Connectivity in climate-related disclosures

Abstract

This paper investigates the level of connectivity between climate-related disclosures both inside and outside the financial statements and how this connectivity is associated with information asymmetry. Inspired by recent regulatory activities on this topic, the paper develops a model for scoring connectivity regarding climate-related matters in annual reports. Using a sample of European-listed firms reporting under IFRS® Accounting Standards from 2022 to 2023, the study shows that the number of disclosures related to climate-related matters in the financial statements has increased over the two years studied. However, the level of connectivity between these disclosures remains low. All firms included in the sample state a climate-related commitment and discuss climate-related risks outside the financial statements. However, only 25% provide firm-specific disclosures about climate-related matters within the financial statements that describe how these matters are expected to impact the financial statements. Furthermore, the paper tests the relationship between the level of connectivity and information asymmetry, measured through bid-ask spreads and analyst forecast errors and dispersion. The results indicate that a higher level of connectivity in climate-related disclosures decreases the bid-ask spread when measured over a long interval, suggesting that increased connectivity has the potential to reduce information asymmetry. However, this study finds no support for the notion that these disclosures are helpful to analysts in making estimates. The study contributes to the currently limited academic literature on climate-related disclosures in financial statements and provides timely evidence for regulators and standard setters as part of the ongoing regulatory debate.

Key words: Climate disclosures, climate-related disclosures in the financial statements, connectivity

1. Introduction

Climate change is expected to affect businesses in the coming decades, and regulatory efforts to reduce society's impact on climate change are increasing. Although firms are taking actions to mitigate their impact, climate change poses a significant financial threat to many firms, particularly in certain sectors. Furthermore, there is considerable pressure from stakeholders and regulators for firms to communicate and disclose clear commitments regarding their planned actions to mitigate their impact on climate change. Additionally, there is a demand for this information to be treated consistently across firms' corporate reporting—a concept referred to as "connectivity" (ESMA, 2021-2024; EFRAG, 2024). There is a growing emphasis from regulators, including the European Securities and Markets Authority (ESMA) (ESMA, 2021-2024), the UK's Financial Reporting Council (FRC, 2022), the European Systemic Risk Board (ESRB, 2024) the International Accounting Standards Board (IASB) (IFRS Foundation, 2023a-m), and the European Financial Reporting Advisory Group (EFRAG) (EFRAG, 2023-2024), for firms to report on climate-related matters in their financial statements. This paper investigates the connectivity between climate-related disclosures in European firms' annual reports.

The IASB has been working on the topic of climate-related disclosures in financial statements for the past few years. In 2020, they published educational material to illustrate the effects of climate-related matters on financial statements (IFRS Foundation, 2020). In March 2023, the IASB initiated a project to investigate how financial statements can provide more detailed information about climate-related risks. The inception of this project was prompted by an agenda consultation in which stakeholders emphasized that climate-related risks are often perceived as remote and long-term in nature (IFRS Foundation, 2023b). In July 2024, an exposure draft featuring illustrative examples was released, aiming to elucidate the application of IFRS standards in depicting the effects of climate-related and other uncertainties in financial statements (IFRS Foundation, 2024a-e). Appendix C provides a list and timeline of influential documents issued by regulators as a part of this debate.

Climate disclosures outside of financial statements have been studied to a considerable extent (Christensen et al., 2021), but there is still limited large-scale evidence on climate disclosures within financial statements (Müller et al., 2024). However, some recent practitioner studies, as well as a few academic studies, show that disclosures about climate-related matters in financial statements have increased in recent years (Agrawal et al., 2024; AMF, 2022; Baboukardos et al., 2021; Borghei et al., 2024; Davidson, 2024; EFRAG, 2023; EY, 2024a-b; Mazars, 2023; Müller et al., 2024; Pinnuck et al., 2021-2024; UKEB, 2023; van der Tas et al., 2022; The Financial Supervisory Authority of Norway, 2023; You & Simnett, 2022). Despite this, very few firms provide these types of disclosures overall, and the quality of the disclosures is generally low. Prior studies highlight the perceived disconnect between the disclosures provided outside and inside the financial statements (often referred to in practice as the front-end and back-end of the annual report), which has been noted by stakeholders and regulators. However, these studies do not address how this disconnect impacts investors—a concern raised by the IASB (IFRS Foundation, 2023a-m).

The information risk literature documents that disclosures within corporate reporting with high information content are associated with reduced information asymmetry between firms and investors (Chen et al., 2015; Cheng et al., 2013; Christensen et al., 2021; Gupta et al., 2018; Hope, 2003; Leuz & Wysocki, 2016; Peterson et al., 2015). Moreover, more precise disclosures should reduce investors' perceived risk and uncertainty regarding variances in cash flows (Heinle and Smith, 2017). Given the uncertainty associated with climate-related matters and their potential impact on firms' financial statements, the argument is that a higher level of connectivity between the disclosures about climate presented outside and inside the financial statements has the potential to be associated with lowered perceived risk by investors. However, prior literature also shows that disclosures about risk factors and

accounting items involving a high level of estimation uncertainty can increase perceived risk among investors (Gordon et al., 2019; Glendening, 2017; Levine & Smith, 2011; Kravet & Muslu, 2013). Since disclosures about climate-related matters involve a significant amount of estimation uncertainty, there is support for the relationship between connectivity and investors' perceived risk to also be the opposite. Thus, the overall assumption is that a higher level of connectivity between climate-related disclosures outside and inside the financial statements is associated with increased perceived risk. Perceived risk is measured as bid-ask spread and analysts' earnings estimates, common proxies used to capture the perceived risk of investors (see e.g. Barth et al., 2017; Wang et al., 2024; Paananen et al., 2021).

The regulatory complexities surrounding the topic of connectivity in climate-related disclosures motivate this paper, which has a two-fold aim. First, the paper describes and corroborates previous findings on climate-related disclosures in financial statements for the years 2022-2023 for a large sample of 787 European firms listed on regulated markets, operating in sectors highly exposed to climate risk (Consumer Discretionary, Consumer Staples, Energy, Industrials, Materials, Real Estate, and Utilities), based on Task Force on Climate-related Financial Disclosures (TCFD) classification of non-financial sectors that are highly likely to be impacted by climate change (TCFD, 2021). Secondly, the paper aims to provide evidence on how the level of connectivity is associated with information asymmetry. Evidence on the capital market impact of connected disclosures can serve as important input to the ongoing regulatory activities (Wang et al., 2024).

Disclosures about climate-related matters are collected from both inside and outside the financial statements. The financial statements are defined as the full set of financial statements in accordance with IAS 1.10 (IFRS 18.10) (see Appendix A), while "outside the financial statements" encompasses all other parts of the annual report that are not included in the financial statements. The level of connectivity between climate-related disclosures inside and outside the financial statements is measured by manually scoring them into three different categories: 1) Lack of connectivity, 2) Weak connectivity, and 3) Strong connectivity. These categories are developed from the illustrative examples released by the IASB (IFRS Foundation, 2024a-e).

The sample includes firms that disclose a climate-related commitment along with their exposure to climate risks outside the financial statements. Firms that provide no disclosures about climate in the financial statements score in category 1, those that discuss climate on a general basis score in category 2, while those that provide firm-specific disclosures describing how climate-related matters are expected to impact the financial statements are scored in category 3. Furthermore, data is also collected on which accounting areas are being discussed, whether disclosures in the financial statements are provided in a single summary note as prompted by ESMA (ESMA, 2022), whether cross-references are included, and whether climate is mentioned in the auditor's report.

Descriptive results highlight that 55% of the sample firms provide some kind of climate-related disclosures in their financial statements, scoring in category 2 or 3. Firms in Norway, France, and the United Kingdom show the highest levels of disclosure in the financial statements at 84%, 80%, and 71%, respectively. Looking at sectors, the Energy sector has the most firms disclosing climate-related information in the financial statements (77%), followed by Materials (61%) and Consumer Staples (60%). The most common areas where climate is mentioned as impacting financial statement items include impairment of goodwill, non-current assets (defined as property, plant and equipment, right-of-use assets, and intangible assets) and provisions and/or contingent liabilities (59%, 58%, and 21%, respectively). These results are consistent with the findings of prior studies (Agrawal et al., 2024; Baboukardos et al., 2021; EFRAG, 2023; EY, 2024a-b; Pinnuck et al., 2021-2024).

Furthermore, the results show that disclosures about climate-related matters in the financial statements increased among the sample firms during the years studied. In 2022, only 48% of the sample firms

provided some kind of disclosures, whereas this figure increased to 62% in 2023. This result aligns with previous studies indicating that such disclosures tend to increase over the years (Agrawal et al., 2024; Baboukardos et al., 2021; EFRAG, 2023; EY, 2024a-b; Pinnuck et al., 2021-2024) which could be explained by the intensified regulatory focus in recent years. Additionally, 48% of the sample firms that provide disclosures in the financial statements disclose summarized information about climate-related matters, either as a single note or as a separate section within disclosures about accounting policies or key judgements and uncertainties. Furthermore, 25% cross-reference disclosures about climate in other parts of the annual report, and climate is discussed in the auditor's report for 38% of the firms that provide climate-related disclosures.

The test of the relationship between the level of connectivity in climate-related disclosures and investors' perceived risk, however, shows dispersed results. The level of connectivity is negatively related to bid-ask spreads when measured over a longer period. This indicates that greater connectivity with regards to climate-related disclosures, to some extent, helps lower information asymmetry when considering the broader information environment. However, when measuring bid-ask spreads over a shorter interval directly after the reporting date, the level of connectivity appears to increase perceived risk. Furthermore, there is no support from the test that the level of connectivity matters for analysts' ability to provide estimates, as measured by forecast error and dispersion among forecasts.

The study contributes to ongoing regulatory activities related to connected corporate reporting while providing timely evidence for regulators and standard setters, such as the IASB, ESMA, and EFRAG. Furthermore, it adds empirical evidence to the currently scarce academic literature on climate-related disclosures in financial statements as well as specifically on the topic of connectivity with regards to climate-related disclosures.

The remainder of the paper is structured as follows: Section 2.1 begins with a description of climate-related disclosures under IFRS Accounting Standards, followed by a discussion of prior research and hypothesis development in Section 2.2. Next, Section 3 describes the research design and sample selection, along with descriptive statistics. Empirical results from the hypothesis testing are presented in Section 4. Thereafter, Section 5 concludes with the most important findings of the study, as well as suggestions for future research.

2. Background and prior research

2.1 Climate-related disclosures under IFRS Accounting Standards

There is currently no single IFRS accounting standard that explicitly refers to climate-related matters, but the IASB requires firms to consider the effects of these matters in the context of the financial statements as a whole. When a firm prepares its financial statements under IFRS, it should consider whether investors could reasonably expect that emerging risks, such as climate-related risks, could affect the amounts reported in the financial statements. Additionally, firms should determine what information about the effect of emerging climate-related risks on the assumptions made in preparing the financial statements is material and thus should be disclosed. Considerations could relate to various accounting areas such as useful life and residual values, impairment, fair value adjustments due to higher capital costs, losses on financial instruments stemming from heightened counterparty risks, provisions, and increased liabilities related to anticipated environmental damages, levies, or non-compliance with reported net-zero targets (IFRS Foundation, 2023a).

In accordance with IAS 1.125 (IFRS 18.31A), firms need to disclose information about the assumptions made about the future and other major sources of estimation uncertainty at the end of the reporting period that have a significant risk of resulting in material adjustments to the carrying amount of assets

and liabilities within the next financial year (see Appendix 1). These disclosure requirements could include a broad range of scenarios, which is why firms need to apply judgment to their own facts and circumstances to determine what disclosures to provide. The IASB and ESMA state that climate-related risks could be a source of estimation uncertainty, which a firm needs to provide disclosures about (ESMA, 2023; IFRS Foundation, 2023a; IFRS Foundation 2024e).

Several other IFRS Accounting Standards also require specific disclosures about how a firm makes certain decisions under the standard, such as how the useful life of property, plant, and equipment is determined under IAS 16, or the significant assumptions made when performing the annual impairment test of goodwill in accordance with IAS 36 (see Appendix 1).

The IASB has for the past years been working on the topic of connectivity and climate-related disclosures in the financial statements. In 2020, they published a first version of educational material to illustrate the effects of climate-related matters on financial statements, which was republished in 2023 (IFRS Foundation, 2020). In March 2023, the IASB initiated a project to investigate how financial statements can provide more detailed information about climate-related risks (IFRS Foundation, 2023b). The first action taken as a part of this project was publishing an exposure draft of illustrative examples in July 2024, to illustrate how climate-related matters should be considered among various IFRS Accounting Standards. Example 1 of this exposure draft clarifies that firms also need to consider the disclosure requirement in IAS 1.31 (IFRS 18.20) (see Appendix 1) when considering the effect of climate change. Depending on external and internal factors, there could be situations where firms need to provide additional disclosures beyond those explicitly stated in each IFRS Accounting Standard (IFRS Foundation, 2024e).

The European Securities and Markets Authority (ESMA), the EU's financial markets regulator and supervisor, has prioritized climate-related disclosures in financial statements as focus areas for the enforcement between 2021 and 2023 (ESMA, 2021-2023) and continues to emphasize this area of importance in 2024 (ESMA, 2024). ESMA states that firms should treat the disclosure of climate-related risks in financial statements with the same level of importance as in sustainability reports, management reports, and financial reports (ESMA, 2021-2024). The stance is as follows:

> *"…consistent treatment of climate-related matters across the annual financial report is a key element to prevent the risk of greenwashing" (ESMA, 2022, p. 2).*

ESMA expects that when firms, particularly those in highly exposed sectors, conclude that there is no material financial impact from climate-related matters on their operations and/or in the measurement of their assets and liabilities, they should disclose the assessments performed, judgments made, and the time horizon used to reach such a conclusion. Disclosures should be tailored to the specific circumstances of individual issuers. ESMA encourages firms to include these disclosures in a separate note or section, along with cross-references to further information, if applicable (ESMA, 2022).

The regulatory focus on these types of disclosures highlights that this is an area where improvement is needed. Some practitioner studies and a few academic studies have examined the current state of climate-related disclosures in financial statements. These studies are presented and summarized in Appendix B. The findings support the need for regulatory activities by showing that, overall, not many firms provide these types of disclosures, even though there has been an increase in recent years. When disclosures are provided, they are often of a boilerplate nature rather than firm-specific (Agrawal et al., 2024; AMF, 2022; Baboukardos et al., 2021; Borghei et al., 2024; Davidson, 2024; EFRAG, 2023; EY, 2024a-b; Mazars, 2023; Müller et al., 2024; Pinnuck et al., 2021-2024; UKEB, 2023; van der Tas et al., 2022; The Financial Supervisory Authority of Norway, 2023; You & Simnett, 2022).

2.2 Hypothesis development

Theories on corporate disclosures suggest that high-quality disclosures can mitigate agency and adverse selection issues by decreasing information asymmetry. The idea is that if there is information asymmetry, uninformed investors will be at a disadvantage compared to informed investors. To mitigate this effect, uninformed investors may trade less frequently in the firm's stock, thereby reducing its liquidity (Amihud & Mendelson, 1986; Diamond, 1985; Diamond and Verrecchia, 1991; Kim and Verrecchia, 1994; Lev, 1988; Leuz & Verrecchia, 2000).

Information asymmetry in capital markets can be measured in different ways. One commonly used proxy is the bid-ask spread, which serves as a measure of market liquidity. The argument is that less-informed investors may require price protection, which is reflected in wider bid-ask spreads. Another prominent participant in capital markets is analysts. High-quality disclosures enhance analysts' understanding of an entity's performance and outlook, leading to improved forecast accuracy and less dispersion among analysts' forecasts. Substantial empirical evidence supports this notion, demonstrating that disclosures in corporate reporting with high information content are associated with decreased bid-ask spreads, increased accuracy in analysts' earnings estimates, and decreased dispersion in those estimates (see e.g., Chen et al., 2015; Cheng et al., 2013; Christensen et al., 2021; Gupta et al., 2018; Heinle and Smith, 2017; Hope, 2003; Lehavy et al., 2011; Leuz & Wysocki, 2016; Li et al., 2021; Peterson et al., 2015). Furthermore, there is a large body of literature on integrated reporting showing that higher-quality integrated reports and greater connections between financial and non-financial information are associated with lower information asymmetry in capital markets (see e.g., Barth et al., 2017; Bernardi & Stark, 2018; Wang et al., 2024; Zhou et al., 2017).

Focusing specifically on climate-related disclosures, there is evidence indicating that climate-related information in sustainability reports is associated with lower analysts' forecast errors (Dhaliwal et al., 2012), lower bid-ask spreads (Adhikari and Zhou, 2022; Schiemann and Sakhel, 2019; Gerged et al., 2020), lower firm risk (Alsaifi et al., 2021), and lower investor uncertainty (Berkovitch et al., 2021). The relationship is stronger the more specific the information provided is. Furthermore, in a study specifically examining disclosures under IFRS Accounting Standards about environmental liabilities, Paananen et al. (2021) suggest that more specific disclosures are associated with lower bid-ask spreads and reduced analysts' forecast errors and dispersion. Additionally, Baboukardos et al. (2023) show that firms already disclosing categories required by IFRS S2, the International Sustainability Standards Board (ISSB) recently developed sustainability standards, have lower firm risk.

However, when it comes to disclosures about risk factors or accounting items involving a high level of estimation uncertainty, the evidence is more dispersed. Gordon et al. (2019) show that disclosures of critical accounting policies and estimates increase analysts' forecast errors and dispersion. Additionally, there is evidence that these types of disclosures are negatively associated with the predictive value of earnings (Glendening, 2019; Levine & Smith, 2011). Furthermore, there is evidence that an increase in risk disclosures is associated with heightened stock return volatility and trading volume, as well as dispersed forecast revisions around filings (Kravet & Muslu, 2013).

Since disclosures about climate-related matters involve a significant amount of estimation uncertainty, there is support for the idea that the relationship between these disclosures and investors' perceived risk may also be negative. Furthermore, there are ongoing discussions surrounding the IASB's project. In the comment letters, examples—particularly Example 1, which serves as inspiration for the design of measuring connectivity in this study (see section 3.2)—receive criticism from stakeholders for potentially leading to information overload or obscuring other significant information in the financial

statements (IFRS Foundation, 2025). As discussed by EFRAG (2024) and Agrawal (2024), there are, and should be, boundaries between different reports, and some information, for valid reasons, does not belong in the financial statements due to the definitions and recognition criteria of IFRS Accounting Standards. Achieving this balance is challenging for firms in practice.

Hence, evidence can support a relationship between a higher level of connectivity and investors' perceived risk in both directions. The increased stakeholder pressure for connectivity between climate-related matters in a firm's reporting, along with evidence suggesting that more connected and specific disclosures can lower investors' perceived risk, supports the idea that a higher level of connectivity decreases perceived risk among investors. However, there is also evidence that the relationship might be the opposite when accounting items involve a high level of uncertainty. This leads to the formulation of the following two-directional hypothesis:

H1: The level of connectivity between climate-related disclosures outside and inside the financial statements are associated with investor's perceived risk.

3. Research design

3.1 Sample selection

The study examines disclosures about climate-related matters in firms' annual reports. As explicitly prompted by ESMA, firms operating in sectors that are highly exposed to climate risks should provide climate-related disclosures not only in their sustainability reports or other information channels but also in their financial statements, ensuring connectivity between these disclosures (ESMA, 2021-2024). Based on this background, the sample focuses on seven sectors exposed to climate risk, as defined by Refinitiv Eikon's GICS Sector Name: Consumer Discretionary, Consumer Staples, Energy, Industrials, Materials, Real Estate, and Utilities. These sectors were chosen based on the Task Force on Climate-related Financial Disclosures (TCFD) classification of non-financial sectors that are highly likely to be impacted by climate change (TCFD, 2021). The TCFD is a framework developed to help firms more effectively disclose climate-related risks and opportunities in their reporting. This framework is being disbanded, and the responsibility for its development is being transferred to the IFRS Foundation (TCFD, 2024). However, it remains relevant for this study, as it was applied by firms during 2022 and 2023, the years being studied. The chosen sectors are also consistent with prior research focusing on climate-sensitive sectors (Agrawal et al., 2024).

The sample includes firms publicly traded on European regulated stock exchanges and operating in the aforementioned sectors from 2022 to 2023. The reason for restricting the sample to these two years is the expectation that there will be more climate-related disclosures in the 2022/2023 financial statements compared to preceding years, due to the intensified debate and focus from regulators and stakeholders in recent years. The initial sample consists of 4 572 firm-year observations (2 286 unique firms). Firms are excluded if they do not discuss climate-related matters outside the financial statements (see further discussion in Section 3.2) or do not have an annual report available in a searchable format in English. Furthermore, some data are lost due to missing information in the public databases used for this study (S&P Capital IQ and Refinitiv Eikon). The final sample yields 1 574 firm-year observations and 787 unique firms. Table 1 presents the sample composition and distribution by country and sector.

Table 1 – Sample selection and break-down

Panel A: Sample selection

	Firm-year observations	Unique firms
Sample frame: Firms listed on European regulated securities markets between 2022-2023 in selected sector	4 572	2 286
After removal of firm-years where no annual report was found in searchable format in English	4 308	2 154
After removal of firm-years for firms not discussing climate outside the financial statements	4 298	2 149
After removal of firm-years for which variable data is missing	1 574	787
Total observations for bid-ask spread analysis	*1 574*	
Total observations for analyst forecast and dispersion analysis	*1 359*	

Panel B: Sample breakdown

Region	Obs.	%	Sector	Obs.	%
Anglo			Consumer Discretionary	310	20
United Kingdom	426	27	Consumer Staples	152	10
Ireland	22	1	Energy	86	5
Continental			Industrials	566	36
Austria	40	3	Materials	192	12
Belgium	28	2	Real Estate	176	11
France	146	9	Utilities	92	6
Germany	168	11	*Total*	*1 574*	*100*
Greece	20	1			
Italy	106	7			
Luxembourg	26	2			
Netherlands	70	4			
Portugal	22	1			
Spain	72	5			
Eastern					
Czech Republic	2	0,1			
Hungary	4	0,2			
Poland	24	1			
Romania	2	0,1			
Scandinavian					
Denmark	56	4			
Finland	66	4			
Norway	74	5			
Sweden	200	18			
Total	*1 574*	*100*			

3.2 Level of connectivity in annual reports

Disclosures are collected from both inside and outside the financial statements utilizing the database Corporatings, which allows for dividing firms' annual report into different sections. The financial statement is defined as the financial statements in accordance with IAS 1.10 (IFRS 18.10) (see Appendix A), while "outside the financial statement" is defined as all other parts of the annual report.

Sections from the different parts of the annual reports are extracted using a combination of word search approach as well as Corporatings AI function specified in Table 2. The search is based on regulatory expectations that if a firm discusses and describes climate-related risks and related actions, such as climate-related commitments like net-zero targets, outside of the financial statements, these should be given due consideration in the financial statements (ESMA, 2021-2024; IFRS Foundation, 2020; IFRS Foundation, 2023b).

Furthermore, the word search for the parts outside of the financial statement is inspired by Sautner's (2023) bigrams for capturing climate change exposure. The expectation, in accordance with prior research (see Appendix C), is that the disclosures in the financial statements are less detailed and can therefore be expected to be captured with a more high-level word search. This was ensured by manual sample selections and complemented with Corporating's AI search, which captures disclosures more broadly.

Table 2 – Disclosure search approach

Section in annual report	Word search	AI search
Outside the financial statements	climate climate-related risks climate risks transition risk transitional risk physical risk transition climate risks transitional climate risks physical climate risks extreme whether storms flooding drought environmental risks climate-related target carbon emission reduction target reduced emissions net zero/net-zero neutral/carbon neutral/climate neutral Task Force on Climate-related Disclosures/TCFD Global Reporting Initiative/GRI	Semantic search on "Climate change". Corporating's AI search relies on techniques from artificial intelligence, particularly natural language processing (NLP) and deep learning. Each part of report is transformed into a vector and the search query is similarly transformed into a vector, which is performed using the language model BERT. The similarity between the query vector and the document vector is calculated (using a measure like cosine similarity) and the closer the two vectors are, the more semantically similar their content is. Fragments are ranked based on their semantic closeness to the query and each fragment is assigned a relevance score.
Financial statements	climate, environmental	See above.

The primary focus for extracting disclosures outside the financial statements is determining whether a firm discloses: 1) Climate-related targets such as net-zero commitments, and 2) Exposure to climate change, such as physical risks and transition risks.

The basis for focusing on these disclosures outside the financial statements is that the fact that these disclosures are provided, along with the fact that the firm operates in a sector with exposure to climate-related risks, leads to stakeholders' expectation of disclosures about climate-related matters in the financial statement (ESMA, 2021-2024; IFRS Foundation, 2020; IFRS Foundation, 2024e). Firms from the initial sample that do not provide any information on climate outside the financial statements is considered missing data.

The disclosures extracted from the financial statements are manually reviewed and scored into the three categories described in Table 3 below. For examples of scoring, see Appendix D. To ensure validity in the manual scoring, the scoring was initially performed for 2023 annual reports. Subsequently, 2022 was added, and the passage of time between the scoring allowed for revisiting the 2023 scores to ensure consistency and facilitate comparison between the years. Additionally, the scoring was discussed and reviewed by an independent researcher. Furthermore, the researchers involved in the scoring are practitioners working at a Big 4 accounting firm as financial reporting specialists particularly focusing on consulting clients on the topic of connectivity and climate-related matters in the financial statements. There has also been engagement with various regulators, such as members of the IASB, EFRAG and ESMA, to receive input on the methodology and the possibility for policy implications. Also, prior studies like Barth et al., 2017, Cahan et al., 2016 and Wang et al., 2024, use proprietary data from Big 4 accounting firms to construct the sample and independent variable.

Table 3 – Scoring connectivity in climate-related disclosures

Category	Description
Lack of connectivity (Score 1)	Firms that outside the financial statements disclose 1) A climate-related commitment and 2) That their business is impacted by climate change (such as physical and/or transition risk). In the financial statements, there are no disclosures on climate-related matters.
Weak connectivity (Score 2)	Firms that outside the financial statements disclose 1) A climate-related commitment and 2) That their business is impacted by climate change (such as physical and/or transition risk). In the financial statements, there are disclosures on climate-related matters. However, disclosures are general and do not explicitly state how climate-related risks are expected to impact the financial statements.
Strong connectivity (Score 3)	Firms that outside the financial statements disclose 1) A climate-related commitment and 2) That their business is impacted by climate change (such as physical and/or transition risk). In the financial statements, climate-related disclosures are firm-specific and describes how climate-related matters are expected to impact the financial statements, including: • Which items in the financial statements that are or are expected to be impacted by climate-related matters. • A description of whether climate-related matters have a significant impact on the financial statements or not. When not material, the firm explains why, and the considerations made. • When applicable for particular items, sensitivity analysis and scenario analysis are provided.

The categories are based on the exposure draft of illustrative examples published by the IASB (IFRS Foundation, 2024e), particularly Example 1. This example illustrates the requirement to provide climate-related disclosures in the financial statements for a firm that discloses climate-related risks and targets outside the financial statements and operates in a sector expected to be highly impacted by climate change. The example demonstrates that the application of IFRS Accounting Standards to the firm's facts and circumstances does not result in any impact on the firm's financial position and performance. This is because the affected assets were nearly fully depreciated, the recoverable amounts of the affected cash-generating units significantly exceed their respective carrying amounts, and the firm has no asset retirement obligations.

However, the example states that the firm must consider the requirement in IAS 1.31 (IFRS 18.20). When considering firm-specific qualitative factors (the disclosures provided in other parts of the annual report) and external qualitative factors (the industry in which the firm operates), the information about the considerations made regarding climate change is deemed likely to influence users' decision-making. Thus, the firm discloses the fact that the transition plan has no effect on the financial position and performance and explains why.

The scoring of annual reports based on certain disclosures being made outside the financial statements compared with disclosures in the financial statements are thus a way to operationalize connectivity in relation to climate-related disclosures.

To gain further insights into the data and to be able to compare with previous studies, data will also be gathered on the accounting topics being discussed in the disclosures, aggregated by accounting standard. Further, data will be collected on whether a single note summarizing the considerations made with

regards to climate in the financial statement as well as whether cross-references to other parts of the annual report are made. Both these phenomena can be considered connectivity mechanisms (Agrawal et al., 2024) and disclosing the considerations made in a single note is explicitly suggested by ESMA (ESMA, 2022). Furthermore, data on whether climate is discussed in the auditor's report are also being gathered. Prior studies (see e.g., Agrawal, 2022; Baboukardos et al., 2021, Pinnuck et at., 2022-2025) collect data on whether climate is being discussed in the auditor's report. The auditor's report was manually extracted from the annual report, using only the word "climate" as the search term. External pressure has the potential to influence firms' choices to disclose information (Müller et al., 2024; Paananen et al., 2021), making it interesting to gather data on whether climate-related matters are discussed by the auditor, as this could potentially impact firm behavior.

3.3 The level of connectivity and information risk

To test hypothesis 1, bid-ask spread and analysts' forecast error and dispersion are used as a proxies of investor's perceived risk (see e.g., Chen et al., 2015; Cheng et al., 2013; Gupta et al., 2018; Hope, 2003; Peterson et al., 2015; Paananen et al., 2021, Wang et al., 2024). The following OLS models are applied:

$$BidAsk_{it,n} = B_0 + B_1 Connectivity\_Score_{it} + lnMV_{it} + BM_{it} + ROA_{it} + sdNI_{it} + Lev_{it} + FreeFloat_{it} + NumSegments_{it} + SRF_{it} + Enforce_{it} + Big4_{it} + ESG\_Score_{it} + Emissions_{it} + \varepsilon_{it}$$

$$AF_{it,n} = B_0 + B_1 Connectivity\_Score_{it} + lnMV_{it} + BM_{it} + ROA_{it} + sdNI_{it} + Lev_{it} + FreeFloat_{it} + NumSegments_{it} + SRF_{it} + Enforce_{it} + NumEstimates_{it} + Big4_{it} + ESG\_Score_{it} + Emissions_{it} + \varepsilon_{it}$$

where subscripts *i* and *t* refer to firm and time, respectively.

The bid-ask spread (*BidAsk*) is calculated as the difference between a firm's daily closing bid and ask price scaled by the average bid and ask price $[\sum_i^n((ask_i - bid_i)/(\frac{ask_i + bid_i}{2}))]/n$. Analysts' forecast error is calculated as the absolute difference between the consensus one-year-ahead earnings forecast per share and the actual earnings per share scaled by actual earnings per share. Further, analysts' forecast dispersion is calculated as the standard deviation of analysts' one-year-ahead estimates scaled by actual earnings per share.

The variable of interest in the model is *Connectivity_Score,* which refers to the level of connectivity in a firms' annual report with regards to climate-related disclosures, as described in section 3.2. The OLS model also includes a set of control variables that may influence the level of a firm's disclosures as well as information asymmetry. Following Paananen et al. (2021) and Wang et al. (2024), the model controls for the effects of firm size, measured as the natural logarithm of a firm's market value of equity (l*nMV*), and a firm's growth potential, captured by the book-to-market ratio (*BM*). Leverage is measured by the ratio of debt to total assets (*Lev*) and return on assets serves as a measure of performance (*ROA*). Ownership dispersion, which can impact disclosure and firm behavior, thereby demanding various levels of disclosures, is captured by the free float of total shares (*FreeFloat*) (Paananen et al., 2021).

Further controls include the size of total accruals in firms (*Accruals*), the number of analysts following the firm (*NumEstimates*) (used as a control in the regressions with analyst proxies) and earnings volatility (*sdNI*), as these are expected to be associated with information asymmetry. The number of business segments (*NumSegments*) is used to control for the complexity of operations (Paananen et al., 2021; Wang et al., 2024) and the combined enforcement and audit index created by Brown et al. (2014) is used to control for the influence of country-level enforcement (*Enforce*), which can drive cross-sectional differences (Paananen et al., 2021).

Furthermore, the model controls for whether a firm provides sustainability disclosures in accordance with well-known regulatory frameworks such as the Global Reporting Initiative (GRI) or the Taskforce on Climate-related Financial Disclosures (TCFD) (*SRF*), as well as whether they are audited by a Big 4

accounting firm (*Big4*), to account for audit quality (Paananen et al., 2021). Following Wang et al. (2024), controls also include a sustainability score gathered from Refinitiv Eikon (*ESG_Score*).

Lastly, since the focus of the study is on climate-related matters, reported emissions (*Emissions*) are included as a control, inspired by Baboukardos et al. (2023), which utilize average Scope 1 and Scope 2 emissions over a three-year period to sample firms with exposure to climate risk. This study utilizes the emission factor as a control, as it is expected to capture exposure and thus the likelihood to disclose. Preferably, Scope 3 emissions would be used to capture exposure to climate change more broadly, but they are excluded as they limit the sample too much. Finally, controls are also included for regions, industry, and year-fixed effects. All variables are described and defined in Table 4.

Table 4 – Variable definitions

Variable	Description
Dependent variable	
BidAsk	The bid-ask spread is calculated for two different measurement periods, a long and a short window. The long window spans from five months before and seven months after the report release date, following Wang et al., 2024. The short window spans five days after the report release date, following Paananen et al., 2021. The bid-ask spread for the long window is calculated as the natural logarithm of the median of daily $\sum_i^n((ask_i - bid_i)/(\frac{ask_i+bid_i}{2}))]$. The bid-ask spread for the short window is calculated as the average difference between a firm's daily closing bid and ask price scaled by the average bid and ask price $([\sum_i^n((ask_i - bid_i)/(\frac{ask_i+bid_i}{2}))]/n$, where *n* is the total number of trading days, i.e., 5 days.
AF_error	The absolute difference between the consensus one-year-ahead earnings forecast per share and the actual earnings per share scaled by actual earnings per share.
AF_dispersion	The standard deviation of analysts' one-year-ahead estimates scaled by actual earnings per share.
Independent variable	
Connectivity_Score	Level of connectivity between climate-related disclosures in the annual reports for each firm *i* in year *t* based on scoring of climate-related disclosures outside and inside the financial statements, as described in section 3.2.
Control variables	
lnMV	The natural logarithm of market value. A proxy for firm size.
BM	Book-to-market ratio: Common equity/market value. A proxy for firm growth.
ROA	Return on assets: Net income/Total assets. A proxy for firm profitability.
Accruals	Total operating accruals measured as: $Accruals_{it} = (EBITDA_{it} - Cashflow\ from\ operating\ activities_{it})$
sdNI	The standard deviation of earnings over the most recent five years.
Lev	Debt-to-assets ratio. A proxy for firm leverage, calculated as total debt/total assets * 100.
FreeFloat	The percentage of total shares in issue available to ordinary investors for firm *i* at the end of fiscal year 2022. A proxy for ownership dispersion.
NumSegments	The number of business segments. A proxy for complexity of the firm operation.
SRF	An indicator variable that equals "1" if the firm prepare their sustainability report in accordance with a well-known sustainability reporting framework, such as the TCFD and GRI, and "0" otherwise.
Enforce	A country-level enforcement proxy based on the composite index (Enforce + Audit) created by Brown et al. (2014).
NumEstimates	The total number of analysts following the firm *i* in year *t*.
Big4	An indicator variable that equals "1" if the auditor is among the big four auditors (Deloitte, Ernst & Young, KPMG, and PricewaterhouseCoopers), and "0" otherwise.
ESG_Score	An indicator variable that equals "1" if the firm has an ESG Score in Refinitiv Eikon.
Emissions	Total Scope 1 and Scope 2 emissions in Refinitiv Eikon.

Note: The variable "Connectivity_Score" is constructed based on hand-collected data from annual reports utilizing the database Corporatings, as described in section 3.2. The variable SRF is also manually constructed based on word-search in the annual reports. All other variables and underlying data are obtained from S&P Capital IQ and Refinitiv Eikon.

3.4. Descriptive statistics

Table 4 presents summary statistics for all regression variables. The mean of level of connectivity between climate-related disclosures (*Connectivity_Score*) is 1,79, indicating that approximately half of the sample firms provide some kind of disclosures about climate-related matters in the financial statements. Further analysis and discussion around the connectivity score is found in section 3.5. The pairwise (Pearson) correlation in table 6 shows a negative and significant (p-value <0,01) relationship among bid-ask spreads measured at a long window (five months before and 7 months after the report release date) (*BidAsk-5+7*) and level of connectivity between climate-related disclosures (*Connectivity_Score*). However, there is no significant relationship between the bid-ask spread over a five-day window after the release of the annual report (*BidAsk5*) and *Connectivity_Score* or between analyst forecast error (*AF_error*) or dispersion (*AF_dispersion*) and *Connectivity_Score*. Among other firm factors, Leverage (*Lev*), Market value (*lnMV*), having a sustainability report (*SRF*) and a Big4 auditor (*Big4*) are also positively and significantly correlated with the connectivity variable.

Table 5 – Summary statistics

Variable	***N***	**Mean**	**Min**	**Max**	**SD**
Dependent variables					
BidAsk-7+5	1 574	-6.295	-8.518	-3.856	0,998
BidAsk5	1 574	-0,007	-0,799	0,408	0,135
AF_error	1 337	0,687	0,001	13,085	1,735
AF_dispersion	1 337	0,104	-7,324	25,516	0,942
Independent variable					
Connectivity_Score	1 574	1,79	1	3	0,808
Control variables					
lnMV	1 574	8,068	1,628	14,398	1,887
BM	1 574	0,840	-0,099	3,934	0,707
ROA	1 574	0,038	-0,215	0,228	0,038
Accruals	1 574	0,024	-0,556	0,663	0,145
sdNI	1 574	4,976	0,961	9,454	1,792
Lev	1 574	0,587	-0,192	1,090	0,175
FreeFloat	1 574	66,669	0,379	99,978	25,94
NumSegments	1 574	3,298	1	16	2,041
SRF	1 574	0,781	0	1	2,042
Enforce	1 574	43,584	0	54	9,087
NumEstimates	1 574	13.171	1	51	9,339
Big4	1 574	0,950	0	1	0,218
ESG_Score	1 574	0,769	0	1	0,422
Emissions	1 574	1 732 289	47	43 314 202	6 082 583

Table 6 – Pairwise correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Connectivity_ Score	1																		
2	BidAsk-5+7	-0,308***	1																	
3	BidAsk5	0,041	0,006	1																
4	AF_error	0,016	-0,003	-0,004	1															
5	AF_dispersion	0,000	-0,042	-0,019	0,448	1														
6	lnMV	0,189***	-0,670***	0,009	-0,050**	-0,0612**	1													
7	BM	-0,028	0,178***	-0,024	-0,008	0,0131	-0,271***	1												
8	ROA	0,031	-0,142***	-0,024	-0,049*	-0,044*	0,193***	-0,251***	1											
9	Accruals	0,020	-0,053**	-0,031	0,162***	0,042*	0,019	0,067***	0,089***	1										
10	sdNI	0,230***	-0,568***	-0,005	0,041	0,041	0,745***	0,127***	-0,023	0,029	1									
11	Lev	0,067***	-0,0757***	-0,011	0,028	0,014	0,008	-0,205***	-0,095***	-0,012	0,0418*	1								
12	FreeFloat	0,120***	-0,357***	0,010	-0,039	-0,048*	0,098***	-0,101***	0,406	-0,009	0,014	0,032	1							
14	NumSegments	0,153***	-0,196***	-0,025	-0,045*	-0,057**	0,293***	0,018	0,003	0,040	0,182***	0,090***	-0,072***	1						
15	SRF	0,161***	-0,374***	0,025	-0,033	-0,034	-0,168***	-0,105***	0,025	0,029	0,038	0,016	0,239***	0,038	1					
16	Enforce	0,269***	-0,078**	0,048*	-0,033	-0,034	-0,200***	-0,068***	-0,007	-0,111***	-0,133***	-0,036	0,296***	-0,1346***	0,216***	1				
17	NumEstimates	0,330***	-0,671***	-0,021	-0,063**	-0,086***	0,534***	-0,108***	0,040	0,061**	0,310***	0,115***	0,216***	0,196***	0,305***	0,141***	1			
18	Big4	0,076**	-0,111***	-0,006	-0,022	-0,037	0,122***	-0,034	-0,008	-0,005	0,028	0,064**	0,052**	0,034	0,054**	-0,036	0,074***	1		
19	ESG_Score	0,098***	-0,216***	0,043*	0,049*	0,043*	0,200***	0,016	-0,006	0,033	0,059**	0,053**	0,102***	0,125***	0,103***	-0,025	0,182***	0,081***	1	
20	Emissions	0,202***	-0,251***	-0,053**	-0,004	0,044*	0,291***	0,096***	0,016	0,080***	0,386***	0,045*	-0,008	0,202***	0,069***	-0,041	0,335***	0,021	0,085***	1

***p < 0.01, **p < 0.05, *p < 0.1

3.5. Trend and cross-sectional analysis of level of connectivity between climate-related disclosures

To gain further insights into the sample and the level of connectivity regarding climate-related disclosures in firms' annual reports, a cross-sectional analysis by sector and country as well as a trend analysis of the development between the categories of disclosure levels over the observed years is presented in Tables 7 and 8 below.

The analysis by sector shows that most climate-related disclosures in financial statements are found in the Energy sector (21% in category 2 and 56% in category 3), followed by Materials (31% in category 2 and 31% in category 3) and Consumer Staples (32% in category 2 and 28% in category 3). The Energy sector also has the highest number of firms with the greatest level of connectivity concerning climate-related disclosures, with 56% of the firms in category 3, followed by Utilities with 41% and Materials with 31%. This aligns with the study by Pinnuck et al. (2024), which also report results showing that firms in the Energy and Utilities sector report greatest prevalence of climate-related disclosures in the financial statements for a sample of listed firms in mainly Australia and New Zealand.

Looking at the analysis by country, there are significant differences to note among the countries. Norway has the highest number of firms providing climate-related disclosures in their financial statements, with 34% in category 3 and 50% in category 2. This is followed by France, with 40% in category 2 and 40% in category 3, and the United Kingdom (UK), with 35% in category 2 and 36% in category 3. These same countries also score highest in terms of connectivity, with 50%, 40%, and 36% in category 3, respectively. The fact that Norwegian firms appear to be at the forefront of these matters aligns with findings from previous studies. A study conducted by EY for annual reports between 2021 and 2023 shows that the percentage of Norwegian firms disclosing about climate-related matters in the financial statements increased from 49% in 2021 to 72% in 2023 and 79% in 2024 (EY, 2024b).

With 426 firm-year observations and 213 unique firms, the UK is the country with the highest number of firms included in the sample. All these firms are listed on the London Stock Exchange, which obliges them to disclose climate-related information in accordance with TCFD guidelines. This has been mandatory for certain UK-registered firms since 6 April 2022 (Government UK, 2021). All firms included in the sample prepare disclosures in accordance with TCFD for both 2022 and 2023. TCFD requires firms to disclose the financial impact of climate-related risks and opportunities, such as impacts on revenue, expenditures, assets, liabilities, and capital and financing (TCFD, 2021). The fact that these disclosures are mandatory outside of the financial statements may explain why UK firms, to a high extent, also provide these disclosures inside the financial statements. 29% of the UK sample firms explicitly cross-reference to the TCFD disclosures from the financial statements. These results align with prior studies. Müller et al. (2024) suggest that a driving factor for providing climate-related disclosures in financial statements is regulatory pressure from enforcement bodies, and the results show that firms located in countries with more proactive enforcement bodies have more climate-related disclosures in their financial statements. Furthermore, Agrawal et al. (2024) compare firms across different IFRS jurisdictions, and the results indicate that 80% of the UK sample firms provided disclosures in their financial statements in 2022.

Following the UK, Sweden, Germany, and Italy have the most firm-year observations in the sample. In Germany, 51% of the sample firms provide some form of climate-related disclosures, but only 20% score in category 3. Italian firms disclose even less about climate in their financial statements, with 33% providing disclosures at all and only 7% achieving the highest level of connectivity. Perhaps most notable is Sweden, where only 18% of firms provide disclosures in their financial statements, and just 5% score in category 3. However, this result aligns with a study conducted by EY, which examined Swedish Large Cap non-financial firms across all sectors. The study shows that only 17% disclosed in 2022 and 33% in 2023 (EY, 2043a-b).

Furthermore, the trend analysis in Table 8 shows that the number of firms disclosing climate-related information in their financial statements has increased between 2022 and 2023. In 2022, 48% of the sample firms provided disclosures, which increased to 62% in 2023. Given that the topic is relatively new, the number of prior studies is limited and varies in terms of sample size and geographic area,

making it difficult to compare the overall results in detail with previous studies. However, several studies indicate an increase over the years being studied, suggesting that the results align with this trend (see e.g., Agrawal et al., 2024, Baboukardos et al., 2021; Borghei et al., 2024; EY 2024a-b; Pinnuck et al., 2025;). This is consistent with expectations, as regulatory focus on these matters has also increased over the years. Further, this is also supported by the fact firms in the sample (Prosegur Cash SA (Spain) and Repsol SA (Spain)) explicitly mention that they consider the IASB's educational material in preparing the disclosures for the financial statements (IFRS Foundation, 2020).

However, since the sample focuses on firms in climate-sensitive sectors, which, according to ESMA, are particularly required to disclose climate-related information (ESMA, 2022), it could still be argued that the overall number of firms disclosing remains low. Additionally, only 20% of the firms that provided disclosures scored in category 3 in 2022, and this increased to 29% in 2023 (25% when looking at all firm-year observations). This indicates that many disclosures were of a boilerplate nature, merely stating that climate-related matters are considered without explaining whether the impact is significant or how that conclusion was reached. These results are generally consistent with previous studies (Agrawal et al., 2024; AMF, 2022; Baboukardos et al., 2021; Borghei et al., 2024; Davidson, 2024; EFRAG, 2023; EY, 2024a-b; Mazars, 2023; Müller et al., 2024; Pinnuck et al., 2021-2024; UKEB, 2023; van der Tas et al., 2022; The Financial Supervisory Authority of Norway, 2023; You & Simnett, 2022)

Table 7 – Cross-sectional analysis

Sector	N	Category 1	Category 2	Category 3
Consumer Discretionary	310	51%	31%	18%
Consumer Staples	152	40%	32%	28%
Energy	86	23%	21%	56%
Industrials	566	46%	34%	20%
Materials	192	39%	31%	31%
Real Estate	176	60%	26%	15%
Utilities	92	42%	16%	41%

Country	N	Category 1	Category 2	Category 3
Austria	40	63%	20%	18%
Belgium	28	46%	33%	11%
Czech Republic	2	50%	50%	0%
Denmark	56	61%	34%	5%
Finland	66	68%	21%	11%
France	117	20%	40%	40%
Germany	168	49%	30%	20%
Greece	20	70%	25%	5%
Hungary	4	50%	25%	25%
Ireland	22	32%	36%	32%
Italy	106	67%	26%	7%
Luxembourg	14	46%	38%	15%
Netherlands	46	34%	47%	19%
Norway	62	16%	34%	50%
Poland	24	67%	8%	25%
Portugal	22	55%	27%	18%
Spain	72	40%	28%	32%
Sweden	200	83%	13%	5%
United Kingdom	304	29%	35%	36%

Note: The table provides descriptive findings from cross-sectional comparison of the dependent variable (see full definition in table 3).

Table 8 – Trend analysis

Year	N	Category 1	Category 2	Category 3
2022	787	52%	28%	20%
2023	787	38%	33%	29%

Furthermore, Table 9 presents an analysis by accounting area for the sample firms disclosing climate-related matters in their financial statements. Table 10 provides an analysis of other data points gathered, such as whether the firms present a single note discussing climate-related matters, if cross-references are provided to other parts of the annual report, and whether considerations of climate-related matters are mentioned in the auditor's report.

The aggregation by accounting area was made with regards to the kind of accounting questions being discussed. The analysis shows that the most commonly discussed areas in relation to climate-related matters are impairment of goodwill (59%), non-current assets (defined as property, plant, and equipment, intangible assets excluding goodwill, and right-of-use assets) (58%), and provisions/contingent liabilities (21%). Given that approximately 60% of the sample firms belong to the sectors of Energy, Industrials, Materials, and Utilities, these results are not surprising, as these firms are typically asset heavy.

In relation to non-current assets, firms discuss areas such as considerations made regarding the useful lives of the assets, impairment, and judgments related to residual values. For disclosures about the impairment test of goodwill, firms address topics such as the impact of commodity prices, the inclusion of planned investments in accordance with the transition plan, and considerations made in relation to a performed climate risk scenario analysis. Provisions are typically related to decommissioning obligations, which are common in these sectors, but some firms explicitly state that they have considered whether there are any other provisions or contingent liabilities arising from climate-related considerations. This is particularly interesting in light of the agenda decision published by the IASB in 2024, which discusses whether climate-related commitments could give rise to the recognition of a provision (IFRS Foundation, 2024f). None of the sample firms reported any provisions recognized due to climate-related commitments.

Overall, only three of the sample firms explicitly state that financial statement items have been impacted due to climate-related matters: two in relation to impairment of assets (Nilfisk Holding A/S (Denmark) and Orkla ASA (Norway)) and one regarding changing the useful life of assets due to the transition plan (SSAB AB (Sweden)). The findings regarding the accounting topics being discussed align with prior literature (Baboukardos et al., 2021; EFRAG, 2023; Agrawal et al., 2024; and Müller et al., 2024). Furthermore, all accounting areas that firms disclose about are mentioned in the educational material published by the IASB (IFRS Foundation, 2020), and several are covered by the exposure draft of illustrative examples (IFRS Foundation, 2024e).

Looking closer at the analysis by other data points in Table 10, 53% of firms disclosing climate-related matters in their financial statements provide summary information in a single note/section (i.e., a separate heading) within the financial statements. The phenomenon of summary disclosures about climate-related matters in the financial statements is also discussed by Agrawal et al. (2024) as a connectivity mechanism, providing users of financial statements with information about whether climate-related matters discussed outside of the financial statements are considered and, if so, whether they have any impact.

Typically for the sample firms, this information is presented as a section among accounting policies or disclosures about key judgments and estimates, although some firms provide a single note at the end of the financial statements. These results support the notion that disclosures are driven by regulatory activities, as ESMA has explicitly suggested this method of disclosing (ESMA, 2022). For the sample firms in general, this single note contains a summary of the considerations made in relation to the financial statements, along with a statement of whether the impact is considered material, which aligns with how firms are suggested to disclose according to Example 1 in the IASB's draft illustrative examples (IFRS Foundation, 2024e), even though the example does not explicitly require this information to be presented in a single note. Among the sample firms that score in category 3, i.e., the

highest level of connectivity, 73% provide disclosures in a single note, often with cross-references to further information in particular note disclosures for items being considered.

Furthermore, cross-referencing items to other reports can also be considered a connectivity mechanism (Agrawal et al., 2024). 26% of the sample firms providing disclosures cross-reference information found in other parts of the annual report, typically the sustainability report or management commentary. Approximately 55% of these firms are from the UK and refer to the mandatory TCFD disclosures, as discussed earlier.

The results showing that 40% of the auditor's reports discuss climate-related matters are consistent with prior literature (Baboukardos et al., 2021; Agrawal, 2022). However, given the results from Müller et al. (2024), which suggest that whether the auditor's report considers climate as a key audit matter elicits such disclosures from firms, one would expect to find even more auditor's reports discussing climate-related matters among the sample firms. Furthermore, the results are again driven by the inclusion of UK firms, which account for 78% of the total reports where climate is discussed in the auditor's report. This can be explained by the fact that the mandatory TCFD-aligned disclosures form part of the annual report and fall within the scope of the auditor's opinion. The UK Government requires that auditors read other financial and non-financial information and consider whether it is materially inconsistent with the financial statements, the knowledge they acquired through the audit, or otherwise appears to be materially misstated. However, the TCFD-aligned disclosures themselves are not subject to an assurance opinion (Government UK, 2021). For all UK sample firms where climate is discussed in the auditor's report, the auditor's comment on the consistency between the climate-related disclosures in accordance with TCFD and the financial statements, often referring to where in the financial statements the disclosures are provided.

Table 9 – Analysis by accounting area

Accounting area	N	Percentage
Non-current assets (PP&E, Intangible assets excluding goodwill & RoU)* (IAS 16, IAS 38, IFRS 16, IAS 36)	495	58%
Investment properties (IAS 40)	70	8%
Biological assets (IAS 41)	16	2%
Impairment of goodwill (IAS 36)	505	59%
Inventory (IAS 2)	53	6%
Investments in associates/joint ventures (IAS 28)	12	1%
Financial instruments** (IFRS 7, IFRS 9, IFRS 13)	138	16%
Deferred tax (IAS 12)	78	9%
Provisions and contingent liabilities (IAS 37)	177	21%
Defined benefit plans (IAS 19)	47	5%
Power purchase agreements (IFRS 10, IFRS 11, IFRS 16, IAS 16 or IAS 20)	23	3%
Share-based payments/incentive programs (IFRS 2, IAS 19)	54	6%
Revenue (IFRS 15)	14	2%
Government grants (IAS 20)	4	0,5%
Segment reporting (IFRS 8)	12	1%
Going concern (IAS 1)	168	20%

Note: *Includes estimates and judgements regarding useful lives, impairment and/or residual values.
** Includes sustainability-linked financing arrangements, measurement of trade receivables (expected credit losses, ECL) and/or fair value measurement of assets such as contingent considerations etc.

Table 10 – Analysis by other data points

Other	N	Percentage
Single note*	460	53%
Cross-reference**	227	26%
Auditor's report***	323	40%

Note: *Includes firms that provide a single note/section (i.e., separate heading) about climate-related matters in the financial statements, where a summary of the considerations made are provided.
**Includes firms that cross-reference between the financial statements and other parts of the annual report, with page reference or references to specific sections.
*** Includes firms where the auditor mention climate as a consideration in the independent auditor's report. It is however not always discussed as a key audit matter.

4. Tests of hypothesis 1

4.1 The relationship between level of connectivity and investor's perceived risk

The hypotheses concern the association between the level of connectivity regarding climate disclosures in annual reports and information asymmetry in equity capital markets, measured as bid-ask spreads and analysts' forecast error and dispersion.

Table 12, Panel A presents the estimated coefficients from this regression for bid-ask spreads over two measurement periods: one long window spanning five to seven months after the report release date (*BidAsk-5+7*) and a short window of five days after the report release date (*BidAsk5*). The results are dispersed; however, they align with the hypothesis that there is an association between the level of connectivity and investors' perceived risk when measured as bid-ask spreads. For the long window, the coefficient is negative and significant (p-value < 0.05), indicating that greater connectivity regarding climate-related disclosures reduces bid-ask spreads. However, when examining the shorter interval of five days following the annual report release date, the coefficient is positive and significant (p-value < 0.05), indicating that a higher level of connectivity increases bid-ask spreads. Hence, the results suggest that in the short term, the release of this information increases uncertainty among investors. However, when considering the overall information environment for these firms over a longer time period, there appears to be lower information asymmetry.

Table 12, Panel B presents the estimated coefficients from the regression for the analyst forecast error (*AF_error*) and dispersion (*AF_dispersion*). As for the bid-ask spread, also for these regressions the results are dispersed, with a positive coefficient for analyst forecast errors and a negative coefficient for analyst dispersion. However, neither of the coefficients are significant, why it is not possible to conclude that there is any association between the level of connectivity and analyst forecast error and dispersion.

The coefficients of the control variables generally take the expected signs, although some differ from expectations. Firms with a sustainability report and lower standard deviation of net income has lower bid-ask spreads. However, firm size is associated with higher bid-ask spreads in this sample, whereas for analyst data, the firm size and profitability is as expected associated with least analyst error. Leverage, standard deviation of net income and accruals are however positively associated with analyst forecast errors. For analyst dispersion, there is not a lot of significant association between the controls of this sample, together with a low adjusted R^2.

The dispersed results make it hard to reach an overall conclusion on the relationship between level of connectivity and information asymmetry, based on the current sample. Prior studies looking at different proxies typically find consistent results. The significant negative relationship between the bid-ask spread measured at a longer window and connectivity score however provides some indication of the potential for greater connectivity actually lowering perceived risk, in line with the notion from the ongoing discussions that investors are seeking for better information regarding climate-related matters in the financial statements. One possible interpretation is that these matters might increase the perceived risk in the short-term since they are associated with a high level of uncertainty. However, in the longer term this kind of information is incorporated in the overall information environment and helps lowering the investor's overall risk perception of the firm. However, it is not possible to conclude from this study that the information is particularly useful to analysts in their forecast accuracy.

Table 12: Test of the association between connectivity score and information risk (H1)

	Panel A: Bid-Ask spread used as proxy				**Panel B: Analyst forecast errors and dispersion used as proxy**			
	BidAsk-5+7		BidAsk5		AF_error		AF_dispersion	
	Coefficient	t	Coefficient	t	Coefficient	t	Coefficient	t
Connectivity_Score	-0,063**	-2,39	0,010**	2,16	0,039	0,59	-0,051	-1,50
lnMV	0,324***	-13.02	0,002	0,40	-0,180***	-3,14	-0412	-0,95
BM	-0,007	-0,19	-0,004	-0,51	-0,007	-0,06	-0,019	-0,69
ROA	-0,282	-0,88	-0,074	-1,36	-2,083***	-3,06	-0,281	-0,69
Accruals	0,003	0,02	-0,018	-0,72	2,110***	2,77	0,352	1,08
sdNI	-0,074***	-3,29	-0,002	-0,62	0,165***	2,77	0,004	0,19
Lev	-0,305***	-2,38	-0,005	-0,29	0,012***	3,02	0,000	0,47
FreeFloat	-0,008***	-8,35	-0,000	-0,82	-0,002	-0,47	-0,000	-0,15
NumSegments	-0,008	0,85	-0,003	-1,84	-0,039	-1,41	0,002	0,15
SRF	-0,347***	-6,19	-0,008	0,77	-0,387	-1,44	-0,082	-0,84
Enforce	-0,347	1,43	0,001	1,32	0,033***	2,30	0,017***	3,11
NumEstimates	-	-	-	-	-0,011	-1,14	0,005	0,89
Big4	-0,113	-1,66	-0,008	-0,50	0,164	1,88	0,036	0,87
ESG_Score	-0,069	-1,37	0,015	-0,50	0,480**	2.36	0,146	1,53
Emissions	5.800	1,24	-1.020	-1,08	-1,720**	-2,02	-3,850	-1,38
Intercept	-2,233	-10,6	-0,044	-0,91	-0,237	-0,43	-0,318	-1,30
Region fixed effects	Yes		Yes		Yes		Yes	
Industry fixed effects	Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes	
Adj. R^2	0,662		0,008		0,127		0,023	
N	1 572		1 572		1 335		1 335	

Note: The table presents regression results from tests of the association between level of connectivity and bid-ask spreads as well as analyst forecast errors and dispersion. Bid-ask spreads are measured over two intervals, one longer interval spanning over five months before and seven months after the reporting date (*BidAsk-5+7*) and one short interval of five days following the filing date (*BidAsk5*). Analyst forecast errors are the absolute difference between the consensus earnings per share estimate and the actual earnings per share (*AF_error*) and dispersion is the standard deviation of estimates (*AF_dispersion*). The variable of interest is *Connectivity_Score*. All variables, including control variables, are defined in Table 4. t-statistics are based on standard errors that are clustered by firm. Variable subscripts are omitted from the table (see section 3.2). ***p < 0.01, **p < 0.05, *p < 0.1.

5. Conclusion

This study reports empirical material on connectivity in relation to climate-related disclosures inside and outside the financial statements and its impact on investors' perceived risk. Recently, fast-moving regulatory developments, along with increased pressure from stakeholders for firms to communicate and disclose clear commitments regarding planned actions for mitigating climate change, have highlighted how climate-related matters are treated and disclosed in financial statements. Regulators and prior studies indicate that these matters have not been addressed appropriately throughout firms' annual reports, which is described as an issue for users of financial statements.

This paper utilizes the ongoing regulatory efforts to create a model for scoring connectivity in annual reports concerning climate-related disclosures. This is achieved by using a large sample of European-listed firms in sectors highly exposed to climate-related risks for the years 2022 and 2023. Disclosures about climate-related matters in the financial statements have increased during the years studied, from only 48% in 2022 to 62% in 2023. However, these results are still overall low, considering that the firms in the sample operate in sectors exposed to climate change and have set climate-related commitments while discussing climate-related risks outside of the financial statements; these are the firms that are expected to provide such disclosures. Furthermore, a low number of firms, 20% in 2022 and 29% in 2023 (25% for all firm-year observations) provide disclosures that are specifically tailored to the individual firm, i.e., scoring as high level of connectivity.

Findings in this paper indicate a dispersed relationship between the level of connectivity regarding climate-related disclosures and information asymmetry. There seems to be some indication that a higher level of connectivity has the potential to lower investors' perceived risk when considering the information environment in the longer term, which supports the ongoing regulatory activities focusing on assisting preparers in depicting climate-related matters in the financial statements. However, there is no support that these disclosures, at the current level within this sample, are helpful to analysts in providing estimates.

The study is, however, subject to caveats, particularly in relation to the interpretation of the association between the level of connectivity and the bid-ask spread, as well as analyst forecast errors and dispersion. There is a risk that, despite the inclusion of control variables, the scoring of connectivity in relation to climate disclosures may capture the information quality of the entire annual report rather than the incremental impact of connectivity within climate-related disclosures.

This is an early study on the topic of connectivity regarding climate-related disclosures, and future research is important. Overall, this sample shows a low level of connectivity. Extending the sample period would likely cover more firms providing specific disclosures in the financial statements, increasing the potential for robust findings. It should be particularly noted that this study was conducted on annual reports before the introduction of the Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS), as well as the IFRS S standards. These new sustainability reporting frameworks explicitly require connectivity between information presented in sustainability reports and in financial statements. There is thus an expectation that connectivity will be of greater focus going forward, and conducting more large-scale studies on connectivity will be important to further investigate its impact on capital markets. Moreover, future studies could benefit from utilizing AI and large language models to further develop a suitable model for scoring connectivity in annual reports.

Appendix A – IFRS Accounting Standards references

This Appendix provides a (non-exhaustive) list of the full paragraph of IFRS requirement where climate-related disclosures might be relevant to consider.

IAS 1.10 A complete set of financial statements comprises:

a. a statement of financial position as at the end of the period;
b. statement of profit or loss and other comprehensive income for the period;
c. a statement of changes in equity for the period;
d. a statement of cash flows for the period;
e. notes, comprising material accounting policy information and other explanatory information
    a. comparative information in respect of the preceding period as specified in paragraphs 38 and 38A; and
f. f. a statement of financial position as at the beginning of the preceding period when an entity applies an accounting policy retrospectively or makes a retrospective restatement of items in its financial statements, or when it reclassifies items in its financial statements in accordance with paragraphs 40A–40D.

An entity may use titles for the statements other than those used in this Standard. For example, an entity may use the title 'statement of comprehensive income' instead of 'statement of profit or loss and other comprehensive income'.

IAS 1.31 Some IFRSs specify information that is required to be included in the financial statements, which include the notes. An entity need not provide a specific disclosure required by an IFRS if the information resulting from that disclosure is not material. This is the case even if the IFRS contains a list of specific requirements or describes them as minimum requirements. An entity shall also consider whether to provide additional disclosures when compliance with the specific requirements in IFRS is insufficient to enable users of financial statements to understand the impact of particular transactions, other events and conditions on the entity's financial position and financial performance.

IAS 1.125 An entity shall disclose information about the assumptions it makes about the future, and other major sources of estimation uncertainty at the end of the reporting period, that have a significant risk of resulting in a material adjustment to the carrying amounts of assets and liabilities within the next financial year. In respect of those assets and liabilities, the notes shall include details of:

a. their nature, and
b. their carrying amount as at the end of the reporting period.

IAS 16.73 The financial statements shall disclose, for each class of property, plant and equipment:

a. the measurement bases used for determining the gross carrying amount;
b. the depreciation methods used;
c. the useful lives or the depreciation rates used;
d. the gross carrying amount and the accumulated depreciation (aggregated with accumulated impairment losses) at the beginning and end of the period; and
e. a reconciliation of the carrying amount at the beginning and end of the period showing:
    i. additions;
    ii. assets classified as held for sale or included in a disposal group classified as held for sale in accordance with IFRS 5 and other disposals;

iii. acquisitions through business combinations;
iv. increases or decreases resulting from revaluations under paragraphs 31, 39 and 40 and from impairment losses recognised or reversed in other comprehensive income in accordance with IAS 36;
v. impairment losses recognised in profit or loss in accordance with IAS 36;
vi. impairment losses reversed in profit or loss in accordance with IAS 36;
vii. depreciation;
viii. the net exchange differences arising on the translation of the financial statements from the functional currency into a different presentation currency, including the translation of a foreign operation into the presentation currency of the reporting entity; and
ix. other changes.

IAS 36.134 An entity shall disclose the information required by (a)–(f) for each cash-generating unit (group of units) for which the carrying amount of goodwill or intangible assets with indefinite useful lives allocated to that unit (group of units) is significant in comparison with the entity's total carrying amount of goodwill or intangible assets with indefinite useful lives:

a. the carrying amount of goodwill allocated to the unit (group of units);
b. the carrying amount of intangible assets with indefinite useful lives allocated to the unit (group of units);
c. the basis on which the unit's (group of units') recoverable amount has been determined (i.e. value in use or fair value less costs of disposal);
d. if the unit's (group of units') recoverable amount is based on value in use:
    i. each key assumption on which management has based its cash flow projections for the period covered by the most recent budgets/forecasts. Key assumptions are those to which the unit's (group of units') recoverable amount is most sensitive;
    ii. a description of management's approach to determining the value(s) assigned to each key assumption, whether those value(s) reflect past experience or, if appropriate, are consistent with external sources of information, and, if not, how and why they differ from past experience or external sources of information;
    iii. the period over which management has projected cash flows based on financial budgets/forecasts approved by management and, when a period greater than five years is used for a cash-generating unit (group of units), an explanation of why that longer period is justified;
    iv. the growth rate used to extrapolate cash flow projections beyond the period covered by the most recent budgets/forecasts, and the justification for using any growth rate that exceeds the long-term average growth rate for the products, industries, or country or countries in which the entity operates, or for the market to which the unit (group of units) is dedicated;
    v. the discount rate(s) applied to the cash flow projections;
e. if the unit's (group of units') recoverable amount is based on fair value less costs of disposal, the valuation technique(s) used to measure fair value less costs of disposal. An entity is not required to provide the disclosures required by IFRS 13. If fair value less costs of disposal is not measured using a quoted price for an identical unit (group of units), an entity shall disclose the following information:

i. each key assumption on which management has based its determination of fair value less costs of disposal. Key assumptions are those to which the unit's (group of units') recoverable amount is most sensitive;
ii. a description of management's approach to determining the value (or values) assigned to each key assumption, whether those values reflect past experience or, if appropriate, are consistent with external sources of information, and, if not, how and why they differ from past experience or external sources of information;
iii. the level of the fair value hierarchy (see IFRS 13) within which the fair value measurement is categorised in its entirety (without giving regard to the observability of 'costs of disposal');
iv. if there has been a change in valuation technique, the change and the reason(s) for making it.

f. If fair value less costs of disposal is measured using discounted cash flow projections, an entity shall disclose the following information:
i. the period over which management has projected cash flows;
ii. the growth rate used to extrapolate cash flow projections;
iii. the discount rate(s) applied to the cash flow projections;

g. if a reasonably possible change in a key assumption on which management has based its determination of the unit's (group of units') recoverable amount would cause the unit's (group of units') carrying amount to exceed its recoverable amount:
i. the amount by which the unit's (group of units') recoverable amount exceeds its carrying amount;
ii. the value assigned to the key assumption;
iii. the amount by which the value assigned to the key assumption must change, after incorporating any consequential effects of that change on the other variables used to measure recoverable amount, in order for the unit's (group of units') recoverable amount to be equal to its carrying amount.

Appendix B – Descriptive studies of climate-related disclosures in the financial statements

This appendix provides a non-exhaustive list of descriptive practitioner studies (except for Agrawal et al., Borghei et al., Müller et al., and van der Tas et al.) investigating climate-related disclosures in the financial statements.

Year	Preparer	Title and Link to Source	Sample
2021-2024	Chartered Accountants Australia and New Zealand	Climate related risks are having an impact | CA ANZ Climate risk in financial statements | CA ANZ Research report on the impact of climate-related risks on financial statements | CA ANZ Research into the effects of climate-related risks on financial statements | CA ANZ	360 firms from Australia/New Zealand/Globally between 2021-2024
2021	Mazars	Financial reporting of European companies on climate issues Findings from 2021 financial statements	80 firms from France/EU
2021	ACCA	Climate-change risk-related disclosures in extractive industries: a comparative study	56 firms globally between 2021-2022
2022	AMF	Overview of information provided in the 2021 financial statements and the effects of climate change and commitments made by companies	27 firms from France
2022	AASB/AUASB	Climate-related disclosures and assurance in the Annual Reports of ASX-listed companies	All listed firms in Australia between 2018-2021 (around 1 900 firms, depending on year)
2022	van der Tas, Aggarwal, and Maksimovic	Effects of climate change on financial statements of entities listed in the Netherlands	88 firms from the Netherlands
2023	UKEB	A Study in Connectivity: Analysis of 2022 UK Company Annual Reports	9 firms from UK
2023	ESMA	Climate-related risks in the financial statements	98 firms from EU
2023	Financial Supervisory Authority of Norway	Information on climate-related matters in annual financial reports	11 firms from Norway
2024	EY	Så återspeglas klimatrelaterade frågor i svenska finansiella rapporter | EY - Sverige	101 firms from Sweden
2024	EY	Klima i regnskapet | EY Norge	Listed firms from Norway
2024	Carbon Initiative Tracker	Flying Blind: In a holding pattern. The continued absence of climate and transition risk in financial reporting	140 firms globally
2024	Müller, Gaizka, Thorsten and Wagner	Climate disclosures in the financial statements	595 firms from EU
2024	Borghei, Linnenluecke and Bui	The disclosure of climate-related risks and opportunities in financial statements: the UK's FTSE 100 | Emerald Insight	All firms listed on UK FTSE 100 between 2016-2020
2024	Agrawal, Bayne, Hellman and Wee	Connectivity and Boundaries of Climate-related disclosures in Annual Reports by Prerana Agrawal, Lyndie Bayne, Niclas Hellman, Marvin Wee: SSRN	80 firms from Australia, Canada, EU and UK

Appendix C – Timeline of policy documents on climate-related disclosures in the financial statements

This Appendix provides a (non-exhaustive) list and timeline of influential policy documents issued by financial reporting standard setters and enforcement authorities on the topic of climate-related disclosure in financial statements.

Year	Preparer	Title and Link to Source	Summary
2018	AASB/AUASB	Climate-related and other emerging risks disclosures: assessing financial statement materiality using AASB Practice Statement 2	AASB and AUASB highlight that climate-related risks are predominantly presented outside of the financial statement and that firms need to consider this when making materiality judgements related to the financial statements.
2020	IASB	IFRS Standards and climate-related disclosures	Educational material published by the IASB for the first time in 2020 and republished in 2023 (latest version is being linked) discussing how climate-related matters should be taken into account when preparing financial statements under IFRS Accounting Standards.
2021-2024	ESMA	European common enforcement priorities for annual financial reports (2021, 2022, 2023, 2024)	Consistent treatment of climate-related matters across the annual financial report are raised by ESMA as a common enforcement priority for 2021-2023 and still discussed as an important topic in 2024.
2023	UKEB	Climate-Related Matters: Summary of Connectivity Research	The UK Endorsement Board (UKEB) conducted a desktop review of 24 research reports and articles published, during the period February 2020 to April 2023, by both UK and global organizations. The documents reviewed comment on climate-related disclosures and their connection with financial statements.
2023	IASB	Climate-related and Other Uncertainties in the Financial Statements	In March 2023, the IASB added to its work plan a project to explore targeted actions to improve the reporting of the effects of climate-related risks in the financial statements.
2023	ESMA	The Heat is On: Disclosures of Climate-related Matters in the Financial Statements	A report published by ESMA with the aim to assist and enhance the ability of firms to provide more robust disclosures and create more consistency in how climate-related matters are accounted for in financial statements.
2023	XRB	Climate-related matters in financial statements	A publication from New Zealand External Reporting Board intended to help firms understand the requirements in New Zealand accounting standards relating climate-related matters in the financial statements.
2024	ESBR	Climate-related risks and accounting	A report from European Systematic Risk Board (ESRB) which analyses how climate-related risks are addressed in IFRS Accounting Standards and reflected in financial statements prepared in accordance with those standards, all from a financial stability perspective.

2024	EFRAG	Connectivity between Financial Reporting and Sustainability Reporting	An initial paper of EFRAG's project on connectivity between financial reporting and sustainability reporting. The purpose of the initial paper is to raise awareness of the articulation and conceptual foundations of the notion of connectivity as primarily reflected in the ESRS' and ISSB Standards' connectivity/connection requirements and of the boundaries of different Annual Report sections.
2025	EFRAG	Roundtable discussion – Practical considerations for connecting financial and sustainability reporting. Webinar report	As part of EFRAG's research project on connectivity, on 25 April 2025, EFRAG organized a multistakeholder online joint outreach webinar/roundtable on practical considerations for connecting financial and sustainability reporting. This report summarizes the roundtable discussions.

Appendix D – Examples of scoring connectivity in climate-related disclosures

SSAB Annual report 2023 – Category 3	
Outside the financial statements	
Section	**Disclosures**
Sustainability report	At SSAB, risk management is integrated into the annual strategy process. Sustainability risks, including climate-related risks, are included in the overall risk assessment and presented annually to the Board of Directors. During the year, SSAB initiated work to develop the systematic assessment of risks of adverse impacts on people and the environment, as well as the process for assessing sustainability-relevant risks with a financial impact on the Group.
Sustainability report	SSAB's annual carbon dioxide emissions in Sweden and Finland correspond to approximately 10% and 7% respectively of total national emissions. This makes it extremely important for SSAB to reduce emissions to help each country reach its climate goals.
Sustainability report	SSAB's targets for greenhouse gas emissions are approved by the Science Based Targets initiative (SBTi), based on an ambition level of "below 2°C". This includes Scope 1 and Scope 2 and represents a 35% reduction in emissions between 2018 and 2032.
Sustainability report	At a general level, SMHI's simulation showed that the largest climate effects at SSAB's facilities, both in scenarios with low and high future emissions, are expected to occur in the form of a warmer climate and increased precipitation. For the Nordic facilities, especially in northern Sweden and Finland, this may mean increased precipitation in the form of rain during the winter. SSAB continuously reviews any physical climate risks at the local level and takes these into account in both the planning and implementation of the transformation of the sites to fossil-free steelmaking. The additional cost for this is not expected to be material for the Group as a whole. During the year, a number of events linked to climate change, such as high temperatures and precipitation, occurred in the outside world. This has not resulted in increased costs or other financial consequences for SSAB, but shows an increased risk in society in general of higher costs for adaptation and measures linked to climate change. For more information about the financial impact of climate risks, see the Risk section and notes A.2, C.1 and C.5.
Financial statements	
Section	**Disclosures**
Note A.2 Principles of preparation of the report	Risks related to climate change The Task Force on Climate-Related Financial Disclosures (TCFD)recommends companies to report on their climate-related risks and opportunities and to improve transparency on how to address them. SSAB has analyzed these risks and opportunities through two alternative scenarios: a low future emissions scenario and a high future emissions scenario. SSAB's business strategy to transform into fossil-free steelmaking is well positioned in both scenarios. The expected physical climate change effects for SSAB include rising temperatures and precipitation levels in most of SSAB's production sites, but additional related costs are not expected to be significant. Consequently, the main risks relate to the Group's transformation to fossil-free steelmaking. The transformation itself is a significant opportunity for the Group, but risks include delays in the transformation due to political and regulatory reasons, as well as unsuccessful implementation of the transformation program and investments. There is also uncertainty on emission allowance price development. For more information, see Climate-related risks and opportunities in the Sustainability Report. The transformation to fossil-free steelmaking will impact SSAB's financial reporting. The remaining useful lives of the assets in Sweden and Finland that will be replaced in the transformation are reviewed regularly. In June, 2023, the SSAB Board of Directors made the investment decision regarding the conversion of the Oxelösund mill in Sweden with the aim to start production with the new system in the end of 2026. Consequently, SSAB revised the remaining useful life estimates for the assets that will be replaced and become obsolete by the new production system so that these assets will be depreciated to their residual values by the end of 2026. As of July, 2023 the change increased SSAB's annual depreciation by approximately SEK 40 million. Regarding value-in-use calculations for impairment testing, climate risks have been taken into account to the extent they could be estimated. Future capital expenditure and other cash flows regarding the transformation to fossil-free steelmaking have not been included in the calculations. For more information, see note C.1 for useful lives of tangible fixed assets and impairment testing.
Note C.1 Intangible and tangible fixed assets	When calculating the recoverable amounts of cash-generating units to assess any impairment, a number of assumptions about future conditions and estimates of parameters is made. Key assumptions include discount rate (WACC), long-term growth rate and development in volumes, sales prices, costs and capital expenditure. The discount rate is defined separately for each business segment to reflect specific risks applicable to the segment and it is based on the average long-term interest rates during November–December and is stated before tax. The longterm growth rate corresponds to the forecasts available in industry and analyst reports as well as management's strategic assumptions and knowledge of the steel industry. The estimated gross margins are based on

	historical results and expected market trends for each business segment. Climate risks have been taken into account to the extent that they could be estimated. Future capital expenditure and cash flows regarding SSAB's transformation to fossil-free steelmaking have not been included in the calculations. An increase in discount rate of 0.5 percentage points for Tibnor and Ruukki Construction would not imply any impairment. A reduction of 0.5 percentage points in the margins for Tibnor and Ruukki Construction would entail an impairment of SEK 63 million.
Note D.2 Net debt/cash	During the year, SSAB issued two five-year unsecured sustainability-linked bonds of SEK 2,100 million. The interest rate level is linked to SSAB meeting the various milestones in the company's climate goals, which are also approved by the Science Based Target Initiative.

Axfood Annual Report 2023 – Category 2	
Outside the financial statements	
Section	**Disclosures**
Strategy	Axfood will have net zero emissions from its own operations by 2030 at the latest. In 2023, total greenhouse gas (GHG) emissions (Scope 1, 2 and part of Scope 3) amounted to 46,475 tonnes of CO2 equivalents (44,571).
Administration report	Like all business activities, Axfood's business is exposed to risks. Risks are something that can affect Axfood's operations negatively. Managed properly, however, they can also add value. How risks are managed is of great significance. Axfood breaks down the Group's risks into operational, strategic and financial risks. In recent years, the risk scenario has been impacted by a number of external factors, such as the Covid-19 pandemic, growing criminality, and increased crisis preparedness in society. Managing changing external factors is a continuous part of the risk management process. The operational and strategic risks that could have the greatest impact on the Group are IT and information security risks, the risk of disruptions in the logistics chain, and liability and trust risks. Axfood's operational and strategic risks are described on pages 28–32. Financial risks are described in Note 22. Climate and environmental risks are included in operational risks. The risk scenario in this is multi-faceted and covers brand issues, availability of food ingredients as well as costs that may arise as a result of political decisions. One way to address challenges is through purchasing from different production areas. A detailed description of Axfood's work with climate and environmental risks is provided in the Sustainability Report
Sustainability report	Axfood's climate targets encompass both its own and suppliers operations as well as reducing the climate impact per kilo of food sold. To promote more sustainable production and consumption of food, Axfood is to annually reduce its climate impact per kilo of food sold through changes to the sales mix. The largest contribution would come from decreasing meat consumption, which has the highest carbon footprint in all food categories, relative to other sales. In 2023, the estimated carbon footprint per kilo of food sold was 1.9 kilo CO2 equivalents (1.9). Changing consumption patterns as a result of food price inflation, with increased meat consumption, impacted the sales mix. Axfood's own operations are to have net zero emissions by 2030 at the latest in order to help limit GHG emissions to meet both Sweden's Environmental Objectives and the Paris Agreement. The definition of "own operations" includes emissions from Scope 1, Scope 2 and parts of Scope 3. The target states that emissions need to be at least 85% lower compared with the base year 2020. Emissions from purchased energy, refrigerants, business travel and transports are offset by measures to bind or counteract equivalent quantities of GHG emissions in another area. In 2023, this was carried out through the company Eken Financing AB, which ensures that forests stand longer to bind more carbon, and in the projects Biokol.se and Solvatten. Biokol.se produces biocarbon that is mixed in farmland, while Solvatten provides people living in poverty with clean and hot water in a more environmentally friendly manner that reduces GHG emissions and counteracts the loss of biodiversity.
Sustainability report	Axfood and other companies in the Haga Initiative prepare a joint emissions disclosure that presents the companies' climate impact and measures to reach net zero emissions by 2030. The goal is to encourage engagement and demonstrate the connection between ambitious climate strategies and increased profitability through a joint, transparent climate disclosure. In 2023, Axfood worked on its opportunities to establish targets in line with the Science Based Targets initiative (SBTi), work that is continuing in 2024. As a part of this review, work is under way to develop the existing climate reporting, primarily regarding Scope 3 emissions, and to map out and quality-assure emissions along the entire value chain in order to analyze which areas offer the greatest potential for emission reductions and to prepare a transition plan outlining how emissions are to be reduced.
Sustainability report	Transition risks are financial risks that may arise during the conversion to a more circular economy with less impact on the climate and biodiversity. More stringent environmental policies, new regulations, developments in technology and changing markets may affect Axfood's operations and result in higher costs, for example for energy, materials and fuels in the short and long term. In the short term, there is a risk of not responding to the trend toward more environmentally aware consumers and changes in shopping behaviour by adjusting the assortment. This could lead to lower sales and contribute to uncertainty on the part of investors and other stakeholders concerning how the Group manages climate issues. In the medium to longer term, more investments may be needed

	when replacing heating and refrigeration systems in stores and warehouses in order to make energy consumption more efficient and reduce the use of non-approved refrigerants. Higher energy costs for purchased electricity, refrigeration and heating due to higher environmental taxes or a limited supply are also viewed as transition risks. Diversifying the Group's vehicle fleet is expensive but strategically important in the transition to a climate-neutral economy. This process reduces the risk of higher costs as a result of rising diesel prices, taxes or limited supply. More stringent environmental legislation, in the form of Sweden's adoption of the KunmingMontreal agreement and the European Green Deal, as well as higher expectations from consumers and investors about sustainable goods production, will likely lead to increased costs.
Sustainability report	Physical risks are associated with climate- and weather-related events such as drought, floods and storms. These events may have both direct financial consequences through property damage to stores and indirect consequences from lost or more expensive deliveries. Increased precipitation and higher sea levels may result in flooding making stores unable to remain open, resulting in lower sales. A warmer climate may result in higher operating costs as the need for refrigeration in warehouses and stores increases. In the case of new establishments, the necessity to locate the buildings to prevent the risk of flooding and ensure that equipment maintains the necessary energy performance is taken into account. Axfood believes that it is more expensive to compensate for these impacts afterwards than to prevent damage. Extreme and challenging weather conditions as a result of global warming are an ever-increasing challenge for food production. It may become more difficult to obtain certain products, which may result in higher prices that affect sales. Diversifying risk requires a clearer distribution of risk across several geographic areas as early as during the purchasing process, work that is already being carried out in several product categories. Biodiversity loss will lead to increased occurrence of pests, reduced pollination and reduced soil fertility, which will lead to lower-quality, more sporadic harvests. This, in turn, will likely lead to a need for price hikes. Marine resources will also be negatively impacted and seafood costs will increase. Ecosystems that are destroyed or damaged could also lead to reduced carbon capture by plants and soil, which would result in increased greenhouse gases that further accelerate climate change.
Financial statements	
Section	**Disclosures**
Note 2 Key estimates and assumptions	In impairment testing of goodwill and other intangible assets, estimates are made regarding future conditions for the calculation of the recoverable amount of the cash-generating units. The recoverable amount is based on the Executive Committee's estimate of future cash flows, which are discounted using an estimated average cost of capital. The estimates are based on various assumptions regarding price and volume trends, external factors such as inflation, changes in electricity and fuel prices, shortages of raw materials and packaging, disruptions in the transport sector, the anticipated competitive situation, and costs related to climate and environmental transitions due to decisions made, established goals and assessed risks. The Executive Committee is of the opinion that reasonable, possible changes in estimates and assumptions would not have such a large effect that they individually would reduce the recoverable amount to a value that is lower than the carrying amount. A sensitivity analysis is presented in Note 15.

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