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Essays on accounting, finance and management considerations of managing net-zero target setting

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INTRODUCTION

1. Motivation

The transition to sustainable finance requires transparency in sustainability reporting because credible disclosures facilitate green finance investments by guaranteeing that corporate climate commitments are accountable and verifiable (Chan et al., 2024). There is a regulatory interest in sustainability reporting in Europe, with the European Sustainability Reporting Directive (ESRS), and globally with the International Sustainability Standard Board (ISSB). Both require companies to disclose sustainability-related data, including forward-looking information, such as risks and targets. Forward-looking information in sustainability reporting refers to climate targets and climate-related risks.

Companies are incentivised to provide credible climate commitments, as investor valuations often rise, when corporations reduce or pledge to reduce their emissions (Armour et al., 2022). However, research reveals a lack of definitions, metrics, and methodology related to sustainability reporting (Cooper and Michelon, 2022). Existing regulatory frameworks frequently fail to offer effective guidance on sustainability disclosure (Christiansen et al., 2023; Allen and Craig, 2016). For instance, the Science-Based Targets Initiative (SBTi), which establishes net- zero targets, has faced criticism for permitting environmental attribute certificates (EACs) to offset scope 3 emissions, potentially compromising corporate responsibility (Hale et al., 2023). Moreover, as Cooper and Michelon (2022) note, sustainability reporting is often fragmented, voluntary, and inconsistent, which can be interpreted as carrying a risk of greenwashing. The motivation for this thesis arises from the identified deficiencies in sustainability reporting and the lack of standardised frameworks for decarbonisation commitments. As a consequence of these deficiencies, sustainability reporting can result in inconsistencies in corporate Greenhouse Gas (GHG) emissions disclosure and stakeholder expectations. To address these issues, this thesis draws on accounting theories, including legitimacy theory and stakeholder theory, to explore ways of enhancing the accountability of sustainability reporting.

This thesis aims to enhance comprehension of decarbonisation commitments via three principal papers: Paper 1 and Paper 2 analyse the progression of labels or terms used to describe carbon commitments, such as carbon neutrality or net-zero, the respective definitions in these decarbonisation commitments and their evolution over time, emphasising the governance and

regulatory challenges associated with decarbonisation commitments. Paper 3 investigates the role of stakeholder pressure in decarbonisation commitments, highlighting the fragmentation of parent and subsidiary-level decarbonisation commitments that challenge the legitimacy of the parent company's sustainability reporting. This research is especially timely given the emergence of mandatory disclosure frameworks like the CSRD and the International Financial Reporting Standard - Sustainability Disclosure Standard (IFRS SDS) S2. It seeks to evaluate whether decarbonisation commitments translate into meaningful climate action, or whether they operate primarily via legitimacy theory mechanisms (Chan et al., 2024).

2. Regulatory Drivers of Sustainability Reporting

This section delineates the reporting requirements on corporate sustainability under the three leading sustainability reporting standards, namely the Global Reporting Initiative (GRI), the Task Force on Climate-Related Financial Disclosures (TCFD), ESRS, and the IFRS-SDS. Further, this section discusses the impact of these frameworks.

Regulatory drivers of sustainability reporting have evolved, reflecting an increasing understanding of the challenges involved. The Global Reporting Initiative (GRI) offers a framework for voluntary sustainability reporting and establishes disclosure criteria for GHG emissions targets, including sector-specific guidelines that elaborate on emission targets (GRI, 2021). Further, in 2021, the Task Force on Climate-Related Financial Disclosures (TCFD) revised its annexes, stating that all firms should disclose Scope 1 and Scope 2, regardless of materiality, while the disclosure of Scope 3 GHG emissions is subject to materiality (TCFD, 2021). This voluntary framework is essential for assessing a firm's alignment with net-zero. Thus, in line with TCFD, the Portofolio Aligment Team's (PAT) technical report, measures firms' portfolio alignment with net-zero GHG reduction (TCFD, 2021).

The EU implemented the Non-Financial Reporting Directive (NFRD), as one of the first initiatives in sustainability reporting, aiming to ensure the effective disclosure of general non-financial information, including some sustainability data. The Corporate Sustainability Reporting Directive (CSRD) expanded the NFRD in 2022, mandating sustainability reporting for more European companies (Chan et al., 2024). This includes the disclosure of sustainability information under European Sustainability Reporting Standards (ESRS), serving as a sustainability equivalent to the International Financial Reporting Standards (IFRS). The typical ESRS E1 requires companies to

disclose and verify critical sustainability information, including declaring their environmental effects and establishing climate goals by 2024 (Hummel & Jobst, 2024). However, the ESRS does not mandate firms to set or disclose specific environmental goals and targets, such as attaining net-zero emissions. Conversely, the IFRS SDS S2, established by the International Sustainability Standards Board (ISSB), mandates that companies identify pathways for achieving net-zero emissions, regardless of a specific corporate target (Chan et al., 2024).

In essence, GRI provides a more comprehensive framework than the ESRS and IFRS SDS but is voluntary rather than mandatory. As ESRS and IFRS SDS are mandatory, they are expected to drive companies toward greater efficiency and the adoption of net-zero targets. In theory, this means that technological progress and societal transformations will offset these emissions.

3. Legitimacy Theory

Legitimacy theory explains how firms seek public endorsement by aligning their activities with stakeholder expectations (Suchman, 1995). According to Seele and Gatti (2017), there are three strategies to attain corporate legitimacy: pragmatic legitimacy, moral legitimacy, and cognitive legitimacy:

- *Pragmatic legitimacy* refers to major stakeholders' perceptions of corporate activities and their communication. This involves the ability of the organisation to persuade key stakeholders that it can play a legitimate role in serving their self-interest by providing valuable products and services, paying dividends, generating returns, and delivering on promises made to various stakeholder groups (Bowen, 2017).
- *Moral legitimacy* is based on the judgment of whether a corporate activity is morally appropriate, usually reflecting value system's and beliefs of its audience (Suchman, 1995).
- *Cognitive legitimacy* is an organisation's audiences' assumed beliefs; as Basu and Palazzo simplify (2008), the environment regulates the firm.

Legitimacy theory is relevant for this dissertation because the aforementioned legitimacy types can be connected with a communication strategy (i.e., explicit vs implicit), which will be used to identify potential greenwashing in corporate reporting patterns. Further, Bitektine (2011) argues that multiple forms of legitimacy can coexist within an organisation, implying that one type of legitimacy is more predominant than another within a particular corporate reporting pattern. Thus, it is necessary to distinguish whether a company's legitimacy strategy is implicit or explicit and

specify if any moral, pragmatic, and cognitive legitimacy is predominant within a corporate setting.

Table 1: Overview of the five identified corporate reporting patterns in paper 2 of this study.

Communication Strategy	Predominantly Moral Legitimacy	Predominantly Cognitive Legitimacy	Predominantly Pragmatic Legitimacy
Explicit	'Mea-culpa'	'Science-based revision'	*'CO2e scope shifting'*
Implicit	Not observed	'Pausing'	'Greenhushing'

The table summarises the five corporate reporting patterns, communication strategies and legitimacy types.

4. Stakeholder Theory

Freeman (1984) explained stakeholder theory as a conventional shareholder-focused perspective, arguing that firms have responsibilities that extend beyond generating financial returns for shareholders. Building on this foundation, Donaldson and Preston (1995) expanded the theory by incorporating moral and ethical components to stakeholder participation, arguing that firms must acknowledge humanity as a major stakeholder, especially in the context of global issues such as climate change and sustainability.

According to stakeholder theory, firms do not perceive stakeholder demands, rather they are subject to stakeholder pressure (Freeman, 1984). This pressure can be both internal (investors, consumers and employees) and external (through actors such as NGOs, activists, and environmental advocacy groups). These internal and external stakeholders often impose conflicting demands on firms regarding sustainability reporting (Kuruppu and Milne, 2010). Sustainability reporting is sensitive to the demands and pressures of stakeholders, with the reporting focus on the issues most important to stakeholders (Van Coppenolle et al., 2023).

Mahajan et al. (2023) link stakeholder theory to stakeholders and shareholders, differentiating accordingly:

"encourages-organizations to acknowledge and consider their stakeholders, which exist internally or externally to the organisation promotes understanding and managing stakeholder needs, wants, and demands and thus represents a holistic and responsible framework that goes

beyond the focus of shareholders in decision-making process, which in turn, enables organizations to be strategic, maximize their value creation, and safeguard their long-term success and sustainability."

5. Thesis Outline and Contributions

The section summarises the three papers of this thesis, with research questions supported by the aforementioned literature. Table 1 summarises the research topics, data and contributions for the three papers.

Paper 1 - Net-Zero Targets and Governance: A Literature Review (2009-2021) - Summary and Contribution

The first paper of this thesis is a systematic literature review that investigates the definition, technology and industry sector development regarding net-zero from 2009 to 2021 (Paper 1). The research questions are: What is the net-zero definition? Is net-zero emissions reporting accounting for scopes 1,2, and 3? What are the net-zero offsetting practices? What are the net- zero targets at the sectoral level?

The systematic literature review follows PRISMA-P guidelines (Moher et al., 2015) and spans a ten-year period (2009-2021) (Shamseer et al., 2015). While the study acknowledges the importance of accounting theories such as legitimacy and stakeholder theories, in sustainability reporting, although it does not explicitly utilize or apply a specific theoretical framework.

Paper 1 contributes to the literature by proposing a net-zero corporate definition: the 'net-zero protocol'. The net-zero protocol definition should take into consideration: (i) transparent and standardised calculation process of GHG; (ii) reporting on scope 1, 2 & 3 emissions, (iii) employment of net-zero practices; (iv) cross-sectoral net-zero alignment; and (v) alignment of corporate governance with sustainability disclosure. While a target formulation may be ambitious or vague, the net-zero protocol definition may help to reduce the misleading use of net- zero target formulation and potentially mitigate greenwashing concerns.

Paper 1 concludes with six significant implications. First, it enhances the comprehension of net-zero targets and their governance, enriching knowledge in academia and practice. Second, this study highlights reporting across Scopes 1, 2 & 3 GHG emissions due to the lack of standard definitions and frameworks in corporate emission targets, particularly net-zero targets (IPCC,

2018; EC, 2018). Third this study proposes a net-zero protocol definition which emphasises the need for Scope 1, 2, & 3 GHG emissions accounting, technology employment, sectoral comparability, and alignment of corporate governance with sustainability disclosure. Fourth, the protocol offers regulatory bodies a potential foundation clarifying regulatory criteria and reporting frameworks, potentially mitigating greenwashing. Fifth, companies that implement this protocol may enhance their reputation, foster stakeholder trust, and achieve their emission targets. Finally, this study addresses climate change by enhancing corporate accountability and accelerating the transition to a climate-neutral economy, thus contributing to climate change mitigation.

Paper 2 - Net-Zero by 2050, but Carbon Neutral Now: The Paradoxical Reporting of Green Claims—Summary and Contribution

Paper 2-investigates the question: How do companies rationalize past carbon-neutral claims while simultaneously committing to future net-zero targets, despite the scientific equivalence of the definitions of carbon neutrality and net-zero? This study employs legitimacy theory, as explained in section 3, to explore how companies construct narratives and rationalise this definitional dissonance.

A longitudinal content analysis is employed as the research method, examining corporate reports of twenty-five companies, that claimed carbon neutrality in the past, but still formulate net-zero targets for the future. The longitudinal approach covers corporate reports from the years 2005 to 2021. Further, this analysis uses detailed coding of corporate disclosures to extract data on carbon neutrality and net-zero definitions, ensure consistency in scope reporting, and evaluate the reporting of carbon neutrality offsets. In practice, this study establishes a connection between legitimacy types (moral, cognitive, and pragmatic) and the explicit/implicit communication strategy component, which may indicate potential corporate practices of greenwashing.

This study identifies five distinct corporate reporting patterns: (1) *explicit moral legitimacy: 'mea-culpa';* (2) *explicit cognitive legitimacy: 'science-based revision';* (3) *explicit pragmatic legitimacy: 'CO2e scope shifting';* (4) *implicit cognitive legitimacy: 'pausing' and* (5) *implicit pragmatic legitimacy: 'greenhushing'.* In detail, the *'mea-culpa'* pattern is defined for overstating climate credentials, the *'science-based revision'* pattern is a continuous carbon neutrality revision, the *'CO2e scope shifting'* renders the previous carbon neutrality claim insufficient, the *'pausing'*

interrupts the reporting of green claims and the *'greenhushing'* obscures green claims with ambiguous corporate statements.

Paper 2 makes three significant contributions to the literature. First, it enhances legitimacy theory with the integration of explicit and implicit communication strategy components building on Brown et al. (2016). Brown et al. (2016) characterise explicit legitimacy as stakeholder communication and implicit legitimacy as norms and ideas; this research characterises explicit legitimacy as direct and consistent reporting patterns and implicit legitimacy as indirect and omitted corporate reporting patterns. Hence, this study classifies *'mea-culpa', 'science-based revision'* and *'CO2e scope shifting'* as explicit communication strategies and *'pausing'* and *'greenhushing'* as implicit communication strategies.

Second, by linking the legitimacy types with the suggested corporate reporting patterns, this paper refines greenwashing theory. It concludes that the pragmatic legitimacy reporting patterns may exhibit a stronger propensity for greenwashing than the cognitive reporting patterns of this study. This notion is further supported by Suchman (1995), who posits that pragmatic legitimacy is strategic, whereas cognitive legitimacy pertains to the evaluation of validity within the corporate context.

Third, this study contributes to greenwashing theory with the proposition of distinct corporate patterns '*greenhushing*' and '*pausing*'. The suggested definition of '*greenhushing*' extends beyond previous research that connects greenhushing to strategic silence (Horiuchi et al., 2009; Font et al., 2016; Carlos and Lewis, 2018; Ginder et al., 2019), concluding that the '*greenhushing*' reporting pattern first exhibits silence and then rushing, resulting in ambiguous green claims. Further, paper 2 distinguishes the '*pausing*' pattern, as a temporary suspension of corporate statements, indicating potential inaccuracy in previous green claims. This contrasts with Carlos and Lewis (2018), who associate the silent concept with green certifications regarded as valid accomplishments.

Paper 2 yields two main implications for corporate practice and regulations. First, the identified corporate reporting patterns explain how firms manage stakeholder expectations while sometimes partaking in greenwashing practices. Second, this research indicates that pragmatic legitimacy patterns are more susceptible to greenwashing accusations, explaining firms' difficulties with self-regulation and accountability. The suggested corporate patterns provide regulators, investors, and stakeholders with a tool to detect greenwashing and foster a comprehensive framework for

corporate environmental accountability. This analysis enhances the theoretical understanding of legitimacy in sustainability reporting and advocates transparent reporting standards and advanced global decarbonisation commitments.

Paper 3 - Clients, Employees and Institutional Owners: Determinants of Corporate Decarbonisation Commitments? - Summary and Contribution

Paper 3 examines whether clients, employees, or institutional investors affect corporate decarbonisation commitments. First, this quantitative analysis hypothesises that companies facing customer pressure, often expressed in green revenue, are more likely to set decarbonisation commitments (H_1). Stakeholder theory posits that aligning stakeholder expectations with decarbonisation commitments is an important means of retaining important stakeholders. For instance, firms with green revenues via legislative mechanisms like the EU Taxonomy (Bassen et al., 2022) can support decarbonisation commitments. Further, institutional ownership significantly influences corporate sustainability practices and, by extension, corporate decarbonisation commitments. Institutional ownership demands transparency and accountability from their investee companies, using their ownership interests to encourage corporate climate risk disclosure (Cohen, S., Kadach, I., & Ormazabal, 2023; Ilhan, Krueger, Sautner and Starks, 2023). Accordingly, this research hypothesises that companies with institutional ownership are more likely to adopt decarbonisation commitments (H_2). Second, Paper 3 hypothesises that companies, experiencing greater pressure from employees, are more likely to set decarbonisation commitments (H_3). Employees represent a key stakeholder group and workforce for the firm, which also encourages the hiring of new employees. This influence is reinforced not only through financial incentives but also through shared values, aligning with stakeholder theory, which emphasizes that companies should consider the interests of all stakeholders, not only shareholders (Donaldson and Preston, 1995). Companies that prioritise employees aligned with corporate strategic objectives frequently incorporate sustainability reporting into their overall strategic vision, thereby improving reputation and organisational transformation (Kuruppu & Milne, 2010). Hence, companies that experience pressure from employees should further evaluate and implement sustainability initiatives, such as decarbonisation commitments.

This study also differentiates between decarbonisation commitments made at the parent and subsidiary entity levels. While both parent and subsidiary entities can commit to decarbonisation

commitments, those made at the subsidiary level often only cover part of the parent's company's operating activity regarding greenhouse gas emissions (GHG). That is to say, a parent decarbonisation commitment usually covers all subsidiaries and the entire operational GHG scope. The decision to sign a decarbonisation commitment at the parent or subsidiary level may relate to stakeholder pressures. For instance, for specific markets, products, or services, customer pressures are presumably stronger at the subsidiary level. Thus, paper 3 hypothesises that companies facing high customer pressure are more likely to make decarbonisation commitments at the subsidiary rather than parent level (H_4). Conversely, institutional owners and employees who exert pressure on the company's total value are expected to influence parent-level decarbonisation commitments. Relating to this argument, we further hypothesise that firms' higher employee pressure is related to a higher likelihood that the commitment is made at the parent-level rather than at the subsidiary-level (H_5). Similarly, we also hypothesise that firms experiencing more institutional pressure are more likely to sign with a parent than with a subsidiary entity (H_6).

The findings from Paper 3 emphasise the diverse influence of different stakeholder groups on corporate decarbonisation commitments. This study concludes that institutional ownership is more likely to affect a firm's decision to set a decarbonisation commitment, followed by employees exerting pressure. Furthermore, this study introduces a novel distinction between decarbonisation commitments at the parent and subsidiary entity levels. Subsidiary-level decarbonisation commitments are usually influenced by market-specific constraints, particularly by customers, however parent-level decarbonisation commitments are influenced by broader pressures from employees exerting pressure and institutional owners.

Paper 3 presents one key implication for policy, practice, and research. Subsidiary-level decarbonisation commitments driven by consumer pressures challenge parent-level decarbonisation commitments, emphasizing the need for legislative frameworks that harmonise corporate entities. Subsidiary-level decarbonisation commitments often fail to reflect internal company dynamics such as regulatory deficiencies and greenwashing risk. Regulatory deficiencies in sustainability reporting weaken the explanatory power of legitimacy theory in interpreting green claims (Paper 2) and stakeholder theory in understanding decarbonisation commitments (Paper 3). In adequate regulatory measures enable firms to exploit leverage ambiguous definitions of carbon neutrality and net-zero, leading to strategic misrepresentation of green claims and greenwashing

(Paper 2). Additionally, the fragmented regulatory landscape causes inconsistent decarbonisation commitments across corporate entities.

Table 1: Key elements of the thesis papers

	Paper 1	Paper 2	Paper 3
Title	Net-Zero Targets and Governance: A Literature Review (2009-2021)	Net-Zero by 2050, but carbon neutral now: The paradoxical reporting of green claims	Clients, employees, institutional owners: determinants of corporate decarbonisation commitments?
Research Highlights	GHG calculation, Scope 1, 2 and 3 reporting, net-zero technology, net-zero cross-sector alignment, corporate governance, sustainability disclosure	Carbon Neutral, Greenhushing, Greenwashing, Explicit Legitimacy, Implicit Legitimacy, Net-Zero	Decarbonisation commitments, green revenues, Employees, Institutional ownership, Parent Entity, Stakeholder Theory and Subsidiary entity
Data	50 Journal articles from Scopus	Green claims dataset from Net-Zero Zeal	I. Decarbonisation commitments dataset from UNFCCC Actors II. Corporate legal entities as expressed in the database of the Global Legal Entity Identifier Foundation (GLEIF) III. Environmental and financial data from FTSE Russell IV. Contextual financial variables from Refinitiv
Methods	Systematic Literature Review following Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) guidelines	Coding green claims regarding carbon neutrality and net-zero definitions, scope reporting, and carbon neutrality offsets.	Survival Analysis Model with Weibull parametric regression model and sensitivity analysis with Cox hazard model
Contributions	I. The study contributes to research with the suggestion of the net-zero protocol definition. Regulators, companies and	I. The suggested corporate patterns describe how corporations manage stakeholder expectations and	I. Institutional ownership and employees drive decarbonisation-commitments and related climate actions.

	stakeholders may apply this protocol and mitigate climate change and greenwashing.	sometimes greenwash. II. Pragmatic legitimacy patterns are more prone to greenwashing accusations, explaining firms' difficulty with self-regulation and accountability. III. The proposed corporate patterns offer regulators, investors, and stakeholders a tool to identify greenwashing.	II. Subsidiary-level commitments to customer pressure demands undermine parent-level environmental initiatives, highlighting the necessity for regulatory frameworks that align corporate entities.
Implications	I. Offers academic and practical insight into net-zero targets. II. Highlights deficiencies in existing reporting III. Proposes a net-zero protocol definition. IV. Innovates regulation via net-zero protocol definition. V. Enhances corporate reputation and fosters stakeholder trust. VI. Facilitates climate change mitigation with corporate accountability.	I. Pragmatic legitimacy patterns are more susceptible to greenwashing accusations. II. The suggested corporate patterns provide a tool to identify greenwashing accusations. III. Advances the understanding of legitimacy theory in sustainability reporting and advocates transparent reporting standards.	I. Subsidiary-level decarbonisation-commitments challenge parent-level decarbonisation commitments, highlighting the need for sustainability reporting harmonisation across corporate entities.

Table 1 provides an overview of the thesis by summarising the focus of each paper, including the titles, research highlights, data, methods, contributions, and implications.

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Paper 1

Net-Zero Targets and Governance: A literature review (2009-2021)

Published in:
Handbook on Corporate Governance and Corporate Social Responsibility[1]
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Abstract

A critical aspect of carbon disclosure lies in the reporting of a company's emission targets. Therefore, as target formulation can be ambiguous, it might be exploited for purposes of greenwashing, especially if labels are applied, for which no clear definition is provided. This study presents a literature review analysis of the label "net-zero" targets and their governance for the years 2009-2021. I review elements of the net-zero definition and suggest a 'net-zero protocol' within the corporate setting, which should consist of: (i) a transparent and standardised calculation process for GHG emissions, (ii) reporting on scope 1, 2, & 3 emissions, (iii) employment of net-zero practices (iv) cross-sectoral net-zero alignment and, (v) alignment of corporate governance with sustainability disclosure. The literature review also suggests further avenues for research on corporate target-setting and especially on "net-zero" targets and governance.

[1]Paliampelou, I. (2024) 'Net Zero targets and governance: a literature review (2009-2021)'In Michael Magnan and Giovanna Michelon (eds.) Handbook on Corporate Governance and Corporate Social Responsibility, 49–66, Cheltenham: Edward Elgar Publishing. DOI: https://doi.org/10.4337/9781802208771.00014

1. Introduction

In 2018, the European Union (EU) announced its long-term strategy for a climate-neutral economy by 2050, an economy with net-zero greenhouse gas emissions. Specifically, a set of principles consistent with the Sustainable Development Goals (SDGs) put forward by the United Nations should lead the transition to a climate-neutral Europe[2] (EU, 2018).

In recent years, there has been an outburst of corporate climate target announcements in relation to corporate greenhouse gas (GHG) emissions and climate strategy. Companies commit to corporate climate targets, making use of various climate-related labels such as *carbon neutral*, *climate neutral* or *net negative.* Often, the specific definitions of these labels are unclear, which generates ambiguity in the accountability of corporate environmental claims.

Furthermore, by setting corporate climate targets, firms commit to achieving their climate strategy within a certain period (e.g., net-zero by 2050), thus influencing investors' and shareholders' decisions in the long term. Both the corporate and academic communities are actively seeking clarification on corporate target definitions. This is necessary to better understand a firm's climate profile, meaning whether the firm is actively and substantially improving its environmental impact or rather using climate-related disclosure to gain legitimacy while not substantially improving its carbon footprint. For example, a firm that provides a clear definition in terms of its corporate climate targets and detailed corporate reporting on scopes 1, 2 and 3 can be perceived as actively and substantially improving its climate impact.[3] On the contrary, a firm that provides a misleading corporate climate target definition and obscure GHG emissions accounting on scopes 1, 2 and 3 might not be interested in substantially improving its climate impact, but rather aims to gain legitimacy mainly through means of disclosure. In the latter case, there are examples of organisations that shift their corporate climate targets (i.e., from *carbon neutral* to *Net-Zero*) but

[2]The principles include: 'accelerate the clean energy transition', 'support consumer choices that reduce climate impact', 'carbon-free' transport, 'promote a sustainable bio-economy', 'innovation towards a digitalised and circular economy', 'strengthen infrastructure and make it climate proof', accelerate near-term zero-carbon research, innovation and entrepreneurship, 'mobilise and orient sustainable finance', 'invest in human capital', 'align structural policies with climate action and energy policy', 'ensure the transition is socially fair', 'bring all other major and emerging economies on board', 'prepare for geopolitical shifts', 'support to third countries in defining low-carbon resilient development through mainstreaming and investments (EU,2018).

[3] The GHG Protocol Corporate Standard classifies a company's GHG emissions into three 'scopes. Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

their climate strategies and GHG emissions accounting on scopes are not aligned. Thus, a firm could appear to promise a corporate climate target to legitimise its societal contribution towards the environment for a length of time and signal investors that it is a 'green' company, but in practice, it may be using a corporate climate target for greenwashing.

The scientific consensus is to the effect that to get to net-zero emissions by 2050, significant advancements in market offsetting mechanisms and offsetting technologies are to be made and employed drastically at the industrial level. These milestones on the economic-regulatory and scientific levels may support a firm with the necessary framework to commit to its corporate climate target, transition to a low-carbon economy and refrain from greenwashing.

On a broader scale, investors are interested in knowing which sectors claim corporate climate targets. Analyses suggest that although some sectors commit to corporate climate targets, most sectors must overcome economic, legal and scientific barriers to move forward in this respect. There is increased stakeholder interest in corporate climate targets. Investors and other stakeholders learn about challenges for firms and risks of whole industries. Stakeholders can drive substantial climate-impact improvements in companies, for example, through stakeholder engagement in sustainability disclosure (e.g., demand for net-zero target disclosure). To increase stakeholder trust in the targets that they disclose, companies need to show they have implemented an appropriate corporate governance model. Therefore, by aligning the corporate governance model with sustainability disclosure, firms can gain legitimacy.

This chapter aims to review various net-zero definitions and their elements to suggest a 'net-zero protocol'. It does so by providing answers to well-defined clinical questions using a systematic literature review[4]. Specifically, the following research questions are tackled:

1. *The Net-Zero 'jigsaw puzzle' definition*

2. *Net-zero emissions in terms of scopes 1, 2 or 3*

3. *Net-Zero Offsetting Practices*

[4]We follow the checklist of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) (Moher et al., 2015). This study assumes that the fundamental components of Net-Zero are scope, Net-Zero offsetting practices, Net-Zero target claim (sectoral level) and corporate governance. The step-by-step description of the literature review process is provided in Appendix A. Of course, there are other factors to consider that are beyond the purpose of this study and for simplification reasons are discounted.

4. *Net-Zero targets on a sectoral level*

5. *Corporate governance and net-zero targets*

1. The Net-Zero 'Jigsaw Puzzle' Definition

This section focuses on research question 1 (How is Net-Zero defined?) and describes the historical timeline of relevant net-zero definitions. In this section, I further analyse the controversies about the net-zero definitions. In addition, this review study explains which net- zero definition should be used and in what context and introduces the 'net-zero protocol'.

The most prominent term that companies use when referring to their climate targets is *carbon neutral*. Initial research on carbon offset providers defines carbon neutrality as a process with three independent steps: (1) determine the extent of the carbon footprint, (2) implement emissions reduction measures, and (3) offset the remaining amount (Dhanda and Hartman, 2011). Further analysis of the role of carbon offsets in the hotel industry defines *carbon neutral* as a score of four market indicators: project quality, carbon calculations, quality information of providers and price per ton of carbon offset (Dhanda, 2014). Today, the most standardised equivalent term of *carbon neutrality* is *net-zero carbon dioxide (CO_2) emissions,* which means emissions are achieved when anthropogenic CO_2 emissions are balanced globally by anthropogenic CO_2 removals over a specified period (Table 1) (IPCC, 2018). Moreover, recent research defines *carbon neutrality* as 'carbon replacement, carbon reduction, carbon sequestration and carbon cycle'; the four main aspects to achieve carbon neutrality (Zou *et al.*, 2021).

Several organisations and corporations make use of the term *climate neutral* on their websites and/or sustainability reports. Early research considers the ethical aspect of climate neutrality as *'the best guarantee of ensuring that the poor and vulnerable are spared from even more threatening impacts such as heat waves, crop failures, floods, water shortages that will increasingly threaten their lives and livelihoods'* (IPCC, 2014). Another ethical definition of climate neutrality follows a four-step process: 1) measurement of emissions, 2) reduction, 3) substitution of 'high-energy emission sources' to one with little or no emissions and, 4) compensation for emissions after the substitution efforts, normally with carbon credits (Ziegler,

2016). Moreover, climate neutrality is a legitimate strategy when it does not violate human rights and reduces the human risks of climate change. Consequently, a plausible climate neutrality strategy is for the developed countries to invest in transition as they are advanced in technological and social reduction and substitution (Ziegler, 2016).

Yet, an ethical definition per se for climate neutrality is insufficient to quantify greenhouse gas (GHG) emissions. There is a general scientific consensus that climate neutrality refers to *'a state in which human activities result in no net effect on the climate system. Achieving such a state would require balancing of residual emissions with emission (carbon dioxide) removal as well as accounting for regional or local biogeophysical effects of human activities that, for example, affect albedo or local climate'* (IPCC, 2018).

According to the European Climate Law, climate neutrality by 2050 means 'achieving net-zero greenhouse gas emissions for EU countries as a whole, mainly by cutting emissions, investing in green technologies and protecting the natural environment' (Table 1) (EC, 2018). From an environmental perspective, the carbon neutrality definition takes into consideration only CO_2 emissions. However, different GHG gases have different warming potentials. For instance, methane has a 100-year global warming potential of 32 times that of CO_2 (Nisbet, *et al.*, 2020). Hence, a climate-neutral definition is more unitary, allowing methane and other GHGs to be brought together under one term (Nisbet, *et al.*, 2020). The climate neutrality term has a more scientific basis in relation to the carbon neutrality term, and it could be more precise by referring to all anthropogenic influences, not solely to Kyoto-GHG emissions (Brovkin *et al*. 2013).

A more scientific perspective of the net-zero term is that of net-zero energy systems, if we assume that an energy system is a set of energy sub-systems. A net-zero energy system does not add any GHG emissions into the atmosphere (Davis *et al.*, 2018). Research explains that there are technological and economic constraints to achieving net-zero energy systems during this century. Among others, there is a challenge for emissions-free electricity, electrified substitutes for most fuel-using devices, alternative materials, and carbon-neutral fuels. However, these technologies are still under development. Thus, it is crucial to keep researching and deploying any of the available technologies as soon as possible (Davis *et al.*, 2018).

In recent years, the term *net negative emissions* has been used predominantly by corporations that are ahead in their climate neutrality commitments. Specifically, the term 'net negative emissions' refers to the result of human activities where more greenhouse gases are removed from the atmosphere than are emitted into it. The quantification of negative emissions depends on the climate metric chosen to compare emissions of different gases, such as global warming potential, global temperature change potential and others as well as the chosen time horizon (Table 1) (IPCC, 2018). In other words, net negative not only reduces current GHG emissions but also reduces past GHG emissions via offsetting practices at the same time. While the term climate neutrality 'trades' emissions emitted for the emissions removed, the term net negative emissions compensate for past emissions, and viable technological solutions can contribute to achieving climate neutrality by 2050.

Net-Zero Definitions	Definitions	Author, Year
Carbon Neutral	Net-zero carbon dioxide CO2 emissions, that is emissions achieved when anthropogenic CO2 emissions are balanced globally by anthropogenic CO2 removals over a specified period.	IPCC, 2018
Climate Neutral	Achieving net-zero greenhouse gas emissions for EU countries, mainly by cutting emissions, investing in green technologies and protecting the natural environment.	EC, 2018
Net Negative emissions	The term net negative emissions refers to the result of human activities where more greenhouse gases are removed from the atmosphere than are emitted into it.	IPCC, 2018

Table 1: The above table summarises the considered net-zero definitions for this study: carbon neutral, climate neutral and net negative emissions. This research assumes that the definition of net-zero greenhouse gas emissions is equivalent to the term climate neutral according to EC (2018).

Moreover, all net-zero definitions have a fundamental complication: the lack of a standard carbon emissions calculation (Murray and Dey, 2009). Thus, it is questionable how derivative calculations are estimated. Precisely, how is carbon reduction calculated, or how is offsetting calculated? Recently, the IPCC delivered a consensus formula on estimating the GHG emissions in relevant fuel combustion activities (energy industries, manufacturing industries and construction, transport, other sectors, non-specified) in the Emission Factor Database (EFDB) (IPCC, 2021). On an aggregate level, this calculation can provide an estimation for sectoral GHG emissions (IPCC,2021).

Globally, there is a lack of standard GHG emission calculation at the corporate level. The GHG protocol provides optional calculation tools that enable corporations to 'develop comprehensive and reliable inventories' to assist nations in tracking their GHG emissions (Greenhouse Gas Protocol, 2021). This is a 'cross-sectoral' GHG emission calculation tool that applies to industries and businesses regardless of sector. It is free and Excel-based and was launched via the GHG Protocol and WRI (Greenhouse Gas Protocol, 2021).

Previous research brings to light different net-zero definitions as a function of decarbonisation strategies and various climate metrics. Although there are different Net-Zero definitions, the climate-neutral term is more unitary than the carbon-neutral as it takes into consideration all GHG emissions. However, any corporation making use of the term *net negative* would be perceived as sustainably advanced, as it would not only curb current GHG emissions but also offset past GHG emissions.

Moreover, on a corporate level, there is a need to establish an 'agreed-upon' definition that would limit companies from adopting whichever definition best suits their climate business strategy and hence reduce the risk of greenwashing. Thus, this study suggests the adoption of a 'net-zero protocol'. Of course, there are internal and external corporate factors to consider when developing a 'net-zero protocol'. Yet, it is impossible to overlook the lack of a standardised measurement

system based on an agreed-upon common calculation of GHG emissions. Therefore, an optimal 'net-zero protocol' should imply the implementation of such a standardised measurement system.

2. Net-zero Emissions in Terms of Scopes 1, 2 or 3

According to the Greenhouse Gas Protocol, Scope 1 refers to direct GHG emissions that the company makes, excluding GHG emissions that are not covered in the Kyoto Protocol, CFCs and NOx that may be reported separately (WBCSD and WRI, 2012). Scope 2 refers to indirect GHG emissions of a company due to purchased electricity, thus emissions that occur on the company site (WBCSD and WRI, 2012). Scope 3 refers to all remaining indirect emissions resulting 'from sources not owned or controlled by the company' (WBCSD and WRI, 2012).

To comprehend what corporations define as net-zero, it is vital to analyse scopes 1, 2 and 3. Reporting on scopes is considered a fundamental element of the net-zero definition on a corporate level and hence analyzed accordingly to inspect its suitability for the implementation of a 'net-zero protocol'. A gap in the literature concerning net-zero and corporate accounting in scopes 1, 2 and 3 indicates the need for future research in this field. Yet, research on annual corporate reports and corporate announcements may assist in comprehending corporate net-zero reporting on scopes 1, 2 and 3.

As of today, when a corporation commits to a net-zero target and reports under scopes 1, 2 and 3 voluntarily, if it has a serious net-zero commitment, it should report on all scopes, whether the reduction on scope is meaningful in terms of emissions or not. For example, Microsoft has reported being *carbon neutral* since 2012, committed to a *net-zero* target in 2020 and aims to be '*carbon net negative* in all scopes by 2030' while reporting GHG emissions for scopes 1, 2 and 3 downstream since 2014 (Microsoft, 2016; The Official Microsoft Blog, 2020).

Yet there are corporations that use a net-zero target as a marketing strategy to signal to investors a good environmental performance. It is often the case that companies report on scopes 1 and 2 and partially on scope 3 in terms of their emissions reductions. For example, Zalando claims to be *carbon neutral*, *net-zero* and committed to a *net-zero target* in 2019 (edie.net,2019; Zalando, 2020). Here, there is confusion not only in terms of the carbon accounting but also in terms of the

'net-zero protocol' that the company is applying; that is both *carbon neutral* and *net-zero,* at the same time. Specifically, Zalando became *carbon neutral* on the 24th of October 2019 and *net-zero* on the 30th of October 2019 (edie.net,2019; Zalando, 2020). Relative to the *carbon neutral* term, the company reports more details on scopes 1, 2 and partially 3 upstream, while on the *net-zero* term, Zalando reports only refers to scopes 1 and 2 (edie.net,2019; Zalando, 2020). Therefore, reporting on the net-zero term is insufficient.

By analysing corporate disclosures on scopes 1, 2 and 3 emissions, one can deduce what organisations perceive as net-zero and net-zero target. Thus far, a lack of a mandatory carbon accounting framework creates a lack of cohesion when evaluating total GHG and scopes 1,2 and 3 of a corporation and brings further confusion in developing and setting a 'net-zero protocol'.

In 2021, the European Commission (EC) proposed to amend the existing reporting requirements of the Non-Financial Reporting Directive (NFRD) through the development of the Corporate Sustainability Reporting Directive (CSRD), targeting medium-sized and large companies (EC,2021). The proposal requires auditing of reported information, detailed reporting following mandatory EU sustainability standards and requires firms to digitally tag reported information on social media (EC,2021). The EU plans to adopt the new set of standards by October 2022 (EC,2021). The European Financial Reporting Advisory Group (EFRAG) launched the public consultation process for the European Sustainability Reporting Standards (ESRS) Exposure Drafts on 29th April 2022, which shows some developments towards mandated disclosures about scope 1, 2 and 3 emissions (ESRS E1, 2022).

The lack of a mandatory carbon accounting framework in carbon accounting renders the evaluation of corporate carbon accounting somewhat confusing. In detail, the lack of a mandatory carbon accounting framework in scopes 1, 2 and 3 impedes the development and application of a corporate 'net-zero protocol'. Even though there is a lot of discussion about what should be compulsory or voluntary in carbon accounting reporting, it is beyond the purpose of this analysis. Yet, it is vital to consider the implementation of a mandatory carbon accounting framework in scopes 1, 2 and 3 within the function of a 'net-zero protocol'.

CASE STUDY

Explain the use of scopes 1, 2 and 3 within the net-zero definition based on the corporate example of HSBC.

In recent years, many corporations have shown optimism with respect to their net-zero scopes 1, 2 and 3 disclosures. Yet, at times, the corporate net-zero definition in use may not be sufficient to reduce GHG emissions in scopes 1,2 and 3 by 2050. For example, a company claiming to become net negative by 2050 should apply a stricter environmental strategy to reduce emissions in all scopes by 2050 than a company that claims to become carbon neutral by 2050. Other times, various corporate net-zero definitions are used to disclose scope 1,2 and 3 emissions within the same company report or company official announcement. Another pattern in net-zero carbon accounting is the discontinuity in the net-zero definitions that a company claims in different years.

For instance, HSBC claims to have been carbon neutral since 2005 and remained carbon neutral until 2012 in scopes 1 and 2 (HSBC, 2006; HSBC Holdings plc,2009; HSBC, 2010; HSBC-Holdings, 2011; HSBC-Holdings, 2012). In 2011, HSBC announced that it would no longer be carbon neutral from 2012 due to changes in international carbon markets and instead use an eco-efficiency fund to use the funds previously allocated for HSBC's carbon neutrality program HSBC-Holdings, 2011; HSBC-Holdings, 2012). For the period 2012-2018, HSBC makes no use of net-zero definitions in its annual sustainability reports (HSBC, 2013; Holdings plc, 2015; Holdings, 2017; HSBC, 2018). Finally, in 2019, HSBC announced the ambition to become carbon neutral by 2050 and in 2020 announced its ambition to become net-zero by 2050 in scopes 1,2 and partially scope 3 downstream (Quinn, 2019; Holdings plc,2020).

Among other company examples, this specific case study points out the most challenging issue in sustainability-net-zero reporting, i.e., the lack of a standard framework that a company should comply with following its environmental strategy and scope. In most cases, an ambiguous corporate sustainability practice affects corporate legitimacy and signals a greenwashing factor to investors.

3. Net-Zero Offsetting Practices

The following section reviews how the 'net-zero offsetting practices' term determines the amount of net emissions. The subtrahend of the net-zero equation (i.e. emissions - net-zero offsetting practices = net emissions) is commonly classified as either compensation or substitution (Ziegler, 2016).

Compensation is the final step to follow once all reduction and substitution efforts are exhausted. Here, compensation is equivalent to offsetting the emissions that a firm is not able to substitute via various offsetting options (Ziegler, 2016). Following the reasoning of this literature review, net-zero offsetting practices are considered a vital element for the use of the net-zero definition in the corporate setting and hence subject to analysis towards the application of 'a net-zero protocol'.

Carbon offsetting *'occurs when an individual or an organization pays a third party to reduce emissions of greenhouse gases on its behalf' and so the offsetting takes place when an individual or an organization pays a certain amount towards a project in order to offset emissions from the atmosphere'* (Dhanda, 2014). Carbon offsets can be either compulsory or voluntary, the former offsets are called certified emission reductions and the latter 'gourmet' offsets (Dhanda, 2014).

If corporate offsetting is used to decrease total emissions, then offsetting becomes an important process within the corporate climate strategy (Dhanda, 2014). In general, companies that commit to some kind of climate neutrality target rely on offsetting as a main constituent of their climate change strategy (Kreibich and Hermwille, 2021).

There are regulated and non-regulated offsetting mechanisms. For example, the European Union Emissions Trading Scheme (EU-ETS) is a regulated mechanism for trading emissions, where for each allowed CO_2 ton one buys the equivalent CO_2 permit (Haszeldine *et al.,* 2018). With this kind of trading mechanism, the main incentive to reduce emissions is to reduce the cost of CO_2 emissions. Of course, a low price for CO_2 emissions would provide only a low incentive, as a firm can buy as many permits as it wishes and continue to emit CO_2. For instance, a few companies in energy-intensive sectors bought offsets in emerging markets, causing a carbon-leakage effect. (EC, 2021)

Another issue is that the EU-ETS is set up in a way that the price for CO_2 emissions is determined by the market and not by economic activities per se. Consequently, during an economic recession, the price of CO_2 permits drops as it did during the Great Recession, resulting in a surplus of CO_2 permits with a very low CO_2 price. Recent research proposes the conditionality of carbon credits on the adoption of science-based targets to 'force' climate change mitigation activities within a firm's operations (Kreibich and Hermwille, 2021). Should the deployment of offsetting technologies become commercialised, reaching net emissions by 2050 would become an attainable goal.

Carbon Capture and Sequestration (CCS) is a group of technologies that aims to reduce GHG emissions because of the extraction, combustion, and utilisation of fossil fuels and carbon-containing resources (Haszeldine *et al.*, 2018). Yet, to develop CCS, it can take years until there is clean mapping of the subsurface for geological storage and storage permits (Haszeldine *et al.*, 2018). In essence, the problem is not only scientific but also bureaucratic, as most governments do not have precise knowledge of their surface storage potential. For proper deployment of CCS, not only is policy intervention needed, but also funding to render the technology available at the industrial level (Haszeldine *et al.*, 2018). CCS is essential for further technologies to become available at an industrial scale, such as Bioenergy with Carbon Capture and Storage (BECCS) and Direct Air Capture (DAC). For example, although there is reasonable research and development in the UK for BECCS, there is no CCS infrastructure, although the North Sea has great potential for offshore storage. There are only 23 large CCS projects worldwide (García-Freites, Gough and Röder, 2021). Therefore, CCS technologies are not yet deployed on a commercial scale to account towards 'netting' of emissions by 2050.

Both non-regulating offsetting mechanisms (e.g. EU-ETS) and offsetting technologies contribute towards the compensation of emissions according to Ziegler's theory (2016). By contrast, substitution is the replacement of high-energy carbon with low-energy carbon. Nevertheless, Ziegler (2016) points out, there is a probability of additionality when applying substitution. For example, making use of the land for ethanol production does not necessarily account for substitution resulting in land-use change and biodiversity loss (Duden *et al.*, 2020). Therefore, for transparent substitution, emissions accounting and sustainability criteria should be considered

(Ziegler, 2016). Because there is no certainty in additionality, substitution should not account towards the 'netting' of emissions.

If a company abstains from its carbon-neutral claim, such an action could be interpreted as greenwashing (Dhanda, 2014). However, a possible greenwashing factor in substitution and compensation may render net-zero by 2050 unrealistic.

In a way, substitution is equivalent to avoided emissions 'as emission reductions which occur outside of a product's lifecycle or value chain, but as a result of the use of that product' (WBCSD and WRI, 2012). The factor of substitution in greenwashing may be high as avoided emissions is to claim a benefit that does not occur to the company per se. Thus, it is vital that corporations provide voluntary, detailed reporting on avoided emissions to limit possible boycotts and greenwashing risks.

The degree of greenwashing might be lower for compensation than for substitution because a company has to account for the means of offsetting. Nevertheless, there are various studies that highlight the potential for greenwashing in compensation. For example, as part of a compensation scheme in Brazil, 23,100 eucalyptus trees were planted to make iron production feasible, at the same time the project was criticised for endangering the flora and fauna and contaminating the river (Ziegler, 2016).

While there is a plethora of net-zero offsetting practices, there are also social, economic and environmental challenges to overcome. Offsetting practices via carbon credits could be rewarding amidst high prices for CO_2 emissions. Offsetting via CCS technologies is not yet a viable solution on a commercial scale, due to social, economic and environmental restrictions as well as the time needed to invest in R&D. Moreover, substitution activities should not count towards offsetting due to possible additionality and the fact that a corporation could account for emissions that it does not own. Ideally, the consideration of employment of a financially independent body that aims to verify net-zero offsetting practices can audit reporting on corporate information (Hoepner, Paliabelos and Rogelj, 2021). This can enable accuracy and transparency when accounting for annual net emissions and hopefully limit greenwashing.

4. Net-Zero Targets on a Sectoral Level

The scope of this section is to analyze the net-zero definition at the corporate sector level. The rationale here was to gather data at the corporate level and consider the sector level as the aggregate of *x* companies claiming net-zero targets in a *y* sector. Due to limited net-zero targets on a corporate level, only net-zero targets on the sector level are taken into consideration. Technology innovation and policy alignment are fundamental for the net-zero transition to materialise by 2050.

As of October 2021, Net-Zero Tracker recorded that 136 out of 198 countries, 115 out of 713 regions, 235 out of 1,777 cities and 681 out of 2,000 companies reported net-zero targets (Net-Zero-Tracker, 2021). Over the last few years, various corporations have claimed net-zero targets either on corporate annual reports or corporate announcements. But the Net-Zero Tracker also reveals that many did not (yet) commit to Net-Zero targets to achieve net-zero emissions by 2050. Additionally, Nurdianawati and Urban (2021) propose that companies should not only commit to short-term net-zero targets (e.g., 2030) but also to long-term Net-Zero-targets to avoid carbon lock-in assets and achieve full decarbonisation.

It is vital to assess a corporate net-zero target in terms of GHG emissions to evaluate a company's environmental performance. For example, many hotels and resorts use the term *carbon neutral* on various occasions and with various meanings; some do not report about their carbon offsetting practices and some firms seem to use the term *carbon neutral* for marketing purposes, which can be considered greenwashing (Dhanda, 2014).

A study that focuses on climate claims of the world's 35 largest meat and dairy companies concludes that only four companies report net-zero targets (Lazarus, McDermid and Jacquet, 2021). Moreover, one of the net-zero companies, Fonterra, focuses solely on carbon dioxide reduction and lobbied for the 47% methane reduction targets in New Zealand while arguing that there should 24% net reduction from the year 2017 (Fontera, 2019).

The most emission-intensive sectors of power generation, transport and heavy industry (i.e. steel production) need to overcome key engineering and economic challenges (e.g. carbon pricing) to become Net-Zero (Kaya, Yamaguchi and Geden, 2019). To realise carbon neutrality, it is necessary to undergo carbon replacement in electricity, heat and hydrogen, which is expected to

reduce CO_2 emissions by 45% in 2050 (Zou *et al.*, 2021). Electricity replacement refers to 'green' electricity (e.g., hydro or wind power) that can replace thermal power; heat replacement refers to photothermal and/or geothermal resources that can replace fossil fuel heating and hydrogen replacement refers to green hydrogen instead of gray hydrogen (Zou *et al.*, 2021).

As cost-optimisation scenarios show, Carbon Dioxide Removal (CDR) deployment by 2100 would account for over 15 Gt of carbon dioxide on an annual basis (IPPC, 2018). Therefore, a different course of action is necessary to decarbonise high-emitting sectors and achieve net-zero by 2050. There is a consensus for the development of a low-energy society, where CDR would contribute towards offsetting residual emissions that are either high-priced or impossible to mitigate (Kaya, Yamaguchi and Geden, 2019). In this scenario, CDR technologies would be deployed for the offsetting of net removals from agriculture, forestry and land-use (as cited in Grubler *et al.*, 2018). However, recent research compares 29 industry transition roadmaps across 13 countries by analysing policy, finance and technology to assess climate neutrality transition in heavy industry. It concludes that decarbonisation options are practical only if a large part of an industry deploys them (Johnson *et al.*, 2021).

The transport sector is one of the most emitting sectors, with mobility accounting for 50% of the total emissions in Europe alone (Peksen, 2021). Since 71,27% of hydrogen derives from natural gas, only green hydrogen can support a climate-neutral economy and thus cross-sectoral change is required to achieve CO_2 targets by 2030 (Peksen, 2021). There is a challenge to develop new energy vehicles that operate on green hydrogen (i.e. fuel cells, and batteries) and simultaneously compensate for economic, social and environmental demands (Peksen, 2021). The transition to new energy vehicles is gradual and should be compatible with a feasible policy setting.

A 'cap and surrender' prototype policy, much like the EU-ETS equivalent, but a much more radical measure embedded with an adequate policy strategy, could pave the way to get to net- zero by 2050 (Enzmann and Ringel, 2020). Here, car owners hold road transport allowances (RTAs) that are stored in an electronic allowance card (EAC); these are tradable emission allowances just as CO2 emission permits, in other words, one RTA is equivalent to 1 ton of CO2 (Enzmann and Ringel, 2020). When buying fuel at a fuel station, both money and emission allowances are 'surrendered'. Once exhausted drivers can buy RTAs on the secondary market. An aggressive cap-

and-surrender policy is to incentivise producers of CO_2 to emit less; in other words, high-emitting vehicles pay higher costs for RTAs (Enzmann and Ringel, 2020).

Industry is the most challenging sector to commit to a net-zero target. Although electrified industrial processes with zero electricity can reduce GHG drastically when compared with fossil fuel industrial processes, there is little incentive to switch due to high electrification costs (Wei, McMillan and de la Rue du Can, 2019). Thus, the decarbonisation of industry will depend on future energy and environmental policies (Wei, McMillan and de la Rue du Can, 2019).

Finally, although the tourism sector is declared to be 'carbon-neutral' (2021 Glasgow declaration: to a Decade of Tourism Climate Action), there is no transition roadmap on how this sector will transit to net-zero by 2050 or specific support in research (Scott and Gössling, 2021). For instance, comparative net-zero transition risk is higher for tourism companies found in Angola, Somalia, Chad and Mauritania, as they are carbon-intensive economies with a high percentage of GDP depending on tourism (Scott and Gössling, 2021).

A holistic approach would allow net-zero targets to align a net-zero strategy among governments, sectors and companies. For example, Sweden developed a climate policy, which aligned local net-zero targets with national goals along with innovations in technology. This renders decarbonisation of energy-intensive industries feasible by 2045 (Nurdianawati and Urban, 2021).

Even though many countries, companies and sectors are setting net-zero targets, there is a need for aligning net-zero targets across sectors, as in Sweden's case, to scale up decarbonisation in high-emitting sectors. Low-carbon transitional changes should materialise not only high high-emitting sectors (power generation, transport, industry) but across all sectors. Carbon replacement is vital to realise carbon neutrality in electricity, heat and hydrogen. Overall, innovation in technology across different sectors is at the primary stage.

5. Corporate Governance and Net-Zero Targets

There is a gap in research as far as net-zero targets and governance are concerned. Yet, following the assumption that net-zero targets disclosure falls within the broader spectrum of sustainability

disclosure, a few studies analyse the mappings between governance and sustainability disclosure as well as sustainability performance.

Charreaux defines corporate governance as *'the set of mechanisms that define powers and influence decisions of the chief executive'* and thus includes boards, managers and shareholders (Charreaux, 1997). Good corporate governance and sustainability disclosure are complementary mechanisms that can assist companies in dialogue with stakeholders (Michelon and Parbonetti, 2012). Similarly, good corporate governance and disclosure on net-zero targets can enhance the company-stakeholder relationship. When we talk about corporate governance and sustainability disclosure, we normally refer to two theories: stakeholder theory and legitimacy theory. Stakeholder and legitimacy theories often explain the effect of corporate governance on sustainability disclosure (i.e. net-zero targets) as this is important information that a firm should disclose or signal to its stakeholders to legitimise its operation to society.

While stakeholder theory refers to different interest groups related to a corporation and their roles in shaping management strategies, legitimacy theory refers to society as a whole (Hahn, Reimsbach and Schiemann, 2015). Meanwhile, legitimacy 'communicates information between the company and external organisations and commitment or support of a company's valuable stakeholders' (Mallin, Michelon and Raggi, 2013). Therefore, disclosing net-zero targets within the framework of sustainability disclosure can legitimise a firm's activities by signaling to stakeholders that the corporate governance model is in line with contemporary environmental values.

For the formulation and disclosure of net-zero targets, corporate governance can play an important role. Corporate governance mechanisms can be used to avoid greenwashing by assuring that the definition of the net-zero target or the net-zero definition is transparently communicated and that the definition is consistent across the years. Furthermore, corporate governance processes might also be useful to internally ensure that realistic targets are communicated and that the required actions to achieve these targets are carried out by the firm.

Overall, commitment to corporate social responsibility starts from investors and their representatives on the board of directors, particularly for the board of directors of high-emitting industries (e.g. oil and gas) where there is a need to account for stakeholder's trust, firm reputation

and public perception (Arena, Bozzolan and Michelon, 2015). Moreover, research demonstrates that board monitoring and stakeholder orientation influence the relationship between environmental disclosure and future environmental performance (Arena, Bozzolan and Michelon, 2015). Voluntary corporate governance mechanisms, such as expertise in environmental committee members and corporate sustainability officers, are positively correlated with voluntary GHG disclosure transparency (Peters and Romi, 2014). Sustainability expertise in the corporate governance model and GHG disclosure (i.e. sustainability disclosure) can improve the relationship that the firm has with its stakeholders (Michelon and Parbonetti, 2012). Moreover, gender diversity in the corporate governance model can also contribute towards enhanced sustainability disclosure. A recent empirical study demonstrates that Australian companies with multiple women on the board have a high-quality and quantity of voluntary GHG emission disclosures (Hollindale *et al.*, 2019). Furthermore, evidence from Arena, Michelon and Trojanowski (2018) concludes that CEO psychological traits can positively influence corporate environmental innovation. Yet, empirical research concludes that organisational context and external environment are significant factors to consider when measuring the effect of CEO traits on environmental innovation (Arena, Michelon and Trojanowski, 2018). Research also concludes that managerial environmental awareness and stakeholder function are essential factors towards environmental performance and green production (Zameer, Wang and Saeed, 2021). Specifically, this study shows that following stakeholder theory, stakeholders, i.e., customers, regulators, and managers, can pressure firms to implement business strategies to improve environmental performance and opt for green production.

Although one can expect that internal corporate characteristics and corporate governance models can affect the heterogeneity of sustainability disclosure, an empirical study shows a weak correlation between them. Findings conclude that the presence of independent directors on the board is not necessarily associated with better sustainability disclosure. Independent directors are more relevant in enhancing sustainability disclosure when they are community influencers at the same time. Community influencers can ameliorate sustainability disclosure according to the information they report on media, hence bringing legitimacy as independent directors and improving stakeholder engagement (Michelon and Parbonetti, 2012).

On a regulatory level, regulatory stakeholders could impose penalties should a corporation fail to follow environmental regulatory guidelines and consumers could refuse to buy a product that is not aligned with environmental guidelines (Zameer, Wang and Saeed, 2021). Hence, a manager-stakeholder collaboration may endorse a commitment to net-zero emissions. Apart from climate policy, other external factors that can affect the relationship between corporate governance and sustainability disclosure, such as investor engagement.

Recent analysis of investor reaction to social activist campaigns in the U.S for the years 2011-2015 on stranded assets demonstrates negative cumulative abnormal returns (CARs) from stock market investments in coal companies as a result of stranded asset risk reports and divestment campaign events on coal companies (Byrd and Cooperman, 2017). Significant research shows that institutional investor engagement on governance issues can reduce downside risk and create value for investors (Hoepner *et al.*, 2022). Although reductions in downside risk in institutional governance engagements are large, yet not statistically significant due to the subjective nature of social topics and the time it takes to implement such changes within an organisation (Hoepner *et al.*, 2022). Furthermore, empirical results show that internal corporate governance influences corporate climate action; specifically, intra-organisational factors such as organisational involvement and inclusion of climate change risk management impact the most corporate climate action (Damert and Baumgartner, 2018).

To summarise, both internal and external corporate characteristics can influence the relationship between corporate governance and sustainability disclosure. Internal corporate governance and intra-organisational factors can positively affect sustainability disclosure. For instance, internal managerial hierarchy, CEO physiological traits and managerial awareness can influence environmental disclosure, environmental innovation, environmental performance and green production (Arena, Michelon and Trojanowski, 2018; Delmas *et al.*, 2004; Zameer, Wang and Saeed, 2021). Research shows that sustainability disclosure and performance are influenced mostly by internal corporate governance characteristics and not external institutional settings (Damert and Baumgartner, 2018). On the contrary, external corporate governance factors such as community influencers and investor engagement can enhance sustainability disclosure and reduce downside risk in governance issues (Michelon and Parbonetti, 2012).

There is a gap in the literature as far as net-zero targets and governance are concerned. Future research may examine various aspects of net-zero targets and governance. For instance, it would be worthwhile to understand internal and external pressures in corporate governance and net-zero targets.

Consequently, good corporate governance can channel efficient means to align with sustainability disclosure and hence with net-zero target disclosure following the proposed 'net-zero protocol' of this meta-review analysis.

5. Concluding Remarks

There is a consensus that the variety of net-zero definitions is subject to ambiguity. Research shows that rather than talking about carbon neutrality, the focus should be instead on climate neutrality, as its scientific rationale is sounder since it considers all GHG emissions. This literature review examines a range of factors, such as scope, net-zero offsetting practices, corporate-sectoral target level and governance, that render a corporate net-zero definition problematic and suggests the implementation of a 'net-zero protocol'. Specifically, a 'net-zero protocol' should consist of (1) a transparent and standardized calculation process for GHG emissions, (2) reporting on scope 1, 2, & 3 emissions, (3) employment of net-zero practices, (4) cross-sectoral net-zero alignments and (5) alignment of corporate governance with sustainability disclosure. To avoid misleading use of net-zero labels and to mitigate greenwashing concerns, several economic, social, environmental and governance barriers are to be overcome. Standard setters and regulators can help by providing clear definitions and guidance (e.g., on the measurement of scope 1, 2 and 3 emissions).

Finally, the literature review identifies a gap in research, especially regarding the following issue*s:* (2) net-zero emissions in terms of scopes 1, 2 or 3, (4) net-zero targets on a sectoral level and (5) the effect of corporate governance on net-zero targets. Therefore, (2) can be analysed only based on corporate reports and corporate statements. (4) is evaluated only in terms of a sector level due to limited published material on a corporate level. Finally, (5) is addressed within the mappings among corporate governance, sustainability disclosure and sustainability performance as well as

external corporate governance factors such as investors, shareholders and climate policy. These research gaps signify the need for future research about the corporate use of net-zero targets.

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Appendix A

The following section summarizes in five steps (Step 1. Eligibility Criteria, Step 2. Information Sources, Step 3. Search Strategy, Step 4. Study Records-Data Management, Step 5. Selection Process, Step 6. Data Collection Process) the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) according to the Items that are relevant for this study and those that are not.

Step 1. Eligibility Criteria: In the following, I explain the paper selection process and the relevant eligibility criteria.

The systematic literature review focuses on published articles that correspond to the protocol designed for Net-Zero (see Step 3) for the years 2009-2021. The search in Scopus was run on the 27th of September 2021. The comprehensive literature search of papers was conducted in English.

Step 2. Information Sources: The information sources approach follows de Freittas Netto *et al.*,2020. To identify and retrieve all relevant publications for the purpose of this systematic literature review the search engine Scopus (https://www.scopus.com) was selected. Scopus search engine has been selected as it has better coverage of literature and detailed string search in comparison with other search engines (i.e. Google Scholar, Web of Science).

Step 3. Search Strategy: I build on a longer list of search terms to capture not only literature directly mentioning and addressing "Net-Zero", but to also identify literature, which is focussing on closely related terms such as "carbon neutral", "climate neutral", or "net negative". The search string is as follows:

(("Net-Zero" OR "carbon neutral" OR "climate neutral" OR "net negative") AND ("target" OR "goal" OR "objective" OR "aim" OR "focus" OR " intention" OR "commitment" OR "ambition" OR "claim" OR "promise" OR "pledge" OR "path" OR "trajectory") AND (LIMIT-TO (SRCTYPE , "j") OR LIMIT-TO (SRCTYPE , "p")) .

The search period is 2009 through 2021. The year 2009 was selected due to the Copenhagen Climate Change Conference in 2009. This is the 15th UNFCCC conference (COP 15) and the 5th Kyoto Protocol Conference (COP 5) (Unfccc.int. 2021). The Copenhagen Conference is a critical

event in the history of climate change negotiations as it scaled up negotiations on the infrastructure including the Kyoto Protocol Clean Development Mechanism and produced the Copenhagen Accord (i.e. constraining carbon for short and long term) (Unfccc.int. 2021).

Step 4. Study Records-Data Management: The algorithm on Scopus is applied for the studied years (see Search Strategy), resulting in 881 conference proceedings and journal articles, which are further filtered to 804 journal articles by eliminating conference proceedings. Further, the Scopus list of 804 papers is narrowed down to 35 selected papers from which only 16 papers are relevant after title and abstract analysis is concluded in the first phase of the selection process (see Step 5). As the number of identified papers is rather low, the literature review was extended to include literature cited in the papers identified and other relevant literature. Therefore, I added 34 references (published papers and sites that are accompanied by an asterisk (*) in the bibliography) to render this meta-analysis sufficient (see References).

Following the PRISMA-P checklist, a few PRISMA-P items have been omitted[5] as they were not applicable for the purpose of this study.

Step 5. Selection Process: Data selection is carried out in four phases. In the first phase data selection involves the analysis of title and abstract in line with de Freittas Nettto *et al.*,2020. The second phase involves downloading selected journals that meet the criteria of this study (see Steps 1,2&3). The third phase consists of the analysis of the Introduction and Conclusion of selected journals. Finally, the fourth phase includes the analysis of the methodology per selected paper.

Step 6. Data Collection Process: Data collection has been carried out following the process explained above (see Step 5). Firstly, the reviewing process includes screening of titles and abstracts and further obtaining selected papers. Secondly, the reviewing process includes the analysis of the Introduction and Conclusion of selected papers and finally the analysis of methodologies among selected papers.

[5]Specifically, data items, outcomes and prioritization, risk of bias individual studies, data synthesis, meta-biases and confidence in cumulative estimates (items 12, 13, 14,15,16 and 17) have been eliminated.

Paper 2

Net-Zero by 2050, but carbon neutral now: The paradoxical reporting of corporate carbon commitments[6]

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Abstract

The years 2020/2021 saw hundreds of corporations announce net-zero greenhouse gas emissions targets by 2050. Curiously, several of these corporations have already claimed to be carbon neutral, in some cases, for over a decade. Scientifically, achieving net-zero greenhouse gas emissions means ensuring carbon-neutral processes. Consequently, the claim to target net-zero greenhouse gas emissions in decades conflicts with the statement of already being carbon neutral, thereby creating a dissonance that could be perceived as greenwashing. In this study, we employ legitimacy theory to enhance our understanding of how companies narrate and possibly rationalise this dissonance. We also connect legitimacy types (moral, cognitive, pragmatic) with an explicit/implicit communication strategy component, resulting in potentially greenwashing corporate reporting patterns. We found five distinct corporate reporting patterns: (1) *explicit moral legitimacy: 'mea-culpa';* (2) *explicit cognitive legitimacy: 'science-based revision';* (3) *explicit pragmatic legitimacy: 'CO2e scope shifting';* (4) *implicit cognitive legitimacy: 'pausing';* (5) *implicit pragmatic legitimacy: 'greenhushing'*. Our results suggest a nuance in theorising greenwashing with *'greenhushing'* and *'pausing'* being rationalised as deliberately implicit legitimacy-focused patterns. Our study contributes to the emerging greenwashing literature by differentiating explicit from implicit patterns and investigating to what extent pragmatic patterns may demonstrate a greater inclination toward greenwashing than cognitive or moral ones.

Keywords: Carbon neutral; greenhushing; greenwashing; explicit legitimacy; implicit legitimacy; net-zero

[6] 2nd Round Revise & Resubmit *at 'Green Disclosure' special issue in Sustainability Accounting, Management and Policy Journal (ABS: 2)*.

1. Introduction

In 2018, the IPCC defined net-zero CO2 emissions in the glossary of SR15 as follows: "Net-zero carbon dioxide (CO2) emissions are achieved when anthropogenic CO2 emissions are balanced globally by anthropogenic CO2 removals over a specified period. Net-zero CO2 emissions are also called carbon neutrality" (IPCC, 2018). In the same year, the European Commission (EC) presented its long-term vision to reduce greenhouse gas (GHG) emissions, aiming for a climate-neutral EU by 2050 (EC, 2020), whereby it defined climate neutrality as "an economy with net-zero greenhouse gas emissions" (EC, 2020)[7]. In 2023, the global green technology market is expected to exceed USD 17.1 billion and will reach a valuation of USD 112.4 billion by 2032[8]. This fact alone led many corporations to become greener or appear green to some extent. Many corporations use the word 'green' as an environmental status to differentiate themselves from competitors that are supposedly not green based on their environmental performance (Delmas and Burbano, 2011).

Given the green boom, hundreds of corporations announced net-zero GHG emissions targets by 2050 before COP26 in Glasgow in late 2021. Curiously, several of these corporations have already claimed to be carbon neutral, in some cases, for over a decade. Scientifically following the IPCC, however, achieving net-zero GHG emissions means ensuring carbon-neutral processes. Consequently, the claim to target net-zero GHG emissions in decades conflicts with the statement of already being carbon neutral. Based on Lyon and Montgomery's (2015) definition of greenwashing[9] as "any communication that misleads people into adopting overly positive beliefs about an organisation's environmental performance, practices, or products", companies which claim current carbon neutrality while promising to achieve net-zero only in several decades are either not really carbon neutral at present or delay net-zero needlessly. In short, such companies make themselves vulnerable to greenwashing accusations. Thus, this study investigates the following research question: *Since carbon neutral and net-zero describe the same scientific state,*

[7] So far only the EC and the IPPC provide a Net-Zero emissions definition. To avoid confusion from different terms, this study follows the IPCC definition which states that carbon neutrality and Net-Zero CO2 emissions are equivalent.

[8] https://www.globenewswire.com/news-release/2023/12/13/2795348/0/en/Green-Technology-Market-Predicted-to-Achieve-USD-112-4-Billion-Valuation-by-2032-Driven-by-a-Steady-24-0-CAGR-Market-us.html.

[9] Greenwashing can be taxonomic; it takes place on many levels, sectors, and activities, and has been identified with many different definitions. For the purpose of this study, greenwashing is scaled down on a firm level.

how do companies claim to have been carbon neutral for the last year(s) rationalise committing to net-zero targets in the distant future?

We identify 25 companies that set net-zero targets while already claiming contemporaneous carbon neutrality and conduct a longitudinal content analysis of their disclosures from 2005 to 2021, coding their claims year by year to arrive at an in-depth understanding of how they position themselves vis-à-vis carbon neutrality and net-zero. We derive five corporate reporting patterns by connecting specific legitimacy types (moral/cognitive/pragmatic) with communication strategy (explicit/implicit) in corporate statements. Conceptually, we employ legitimacy theory to enhance our understanding of how companies narrate and possibly rationalise this dissonance.

This study is the first to analyse carbon-neutral/net-zero definitions in corporate reporting patterns for an extensive time (2005-2021) and combines legitimacy and greenwashing theory. This longitudinal analysis allows us to understand to what extent companies' reporting patterns have been consistent over the years with their claims. Further analysis of communication strategy (explicit/implicit) and legitimacy types (moral/cognitive/pragmatic) can infer accountability or greenwashing behaviour. As a result, we find various patterns ranging from a post-truth ignorance of science via '*greenhushing*' to gaming GHG Scope definitions. More specifically, we identify five distinct corporate reporting patterns: (1) *explicit moral legitimacy: 'mea-culpa';* (2) *explicit cognitive legitimacy: 'science-based revision';* (3) *explicit pragmatic legitimacy: 'CO2e scope shifting';* (4) *explicit cognitive legitimacy: 'pausing';* (5) *implicit pragmatic legitimacy: 'greenhushing'*.

In contemplative review, the '*mea-culpa'* pattern is characterised by a public apology for overpromising climate credentials. The *'science-based revision'* pattern is the uninterrupted and gradual carbon-neutral revision towards a more precise scientific understanding. Further, the *'CO2e Scope Shifting'* pattern repositions the previous claim of carbon neutrality as scientifically insufficient and re-focuses on the new net-zero claim. The *'pausing'* pattern interrupts the disclosure of green claims to allow for repositioning. Ultimately, the *'greenhushing'* reporting pattern diffuses the green claims, reporting problems with vague corporate statements.

This study makes three main contributions to the literature. First, we contribute to theorising legitimacy by introducing an explicit and implicit perspective beyond the theorising of Brown,

Clark and Buono (2016), who conceptualise the former as explicit stakeholder communication and the latter as values and norms. Specifically, we frame implicit legitimacy perspectives as attempts to achieve legitimacy by avoiding explicit communication about controversial topics. For example, a company might avoid providing detailed information on issues that are not clearly defined or where different societal expectations exist. Such strategies can be labelled *'greenhushing'* or deliberate *'pausing'* of green communication (Carlos and Lewis, 2018).

Second, we contribute to greenwashing theory development by interacting legitimacy types (moral/cognitive/pragmatic) with an explicit/implicit component that creates five potentially greenwashing reporting patterns (*'mea-culpa', 'science-based revision'*, *'CO2e scope shifting'*, *'pausing'*, and *'greenhushing'*). Based on these patterns, we distinguish between *'greenhushing'* and strategic silence with this study's two implicit corporate reporting patterns (*'pausing'* and *'greenhushing'*). Like Font, Elgammal and Lamond (2016), we understand *'greenhushing'* at a high level as corporate communication, which aims to under-report or down tone pro-sustainability communication (such as green claims) due to changing stakeholder expectations. While previous research associates *'greenhushing'* with a degree of strategic silence (Horiuchi *et al.,* 2009; Font, Elgammal and Lamond, 2016; Carlos and Lewis, 2018; Ginder, Kwon and Byun, 2019), this study delineates a thin boundary between '*greenhushing*' (i.e., underreporting details) and strategic silence (i.e., omitting to report positive features (Carlos and Lewis, 2018)) in corporate statements. Whereas we theorise '*greenhushing*' as deliberately 'hushed' or 'rushed' appearing corporate communication of green claims without sufficient evidence, we introduce *'pausing'* as a distinct pattern that overlaps with Carlos and Lewis' (2018) strategic silence. However, we theorise *'pausing'* as a response to a previously inaccurate green claim, while the silent notion of Carlos and Lewis (2018) relates to green certifications presented as valid achievements.

In detail, this study classifies five distinct corporate patterns according to their legitimacy types (moral, cognitive, pragmatic) and communication strategy, whether explicit or implicit. The corporate reporting patterns identified as *'mea-culpa*', '*science-based revision*', and '*CO2e scope shifting*' align with the classification of explicit communication strategies, given that the corporate statements are direct and well-documented. However, moral, cognitive and pragmatic legitimacy types differentiate between them (Suchman, 1995). The 'mea-*culpa'* pattern predominantly exhibits explicit moral legitimacy, the *'science-based revision'* pattern predominantly exhibits

cognitive legitimacy, and the *'CO2e scope shifting'* pattern predominantly reflects pragmatic legitimacy (Suchman, 1995). The last two patterns, *'pausing'* and *'greenhushing*', fall into the implicit communication strategy category, as corporate statements are indirect or omitted for years. Nevertheless, the former corporate pattern predominantly reflects cognitive legitimacy, while the latter reflects pragmatic legitimacy (Suchman, 1995).

It is imperative to note our recognition of the simultaneous presence of multiple legitimacy types in the corporate patterns under examination (Bitektine, 2011). Nonetheless, our characterisation is primarily employed to indicate the prevalence of a particular legitimacy type, whether moral, pragmatic, or cognitive.

Hence, we attribute the *'mea-culpa'* pattern predominantly to moral legitimacy. This corporate pattern is distinguished by its moral corporate conduct, exemplified through public apologies for inaccuracies in previous corporate statements of carbon neutrality. Further, we assign the *'CO2e scope shifting'* and *'greenhushing'* corporate patterns predominantly to pragmatic legitimacy (Suchman, 1995). Companies employ tactical communication in corporate statements to benefit stakeholders (Seele and Gatti, 2017). This fact is evident with a strategic shift of scope 3 in the *'CO2e scope shifting'* pattern and the equivalent use of carbon-neutral/net-zero definitions in the *'greenhushing'* pattern. In contrast, we assign the *'science-based revision'* and *'pausing'* corporate patterns predominantly to cognitive legitimacy (Suchman, 1995). Assuming the environment controls the firm, companies may employ cognitive legitimacy to align with societal beliefs (Basu and Palazzo, 2008). Thus, the temporal dimension is crucial as societal beliefs evolve, leading to variations in cognitive legitimacy that companies employ in corporate statements over different periods. For instance, companies systematically employ cognitive legitimacy across various temporal intervals in their corporate statements in the *'science-based revision'* corporate pattern. This approach involves repetitively revising their definition of carbon neutrality to align with evolving societal beliefs. In the *'pausing'* corporate pattern, companies employ cognitive legitimacy in their corporate statements after *'pausing'* periods. This approach enables companies to interrupt and amend incongruent green claims, leveraging time to reframe corporate statements strategically in alignment with prevailing societal beliefs.

This study has practical implications for academics, practitioners, and regulators. As the reporting patterns indicate, companies use labels for their green claims, even if they are unclear. However, companies rely on various strategies to move towards the new label when a clear definition evolves (e.g., a net-zero claim). Clear regulatory guidance might be useful to minimise greenwashing, for instance, mitigating pragmatic legitimacy reporting patterns (i.e., *'pausing'* and *'greenhushing'*).

2. Background and Theoretical Framework

2.1 Types of Legitimacy and Communication Strategies

"Legitimacy is an assumption that an entity's actions are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Deephouse and Suchman, 2009, p.52).

According to Suchman, legitimacy theory explains how to attain organisational legitimacy in alignment with stakeholders' perceptions. Therefore, a legitimate corporation is licensed to operate congruently with stakeholders' interests (Suchman, 1995). Corporate legitimacy can be classified into three types of legitimacy: pragmatic legitimacy, moral legitimacy, and cognitive legitimacy (Seele and Gatti, 2017). As Bitektine (2011) argues, legitimacy types observed in literature are not mutually exclusive; hence, more than one typology can apply to an organisation's legitimacy in a particular social context.

Pragmatic legitimacy results from self-interested calculations of the organisation's key stakeholders and is based on stakeholders' perceptions of the benefits of corporate activities and communication (Seele and Gatti, 2017). Research reveals a few core benefits of attaining legitimacy: gaining reputation and network benefits to address social issues (Bowen, 2017). Regarding reputation, symbolic participation in industry self-regulation social schemes can assist firms in maintaining sound reputations via industry self-regulation and, hence, attain pragmatic legitimacy (Bowen, 2017). Further, regarding network benefits, the more that companies adopt ecolabels or participate in 'green clubs', the more the industry self-regulation scheme is recognised with environmental quality, attracting more firms to enjoy the benefit of adoption (Bartley, 2003; Prakash and Potoski, 2006). This is because, through industry self-regulation-recognised environmental quality, firms can attain pragmatic legitimacy in corporate social responsibility

(Bowen, 2017). In this direction, firms may aim to attain legitimacy pragmatically and maintain their reputation by announcing carbon-neutral/net-zero partnerships or alliances to commit to green claims. Further, adopting green targets, definitions, or claims (i.e., net-zero) seems to enhance the network benefit effect, as the number of companies committing to net-zero increases by the year.

Moral legitimacy rests on judgements (e.g., from a company's managers) about whether the activity is the right thing to do; these judgements usually reflect beliefs about whether the activity effectively promotes societal welfare, as defined by the audience's constructed value system (Suchman, 1995). In this direction, Bitektine (2011) argues that corporate moral legitimacy is evaluating an organisation as beneficial to the whole society or the evaluator's social group. For instance, moral legitimacy in offsetting practices indicates corporate accountability towards decarbonisation.

Cognitive legitimacy refers to the taken-for-granted assumptions of an organisation's audiences (Suchman, 1995). As Basu and Palazzo (2008, p.126) argue, 'the assumption here is that the environment controls the firm'. Therefore, cognitive legitimacy must align with larger belief systems and with the experienced reality of the audience's daily life (Geertz, 1973; DiMaggio and Powell, 1991; Suchman, 1995). For this reason, cognitive legitimacy may differ from one time period to another as societal belief systems shift. Particularly, cognitive legitimacy limits scrutiny of external social actors by applying the taken-for-granted assumptions of the organisations' audiences and allowing cognitive typification of the organisation. For instance, scientists first refer to carbon neutrality in the fifth IPCC assessment report (IPCC, 2014), while after the Paris Agreement, scientists use the term net-zero in the SR15 special report (IPCC, 2018). Hence, corporations adopt these widely accepted definitions in their corporate statements.

In corporate statements, explicit and implicit communication strategies denote two separate methods organisations employ to convey their messages. An explicit communication strategy entails conveying information directly and minimising opportunities for ambiguity. This method is characterised by transparent language and specific climate reporting details in corporate statements to ensure stakeholders comprehend the intended message without uncertainty. Conversely, implicit communication strategy relies on indirect context or cues to convey messages

in corporate statements. This method frequently requires interpreting implied meanings relying on stakeholders' capacity to deduce significance from cues or omitted information in corporate statements. While explicit communication strategy is direct and reduces ambiguity, implicit communication strategy can be more complex and require deliberate messaging to manage stakeholders' perceptions regarding corporate social responsibility (i.e., a company announcing committing to net-zero) or address delicate subjects, for instance, disguising greenwashing.

Implicit communication strategy in corporate communication may convey environmental friendliness without substantiating green claims. Through indirect and ambiguous corporate statements (e.g., simultaneous green commitments) and symbolic gestures (e.g., joining a green alliance), companies can project an image of commitment to corporate social responsibility without implementing changes in their operations. This tactic allows firms to capitalise on growing stakeholder demand for green practices without genuine adherence to environmental standards. Consequently, implicit communication strategy serves as a tool for companies to maintain a positive public perception and mitigate reputation risks associated with greenwashing practices (Vasi and King, 2012).

This study considers all three types of legitimacy: moral, cognitive, and pragmatic legitimacy. Our analysis aims to identify which legitimacy type is most pronounced in corporate green claims. Therefore, we aim to cluster companies with similar legitimacy types. We also analyse green claims across several years to evaluate the consistency of green claims and how this relates to the legitimacy types, especially in cases where there is a noticeable divergence between the claim of achieving carbon neutrality in the present and a net-zero target for the future. Finally, we identify green claims with explicit or implicit strategy communication.

2.2 Legitimacy, Green Claims, and Corporate Disclosure

A common practice for an organisation to attain corporate legitimacy is using green claims or, more broadly, environmental claims. A company pledging an environmental claim signals corporate social responsibility, thus attaining legitimacy with stakeholders and investors. An environmental claim strengthens a company’s reputation, granting a competitive edge in corporate social responsibility among its peers, especially in a sector where few or very few companies make environmental claims. If a corporate environmental claim complies with societal expectations, it

enhances a company's legitimacy. From a climate change mitigation perspective, an environmental claim signals that the company making this claim is better prepared to manage potential climate crises.

An environmental claim's legitimacy is attributed to its nature (i.e., its inherent characteristics). An organisation that pledges an environmental claim based on or connected to scientific evidence naturally attains legitimacy as opposed to an environmental claim with no robust evidence. For example, an environmental claim pledging net-zero by 2050 indicates a more elevated degree of legitimacy than an environmental claim pledging to decrease greenhouse gas emissions by 30% until 2050, simply because the former is directly related to the IPCC.

Essential characteristics of a legitimacy-focused claim are transparency, consistency, and cultural context. This is because a transparent environmental claim that discloses material information in a consistent and ethical framework fosters accountability. Moreover, the users/readers of corporate reports appreciate consistency. Specifically, consistency relates to three dimensions of our study. First, a regular update on reaching the target (e.g., a yearly progress report on achieving net-zero). Second, consistency signals that the target is consistent (e.g., carbon neutral or net-zero). Third, consistency entails stability of the definition behind the green claim (e.g., consistent scope of emissions).

Consistency may refer to a timeframe. For example, a company's green claim regarding its label and definition stays the same over several years while the company regularly reports about the green claim and its progress (e.g., yearly). Another factor that determines the legitimacy of a green claim is cultural context. For instance, corporate legitimate environmental characteristics may be perceived differently in Europe than in the Americas.

In addition to the nature of the claim, the legitimacy of an environmental claim may be influenced by the credibility and expertise of the claimant (i.e., the company pledging an environmental claim). For example, a consulting firm making a green claim may be perceived as more trustworthy than an oil company. However, that could be the view of an environmental activist of an oil company who has no financial interest in the oil company, while an employee with financial interests/benefits may convey a different perception of legitimacy. That is to say that legitimacy is in the eyes of the beholder (Seele and Gatti, 2017).

Previous research addressed the legitimacy of green claims, the absence of established regulatory standards, and the potential risk of greenwashing associated with ambiguous green claims. In the marketing domain, Rotman, Gossett and Goldman (2020) argue that deceptive green claims are associated with greenwashing and recommend regulatory changes to prevent greenwashing in nonagricultural products. In this direction, Petty *et al.* (1994) argue that regulation can mitigate the greenwashing effect in green claims otherwise characterised as 'green promises.'

Another branch of research studies ambiguous corporate communication and disclosure in green claims and addresses the effect of misleading green claims on a company's reputation (Newell, Goldsmith and Banzhaf, 1998). In this direction, the research addresses the association of vague corporate environmental disclosure with greenwashing, which criticises companies that create green talk through statements aimed at satisfying stakeholder requirements in terms of sustainability but without any concrete action (Delmas and Burbano, 2011; de Freitas Netto *et al*., 2020). Greenwashing is a decoupling behaviour, meaning it is symbolic and does not provide environmental protection, but is used when a company fails to fulfil environmental protection commitments. Greenwashing aims to alleviate external public pressures and uncertainties and avoid conflicts with external constituents (Guo *et al*., 2018).

Companies that aim to achieve or increase corporate legitimacy can use green claims. However, green claims are not necessarily aligned with actions. If such misalignment is apparent, the green claim can undermine the company's reputation and even risk greenwashing accusations, particularly in sensitive sectors such as the oil and gas or food industry (ESMA, 2023). In the absence of aspirational climate policies (Nordhaus, 2018) and aligned corporate regulatory requirements in climate-related disclosure, addressing greenwashing will pose a significant challenge as it becomes more intricate.

In recent years, a few voluntary frameworks in climate-related disclosure aimed to promote transparency and mitigate greenwashing in corporate communication, thereby also regarding green claims. The recent European Directive on Green Claims aims to foster green transition and ensure reliable environmental information for product consumers (EC, 2023). The Directive proposes new environmental and impact rules prohibiting 'carbon neutral' and 'net-zero' claims in advertising, packaging, and social media unless verified, thus, providing a solution for

greenwashing as companies have to report a detailed emission reduction plan and undergo independent verification for their corporate statements and activities before providing a green claim (EC, 2023). Regulatory efforts such as the Directive on Green Claims show that greenwashing is perceived as a serious challenge not only in research but also in regulatory and corporate settings.

3. Methodology

3.1 Sample Selection

We derived data on green claims from SDGlabs.ai—Scientists, an organisation that assesses net-zero targets (or the lack of those targets) for over 5,000 firms worldwide. SDGlabs.ai—Scientists analysed corporate sustainability data from official company sustainability reports and official company press releases. Specifically, we focused on the data relating to companies' carbon-neutral claims, net-zero 2050 targets, net-zero definition, carbon-neutral definition, and GHG statements in terms of all three scopes. A total of 526 firms had made net-zero pledges until 2020, of which twenty-five firms (about 4.8%) claimed to be already carbon neutral. We focused on these 25 firms[10] in our analysis, and we analysed their green claims in sustainability reports across the years, from 2005 to 2021.

3.2 Data Coding

As described above, our analysis builds on the sample of companies that report net-zero targets in their corporate statements while claiming to be carbon neutral in past corporate statements[11]. We checked whether and how the companies define "carbon neutral" and "net-zero". This is necessary to understand the extent and relevance of corporate statements and the differences between carbon neutral/net-zero statements and definitions. Thus, we checked whether the definitions are

10 These firms are Allianz SE, HSBC Holdings PLC, BNP Paribas, Nordea Bank, NIBC Bank NV MTN RegS, Moody's Corp, Bank of New York Mellon Corp, Zalando, Thomson Reuters Corp, Royal Bank of Canada, Australia and New Zealand Banking Group Limited., Zurich Insurance Group Ltd, NN Group NV, Atos, .Microsoft, ITVPLC, .Dallas Fort Worth Tex INTL ARP, VMware Class A INC, Gatwick Funding LTD, Royal Schiphol GROUP NV MTN RegS, Schroders PLC, Comcast Corp Class A, Amp LTD, EasyJet. MTN RegS, and Aeroports de Paris SA.

11 In the context of this study, we assumed that green claims, green targets, and green definitions can be considered as subsets within the domain of corporate statements.

equivalent for both terms (i.e., carbon neutral and net-zero) or what differences are there between the definitions. Moreover, we analysed the consistency between net-zero targets and net-zero definitions to understand how much a company deviates from the original target to the actual corporate statement reported. In this direction, we compared whether the total GHG Scope (scope 1, 2 and 3) accounting is greater under the carbon-neutral or the net-zero definition. Finally, to investigate the trustworthiness of carbon-neutral corporate statements, we accounted for offset reporting, and similarly, for net–zero, we accounted for 2050 net-zero scope reduction.

For each company, we first coded the following critical information for our analysis: (1) When did the company make its first carbon-neutral claim? (2) When did the company make its first net-zero claims? (3) How did the company define "carbon neutral" in its first carbon-neutral claim? (4) How did the company define "net-zero" in its first net-zero claim? (5) Are the "carbon neutral" and the "net-zero" definition of the company equivalent? (6) Is the company's net-zero definition suitable for the net-zero target? (7) Is the GHG scope greater under the definition of carbon neutral or net-zero? (8) Is carbon neutral and offsetting reporting? (9) Is net-zero 2050 scope reduction reporting? Appendix 1 summarises the coding and shows each question as a distinct column.

Based on the coding, we can understand companies' carbon-neutral and net-zero statements, the underlying definitions and scopes, and the extent to which carbon offsetting is considered. In essence, by coding the corporate statements and the associated reporting over the period (2005-2021) according to claimed characteristics, this research aims to contrast the legitimacy of corporate statements.

The second part of this study analysed the selected twenty-five companies regarding their sustainability definitions yearly for the period ranging from 2005 to 2021. With this approach, we create a timeline of corporate sustainability reporting for each company from the earliest year of reporting to the latest (see Appendix 2). In detail, this timeline provides corporate information per year on the following aspects: Does the company make a green claim? Is this claim related to carbon neutral, net-zero, or both? We provide the outcome of this coding in Appendix 2.

The results of the firm-year panel allow us to identify and understand the development of green claims over time. Thus, it makes it possible to crossmatch the corporate statements across the years and evaluate whether they are consistent and, if not, how they differ within a company.

Additionally, by comparing companies' green claims development against each other, we can identify differences in the pattern of green claims and thereby cluster companies. Accordingly, the firm-year panel allows us to extrapolate valuable information on the corporate reporting strategy by analysing the consistency of the corporate carbon-neutral and net-zero statements across the years.

To identify patterns of corporate reporting strategies relating to carbon-neutral and net-zero statements, we evaluated the following questions for each company: (1) How consistent are carbon-neutral and net-zero statements over the years? (2) Is there a revision of carbon-neutral and net-zero statements? (3) How quickly does the company switch from carbon-neutral to net-zero statements? Is there a pause in any corporate statement? (4) If there is a pause, how long is it? (5) What is the number of years for a definition to be deliberately removed? Based on these questions, we grouped each company in the studied sample into a pattern of corporate reporting strategy. Ultimately, we linked companies' corporate reporting strategy patterns to legitimacy and greenwashing theories to conceptualise the impact of corporate greenwashing.

4. Discussion of Results

Based on the content and development of corporate green claims, we identified five different patterns of company behaviour in managing the dissonance between having claimed carbon neutrality already and later claiming to reach net-zero decades into the future. In the following, we describe these patterns and show the links to moral, cognitive, and pragmatic legitimacy while theorising about the implicit and explicit differentiations of the claims we observe.

4.1 Explicit Moral Legitimacy: *'mea-culpa'*

If a company claims to be carbon neutral for years but then realises that net-zero under the IPCC's definition can only be reached in the future, then the moral course of action is to explicitly issue an apology for an inaccurate 'carbon neutral' claim. This approach reflects moral legitimacy, that is, moral judgments about the corporate behaviour of what is the "right thing to do" towards social welfare (Suchman, 1995).

Specifically, Microsoft started to claim carbon neutrality in 2012 and, over time, stated that '100% carbon neutrality had been achieved by their global operations every year since 2012' (see Appendix 1 and 2). In 2020, however, Microsoft stopped claiming carbon neutrality and revised its ambition to be 'carbon negative by 2030' with a plan to reduce scope 1 and 2 emissions close to zero and scope 3 emissions by more than half by 2030 (Smith, 2020).

Microsoft distinguishes between carbon-neutral and net-zero definitions, arguing that companies use the definition of carbon-neutral to either remove carbon from the atmosphere (i.e., planting trees) or avoid a reduction in emissions (i.e., payment for not cutting a tree). While sustainable practices of carbon removal, such as planting trees, have a positive impact, fees towards avoiding reduction in emissions that a company pays an organisation not to cut down trees does not necessarily imply a positive impact (Smith, 2020).

Further, Microsoft is the only company apologising for inaccurately using a relatively broad definition of carbon neutrality: investing in offsets that avoid a reduction in emissions instead of removing carbon that has already been emitted. Hence, the definition of carbon neutrality inaccurately addresses the removal of carbon from the atmosphere. For this reason, Microsoft shifted to 'net negative' by employing carbon removal technologies that will allow the company to remove all the carbon it has emitted in scopes 1 and 2 since the founding year 1997 (Smith, 2020).

We labelled this pattern *'mea-culpa'* (i.e., my fault) because companies using this strategy seem transparent and take responsibility for using insufficient carbon-neutral definitions in the past. The move to commit to using a net-zero definition in the future can be interpreted as an approach to abide by a more precise and generally accepted definition, revealing that the goal is not yet reached. Indeed, Microsoft is taking responsibility for reducing its carbon emissions and switching from the label "carbon neutral" to the label "net negative" or "net-zero". This acknowledgement of the company's historical use of an inadequate carbon-neutral definition can also be seen as a commitment to ethical conduct instead of more self-serving strategies such as trying to downplay or even avoid addressing this shift in the terminology of green claims.

The *'mea-culpa'* pattern is characterised by clear and transparent carbon-neutral and net-zero statements disclosure. However, it is essential to highlight that Microsoft has a significant market

cap and resources to invest in sustainability and employ sophisticated industrial carbon-neutral technology. As a huge company, Microsoft undergoes scrutiny from the media and NGOs, which is a stress factor for the company and the accountability of its corporate statements. Additionally, Microsoft understands the importance of stakeholder trust for its business success. Finally, even this reporting pattern can be seen from a more opportunistic perspective. By apologising for using an incomplete carbon-neutral definition in the past and committing to net-zero in the future, the company might aim to show the regulator that corporate self-regulation is possible (Gray, Kouhy and Lavers, 1995).

The strategy employed in the *'mea-culpa'* pattern is expected to be highly effective in building shareholder trust. However, it is crucial to note that this pattern is exclusive to Microsoft, as most companies in this study do not perceive this approach as effective. Ultimately, Microsoft can exhibit corporate social responsibility to its stakeholders and investors through legitimate corporate statements and runs no risk of greenwashing accusations. Finally, Microsoft exhibits explicit moral legitimacy in corporate statements and is, thus, perceived as a low-risk investment option for its stakeholders and investors.

4.2 Explicit Cognitive Legitimacy: *'science-based revision'*

Companies that show this corporate reporting pattern revise their carbon-neutral reporting to gradually shift into net-zero reporting. This gradual shift can reduce the extent of the inconsistency between carbon-neutral and net-zero definitions. Overall, companies in this pattern are not among the first to provide carbon-neutral claims but started to report carbon neutrality typically after 2011 (see Appendix 1). Here, companies start with the first definition of "carbon neutral" and revise it to a second and sometimes a third definition. While the definition of "carbon neutral" has changed over the years, the latest revision of the definition of the term "carbon neutral" tends to be in proximity with the first corporate statement on net-zero. Allianz SE is an exemplary company in this cluster. The company started to report a carbon-neutral corporate statement in 2012, revised the definition of its statement in 2018 and again in 2019, and finally shifted to net-zero in 2020 (see Appendix 2). In the 2019 and 2020 corporate statements, Allianz SE uses the term net-zero for different purposes. In detail in 2019, Allianz SE reported: "We will rigorously pursue decarbonisation and net-zero emissions at least in line with science-based targets", while in 2020,

the company reported: “Engage with O&G companies to set net-zero 2050 targets on Scope 1 and 2 emissions”. Thus, in 2019, the word net-zero refers to the total emission reduction budget, while in 2020, it refers to scope 1 and 2 emissions reduction, thus, a more scientific corporate statement (Paliampelou, 2024). With this reporting strategy, companies first tend to change the definition and then the term itself towards “net-zero”. Further, companies that follow this type of corporate reporting strategy definition in our sample are BNP Paribas, Nordea Bank, NIBC Bank, NV MTN RegS, Bank of New York Mellon Corp, Thomson Reuters Corp, NN Group NV, Dallas Fort Worth Tex INTL ARP, Vmware Class A INC, Aeroports de Paris SA, Amp LTD, and NIBC Bank NV MTN RegS (see Appendix 2).

The *'science-based revision'* corporate pattern reflects cognitive legitimacy in corporate statements, referring to the taken-for-granted assumptions of an organisation's environment (Suchman, 1995). While this pattern is predominantly related to cognitive legitimacy, it is plausible that the association of pragmatic legitimacy also exists.

Further, the *'science-based revision'* corporate pattern can be associated predominantly with explicit cognitive legitimacy as corporate statements of this pattern appear and are documented. While the companies in this reporting pattern do not explain why they change the definitions or labels of their green claims, they do explicitly show the definitions and labels yearly.

The companies in the science-revision corporate pattern value science as they revise their corporate statements, aiming to shift to a net-zero definition gradually. However, companies in the *'science-based revision'* pattern seem to revise carbon neutrality in their corporate statements at specific times. Specifically, companies mainly revise their corporate statements in this corporate pattern and shift to net-zero in 2019-2020, when net-zero corporate culture is booming. From another perspective, the constant revision of corporate statements renders the carbon-neutral revising pattern companies accountable as the definitions appear to be more detailed over time to shift to net-zero gradually. Nevertheless, this pattern risks reputational damage and potential greenwashing accusations due to past non-scientific corporate statements on carbon neutrality. Because a company reports carbon neutrality and later revises its corporate statement to net-zero, it may be interpreted as an admission to falsely reporting carbon neutrality in the past.

In conclusion, the *'science-based revision'* pattern reflects predominantly explicit cognitive legitimacy linked to stakeholder pressure. This is particularly evident as legislative modifications on the carbon-neutral/net-zero definition criteria necessitate companies to provide comprehensive corporate statements.

4.3 Explicit Pragmatic Legitimacy: *'CO2e scope shifting'*

For this corporate reporting pattern, companies report primarily on scopes 1 and 2 and partially on scope 3 upstream in the carbon-neutral claims, allowing for carbon-neutral offsets. Later, companies move toward a net-zero statement with emission reduction targets, typically without allowing carbon offsets. In other words, *'CO2e scope shifting'* companies shift from carbon-neutral to net-zero claims without explicitly explaining the change in scope 3.

ITV PLC is an exemplary company in this cluster. The company reported a carbon-neutral claim. In 2019, the carbon-neutral definition explicitly considers scopes 1, 2, and partially 3 upstream and reports carbon-neutral offsetting in all these scopes via certified carbon offsetting credits. In 2020, ITV PLC reported a change towards a net-zero statement and explained its targets: “net-zero emissions by 46.2% on scopes 1, 2, and 28% reduction on scope 3 emissions upstream by 2030”, where carbon offsetting is not considered anymore. The yearly analysis shows that ITV PLC did not make a green claim until 2019.

This corporate reporting pattern refers to *'CO2e scope shifting'* because companies change their carbon-neutral and net-zero definitions by shifting scope reporting without acknowledging the limitations of incomplete scope corporate statements. This pattern is only identified for ITV PLC and Atos Moody’s Corp.

The *'CO2e scope shifting'* strategic timing implies that companies shift their scope 3 emissions reporting to satisfy stakeholders’ perceptions of corporate communication. Therefore, we attributed this reporting pattern to pragmatic legitimacy (Seele and Gatti, 2017). Additionally, the *'CO2e scope shifting'* companies may shift their scope strategy due to societal-cultural changes and, thus, shifts in corporate cultural models, hence perceived as cognitive legitimacy (Suchman, 1995). However, the *'CO2e scope shifting'* corporate pattern reflects pragmatic legitimacy predominantly, so it is imperative to acknowledge the potential existence of cognitive legitimacy

in corporate statements. Therefore, pragmatic and cognitive legitimacy in shifting the committed scope pattern are not mutually exclusive.

The *'CO2e scope shifting'* pattern reflects predominantly explicit pragmatic legitimacy, as corporate statements within this pattern are direct and documented. The companies that follow this reporting pattern depreciate scientific and honest corporate statements in scope 3 emissions reporting. Specifically, *'CO2e scope shifting'* companies modify their definitions of carbon neutrality or net-zero definitions regarding scope 3 emissions. Companies might rely on this reporting pattern to acknowledge changes in stakeholders' perceptions and enhance company reputation. This is in line with Nishitani *et al*. (2021), who state that organisations with Sustainable Development Goals (SDG) or environmental targets should provide comprehensive reporting on anticipated and realised sustainability activities to mitigate greenwashing risk (Nishitani *et al*., 2021). Thus, companies should offer detailed reporting on all climate-related activities to substantiate present and future scope emissions reduction. However, the *'CO2e scope shifting'* companies report vague corporate statements in scope 3 emissions without taking responsibility for incomplete or inaccurate statements as opposed to the *'mea-culpa'* pattern. Therefore, this reporting pattern gives the impression of disregarding corporate social responsibility, which can even become a reputational risk and erode stakeholder trust. Such a drastic shift in scope reporting in corporate statements may be perceived as a purely superficial action without any fundamental changes in company behaviour. In conclusion, the *'CO2e scope shifting'* corporate pattern employs predominantly explicit pragmatic legitimacy in corporate statements to achieve legitimacy, boost company reputation, and maintain stakeholder engagement.

4.4 Implicit Cognitive Legitimacy: *'pausing'*

For this corporate reporting pattern, companies pause reporting a carbon-neutral statement for one or more years before reporting a net-zero statement. The *'pausing'* pattern implies that companies try to avoid any questions regarding the inconsistency of their green claims and, therefore, decide not to report a green claim for a while. Generally, companies that apply this type of reporting strategy report a carbon-neutral claim, then pause for a few years by removing any relevant corporate statements and finally revise their initial carbon-neutral claim with a shift to reporting a net-zero target.

For example, HSBC reported being carbon neutral in 2005-2007 on scopes 1 and 2 and revised the initial carbon-neutral definition in 2008 regarding scopes 1, 2, and 3 upstream. Specifically, in 2005, HSBC reported “carbon-neutral worldwide operations” (scope 1) and “reduce CO2 emissions and purchase greener energy where available” (scope 2). In 2008, HSBC reported, “HSBC has been carbon neutral since 2005. We have achieved this by cutting energy consumption and business travel in line with our targets and driving further efficiency savings by implementing innovations and technology in HSBC’s operations”. Further, in the period 2009-2011, HSBC made its carbon-neutral claim mostly in terms of scopes 1 and 2 in the annual reports due to the implementation of an environmental initiative that sources low-emission electricity (scope 1 and scope 2) and the reduction of remaining emissions with emission offset purchases. HSBC paused all corporate statements for 2012-2018 (see Appendix A, Table A1). This *'pausing'* of corporate statements was reported in 2011: “Following a review, we decided that from 2012, the business will no longer be carbon neutral because the regulatory environment and international carbon markets have not developed as we envisaged." Finally, in 2019, HSBC revised its carbon neutrality a second time, but without referencing scope. In 2020, HSBC reported the first net-zero corporate statement and specifically stated its ambition to become net-zero by 2050 in scopes 1, 2 and partially scope 3 downstream.

Additional companies in this cluster are Australia and New Zealand Banking Group Ltd, Zurich Insurance Group Ltd, Royal Schiphol Group NV MTN RegS, Comcast Corp, and Royal Bank of Canada.

The *'pausing'* pattern primarily reflects cognitive legitimacy in corporate statements, referring to the taken-for-granted assumptions of an organisation's cultural background (Suchman, 1995). However, time is fundamental when referring to corporate culture and corporate statements. Through time, the assumptions taken for granted by an organisation shift because of societal and cultural changes, which are reflected in a company's corporate statements as well (Suchman, 1995). For instance, as noticed in the study sample, in the early 2000s, corporate culture concentrated on carbon-neutral emissions, while two decades later, corporate culture focused on net-zero emissions. However, it is also possible to associate the *'pausing'* pattern with pragmatic legitimacy, given that suspending corporate statements for extended periods may be construed as a strategic approach to mitigate potential discord with stakeholders’ perceptions of legitimacy.

Although the primary association of the *'pausing'* pattern is with cognitive legitimacy, it is imperative to acknowledge the presence of a pragmatic legitimacy component. Furthermore, corporate communication tends to characterise the '*pausing*' pattern predominantly as implicit cognitive legitimacy, as corporate statements are indirect and omitted for years.

The companies in this cluster seem to discount the importance of consistent definitions as they pause corporate statements for several consecutive years. A company like HSBC may apply a '*pausing*' strategy to avoid using non-scientific corporate statements that can contradict the implied green claims. Nevertheless, the '*pausing*' pattern needs more transparency due to the absence of corporate statements in annual reports. Further, the '*pausing*' pattern lacks credibility because the company has not openly addressed the non-existent corporate statements for consecutive years. Therefore, investors and other stakeholders are not informed about the reasons for non-disclosure and the decision to change from one label (carbon neutral) to another (net- zero).

Essentially, the *'pausing'* corporate reporting pattern is a strategy to avoid scrutiny by temporarily suspending corporate statements when they contradict implied green claims (Carlos and Lewis,2018). Thus, this pattern is related to the '*strategic silence'* proposed by Carlos and Lewis (2018). Therefore, the *'pausing'* pattern potentially threatens the company's reputation and may lead to allegations of greenwashing (Vasi and King, 2012). One reason companies follow this strategy may be the need for corporate refinancing. Research shows that firms with a high carbon footprint receive less refinancing when bank-level commitments are not aligned with firm-level commitments (Kacperczyk and Peydro, 2022).

Conclusively, the '*pausing*' pattern employs predominantly implicit cognitive legitimacy in corporate statements due to corporate culture shifting from carbon neutral to net-zero.

4.5 Implicit Pragmatic Legitimacy: '*greenhushing*'

Companies report a vague net-zero target for this corporate reporting pattern that builds on an equivalent definition to the previously reported carbon-neutral claim. Generally, companies started to report carbon-neutral claims or net-zero targets relatively late (e.g., only in 2019). Thus, in previous years, no corporate statements have been made on either carbon-neutral claims or net-zero targets (see Appendix 1 and 2). This pattern refers to *'greenhushing'* because companies avoid

reporting a green claim for long and simultaneously rush to communicate equivalent carbon-neutral and net-zero corporate statements.

As an exemplary company in this cluster, Zalando reported equivalent carbon-neutral and net-zero definitions in 2019. Specifically, Zalando reports a carbon-neutral definition for scopes 1, 2 and partially scope 3 upstream: "We reached carbon neutrality in our operations (Scope 1 and 2) as well as deliveries, returns and packaging (Scope 3)" while reporting a net-zero definition in scopes 1 and 2 in 2019: "the company is net-zero emissions for scope 1 and 2". Moreover, Zalando removed corporate statements regarding carbon neutrality and net-zero in 2020 and 2021. However, for both 2020 and 2021, Zalando reports that it "commits to reduce scope 1 and scope 2 GHG emissions by 80% by 2025 against a 2017 base year" and to "reduce scope 3 GHG emissions from private label products by 40% per million EUR gross profit by 2025, from 2018 base year". Hence, Zalando's corporate reporting is rather ambiguous, perhaps confusing carbon neutral with net-zero when claiming both definitions in 2019 and no corporate statements in 2021. Other companies that show the '*greenhushing*' reporting pattern are Easyjet, Gatwick Funding LTD, and Schroders PLC.

The '*greenhushing*' pattern reflects pragmatic legitimacy. The reporting decisions appear tactical, aiming to communicate equivalent carbon-neutral and net-zero definitions in corporate statements to show corporate social responsibility and satisfy the interests of the company's key stakeholders (Seele and Gatti, 2017).

While the previous academic contribution of Carlos and Lewis' (2018) associates *'greenhushing'*[12] with '*strategic silence'*, we use the term to define companies which were silent on green claims for a longer time, but which then 'rushed' communication in green claims with a simultaneous reporting of carbon-neutral claims and net-zero targets. This differs from the '*pausing*' pattern, where companies went silent between a carbon-neutral claim and reporting a net-zero target.

The companies that belong to the *'greenhushing'* pattern discount the importance of science in corporate statements as they rush to communicate equivalent carbon-neutral and net-zero corporate statements simultaneously. The organisations that follow the *'greenhushing'* pattern may need

12 'Greenhush', the phenomenon of remaining silent (Horiuchi *et al*., 2009).

clarification about science as they perceive the definitions of carbon neutral and net- zero as equivalent. Accordingly, companies communicate vague green corporate statements to enhance company reputation and to benefit stakeholders' agendas on corporate statements. Hence, the '*greenhushing*' pattern is predominantly associated with implicit pragmatic legitimacy, where corporate statements are indirect and omitted for years, and communication is deliberately misleading due to ambiguity in carbon-neutral and net-zero definitions.

Organisations that influence the substance and structure of corporate disclosure may be perceived as engaging in symbolic environmental actions to attain legitimacy (Tang *et al*., 2023). This type of falsehood in corporate communication lacks accountability and risks potential greenwashing accusations. Companies may use greenwashing to reap the benefits of green communication without substantiating their claims (Lyon and Montgomery, 2015). Similarly, the *'greenhushing'* corporate reporting pattern may risk greenwashing accusations due to 'rushed' and vague communication in green claims.

Ultimately, the *'greenhushing'* pattern employs predominantly implicit pragmatic legitimacy in corporate statements to benefit stakeholders' perceptions.

4.6 Summary of Results

When we link the legitimacy types of this study (pragmatic/cognitive/moral legitimacy) with their respective communication strategy (implicit/explicit), we find that the distinction between implicit and explicit communication strategies is clear in corporate statements. Furthermore, Bitektine (2011) states that legitimacy types can coexist simultaneously. This is why we argue that one of the legitimacy types of this study is predominant without excluding the existence of one of the other legitimacy types (see Table 1).

Table 1: Provides an overview of this analysis' corporate reporting patterns, their respective communication strategy and the explanation of the word 'predominantly' per legitimacy type (see Notes)

Communication Strategy	Predominantly Moral Legitimacy	Predominantly Cognitive Legitimacy	Predominantly Pragmatic Legitimacy
Explicit	*'Mea-culpa'*	*'Science-based revision'*	*'CO2e scope shifting'*
Implicit	*Not observed*	*'Pausing'*	*'Greenhushing'*

Notes: The table provides an overview of the corporate reporting patterns of this study, communication strategies, and legitimacy types. Specifically, the *'mea-culpa'* pattern (predominantly[13]explicit moral legitimacy) as it apologies for having overpromised climate credentials; the *'science-based revision'* pattern (predominantly explicit cognitive legitimacy) as it gradually revises carbon-neutral revision towards scientific understanding; the *'CO2e scope shifting'* pattern (explicit pragmatic legitimacy) as it repositions the previous claim that is scientifically insufficient to focus on a new claim; the *'pausing*' pattern (implicit cognitive legitimacy) as it interrupts climate credentials and claims to allow for repositioning; the *'greenhushing'* (implicit pragmatic legitimacy) as it diffuses the corporate reporting problem with vagueness.

5. Conclusion

This study contributes to the literature in several ways. This is the first research study to analyse carbon-neutral/net-zero claims, their underlying definitions and related targets, and which analyses the discrepancies between them. This longitudinal study (2005-2021) of twenty-five companies that claimed to be carbon neutral in the past and that target net-zero in the future derives five distinct corporate reporting patterns and provides early insights into firm behaviour.

We contribute to legitimacy theory beyond Brown, Clark and Buono (2016) with the addition of explicit and implicit communication strategy components to comprehend how companies rationalise dissonance in corporate statements. While Brown, Clark and Buono (2016) introduce the explicit perspective as stakeholder communication and the implicit as values and norms, we additionally frame explicit legitimacy as direct and as a consistent corporate reporting pattern, where companies provide green claims regularly. Accordingly, we see the reporting patterns of *'mea-culpa'*, '*science-based revision*', and *'CO2e scope shifting'* as explicit strategies. Implicit strategies are characterised by indirect and omitted corporate reporting patterns, where companies

[13]The term 'predominantly' indicates that one legitimacy type is more significant than another within a particular corporate reporting pattern.

do not report green claims for extended periods. This silence can occur between reporting the different green claims (i.e., the *'pausing'* pattern) or before reporting green claims (i.e., the *'greenhushing'* pattern).

In line with Betektine (2011), we also find that the types of legitimacy are not mutually exclusive, meaning a company can try to achieve legitimacy in different ways simultaneously. We found that cognitive and pragmatic legitimacy might coexist simultaneously in four of the five reporting patterns (*'mea-culpa'* being the exception). We use the characterisation 'predominantly' to signify that one legitimacy type is more prominent than the other in a specific corporate pattern.

Further, the suggested corporate reporting patterns enable us to evaluate rigorously how companies fail to commit to their initial green claim. This is supported by case study examples, highlighting how companies risk their reputation if their reporting pattern is associated with greenwashing. Specifically, our contribution to the theory of greenwashing lies in recognising that the suggested pragmatic legitimacy patterns may demonstrate a greater inclination toward greenwashing than cognitive reporting patterns in this study. This is because pragmatic legitimacy is primarily strategic, while cognitive mostly refers to the well-calculated legitimacy of the corporate environment (Suchman, 1995; Basu and Palazzo, 2008).

While research concludes that greenwashing in misleading CSR communication lies in the eye of the beholder (Seele and Gatti, 2017), we analyse why companies employ cognitive and pragmatic corporate reporting patterns to attain legitimacy while risking greenwashing accusations. In this direction, the *'mea-culpa'* reporting pattern is the only reporting pattern subject to no potential greenwashing accusation, as such a pattern implies that the company takes responsibility for past inaccurate corporate statements regarding its carbon-neutral claim. Of course, ultimately, even such an open admission of past mistakes can be a symbolic action if the company fails to improve its carbon emissions in the future. However, from a legitimacy perspective, the 'mea-*culpa'* pattern provides the most clarity to stakeholders about the company's erroneous green claim in the past.

Additionally, we contribute to greenwashing theory by suggesting *'greenhushing'* and *'pausing'* as distinct reporting patterns, beyond the theory of previous studies that associated 'greenhushing' with strategic silence (Horiuchi *et al*., 2009; Font, Elgammal and Lamond 2016; Carlos and Lewis, 2018; Ginder, Kwon and Byun, 2019). Here, we derive that the *'greenhushing'* reporting pattern is

first silent and then deliberately rushed, resulting in inaccurate corporate communication on green claims, while the *'pausing*' reporting pattern shows a temporary suspension of corporate statements resulting in silence. Conversely to Carlos and Lewis (2018), we associate the silence of the *'pausing'* reporting pattern with implicit cognitive legitimacy, suspending corporate statements regarding carbon-neutral claims for the time of revising the underlying definitions and terms of the green claim.

This study has two main implications for academia, practice, and regulations. First, the suggested corporate patterns explain how companies address stakeholder expectations while sometimes engaging in greenwashing practices. Second, this research reveals that pragmatic legitimacy corporate patterns are more susceptible to greenwashing accusations, which explains the challenges that companies face with self-regulation and accountability. Beyond research, policymakers and practitioners may utilise this study's suggested methodology of corporate reporting patterns to detect greenwashing in green claims.

Limitations to this study provide opportunities for future research. Firstly, the analysis of corporate statements for 2005-2021 concludes a significant number of unobserved corporate statements may be attributed to the fact that in early 2000, stakeholders' demand for climate reporting could have been higher [2], resulting in non-detailed corporate reporting. Secondly, and most importantly, there was no uniform international disclosure regulation on climate change reporting in the sample period. Future research may investigate how such pragmatic and cognitive legitimacy development patterns will relate to mandatory sustainability reporting regulation once it is in place (e.g., the ESRS/CSRD in the EU).

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Appendix

Appendix 1: Sample summary table (in order of carbon-neutral commitment year)

Companies	Carbon Neutral (CN) Claim by commitment year	Net-Zero/Carbon Negative/Carbon-Neutral Target Claim (NZT) by target year and commitment year	Carbon-Neutral Definition (carbon neutral)	Net-Zero 2050 Target Definition (net-zero)	Are carbon-neutral and net-zero definitions equivalent?	Are net-zero definition & NZT consistent?	Is GHG Scope greater under carbon-neutral or net-zero definition?	Carbon neutral and offset reporting	NZT 2050 scope reduction reporting
1. Aeroports de Paris SA	CN by 2030 in 2017.	Zero Net CO2 2050 in 2019.	Carbon neutral: scopes 1, 2, and partially 3 upstream.	Not defined.	No	No	Greater under carbon neutral in all scopes by 2030.	Offset – Paris-Charles de Gaulle and Paris-Orly together have 1,600 hectares of impervious surfaces. We have undertaken to limit and offset future impervious surfaces when renovating or developing our airports, by creating holding ponds with a capacity of 500m3 per hectare.	NA
2. Allianz SE	CN in 2012.	NZT 2050 committed in 2019.	Carbon neutral as complete neutralization of their annual emissions of offsets in scope 1 in 2012.	Net-zero scopes: 1, 2 and partially 3 upstream and downstream in 2019.	No	Yes	Greater under net-zero scopes 2 and partially 3 upstream and downstream.	NA	Scopes 1 and 2 20 kgCO2e/boe5 in line with OGCI6. -50 % of AuM to set net-zero by 2050 targets for Scope 1 and 2 greenhouse gas emissions.
3. Amp LTD	CN in 2013.	NZT 2030 in 2019.	Carbon neutral: all scopes in 2013.	Net-zero: scopes 1 and 2 by 2030.	No	Yes	Greater under carbon neutral in all scopes in 2013.	NA	AMP maintained its carbon-neutral position in 2022 and significantly reduced emissions to meet and exceed our scope 1 and 2 reduction target of 42%

									by 2030 from our 2019 base year.
4. Atos	CN in 2018.	NZT 2035 in 2020.	Carbon neutral: scopes 1, 2 and partially 3 based on avoided emissions in 2018.	Net-zero: in all scopes by 2035.	No	Yes	Greater under net-zero in all scopes by 2035.	Since 2018, Atos has offset 100% of any residual CO2 emissions from all its data centres, offices and business travel worldwide through dedicated programs of investment in wind farms in India, managed by our partner EcoAct, enabling Atos to deliver fully compensated hosting services to our clients.	NA
5. Australia and New Zealand Banking Group Limited.	CN in 2010.	NZT 2050 in 2020.	Carbon neutral: scopes 1 and 2 in 2010.	Net-zero: scopes 1, 2 and partially 3 downstream in 2021.	Yes	No	Greater under net-zero in partially scope 3 downstream.	NA	Reducing Scope 1 and 2 emissions by 24% by 2025 and by 35% by 2030 (against a 2015 baseline).
6. Bank of New York Mellon Corp	CN in 2015.	Commitment to support the goal of net-zero 'GHG' emissions by 2050 in 2020.	Carbon neutral: scopes 1 and 2 in 2015.	Not defined.	Yes	Yes	Greater under carbon neutral in scopes 1 and 2.	NA	NA
7. BNP Paribas	CN in 2017.	NZT Carbon Neutral 2050 in 2019.	Carbon neutral: scopes 1 and 2 in 2017.	Net-zero: scopes 1, 2 and partially 3 downstream in 2019.	No	Yes	Greater under net-zero in partially scope 3 downstream.	The Group will also work to offset CO_2 emissions that cannot be directly avoided or easily reduced, such as those arising from staff travel and natural gas consumption, through partnerships with benchmark organizations, in accordance with our Corporate Social Responsibility policies.	NA
8. Comcast Corp Class A	CN in 2006	NZT net-zero carbon 2030 in 2019.	Carbon neutral: scope 1 in 2006.	Net-zero: all scopes by 2030.	Yes	Yes	Greater under net-zero in all scopes by 2030.		Our goal to be carbon neutral by 2035 means reducing our Scope 1 and 2

									emissions, or the direct and indirect emissions we own and control across our global operations.
9. Dallas Fort Worth Tex INTL ARP	CN in 2016.	NZT net-zero carbon 2030 in 2020.	Carbon neutral: scopes 1, 2 and partially 3 upstream in 2016.	Net-zero: scope 1 and partially scope 3 upstream by 2030.	No	No	Greater under carbon neutral in all scopes in 2016.	NA	NA
10.. Easyjet MTN RegS	CN in 2019.	NZT 2050 in 2020.	Carbon neutral: scopes 1 and partially 3 upstream.	Net-zero: scopes 1 and partially scope 3 upstream.	No.	Yes	Greater under net-zero in scopes 1 and partially scope 3 upstream.	We announced that we would become the world's first major airline to operate net-zero carbon flights across our whole network. We are doing this by offsetting the carbon emissions from the fuel used for all our flights through schemes accredited by two of the highest verification standards, Gold Standard and Verified Carbon Standard (VCS).	NA
11. Gatwick Funding LTD	CN in 2017.	NZT 2050 in 2019.	Carbon neutral: all scopes in 2017	Net-zero: scope 1 by 2050.	No	Yes	Greater under carbon neutral in all scopes in 2017.	Offsetting remaining GAL emissions with Gold Standard carbon offsets from Kar-Demir Bozyaka wind farm in Izmir province, Turkey.	Our goal: Reducing GAL Scope 1 and 2 emissions by a further 25% by 2030 (i.e., reach 80% under the 1990 baseline) as part of a science-based goal of reaching net-zero before 2040; sourcing 50% of airport network electricity and 50% of heat network from UK renewable sources via onsite generation and direct purchase agreements (PPAs) by 2030; requiring all GAL and airport duty vehicles, ground support equipment, and mobile construction equipment to

									meet zero or ultra-low emission standards by 2030.
12. HSBC Holdings PLC	CN in 2005.	NZT 2050 in 2020.	Carbon neutral: scopes 1 and 2 in 2005.	Net-zero: scopes 1, 2, and partially 3 downstream in 2020.	No	Yes	Greater under net-zero in partially scope 3 downstream.	In the last quarter of 2005, we offset our Group-wide carbon dioxide emissions of some 170,000 tons by purchasing an equal amount of credits from four projects around the world.	For oil and gas, the IEA indicates in its scenario a reduction of 34% in global sector scope 1, 2 and 3 emissions (Mt CO2e) to 2030 from a 2019 baseline.
13. ITV PLC	CN in 2019.	NZT 2030 in 2021.	Carbon neutral: scopes 1, 2, and partially 3 upstream in 2019.	Net-zero: in all scopes by 2030.	No	Yes	Greater under net-zero in all scopes by 2030.	All of ITV's 2019 emissions from our operations (scope 1), energy use (scope 2) and business travel (scope 3) were offset by purchasing certified carbon offsetting credits	To progress to Net-zero, ITV has committed to emissions reduction targets that have been validated by the Science Based Targets initiative: a 46.2% reduction of our scope 1 and 2 emissions (such as fuel and electricity we use directly), and a 28% reduction of our scope 3 emissions (such as business travel and the products and services that we purchase) by 2030.
14. Microsoft	CN in 2012.	NZT: carbon net negative in 2020	Carbon neutral: scopes 1, 2, and partially 3 downstream in 2012.	Net-zero: carbon net negative in all scopes by 2030.	No	Yes	Greater under net-zero in all scopes carbon net negative.	Implementing an internal carbon fee that will place a price on carbon, based on current market pricing for renewable energy and carbon offsets, and making the company's business divisions financially responsible for the cost of their carbon emissions	Our strategy to reach carbon negative by 2030 is relatively simple—we will reduce our Scope 1 and 2 emissions to near zero by improving efficiency, adopting new solutions, and purchasing zero carbon energy. We are engaging suppliers and our business groups to cut our Scope 3 emissions by more than 50 percent and we will rely on carbon removal to reach carbon negative.
15. Moody's Corp	CN in 2019.	NZT 2050 in 2021.	Carbon neutral: scopes 1, 2	Net-zero: scopes 1, 2 and partially	Yes	No	Greater under carbon neutral in scopes 1, 2	NA	Reduce our absolute Scope 1 and Scope 2 greenhouse gas GHG emissions by

			and partially 3 upstream in 2019.	3 upstream in 2021.			and partially 3 upstream.		50% by 2030 from 2019 levels; reduce by 15% our Scope 3 emissions from fuel and energy-related activities, employee commuting, and business travel by 15% by 2025 from 2019 levels; and have 60% of our suppliers by spend covering purchased goods and services and capital goods set science-based targets by 2025.
16. NIBC Bank NV MTN RegS	CN in 2010.	NZT 2047-2048 in 2020.	Carbon neutral: scope 1 in 2010.	Net-zero: scopes 1, 2 and partially 3 downstream in 2020.	No	Yes	Greater under net-zero in scopes 2 and partially 3 downstream.	NA	NA
17. NN Group NV	CN in 2007.	NZT 2050 in 2020.	Carbon neutral: scopes 1 in 2007.	Net-zero: partially scope 3 downstream in 2010.	No	Yes	Greater under carbon neutral in scope 1.	Achieving net-zero carbon emissions by balancing a measured amount of carbon released with an equivalent amount sequestered or offset, or buying enough carbon credits to make up the difference.	(Non-listed) real estate: aim to set a quantitative decarbonisation target in 1H23; for direct portfolio, aim to be on a 1.5-degree pathway for all buildings by 2030 (scope 1, 2 and part of scope 3); for operational emissions, the aim is to reach net-zero by 2040.
18. Nordea Bank	CN in 2015.	NZT 2050 in 2019.	Carbon neutral: scopes 1 and 2 in 2015.	Net-zero: scopes 1, 2 and partially 3 downstream in 2019.	No	Yes	Greater under net-zero in scope partial 3 downstream.	Nordea's own operations have a net-zero carbon footprint, which is achieved by continuing to reduce our own emissions, purchasing renewable energy, and purchasing carbon offsets equal to the amount of CO2 emitted.	Net-zero 2050 40-50% reduction in carbon emissions across our lending and investment portfolios by the end of 2030. We have a long-term objective to reduce carbon emissions from internal operations by more than 50% by 2030 and by 30% by 2023, compared with 2019.

19. Royal Bank of Canada	CN in 2017.	NZT 2050 in 2021.	Carbon neutral: scopes 1 and 2 in 2017.	Net-zero: already achieved net-zero emissions in 2018.	Yes	No	Greater under carbon neutral in scopes 1 and 2.	NA	NA
20. Royal Schiphol GROUP NV MTN RegS	CN in 2014.	NZT zero CO2 emissions and waste flows 2030 in 2019.	Carbon neutral: scopes 1 and partially 3 upstream in 2014.	Net-zero: scope 1 and partially 3 upstream by 2030.	No	Yes	Greater under net-zero in scopes 1 and partially 3 upstream by 2030.	NA	In 2022, Brisbane Airport reconfirmed its ambition to create a sustainable, world-leading 'Airport City' that future generations can rely on and be proud of. The airport signed the World Economic Forum's Clean Skies for Tomorrow 2030 Ambition Statement and brought forward plans to reach net-zero on Scope 1 and 2 emissions by 25 years to 2025.
21. Schroders PLC	CN in 2019.	NZT net-zero carbon 2020 in 2020.	Carbon neutral: scopes 1 and 2 in 2019	Net-zero: scope 3 by 2050.	No	Yes	Greater under net-zero in scope 1 by 2020.	In addition to our programme to reduce our gross emissions, from 1 January 2020 we have been investing in sufficient carbon offsetting activities to ensure that our own operations will be net-zero for carbon emissions. We commit to reporting on our offsetting investments, alongside our gross emissions, on an annual basis.	Reduce Scope 1 and 2 emissions by 46% by 2030*. Achieve 100% renewable electricity by 2025. Reduce business travel emissions by 50% by 2030*. 67% of suppliers** to set SBTs by 2026
22. Thomson Reuters Corp	CN in 2019.	NZT 2050 in 2020.	Not defined.	Net-zero: scopes 1 and partially 3 upstream in 2020.	Yes	No	Greater under net-zero in scopes 1 and 2.	NA	In 2020, Thomson Reuters joined the Science Based Targets initiative, committing to reduce Scope 1 and 2 greenhouse gas (GHG) emissions by 50% by 2030 from 2018 baseline levels, as well as

									reduce absolute Scope 3 GHG emissions from fuel and energy-related activities, business travel, and employee commuting by 25% by 2025 from 2019 baseline levels. Additionally, Thomson Reuters aims to require 65% of suppliers by spending to have Science Based Targets by 2025.
23. Vmware Class A INC	CN in 2018.	NZT 2030 in 2020.	Carbon neutral: only scopes 1 in 2016.	Net-zero: scopes 1, 2 and partially scope 3 upstream by 2030.	No	Yes	Greater under net-zero in all scopes by 2030.	We are now expanding this concept to demonstrate that by offsetting IT infrastructure growth through virtualization, we can enable the carbon cost of data centres to decrease.	50% reduction in Scope 1 and Scope 2 emissions by 2030 (base year FY19). 50% reduction in Scope 3 employee commute and fuel-and-energy-related emissions by 2030 (base year FY19). 75% engagement of our suppliers (by spend) in setting their own science-based targets by 2025
24. Zalando	CN in 2019.	NZT 2050 in 2019.	Carbon neutral: scopes 1, 2 and partially 3 upstream and downstream in 2019.	Net-zero: scopes 1 and 2 in 2019.	Yes	Yes	Greater under carbon neutral in partially scope 3 upstream and downstream.	MORE strategy, we reached carbon neutrality in our own operations (Scope 1 and 2), as well as deliveries, returns and packaging (Scope 3) as of 24 October 2019. We have achieved this through reduction measures and purchases of carbon offsets via carbon removal projects.	Zalando commits to reduce Scope 1 and 2 greenhouse gas GHG emissions by 80% by 2025 against a 2017 base year. Zalando commits to increase annual sourcing of renewable electricity from 34% in 2017 to 100% by 2025. — Zalando commits to reduce Scope 3 GHG emissions from private label products by 40% per million EUR gross profit by 2025 from a 2018 base year. Zalando also commits that 90% of its suppliers by emissions covering purchased goods and services sold on its platform, packaging and

									last-mile-delivery partners will have science-based targets by 2025.
25. Zurich Insurance Group Ltd	CN in 2014.	NZT 2050 in 2019.	Carbon neutral: scopes 1, 2 and partially 3 upstream and downstream in 2014.	Net–zero: partially scope 3 upstream and downstream in 2019.	No	Yes	Greater in carbon neutral in scopes 1 and 2.	Offsetting remaining carbon emissions by supporting a forestry project in Indonesia. This project complements our flood resilience program, which helps communities adapt to the increased frequency and severity of floods.	Scope 1 and 2: Reduction by 80% in emissions from the vehicle fleet and onsite heating as well as from purchased electricity, heat, and steam by 2029. Scope 3: Reduction by 65% in operational emissions resulting from air rental and business travel, employee commuting, strategic data centres, printed paper, and waste, as well as indirect energy impacts by 65%.

Table A1: Sample summary table. Twenty-five corporations and their carbon-neutral and net-zero corporate statements, their equivalent GHG emissions accounting in terms of scope, their equivalency in definition between carbon neutral (CN) and net-zero (NZ), and their consistency in terms of net-zero and net-zero targets (NZT).

Appendix 2: Sample timeline (in order of carbon-neutral commitment year)

Companies	Identified corporate reporting pattern	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1. Aeroports s de Paris SA	*'Science-based revision'*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	CN1	NZ	NZ	NZ
2. Allianz SE	*'Science-based revision'*	NA	NA	NA	NA	NA	NA	NA	CN	CN	CN	CN	CN	CN	CN1	CN2	NZ	NZ
3. Amp LTD	*'Science-based revision'*	NA	NA	NA	NA	NA	NA	NA	NA	CN	X	CN	CN	CN	CN	NZ	NZ	NZ
4. Atos	*'CO2e scope shifting'*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	CN1	NZ	NZ
5. Australia and New Zealand Banking Group Limited	*'Pausing'*	NA	NA	NA	NA	NA	CN	X	X	X	CN	CN	CN	CN	CN1	CN	NZ	NZ
6. Bank of New York Mellon Corp	*'Science-based revision'*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	CN	CN	CN	CN	NZ	NZ
7. BNP Paribas	*'Science-based revision'*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN1	CN2	NZ	NZ	NZ
8. Comcast	*'Pausing'*	NA	CN	X	X	X	X	X	X	X	X	X	X	X	X	NZ	NZ	NZ
9. Dallas Fort Worth Tex INTL ARP	*'Science-based revision'*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	CN1	CN	CN2	NZ	NZ
10. EasyJet MTN RegS	*'Greenhushing'*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	NZ	NZ
11. Gatwick Funding LTD	*'Greenhushing'*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	NZ	NZ
12. HSBC Holdings PLC	*'Pausing'*	CN	CN	X	CN1	CN	CN	CN	X	X	X	X	X	X	X	CN2	NZ	NZ
13. ITVPLC	*'CO2e scope sbhifting'*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	NZ	NZ

14. Microsoft	***'Mea-culpa'***	NA	NA	NA	NA	NA	NA	NA	CN	CN	CN	CN	CN1	CN	CN	CN	NZ	NZ
15. Moody's Corp	***'CO2e scope shifting'***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	NZ	NZ
16. NIBC Bank NV MTN RegS	***'Science-based revision'***	NA	NA	NA	NA	NA	CN	X	X	CN	X	CN	CN	CN1	CN	CN	NZ	NZ
17. NN Group NV	***'Science-based revision'***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	CN	CN	CN	CN	NZ	NZ
18. Nordea Bank	***'Science-based revision'***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN1	CN2	CN	CN	NZ	NZ	NZ
19. Royal Bank of Canada	***'Pausing'***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	X	X	CN	CN	NZ
20. Royal Schiphol GROUP NV MTN RegS	***'Pausing'***	NA	NA	NA	NA	NA	NA	NA	CN	CN	CN1	X	X	X	CN2	NZ	NZ	NZ
21. Schroders PLC	***'Greenhushing'***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	NZ	NZ
22. Thomson Reuters Corp	***'Science-based revision'***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	NZ	NZ
23. Vmware Class A INC	***'Science-based revision'***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN	CN1	NZ	NZ
24. Zalando	***'Greenhushing'***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	B	X	X
25. Zurich Insurance Group Ltd	***'Pausing'***	NA	NA	NA	NA	NA	NA	NA	NA	CN	X	X	X	X	X	X	NZ	NZ

Table A2: A timeline of the study sample of twenty-five companies for the years 2005-2021 that explains how the definitions evolve over time. This table explains the abbreviations for claims in corporate statements (CN = carbon neutral, CN1 = carbon-neutral first revision, CN2 = carbon-neutral second revision, NV = net-zero, B = both carbon neutral and net-zero, X = no claim, and NA = no data) for this analysis.

Paper 3

Clients, Employees and Institutional owners:

Determinants of Corporate Decarbonisation Commitments?[14]

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Abstract

Decarbonisation commitments are an important communication tool for companies to explain how and in which period they plan to reduce carbon emissions. At the same time, such commitments might be costly because firms can be held accountable if the targets are not achieved. This raises the question: who or what motivates firms to make decarbonisation commitments? We examine the determinants of corporate decarbonisation commitments, focusing on stakeholder pressures from institutional owners, employees and clients. Using survival analysis with Weibull and Cox models, the findings highlight that institutional ownership (*IO*) has the strongest relation to decarbonisation commitments, followed by employees. Additionally, pressure from clients explains decarbonisation commitments at the subsidiary level. While responsive to stakeholder needs, the subsidiary-level commitment dynamic raises questions about the legitimacy and alignment of parent-level climate strategies. The research extends stakeholder theory by linking CSR integration and stakeholder expectations to decarbonisation commitments, underscoring the role of green revenue as a key driver.

Keywords: Decarbonisation commitments, Green revenues, Institutional ownership, Climate actions, Stakeholder theory

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1. Introduction

There is an urgent need to align climate commitments and related climate actions in the public and private sectors with the 1.5 C Paris goal (United Nations Framework Convention on Climate Change [UNFCCC], 2023b). From the perspective of climate change mitigation, companies can contribute to global temperature reduction by integrating decarbonisation commitments with related climate actions as part of their corporate social responsibility (CSR). Understanding the mechanisms driving commitments for corporate emissions reduction is essential, particularly in response to rising CSR expectations from clients, employees and institutional owners. This empirical analysis examines the role of the stakeholder effect in UNFCCC decarbonisation commitments and related climate actions, focusing specifically on the stakeholder groups of clients, employees and institutional owners.

Research interest in decarbonisation commitments is relatively new. For example, Ben-Amar et al. (2024) emphasise connecting firm-level commitments with the Paris Agreement (PA) by highlighting how science-based targets (SBTi) shield businesses from monetary losses during crises. Jiang et al. (2025) highlight the lack of accountability and transparency in emissions reduction targets, demonstrating how these shortcomings might erode stakeholder trust and the legitimacy of business practices. Lemma et al. (2021) further examine the impact of climate commitments on financial strategy, highlighting the advantages to a company's reputation and easier access to long-term debt financing for companies that meet climate action standards. We add to this research by broadening the application of stakeholder theory and expanding its scope in CSR. Thereby, we focus on the effect of stakeholder pressure from clients, employees and institutional owners on firms' decisions to report UNFCCC decarbonisation commitments and to communicate related climate actions. Additionally, in decarbonisation, the likelihood of a company signing the decarbonisation commitment via its parent or subsidiary entity is determined by the stakeholder groups.

For our empirical study, we relied on data from the UNFCCC Actors website (UNFCCC, 2023a) to identify decarbonisation commitments and related information (e.g., Who signed the commitment? Which climate-related actions were implemented?). For an international sample of 5,402 firm-year observations, we employed survival analysis, a medical research methodology (George, Seals and Aban, 2014), to study the likelihood of companies setting decarbonisation

commitments and undertaking related climate actions using financial and environmental variables. We applied a Weibull parametric model to examine the temporal evolution of decarbonisation commitments and related climate actions and further applied the Cox semi-parametric model to evaluate robustness. The findings provide information about the temporal and contextual factors affecting decarbonisation commitments and related climate actions, highlighting their dynamic nature and reliance on essential organisational factors. Our results show that institutional owners and employees with CSR concerns determine decarbonisation commitments and related climate actions, with institutional ownership demonstrating a stronger relationship. We also found that companies with greater customer pressure are more likely to sign decarbonisation commitments and related climate actions with a subsidiary rather than a parent entity. All results included a range of sensitivity analyses.

Our study makes several important contributions to the literature. First, we extend Cohen, Kadach and Ormazabal's (2023) research by acknowledging how institutional ownership improves corporate disclosure of climate risk information and demonstrates that institutional ownership affects decarbonisation commitments and related climate actions. Second, based on Kurruppu and Milne's (2010) study, employee participation in corporate strategic objectives is often associated with internal sustainability reporting. Externally, this alignment boosts a firm's reputation due to its commitment to environmental and social performance. We extend previous findings by showing that employee pressure is also connected to the higher likelihood of firms setting explicit decarbonisation commitments and implementing related climate actions. Third, our findings on the subsidiary-level commitments, especially under client pressure, call into question the parent-subsidiary level commitment condition, as a parent company usually has a sustainability strategy for both the parent company and its subsidiaries. At first sight, this undermines the legitimacy of the parent entity's decarbonisation commitments and climate-related actions and, by extension, challenges the legitimacy of the subsidiary company. A possible explanation is that the subsidiaries experience client pressure most directly. Therefore, in cases where the parent company does not initiate a decarbonisation commitment or related climate action, the subsidiaries might feel pressured to take the first step.

2. Background

2.1 Institutional Setting

Following the PA (Conference of the Parties twentieth session [COP20]), there has been increasing collaboration between governmental entities and non-party stakeholders, including corporations, to establish climate commitments and enhance climate action (UNFCCC, 2023a). A vital tool of this process is the Global Climate Action Portal (GCAP), launched in 2014 by the UNFCCC secretariat and the governments of Peru and France. This platform exhibits the current climate-related commitments of non-party stakeholders globally, enhancing the accountability of voluntary climate commitments (UNFCCC, 2024a).

As of October 2023, 32,524 actors registered commitments on the GCAP portal, including 12,000 actors focusing on climate adaptation and 1,654 investors involved in climate finance, comprising green bonds and refinancing low-carbon investments (UNFCCC, 2023a). Notwithstanding the increase in corporate decarbonisation pledges, existing commitments remain insufficient for the 1.5-degree goal (New Climate Institute, 2023; Net-Zero Tracker, 2023; SBTi, 2023).

The UNFCCC published the Recognition and Accountability Framework for non-party stakeholders to enhance the accountability of voluntary climate commitments and action initiatives by implementing principles of engagement, governance, data management and individual implementation plans (UNFCCC, 2023c). Specifically, the implementation plans set objectives and timelines in line with the framework to verify the integrity and transparency of voluntary commitments of non-party stakeholders (UNFCCC, 2023c).

2.2 Stakeholder Theory

The term ‘stakeholder’ was first introduced by the Stanford Research Institute in 1963 (Boeken, van den Berg and van Steen, 2024), stating that both shareholders and stakeholders should be considered. The theory was further developed by Freeman (1984), who established the theory by arguing that companies have to provide value for all stakeholders, not just shareholders. Thus, this represents a shift from the conventional shareholder-centric perspective of profit maximisation. Donaldson and Preston (1995) argued that firms have a moral obligation to consider all

stakeholders' interests, which can result in long-term profitability. At this point, stakeholder theory emphasises the value of corporate responsibility by embedding ethics and strategic management.

In the early 2000s, stakeholder theory expanded to include sustainability, promoting businesses' adoption of responsible environmental and social practices. This aligns with CSR principles, which urge companies to meet their moral, social and ethical obligations to benefit all stakeholders (Peng and Yang, 2014). Relevant research links stakeholder engagement to CSR commitment and corporate performance. For instance, Adomako and Tran (2022) conclude that stakeholder integration positively influences a firm's CSR commitment, which serves as a link between stakeholder integration and corporate performance. Further research reveals that a firm's CSR commitment enhances social and environmental performance (Anser et al., 2020).

Linking stakeholder theory to specific stakeholder groups like clients and employees highlights its practical implementation in business management. For instance, research proposes that the main stakeholders are shareholders (primary stakeholders), employees (internal stakeholders), customers, suppliers, communities, government and the environment (Mahajan et al., 2023). Another study explains that embedding CSR in corporate culture allows employees to align with these values and reinforces a long-lasting competitive edge for the firm (Waheed and Zhang, 2022). Tao et al. (2023) suggest that customers prefer socially responsible suppliers, as they are risk-averse and align with customers' CSR values, thereby increasing the supplier's likelihood of being selected for new business opportunities.

Empirical research shows that stakeholder pressures and engagement influence corporate sustainability reporting (Gallego-Alvarez Ortas, 2027). This finding is supported—and illustrated—by anecdotal evidence. First, Unilever's business responsibility and sustainability report for 2023-2024 states,

> "As pioneers in the Indian [Fast-Moving Consumer Goods] industry, we are dedicated to embracing safe, superior, and low zero-carbon technologies. These technologies are integral in our efforts to design, manufacture, procure, and supply goods and services to our constantly evolving consumer base, while delighting them with sensorials and benefits, and actively addressing environmental challenges" (Hindustan Unilever Limited, 2024).

This statement shows customers can play an essential role in how a company applies CSR practices in production. Second, in 2022, Apple stated in its environmental progress report that investing in forestry carbon removal and other projects offers investors a financial return (Apple, 2022). This statement illustrates that companies aim to harmonise the profit perspective of their investors with sustainability targets. Third, in 2020, Microsoft's president, Brad Smith, acknowledged to all stakeholders, including Microsoft employees, that using a carbon-neutral definition in the past was insufficient and Microsoft thus revised the net-zero commitment to target 'carbon-negative by 2050' (Smith, 2020). This announcement clarifies that employees with CSR concerns may take the proactive initiative to evaluate and implement efficient corporate decarbonisation commitments.

In conclusion, stakeholder theory evolved from a shareholder-centric approach to a more holistic perspective that integrates CSR alongside stakeholders' interests to achieve sustainability and long-term competitive advantage. Connecting stakeholder theory research with specific stakeholder groups' influence in real-world company examples is vital to comprehending how clients, employees and investors shape CSR today.

3. Hypotheses Development

3.1 Clients' Value Alignment Hypothesis

As shown above, research supports the claim that customers select their suppliers in part based on whether the supplier aligns with their values (Tao et al., 2023). Therefore, from a company perspective and based on stakeholder theory arguments, aligning one's sustainability reporting and decarbonisation commitments with client expectations is a rational business decision. Therefore, the commitment to decarbonisation can be an instrument expected to support client retention and the acquisition of new customers.

Research shows that companies with environmentally focused values, measured by green revenue generation, are more likely to foster green transition and corporate decarbonisation either via regulatory initiatives, such as the EU Taxonomy (Bassen et al., 2022), or via technological advancements, such as green patents (Klausmann et al., 2024). Accordingly, Hypothesis H_1

predicts that a company is more likely to publish a decarbonisation commitment when its green revenue, as an indicator of a sustainable value-aligned client portfolio, is higher.

> *H_1: Companies experiencing higher customer pressure are more likely to set decarbonisation commitments.*

3.2 Investor Pressure Hypothesis

Investors can exert direct pressure on companies through shareholder activism, which has been shown to induce voluntary corporate disclosure regarding climate risk information (Flammer, Toffel and Viswanathan, 2021). Research finds that such efforts are more effective when initiated by institutional investors who value the disclosure of climate risk information, resulting in more disclosure of climate change risks (Flammer, Toffel and Viswanathan, 2021). This finding is supported by other empirical research, which shows a positive association between institutional ownership and a higher likelihood or extent of climate change (risk) disclosure (Cohen, Kadach and Ormazabal, 2023; Ilhan, Krueger, Sautner and Starks, 2023).

Accordingly, we assume that companies with a higher percentage of institutional investors are also more likely to set decarbonisation commitments due to increased pressure from institutional investors. From a theoretical perspective, institutional investors with significant ownership are positioned to demand transparency and accountability, including long-term commitments to corporate emissions reduction. According to stakeholder theory, such commitments by their investee firms give institutional investors a better reputation with their respective stakeholders, such as pension members, bank depositors or insurance policyholders. Essentially, institutional investors instrument corporations via their share ownership to advance the investors' relationships with their stakeholders and improve transparency in climate reporting.

In contrast to H_1, the corporation is acted upon in this process rather than acting on something else. Consequently, we expect a more substantial presence of institutional investors as uniquely positioned stakeholders to incentivise companies to align with their expectations by making decarbonisation commitments. Thus, the percentage of institutional ownership serves as a proxy for shareholder pressure exerted on companies to set decarbonisation commitments.

H_2: Firms that experience higher pressure from institutional owners are more likely to set decarbonisation commitments.

3.3 Employees' Influence Hypothesis

Employees are a vital stakeholder group for companies because companies rely on their continued motivation to work for the company and the willingness of potential new employees to start working for the company. Such motivation is not only increased through monetary means (e.g., competitive salaries or wages) but also shared values, aligning with stakeholder theory, which asserts that companies should regard the interests of all stakeholders, not merely shareholders (Donaldson and Preston, 1995). Therefore, it is not surprising that research shows that employee engagement in CSR practices influences a firm's environmental performance (Kucharska and Kowalczyk, 2019). Research further shows that companies that prioritise employees interested in corporate strategic objectives often integrate sustainability reporting into their strategic vision, using it to facilitate organisational transformation, improve employee engagement and foster innovation (Kurruppu and Milne, 2010). This strategy enhances the company's reputation by committing to enhance the company's environmental and social performance.

Based on the theoretical argument and the findings of previous studies, we argue that companies that rely more on employees are more likely to set decarbonisation commitments. Consequently, companies experiencing higher pressure from employees should continuously enhance their capability to analyse and implement sustainability initiatives.

H_3: Firms that experience more pressure from employees are more likely to set decarbonisation commitments.

3.4 Parent Versus Subsidiary Level Commitment

A company can sign a decarbonisation commitment with a parent or subsidiary. Subsidiary entity commitment may reflect limited operational greenhouse gas (GHG) emissions scope coverage of the parent company. For example, a company that signs a commitment with a subsidiary can generally cover distinct operations. Hence, a subsidiary commitment may cover only a portion of the company's operational activities and thus account for a limited scope of GHG emissions.

However, a parent's entity commitment typically covers all subsidiaries, as it usually considers the entire operational GHG scope.

The decision to sign a decarbonisation commitment at the parent company versus the subsidiary level can also be related to the stakeholder pressures experienced by the company. For example, customer pressure is typically exerted in specific markets, products or services. Therefore, it is more likely that subsidiaries more strongly experience customer pressures. Accordingly, we hypothesise:

> *H_4: Companies experiencing higher customer pressure are more likely to sign with a subsidiary than a parent entity.*

Pressure from employees and investors is more likely to address the company as a whole. First, investors are interested in the overall firm value, which directly relates to the whole company. Second, if employees seek to work for companies that align with their personal values, then such alignments would be most credibly signaled through commitments at the parent level. Accordingly, we hypothesise:

> *H_5: Firms that experience higher pressure from institutional owners are more likely to sign with a parent than with a subsidiary entity.*

> *H_6: Firms that experience more pressure from employees are more likely to sign with a parent than with a subsidiary entity.*

4. Methods

4.1 Sample

This section defines our study sample, the data sources, and the collection and analysis of data. For decarbonisation commitments, we used the UNFCCC Actors website. The website—scraped on January 9th, 2023, with data as of December 31st, 2022—provides information about ISIN, accounting year, organisation name, the year companies set decarbonisation commitments, and further information relating to decarbonisation commitments and related climate actions (e.g., whether the company has a GHG inventory). The dataset, sourced from SDGlabs.ai—Scientists

for Sustainability, encompasses 13,909 companies for the years 2019-2021. Based on the UNFCCC Actors website, we created a dataset by matching the legal names of companies listed on the UNFCCC Actor website with the exact legal entities of the corporations as expressed on the database of the Global Legal Entity Identifier Foundation (GLEIF). This process allowed us to determine if a company signed UNFCCC with its ultimate parent or a subsidiary.

In the next step, we merged the data from the UNFCCC Actors website with FTSE Russell's green revenue data for their All-World Index, which resulted in 5,040 companies and 11,758 firm-years. We further merged with financial variables from Refinitiv, another LSEG-owned company alongside FTSE, and used these environmental and financial data items to calculate variables of interest and control variables, as explained below. Descriptive statistics for all the variables with joint coverage are provided in Table 3. Requiring all the variables used in our estimation models to be available for each observation and considering that survival analysis drops observations in the years after they have changed status (i.e., after making a Net-Zero commitment) results in a final sample of 5,484 firm-year observations.

4.2 Dependent Variables

As we aimed to explain the decarbonisation commitment decision based on stakeholder pressure, the primary dependent variable of our study was *Commitments*, which were time-variant and binary. The *Commitments* variable equaled one if a company published a decarbonisation commitment in this or any previous year and zero otherwise.

Voluntary commitments are climate pledges that aim for transparency and accountability. The UNFCCC introduced the Recognition and Accountability Framework and its Implementation Plan for non-party stakeholders (i.e., businesses) to ensure that these commitments adhere to engagement, governance and data management (UNFCCC, 2023c). The *commitments* variable allowed the tracking and reporting of the progress of voluntary commitments of non-party stakeholders in this sample supported by the GCAP to verify the integrity and accountability of the voluntary climate commitments (UNFCCC, 2024a).

While *Commitments* were our main dependent variable, we also tested whether further variables on climate actions also depend on stakeholder pressure. The UNFCCC Actors website provides more information on such measures.

First, we used a binary variable to track the existence of an *Emission inventory*. Emission inventories compile data on GHG emissions from various sources for accurate assessment and reporting (UNFCCC, 2024a). The UNFCCC initiative of GCAP allows non-party stakeholders to track progress and enhance transparency in GHG reporting, validating climate actions (UNFCCC, 2024a). The GCAP embeds emission inventories into a broader climate framework, which is decisive in monitoring progress towards the PA goals, fostering integrity and trust in global climate efforts (UNFCCC, 2024a). It is important to note that according to GCAP data, firms may report information on *Emission inventory* independently of their *Commitments*. That is to say, a firm may maintain an *Emission inventory* without reporting a commitment to decarbonisation. The *Emission inventory* variable was time-variant and binary. It equaled one if a firm had an emission inventory in the current or previous year and zero otherwise.

Second, the *Finance actions* variable was a binary, time-variant variable, which equaled one if a firm reported *Finance actions* in the current or previous year and zero otherwise. Companies can report *Finance actions* regarding climate finance (e.g., carbon price reporting, green bond issuance reporting; UNFCCC, 2024a).

Third, the *Mitigation actions* variable was a binary, time-variant variable, which equaled one if a firm reported mitigation actions in the current or previous year and zero otherwise. Mitigation actions focus on the significance of voluntary commitments for climate mitigation, emphasising the importance of transparent frameworks (e.g., the GCAP) to ensure that voluntary commitments effectively reduce GHG emissions (UNFCCC, 2024b). The UNFCCC Actors website collects as mitigation actions the mitigation cause and solution as reported in the 2023 CDP-ICLEI questionnaire for non-party stakeholders (UNFCCC, 2023a).

Fourth, impact metrics emphasise the credibility and transparency of non-party stakeholders' voluntary commitments to climate action (UNFCCC, 2024a). For instance, an organisation shows a positive *Impact* if it displays a reduction in GHG emissions in the latest year compared with the previous year. The *Impact* variable was time-variant and binary and equaled one if a firm reported

a positive *Impact* for the current or a previous year and zero otherwise. Accurate GHG emissions reporting in GCAP emission inventories allowed for monitoring the impact progress.

We present three company examples that report *Commitments, Emission inventory, Finance actions, Mitigation actions* and *Impact* in the GCAP platform (i.e., the variable was equal to one) in Table 1.

[Insert Table 1 about here]

4.3 Independent Variables of Interest

To capture customer pressure, we relied on the Company Green Revenue Percentage (*CompanyGR),* which measures the percentage of total revenue derived from sustainable goods and services (London Stock Exchange Group [LSEG] Data & Analytics, 2024a). The Financial Times Stock Exchange (FTSE) Russell's Green Revenues data model evaluates this measure and categorises green revenues across many industries (LSEG Data & Analytics, 2024b). Although relatively new, the measure has been used in recent studies (Bassen, Shu and Tan, 2023).

We used the variable institutional ownership (*IO*) to capture the pressure of institutional investors. *IO* was the percentage of corporate outstanding shares owned by institutional investors, including insurance companies, mutual funds and pension funds (LSEG Data & Analytics, 2024b). This ownership grants institutional investors considerable influence over corporate behaviour, particularly practices and policies concerning sustainability. Recent research concludes that institutional investors' demand for climate-related information increases climate disclosure and reduces carbon emissions (Cohen et al., 2023).

We used selling, general and administrative percentages (*SGApercent*) as an indicator of employee pressure. *SGApercent* denoted the proportion of a company's revenue allocated to Selling, General and Administrative (SGA) expenses. We classified research and development (R&D) expenditures as part of the SGA expenses.

We also determined whether the parent company or a subsidiary signed the decarbonisation commitment. *Signwithsubsidiary* equaled one if a subsidiary signed the commitment and it was zero otherwise. Therefore, the variable described circumstances in which a business enters a

commitment through a subsidiary rather than the ultimate parent firm (LSEG Data & Analytics, 2024a). The parent-subsidiary distinction was essential when evaluating the extent and implementation of commitments and climate-related actions inside business groupings (LSEG Data & Analytics, 2024a).

4.4 Control Variables

We controlled for internal and external factors, which have the potential to explain the decision to sign a decarbonisation commitment. Therefore, for the selection of control, we built on previous literature, e.g., on determinants of target adoption (Freiberg, Grewal and Serafeim, 2021). We controlled for *Profit, Size* and *Volatility* as prior research suggests that these variables relate to the difficulty of firms' carbon emission reduction pledges (Ioanou et al., 2016). *Profit* was calculated with FTSE Russell data as the ratio of gross profit in the numerator and the sum of shareholders' equity and total debt in the denominator in USD dollars. The *Size* was calculated with FTSE Russell data as the logarithm of the sum of shareholders' equity and total debt. Volatility, as provided by Refinitiv, is defined as the standard deviation of returns over the past 12 months (Bolton and Kacperczyk, 2021).

Furthermore, we controlled for *Tobinq* and *Beta_ftse* as these factors impact decision-making in a firm setting a decarbonisation commitment. We accounted for *Tobinq* as companies with high Tobinq are more intangible. *Tobinq* was calculated with FTSE Russell data as the ratio of market capital before investment, the total debt in the numerator, the sum of shareholders' equity and the total debt in the denominator in USD dollars. Furthermore, we accounted for *Beta_ftse* as companies with a higher beta are more sensitive to market fluctuations and most likely undergo investor and stakeholder scrutiny in risk management. This also aligns with relevant empirical analysis that indicates that companies with higher beta are more likely to be compelled to make firm commitments (Bolton and Kacperczyk, 2021). *Beta_ftse,* as provided by FTSE Russell, is defined as the market beta of individual market firms over the past 12 months (Bolton and Kacperczyk, 2021). We provide an overview of all variables explained in Sections 4.2 through 4.4 in Table 2.

[Insert Table 2 about here]

4.5 Survival Analysis Model

This study investigated the determinants of decarbonisation commitments and related climate actions. Therefore, we focused on stakeholder pressures from customers, institutional investors and employees. For our analyses, we applied the method of survival analysis, because, compared to standard logit regression, survival analysis considers not only the information on whether an event occurred but also the length of time it took for an event to occur. Survival analysis is derived from medical research on the survival of patients concerning an event that happens, such as death.[15] Similarly, survival analysis can be applied in scenarios where the occurring event is positive (Hoepner, Majoch and Zhou, 2021; George, Seals and Aban, 2014; Hosmer, Lemeshow and May, 2008). Specifically, the event of interest in our analysis represents a company setting a decarbonisation commitment or undertaking a related action. Thus, when a company makes a decarbonisation commitment, it 'dies' in the sample (conditional probability = 1) as opposed to a company with no commitment that is 'surviving' (conditional probability = 0). The survival analysis runs yearly from 2019 through 2021. Thus, once a company commits, it disappears in the next year's survival analysis sample, creating a ladder effect.

Here, the dependent variable is the hazard rate, the conditional probability that an event occurs at a specific time interval (Hoepner, Majoch and Zhou, 2021; Hosmer, Lemeshow and May, 2008). A parametric Weibull model as a function of time that covariates as follows equation (1):

$$H(x|t) = h_o(t)\, r(x,\beta) \quad (1)$$

The hazard function is the probability of two functions. The function $h_o(t)$ in equation (1) is described as a 'time function', which characterises how the hazard function changes as a function of survival time. The other function, $r(x,\beta)$ in equation (1), described as a 'characteristics function', explains how the hazard function changes as a function of our subject covariates. The Weibull parametric model assumes the baseline time function and follows a Weibull distribution in equation (2):

[15]For instance, in a study on soldiers who had severe injuries during war, researchers may utilize survival analysis to ascertain both, the duration of survival for soldiers' post-injury (time-to-event) and the occurrence of the event itself (death of the injured soldier).

$$h_o(t) = pt^{p-1} \text{ (2), where p is the parameter to be estimated.}$$

Here, $p = 1$, for any year a company sets a decarbonisation commitment or undertakes a related action, the entire time function collapses to 1 and the overall hazard function turns into an exponential regression equation (2). Following Cox (1972), we define the second characteristic function in equation (3):

$$r(x,\beta) = \exp(\beta_1\chi_1 + ... + \beta_p x_p) = \exp(\beta_1 \text{key variables}_i + \beta_2 \text{control variables}_i) \quad (3)$$

Integrating equations (2) and (3) into (1), the Weibull parametric regression model is specified in equation (4):

$$h(x|t) = pt^{p-1} \exp(\beta_1 \text{key variables}_i + \beta_2 \text{control variables}_i) \quad (4)$$

where $h(x|t)$ is the hazard at time (t) for a given set of covariates $x_1 + ... + x_p$. In classic survival analysis, a hazard ratio greater than one indicates that the company is more likely to commit to decarbonisation or take a related action and a hazard ratio less than one means it is less likely to commit to decarbonisation or take a related action.

The Weibull parametric model is a specific case of the Cox hazard model, assuming a parametric form on the baseline hazard function ($h_o(t)$) (Clark et al., 2007). This model is appropriate for modelling data with exponentially increasing or decreasing hazard rates over time. The Cox model does not specify the baseline hazard function as Hosmer, Lemeshow and May (2008) explain but uses a non-parametric Aalen–Breslow estimator to estimate the hazard function. Since net decarbonisation commitments or related action signatories are likely exponential in function, we favor the Weibull model, but theoretically speaking, the function is unknown. Accordingly, we use the semi-parametric Cox hazards model as a robustness test.

5. Results

5.1 Descriptive Statistics

Table 3 provides summary statistics for all dependent, independent and control variables and their distribution across our sample of 5,402 firm-year observations.

[Insert Table 3 about here]

The dependent variable *Commitments* shows a mean of 0.0744 (standard deviation [SD] = 0.26247), signifying that merely 7.44% of companies in the sample set *Commitments*. Likewise, the variable *Emission inventory* has a mean of 0.07487 (SD = 0.26307), indicating that 7.49% of companies maintain their own emission inventories. These descriptives also indicate that firms in this sample are slightly more likely to maintain emission inventories than set *Commitments*. The *Finance actions* variable (mean = 0.04054, SD = 0.19724) shows that only 4.05% of companies take *Finance actions* related to climate change, while the *Mitigation actions* variable (mean = 0.06687, SD = 0.24975), explains that merely 6.69% of firms take *Mitigation actions* related to climate change. Finally, the variable *Impact* has a mean of 0.0746 (SD = 0.26272), indicating that 7.46% of enterprises make a positive *Impact* by reducing scope 1 and 2 GHG emissions.

Regarding the independent variables of interest, *CompanyGR* has a mean of 6.5703 (measured as the percentage value out of 100) and a substantial standard deviation of 17.755, indicating considerable variability in firms with green revenue percentage, suggesting that while many companies exhibit no green revenue percentage (median = 0), for other companies we find all revenues to be classified as green (maximum [max] = 100). *IO* exhibits an average of 17.4884 (i.e., average institutional ownership is 17.4884%), with a relatively wide dispersion (SD = 13.261), indicating that institutional ownership varies greatly among companies, from almost none (minimum [min] = 0.0304) to complete ownership (max = 100). Another critical variable of this analysis, *SGApercent* has a mean of 0.2111 and a relatively low standard deviation of 0.1634, implying that, on average, companies spend 21.11% of their revenue on *SGApercent* expenses with some variability. The variable *SignwithSusidiary* has mean values close to 0 (mean = 0.003) and minimal variations (SD = 0.056). This finding indicates that most companies in this sample do not sign a commitment with a subsidiary or have a low probability of doing so.

5.2 Results of Survival Analysis

5.2.1 Commitments

To test the association between stakeholder effect and decarbonisation *commitments*, we ran a Weibull regression and reported the results of Models 1 through 4 in Table 4. We found no support

for H_1 as *CompanyGR* is not significant in any of the four models. The results showed that variable *IO* is significant across all models, with hazard ratios greater than one and *p*-values significant at $p < 1\%$. This result supports H_2, indicating that companies with a higher percentage of institutional owners are likelier to set decarbonisation *Commitments*. *SGApercent* showed hazard ratios greater than one and *p*-values significant at $p < 5\%$ in all models. This result supports H_3, implying that companies relying more on employees with CSR concerns are likelier to set decarbonisation *Commitments*.

[Insert Table 4 about here]

Furthermore, testing the interaction coefficients[16] in Models 2–4, we concluded that H_4 is supported, but H_5 and H_6 are not. The coefficient for the interaction of *CompanyGRSignwithsubsidiary* showed a hazard ratio greater than one and a *p*-value significant at $p < 1\%$ in Model 2. This finding shows that companies with a higher percentage of green revenues are more likely to sign a decarbonisation commitment with a subsidiary. As argued before, signing by the subsidiary challenges the legitimacy of the commitment, as such a commitment is limited in scope as opposed to a commitment by the parent company.

The firm characteristics show that *Size* and *Profit* were significant at $p < 1\%$ in Models 1–4. This confirms the expectation that more extensive and profitable firms are more likely to make a decarbonisation commitment. Further, consistently significant *Beta_ftse* at $p < 1\%$ in Models 1–4 indicate that firms with more market volatility are compelled to commit to decarbonisation.

In summary, our results suggest that for the dependent variable *Commitments*, there is a more substantial effect of institutional owners' pressure and employees' reliance on companies to set decarbonisation commitments, supporting hypotheses H_2 and H_3. Moreover, we found that the higher the customer pressure, the more likely firms are to sign a commitment at the subsidiary level instead of the parent level, in line with hypothesis H_4. At the same time, we found no support for H_1, H_5 and H_6, meaning that companies are generally not more likely to sign a decarbonisation

[16]The interaction coefficients of this study (*CompanyGRSignwithsubsidiary*, *SGApercentSignwithsubsidiary*, *IOSignwithsubsidiary*) are the dependent variables of this study (CompanyGR, IO, SGApercent) multiplied by the likelihood of signing with a subsidiary entity (Signwithsubsidiary). The coefficients explain the influence of the dependent variables in models 2-4 (Tables 3-5).

commitment due to customer pressure and that a commitment on the subsidiary level is neither more nor less likely if the pressure of institutional investors and employees is higher.

6. Sensitivity Analysis

For the sensitivity analysis, we went beyond the focus of the commitment itself and investigated whether measurement tools or actions related to emission reduction could also be explained by stakeholder pressure (see Section 4.2 for a description of the additional dependent variables). The climate action variables included the following dependent variables: *Emission inventory, Finance actions, Mitigation actions* and *Impact*. The rationale was that the UNFCCC portal provides per-company information on *commitments* and additional climate-related information on *Emission inventory, Finance actions, Mitigation actions* and *Impact* (UNFCCC, 2024a).

The first part of the sensitivity analysis used Weibull regressions on climate action variables to test whether the effect of stakeholder pressure persists providing a different perspective on robustness. The second part of the sensitivity analysis used Cox regressions on all dependent variables of this study (*Commitments, Emission inventory, Finance actions, Impact*) to assess the robustness of the identified stakeholder pressure effects.

6.1. Related Climate Action Variables

To test the association between stakeholder pressure and the dependent variables: *Emission inventory*, *Finance actions*, *Mitigation actions* and *Impact* (see Section 4.2), we ran a Weibull regression and interpreted Models 1–4 as shown in Table 5, Panels A–D. We focused on the effect of the independent variables (see Section 4.3) *CompanyGR, IO, SGApercent* and *CompanyGRSignwithsubsidiary* (interaction coefficient) on the related climate action variables.

6.1.1. *Emission Inventory*, *Finance Actions*, *Mitigation Actions* and *Impact*

The variable *IO* was consistently significant in *Emission inventory, Finance actions, Mitigation actions* and *Impact*, with hazard ratios greater than one and *p*-values significant at $p < 1\%$. This indicates that companies with higher institutional ownership are more likely to maintain an *Emission inventory*, take related *Finance actions*, *Mitigation actions* and make a positive *Impact* by reducing scope 1 and 2 GHG emissions. The variable *SGApercent* demonstrated significance

in dependent variables, with hazard ratios greater than one and *p*-values significant at $p < 1\%$ in all models in *Mitigation actions* and *Impact* (except from Model 2, with a *p*-value significant at $p < 5\%$), $p < 5\%$ in all models in *Emission inventory* and $p < 10\%$ in *Finance actions* in Models 3 and 4. The variable *CompanyGR* showed significance only in finance actions with a hazard ratio greater than one and a *p*-value significant at $p < 5\%$ and in mitigation actions with a *p*-value significant at $p < 10\%$ in Models 3 and 4.

The interaction coefficient *CompanyGRSignwithsubsidiary* was consistently significant in *Emission inventory*, *Mitigation actions* and *Impact* in Model 2 with a hazard ratio greater than one and a *p*-value significant at $p < 5\%$. Furthermore, *CompanyGRSignwithsubsidiary* was significant in *Finance actions* in Model 2 with a hazard ratio greater than one and *p*-value significant $p < 1\%$. This result indicates that companies that made a net-zero-commitment at the subsidiary level and with a higher percentage of green revenues are more likely to maintain an emission inventory, take finance actions, implement mitigation actions and make an impact with a subsidiary rather than with a parent entity. This presents an interesting finding as it indicates that even a net-zero commitment at the subsidiary level is connected to more tangible corporate efforts (e.g., creating an emission inventory, and taking financial actions) to reduce carbon emissions.

[Insert Table 5 about here]

To assess the robustness of these results, we also ran Weibull regressions for further dependent variables: *Initiative participations* and *Actions undertaken* (not reported). We found consistent results for *IO* and *SGApercent,* which are statistically significant in both models. Also, the interaction coefficient *CompanyGRSignwithsubsidiary* is statistically significant in both models (i.e., for *Initiative participations* and *Actions undertaken*), confirming a recurring pattern where companies that make decarbonisation commitments at the subsidiary level and show a higher percentage of green revenues are abnormally more likely to undertake related climate actions.

6.2 Cox Regressions

We used a semi-parametric Cox model (see Section 4.5) as a robustness test, selecting this study's key variables and firm characteristics as specified in Model 1 and shown in Table 6. We then used related climate action variables to test whether the stakeholder effects still held in Model 1.

[Insert Table 6 about here]

In line with our base analysis for the Weibull regressions, we found that *IO* was significant for all related climate action variables, with hazard ratios greater than one and *p*-values significant at *p* <1%. We also found that the variable *SGApercent* was significant for all related climate action variables and particularly significant at *p* <1% for the related climate action variables *Mitigation actions* and *Impact* in Model 1. Additionally, *CompanyGR* was significant at *p* <5% for the related climate action variables *Finance actions* and *Mitigation actions*.

Thus, the Cox results showed robustness for the main independent variables of this study, indicating that a higher proportion of *CompanyGR*, *IO* and *SGApercent* was positively associated with the likelihood of signing a decarbonisation commitment and, to some extent, in implementing carbon-reducing actions. More specifically, institutional ownership strongly predicted the decarbonisation commitment and all related actions. Employee pressure also seemed to predict decarbonisation commitment and related climate actions, but due to the lower significance levels for predicting emission inventory and finance actions, the results were more nuanced (but similar to the Weibull regressions in Table 4). Customer pressure did not predict decarbonisation commitment but showed some relations with a higher likelihood for climate actions and initiatives (again, similar to the Weibull regressions in Table 4).

All control variables were significant in Model 1 for all the related climate action variables. The variables *Size* and *Profit* were significant at 1% for all related climate action variables in Table 5. This indicates that larger and more profitable companies are likelier to make decarbonisation commitments and undertake related climate actions; this finding also aligned with our base analysis for *Commitments* and related climate action variables. Further, we found that firms with higher leverage, volatility and a larger Tobinq were more likely to make decarbonisation commitments and undertake related climate actions.

6.3 Logit Regression

We also investigated the determinants of firms' decisions to make a decarbonisation commitment at the subsidiary level. Accordingly, we employed logit regression, selecting this study's key

variables and firm characteristics as shown in Table 7. Here, we used *Signwithsubsidiary* as the dependent variable. Additionally, we controlled for industry-fixed effects.

[Insert Table 7 about here]

CompanyGR showed a positive coefficient, which was significant at p <5%, suggesting that companies with a high green revenue percentage are more likely to make a decarbonisation commitment at the subsidiary level instead of the parent entity. This result also aligned with our base analyses for *Commitments* and *Related climate action variables* in Models 1–4 (Tables 3–4). *IO* showed a negative coefficient, which was significant at p <10%, implying that companies with higher institutional ownership are less likely to sign a decarbonisation commitment at the subsidiary level. SGApercent did not show a significant coefficient and, therefore, seemed not to be a relevant determinant of making a decarbonisation commitment at the subsidiary level.

The control variables *Profit*, *Volatility* and *Beta_ftse* were significant at p <10%. The negative coefficient of *Profit* indicated that less profitable firms were more likely to sign a commitment with a subsidiary than with a parent entity. At first sight, this outcome might seem to contradict our base analysis, wherein larger and more profitable companies set *Commitments* and undertake *Related climate actions* in Models 1–4 (Tables 3–4). One must keep in mind that the analysis in Table 6 refers to the decision at which level (subsidiary versus parent) the commitment will be made. So, while larger and more profitable firms are more likely to make a decarbonisation commitment, there is a higher likelihood that less profitable firms will make the decarbonisation at the subsidiary level.

We also found that more volatile firms and firms with lower betas were more likely to make the decarbonisation commitment at the subsidiary level instead of at the level of the parent entity. These results further contribute to the understanding of determinants of the decarbonisation commitments by showing that the decision to sign such a decarbonisation commitment at the subsidiary or parent level is not random but rather can be explained through customers' and investors' pressure as well as through some firm characteristics.

7. Discussion and Conclusion

With our study, we provide the first empirical evidence linking specific stakeholder groups (clients, employees and institutional owners) to decarbonisation commitments and related climate actions. We analysed determinants of these decarbonisation commitments by combining data from various data providers (UNFCCC, FTSE, Refinitiv) and by employing Weibull regressions as well as a range of sensitivity analyses to understand the role of related climate actions and assess the robustness of our results against other empirical approaches.

Our study offers several contributions to the existing literature. Notably, it identifies institutional ownership and employees as substantial factors in motivating a company to set decarbonisation commitments and undertake related climate actions. This contributes to Cohen, Kadach and Ormazabal's (2023) findings that institutional ownership enhances corporate climate risk disclosure. We extended this consensus by revealing that institutional ownership is not only a determinant of more transparency, but also a motivator to set decarbonisation targets and to initiate supportive actions.

Kurruppu and Milne (2010) explain that employee engagement in corporate strategic objectives often aligns with sustainability reporting internally, while externally, this alignment enhances a firm's reputation via its commitment to environmental and social performance. Our findings add to the literature by demonstrating that the relationship between employees and company behaviour indeed works in both directions. Employees are not only considering the environmental performance of the firm they plan to work for, but a powerful stakeholder group that can motivate companies to set decarbonisation commitments and initiate related climate actions.

We addressed a gap in the literature by further analysing determinants of whether companies set decarbonisation commitments at the parent or subsidiary level. We found that customer pressure is related to a higher likelihood of making decarbonisation commitments at the level of a subsidiary rather than a parent entity. On one hand, this finding illustrates that subsidiaries are more likely to experience customer pressure (e.g., specific requests or feedback) and, in some cases, therefore move ahead to make a decarbonisation commitment even if the parent company is not ready for such a commitment. On the other hand, subsidiary-level commitment may account for limited reduction in scope 1 and 2 GHG emissions, as only the parent entity can introduce company-wide

decarbonisation initiatives. Therefore, the recurring pattern of a company setting a commitment or undertaking a related climate action at the subsidiary level rather than at the parent level challenges the legitimacy of the parent entity.

This study has two main implications for policy and practice. First, from a practical perspective, firms should be aware of their stakeholders and the stakeholders' preferences regarding climate-related actions and targets. A basis for sustainability reporting is the materiality assessment, including stakeholder involvement. Our results show that stakeholders can determine firm behaviour on climate-related targets, which emphasises the importance of stakeholder involvement. Second, the observed pattern of subsidiary-level commitments responding to customer pressures raises issues of legitimacy and coherence of parent-level environmental strategies, highlighting the necessity for the coherence of decarbonisation efforts across all corporate entities. This illustrates how decarbonisation commitments can be implemented not only in a top-down approach but also in a bottom-up fashion.

Although our findings are robust, they merit future research, especially regarding parent- versus subsidiary-level decarbonisation commitments. Additionally, future research may study the type of institutional ownership that drives decarbonisation commitments and/or related climate actions. Subsequent studies could also investigate how (e.g., through which channels) employees with CSR ethics stimulate decarbonisation commitments and/or related climate actions.

Finally, it is important to note the following: while our results provide robust evidence of stakeholder effect in shaping a firm's decisions to sign a decarbonisation commitment and to engage in related climate actions to work towards reaching net-zero, many companies fail to set such commitments. Here, research is more generally concerned with understanding how and when companies make such commitments, and to what extent regulation can lead to more clarity on how commitments and realistic milestones and plans can be created and implemented.

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Tables

Table 1. UNFCC Dependent Variables: Company Examples

Companies	**UNFCCC Dependent Variables**				
	Commitments	***Emission inventory***	***Finance actions***	***Mitigation actions***	***Impact***
Apple Inc., United States of America	'Reduce CO_2e emissions from operations and selected upstream and downstream activities by 61% from 2019 to 2030.'	'Scope 1 and 2 emissions 2022' and 'Scope 3 emissions 2022'	'USD 1.5 billion of green bonds issued in 2016' and 'USD 1 billion of green bonds issued in 2017'	No reporting	'Latest emissions (2022) compared to previous inventory (2021), increased.'
Coded as	1	1	1	0	1
Delta Air Lines, United States of America	'Achieve net-zero carbon emissions by 2050 at the latest.'	'Scope 1 and 2 emissions 2022' and 'Scope 3 emissions 2022'	'carbon price established'	'Low-carbon energy consumption: liquid biofuels'	'-17.8% CO2 reduction in 2022 from base year 2019'
Coded as	1	1	1	1	1
The Walt Disney Company, United States of America	'Reduce operational CO_2e emissions by 46% from 2019 to 2030.'	'Scope 1 and 2 emissions 2022' and 'Scope 3 emissions 2022'	'carbon price established'	'Low-carbon energy consumption: User specified action type reported'	'Changes in GHG emissions-scope 1 and 2 combined' and '-12% CO2 reduction in 2022 from the base year 2019'
Coded as	1	1	1	1	1

Table 1 presents company reporting on commitments as of 2021 and related climate action variables (*Commitments, Emission inventory, Finance actions, Mitigation actions* and *Impact)* and their coding as 0 or 1. The companies selected are also included in the study sample.

Table 2. Summary of Variables

Variables	Definition	Data Source
Dependent variables		
commitments (by year)	The year the organisation commits to a decarbonisation commitment with detailed or non-detailed reporting that refers to scope 1, 2 & 3 scope emission reduction percentage with target year.	UNFCCC Actors website
Emission Inventory (by year)	The organisation maintains an emission inventory denoted as total GHG emissions or scope breakdown emissions into Scope 1 & 2 and possibly Scope 3 with verification.	UNFCCC Actors website
Finance Actions (by year)	The organisation accounts for financial actions. For instance, carbon price reporting (CDP 2023 Climate Change Disclosure) and/or green bond issuance reporting (Climate Bonds Initiative).	UNFCCC Actors website
Mitigation actions (by year)	The organisation lists categories of actions to reduce GHG emissions as reported in the 2023 CDP-ICLEI questionnaire as per company.	UNFCCC Actors website
Impact (by year)	The organisation displays changes in greenhouse gas emissions (Scope 1 and 2 combined). Positive impacts include reductions in greenhouse gas emissions (e.g., latest emissions (2021) compared to base year emissions (2019)/latest emissions (2021) compared to previous inventory (2020).	UNFCCC Actors website
Initiative Participations (by year)	The organisation accounts for initiative participations that aims at long-term decarbonisation practices (e.g., Science Based Targets initiative (SBTi), Climate Ambition Alliance, Race to Zero, Climate Action 100+).	UNFCCC Actors website
Actions Undertaken (by year)	Actions undertaken embed mitigation actions, providing the cause per sector and action (as a solution) as reported in the	UNFCCC Actors website

	2023 CDP-ICLEI questionnaire per company and finance actions.	
Independent Variables of Interest		
CompanyGR	**Company green revenue percentage.**	**FTSE**
IO	**Institutional owners percentage.**	**Refinitiv**
SGApercent	**The proportion of a company's revenue allocated to its selling, general, and administrative expenses (SGA) plus research development (R&D) costs indicates how much of the revenue is spent on employees working in sales, marketing, business administration, research, or development.**	**Refinitiv**
Signwithsubsidiary	**The organisation has not provided evidence that it signed the commitment with the ultimate parent's legal entity, as it either signed with a subsidiary entity or withheld its entity legal form (ELF) code in signing.**	**GLEIF**
Control variables		
Profit	**A ratio that expresses a company's profitability relative to its total financial structure by dividing gross profit by the sum of shareholders' equity and total debt.**	**FTSE**
Leverage	**A ratio calculated as a shareholder's equity relative to total debt indicates that a higher value reflects a greater dependence on equity financing than debt.**	**FTSE**
Beta_ftse	**A firm's stock volatility, relative to the overall market, is benchmarked against FTSE.**	**Refinitiv**
Size	**A company's financial size is expressed as the logarithm of the sum of its shareholders' equity and total debt; that is, a scaled measure of the company's capital structure in euros.**	**FTSE**

Volatility	**Company volatility shows the statistical variation in a company's stock price or returns over time, that is, the level of risk uncertainty relative to market valuation.**	**Refinitiv**
Tobin Q	**A ratio that compares the sum of its market capitalization and total debt (market values of the company's assets) to the sum of its shareholders' equity and total debt (the book values of its assets), indicating whether the firm's market valuation exceeds or falls below its recorded asset value.**	**FTSE**

Table 2 illustrates the summary of proxy variables to capture the accounting, financial and sustainability characteristics of the corporate setting of the firms in our sample. Column (1) shows the variables' names, column (2) explains the variables' definitions and column (3) reports the data used.

Table 3. Descriptive Statistics

Variables	Mean	SD	Min	Median	Max
	(1)	(2)	(3)	(4)	(5)
Commitments	0.7744	0.2624	0	0	1
Emission inventory	0.0747	0.2630	0	0	1
Finance actions	0.0405	0.1972	0	0	1
Mitigations Actions	0.0668	0.2497	0	0	1
Impact	0.0746	0.2627	0	0	1
CompanyGR	6.5703	177.550	0	0	100
IO	17.4884	13.2610	0.0304	14.7667	100
SGApercent	0.2111	0.1634	0.0003	0.1690	0.9905
Signwithsubsidiary	0.0031	0.0560	0	0	1
Leverage	1.5512	1.4947	0	1.0759	13.6078
Profit	0.2772	0.2791	-0.0871	0.2061	5.2033
Beta_ftse	0.5834	0.3553	0.0011	0.5177	9.1432
Size	22.4683	1.2895	15.3362	22.4016	27.2923
Vol	2.2040	0.7806	0.4525	2.0991	7.5195
Tobinq	0.3639	0.2574	0	0.3409	1.0002

Table 3 presents the basic summary statistics of key and control variables for our base sample of 5,402 firm-year observations for the timeframe of 2019–2021. Columns 1–5 report the total observations, mean, standard deviation, minimum, median and maximum, respectively.

Table 4. Stakeholder Effects on Long-Term Commitments to Corporate Emissions Reduction

y=commitments (by year)				
	Model 1	**Model 2**	**Model 3**	**Model 4**
Key Variables				
CompanyGR	1.00193 0.420	1.001896 0.437	1.002311 0.338	1.002122 0.380
IO	1.039385 0.000***	1.039478 0.000***	1.039195 0.000***	1.039637 0.000***
SGApercent	2.517458 0.002**	2.527149 0.002**	2.623249 0.002**	2.549555 0.002**
Interactions				
CompanyGRSignwith subsidiary		1.046618 0.012**		
SGApercentSignwith subsidiary			0.001213 0.072*	
IOSignwithsubsidiary				0.004987 0.078*
Signwithsubsidiary		6.623684 0.000***	28.11199 0.000***	49.14842 0.000***
Firm Characterstics				
Leverage	1.026787 0.631	1.045503 0.417	1.04994 0.374	1.052412 0.352
Size	1.469686 0.000***	1.468194 0.000***	1.46578 0.000***	1.466236 0.000***
Profit	1.655473 0.000***	1.66719 0.000***	1.685682 0.000***	1.681595 0.000***
Tobinq	0.807671 0.509	0.854207 0.627	0.912810 0.780	0.930586 0.826
Vol	0.194979 0.000	0.183063 0.000	0.181750 0.000	0.184591 0.000
Beta_ftse	1.418709 0.000***	1.423152 0.058*	1.42559 0.000***	1.422498 0.000***
N	5.484	5.402	5.402	5.402
Log Likelihood	2273.8001	2263.1423	2262.7942	2262.9706

Table 4 reports the Weibull regression results for stakeholder effects on the long-term *Commitments* to corporate emissions reduction. The dependent variable is *Commitments*. The independent variables include *CompanyGR*, *IO*, *SGApercent*, *Signwithsubsidiary* and *Firm characteristics*. The table shows the hazard ratio and *p*-values for all variables of interest and controls for Models 1–4. All independent variables are lagged by one year. Test for coefficient significance: 1% (***), 5% (**) and 10% (*).

Table 5.

PANEL A: Stakeholder Effects on *Emission Inventory*

y=emission inventory (by year)	Model 1	Model 2	Model 3	Model 4
Key Variables				
CompanyGR	1.00245 0.299	1.002438 0.311	1.002835 0.233	1.002654 0.265
IO	1.038956 0.000***	1.039037 0.000***	1.03877 0.000***	1.039194 0.000***
SGApercent	2.585466 0.002**	2.598231 0.002**	2.695632 0.001**	2.621334 0.002**
Interactions				
CompanyGRSignwithsubsidiary		1.04598 0.013**		
SGApercentSignwithsubsidiary			0.001088 0.070*	
IOSignwithsubsidiary				0.005135 0.079*
Signwithsubsidiary		6.589678 0.000***	28.53114 0.000***	48.28409 0.000***
Controls	YES	YES	YES	YES
N	5.484	5.402	5.402	5.402
Log Likelihood	2286.8235	2276.0703	2275.8008	2275.9173

PANEL B: Stakeholder Effects on *Finance Actions*

y=finance actions (by year)	Model 1	Model 2	Model 3	Model 4
Key Variables				
CompanyGR	1.006512 0.030**	1.006327 0.041**	1.006924 0.023**	1.006668 0.029**
IO	1.034655 0.000***	1.033986 0.000***	1.033627 0.000***	1.034277 0.000***
SGApercent	1.983371	2.044015	2.17871	2.078424

	0.114	0.104	0.075*	0.095*
Interactions				
CompanyGRSignwithsubsidiary		1.049875 0.009***		
SGApercentSignwithsubsidiary			0.000085 0.047**	
IOSignwithsubsidiary				0.001407 0.083*
Signwithsubsidiary		10.54122 0.000***	66.43525 0.000***	106.4112 0.000***
Controls	YES	YES	YES	YES
N	5.484	5.402	5.402	5.402
Log Likelihood	1129.1356	1139.5868	1139.5956	1139.3642

PANEL C: Stakeholder Effects on *Mitigation Actions*

y=mitigation actions (by year)				
	Model 1	**Model 2**	**Model 3**	**Model 4**
Key Variables				
CompanyGR	1.003941 0.103	1.003964 0.108	1.004362 0.074*	1.004185 0.086*
IO	1.038826 0.000***	1.038794 0.000***	1.038531 0.000***	1.038936 0.000***
SGApercent	2.946657 0.001***	2.921916 0.001***	3.035754 0.001***	2.951495 0.001***
Interactions				
CompanyGRSignwithsubsidiary		1.043789 0.019**		
SGApercentSignwithsubsidiary			0.0012827 0.085*	
IOSignwithsubsidiary				0.0073335 0.104
Signwithsubsidiary		7.811659 0.000***	32.35471 0.000***	49.90136 0.000***

Controls	YES	YES	YES	YES
N	5.484	5.402	5.402	5.402
Log Likelihood	2016.9313	2010.6912	2010.4312	2010.4368

PANEL D: Stakeholder Effects on *Impact*

y=impact (by year)

	Model 1	**Model 2**	**Model 3**	**Model 4**
Key Variables				
CompanyGR	1.002421 0.306	1.002409 0.318	1.002806 0.239	1.002626 0.271
IO	1.03897 0.000***	1.039055 0.000***	1.038791 0.000***	1.039212 0.000***
SGApercent	2.595962 0.001***	2.609545 0.002**	2.707554 0.001***	2.633185 0.001***
Interactions				
CompanyGRSignwithsubsidiary		1.046137 0.013**		
SGApercentSignwithsubsidiary			0.0010359 0.068*	
IOSignwithsubsidiary				0.0050558 0.079*
Signwithsubsidiary		6.609179 0.000***	28.90983 0.000***	48.71258 0.000***
Controls	YES	YES	YES	YES
N	5.484	5.402	5.402	5.402
Log Likelihood	2282.7945	2272.2023	2271.9428	2272.0475

Table 5 reports the Weibull regression results for stakeholder effects on *Emission inventory* (PANEL A), stakeholder effects on *Finance actions* (PANEL B), stakeholder effects on *Mitigation actions* (PANEL C) and stakeholder effects on *Impact* (PANEL D). The dependent variables are *Emission inventory* (PANEL A), *Finance actions* (PANEL B), *Mitigation actions* (PANEL C) and *Impact* (PANEL D). The dependent variable is *Commitments*. The independent variables include *CompanyGR*, *IO*, *SGApercent*, *Signwithsubsidiary* and *Firm characteristics*. The table shows the hazard ratio and *p*-values for all variables of interest and controls for Models 1–4. All independent variables are lagged by one year. Test for coefficient significance: 1% (**), 5% (**) and 10% (*).

Table 6. Related Independent Variables Estimated with Cox Regression

	y=commitments	y=emission inventory	Model 1 y=finance actions	y=mitigations	y=impact
Key variables	1.003544 0.145	1.004054 0.091*	1.0085 0.005**	1.005674 0.020**	1.00402 0.095*
CompanyGR	1.003544 0.145	1.004054 0.091*	1.0085 0.005**	1.005674 0.020**	1.00402 0.095*
IO	1.035739 0.000***	1.035307 0.000***	1.029792 0.000***	1.035106 0.000***	1.035285 0.000***
SGApercent	2.338617 0.004**	2.388649 0.003**	2.115103 0.078*	2.717107 0.001***	2.39596 0.003***
Firm Characteristics					
Leverage	0.883007 0.036**	0.8819227 0.034**	0.8224475 0.020**	0.8528175 0.014**	0.8818307 0.034**
Size	1.523773 0.000***	1.521287 0.000***	1.852216 0.000***	1.520118 0.000***	1.520409 0.000***
Profit	1.857299 0.000***	1.859085 0.000***	2.007336 0.001***	1.886493 0.000***	1.863349 0.000***
Tobinq	0.3472788 0.001***	0.3502558 0.001***	0.16466 0.000***	0.2874322 0.000***	0.3522397 0.001***
Vol	0.5552502 0.000***	0.5477281 0.000***	0.5433026 0.000***	0.5258056 0.000***	0.5416501 0.000***
Beta_ftse	1.194324 0.070*	1.194603 0.069*	1.234719 0.074*	1.217974 0.044**	1.194646 0.069*
N	5,484	5,484	5,484	5,484	5,484
Log Likelihood	-2879.1263	-2893.8729	-1521.1016	-2573.7157	-2885.8353

Table 6 reports Cox regression results for related climate action variables estimated with Model 1 of this study. The dependent variables are the related climate action variables of this study (y = *Commitments*, y = *Emission inventory*, y = *Finance actions*, y = *Mitigation actions*, y = *Impact*). The independent variables include *CompanyGR*, *IO*, *SGApercent*, *Signwithsubsidiary* and *Firm characteristics*. All independent variables are lagged by one year. Test for coefficient significance: 1% (**), 5% (**) and 10% (*).

Table 7. Logit Regression

	Model 5 **y=Signwithsubsidiary**
Key variables	
CompanyGR	0.0954838 0.034**
IO	-0.1885432 0.077*
SGApercent	4.942083 0.460
Firm Characteristics	
Leverage	0.5099395 0.654
Size	-0.5663555 0.287
Profit	-9.114982 0.083*
Tobinq	-1.154599 0.789
Vol	2.476437 0.038*
Beta_ftse	-7.018366 0.054*
Fixed Effects	
SicCode1	0.0009395 0.070*
SicCode2	0.0003625 0.310
SicCode3	0.0006691 0.166
SicCode4	-0.0006126 0.131
SicCode5	-0.0011138 0.044**

SicCode6	0.0008282 0.162
SicCode7	-0.0005614 0.177
SicCode8	-0.0005389 0.134
N	503
Log Likelihood	-17.273383

Table 7 reports Logit regression results for Model 5 of this study with industry- fixed effects. The dependent variable is y = *Signwithsubsidiary*. The independent variables include *CompanyGR*, *IO*, *SGApercent*, *Signwithsubsidiary*, *Firm characteristics* and *Fixed effects*. The table shows the hazard ratio and *p*-values for key variables, *Firm characteristics* and *Fixed effects* for Model 5. All independent variables are lagged by one year. Test for coefficient significance: 1% (**), 5% (**) and 10% (*).

Overview Article Contribution

Article	Authors/Share	Year	Title	Journal/Status
1	Paliampelou, I./100%	2024	Net-Zero Targets and Governance: A literature review (2009-2021)	Published in Handbook on Corporate Governance and Corporate Social Responsibility
2	Paliampelou, I/80% Schiemann, F/20%	2025	Net-Zero by 2050, but carbon neutral now: The paradoxical reporting of corporate carbon commitments	Under Review at Sustainability Accounting, Management and Policy Journal
3	Hoepner, A/20% Paliampelou, I/60% Schiemann, F/20%	2025	Clients, Employees and Institutional owners: Determinants of Corporate Decarbonisation Commitments?	Under Review at Business Strategy and Environment