.61***	(3.753)
year_2022	23.44***	(3.639)	25.35***	(3.937)	27.30***	(4.264)
agriculture	2.204	(8.083)	0.326	(8.758)	-1.569	(9.478)
capital_goods	9.853	(9.329)	10.07	(10.10)	10.31	(10.93)
chemicals	56.77***	(13.57)	57.74***	(14.76)	58.82***	(16.02)
construction	36.21*	(15.18)	35.78*	(16.47)	35.45*	(17.86)
electric_ utilities	-11.93	(14.68)	-14.81	(15.90)	-17.68	(17.21)
financial	13.47*	(6.446)	15.91*	(6.980)	18.38*	(7.550)
food_ beverage	-9.014	(15.18)	-9.050	(16.43)	-9.137	(17.78)
metals_ mining	17.79	(21.35)	21.29	(23.09)	24.76	(24.96)
oil_gas	-13.47	(9.731)	-15.18	(10.55)	-16.91	(11.43)
paper_ forestry	65.31**	(22.24)	68.28**	(24.35)	71.61**	(26.64)
real_estate	2.653	(13.06)	1.187	(14.14)	-0.227	(15.30)
transport	-27.67	(14.97)	-30.70	(16.22)	-33.77	(17.55)
_cons	5.463	(16.03)	7.252	(17.37)	8.944	(18.79)
/						
sigma_u	16.66***	(2.074)	18.05***	(2.241)	19.51***	(2.421)
sigma_e	18.62***	(1.143)	20.12***	(1.234)	21.76***	(1.333)
N	295		295		295	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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