Master Thesis U.S.E.

Change In ESG-Firm Behaviour After The Adoption Of SBTi[1]

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Abstract

This thesis studies the Science-Based Target initiative (SBTi) and their effect on corporate ESG-behaviour. Using Refinitiv, a universe of 3,141 firms is created including 962 SBTi companies with the remaining companies being all firms with consistent ESG-Score data from 2013-2021. Applying a firm-fixed effect model I examine three separate hypotheses concerning SBTi adoption affecting emission, ESG-Scores and environmental innovation in the years 2013 until 2021. Over all firms I find a gradual decrease in emissions and increase in ESG and Environmental Innovation Scores across most years, possibly due to recent climate awareness and regulation. The SBTi did not have any significant effect on emission no matter if we look at total emissions, scope one or scope two emissions, showing that setting the targets did not influence company action. ESG and Environmental Innovation Scores on the other hand were slightly negatively influenced, which could result from the SBTi's stricter regulations, time lags or the financial strain approval fees put on firms. Generally, the research suggests taking a closer look at SBTi firms since greenwashing concerns cannot be disproven.

JEL-codes: Q28, Q56, D22, G40

Keywords: SBTi, emissions, ESG, science-based targets

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1 Introduction

Only zero point four degrees. That is how far away we are right now from a temperature rise of 1.5°C, the amount above pre-industrial levels that is necessary to minimize negative influences of climate change, according to the Paris Climate Agreement (IPCC, 2023). In their latest report the Intergovernmental Panel on Climate Change (IPCC) stresses the negative impacts of global warming on our people and ecosystem even further, with climate related risks and long-term effects exceeding previous assessments from 2014. Estimated annual losses range up to over 200 billion US dollar (Handmer et al., 2012). National regulations have tried to mitigate these developments through several policies, including but not limited to emission regulation targets. Research by the World Resources Institute (WRI) has shown though that even if these pledges or nationally determined contributions (NDCs) are achieved, greenhouse gas (GHG) emissions would only be reduced by 7% from 2019 levels by 2030, which is in stark contrast to the 43% needed to reach the 1.5°C target (Fransen et al., 2022). Along with this the IPCC report also points out the “implementation gap” between NDCs and projected emissions which is supported by Jiang et al. (2021), who find that environmental regulations do not impact carbon emission development. Since governmental executions seem to be failing and national regulations take time to be implemented, many companies have decided to set their own corporate targets to reduce GHG emissions. Nevertheless, only a minority of companies mentions ecological limits, connects actions to planetary boundaries in their reporting or uses them to define consumption and emission reduction goals (Bjørn et al., 2017; Haffar &Searcy, 2018). This reinforces the statement of Giesekam et al. (2021) and Gouldson & Sullivan (2013) that most targets are in line with climate policy rather than science, which could result in exceeding planetary boundaries in the model of Steffen et al. (2015) if necessary actions are not taken.

This problem calls for external validation and independent initiatives to assess if the achievement of set goals would trigger the required environmental outcomes. An initiative dedicated to more clarity on this front is the Science-Based Targets initiative (SBTi) that evaluates and approves emission-targets of firms to be in line with SBTi criteria and climate science as a whole. These resulting Science-Based Targets (SBTs) translate the temperature goals of 1.5°C or maximal 2°C as set in the Paris Agreement into a tangible, company specific reduction target reached at a certain year, signalling intentions towards more climate action. They aim to assign a fair share of emissions to a given company or industry which is translated to the amount of emissions a company is allowed to emit in a defined timeframe. This is done by calculating at what time the threshold of CO_2 concentration in our ecosystem is reached as for example in the One Earth Climate Model (OECM) where the global carbon budget should be kept under 400 Gt CO_2 between 2020 and 2050 (Teske, 2022).

While agreeing on progress needing to be made in climate policies, there are several critical (Trexler & Schendler, 2015) and praising (Marland et al., 2015) voices concerning the effectiveness of SBTs. Generally, research by for example Lui et al. (2021) have shown that combined action of international corporate initiatives (ICIs) would reduce emissions in addition to national regulations and Manuel (2021) or Bolton & Kacperczyk (2022) see promising developments for companies committing to SBTi specifically. However, Giesekam et al. (2021) and the SBTi Progress Report (2020) find that just less than half of firms were behind their established target supporting the notion that the effect of SBT setting on general behaviour still needs to be explored further.

Fully understanding this effect of commitment to the initiative on a company's behaviour is needed to see if the SBTi can be used as an effective tool that will aid in combating climate change. It would help the SBTi in evaluating potential impacts, strengths and weaknesses of existing SBTs better and hold firms accountable for their actions. For stakeholders a clear grasp on effects will manage expectations and assist in the evaluation of SBTi companies concerning their actual commitment to sustainability. If expectations are met, trust as well as investor confidence could increase and required talents could be attracted or retained. Awareness of companies concerning the implications of SBTi participation will provide clarity on which topics added transparency is needed and where reports need to be enhanced. This could help to guide them on positioning themselves in the market and therefore being ahead of competitors.

Furthermore, the effectiveness of the SBTi is mentioned by Giesekam et al. (2021) as critical research gap, which I will address in this paper by looking at changes in company behaviour after adoption of SBTi. Academically this adds to the growing research on SBTi, which is underdeveloped due to the fast paced and recent growth of sustainability and respective initiatives. Concretely, this thesis expands papers such as Bolton & Kacperczyk (2022) and Freiberg et al. (2021) since both of them analysed data until 2019, which I aim to extend until 2021 in this study. This is especially important because in these two years a total of 1,461 companies renewed or set their targets and it could have been "too soon for the commitments […] to have materialized" (Bolton & Kacperczyk, 2022, p.4) in previous studies. Secondly, this analysis will shed a light on the effect on different emission scopes as often only scope 1 is analysed. Since indirect emissions such as scope 2 emissions are harder to control or measure, I want to gain insight on how these are affected by SBTi in our analysis for firms to be able to handle them better. Lastly, I measure ESG-behavioural changes through ESG-Scores and Environmental Innovation Scores, which has received even less academic attention than emission reductions.

For this reason, the paper will address the following research question: *How does corporate ESG-behaviour change when companies become part of the SBTi relative to firms not committing to the initiative?* This change can be measured in several different ways. Since the main focus of the SBTi lies on reducing GHG emissions the paper will first study the development of emissions, so: *Does the adoption of SBTi lead to a significant change in emissions by the adopting firms?* Secondly, I examine changes in ESG-Scores over the course of adoption. ESG-Scores do not necessarily look at how ethical a company and their product are but reflect, in the case of Refinitiv, the relative ESG performance and transparency of reporting on material ESG-topics (Calvert, 2021). This helps to evaluate which and to what extent action concerning environmental, social and governance objectives are taken by a firm making it a good proxy for behavioural change. This will be addressed in the question: *Does the adoption of SBTi lead to a significant change in ESG-Scores by the adopting firms?* Thirdly, I take a look at the innovation taking place pre- and post-adoption to assess not only outcomes, but which actions have been taken to implement sustainable practices. By looking at the Environmental Innovation Score I determine: *Does the adoption of SBTi lead to a significant change in environmental innovation by the adopting firms?*

Data to address all points is downloaded from Refinitiv and FactSet and was assessed with a firm-fixed effects regression where I control for time as well as firm size. I also perform separate regressions to find differences between firms that committed to the initiative themselves and firms whose targets were approved by the SBTi. The results are then checked for robustness through a more specific company matching by industry and market capitalization. A more detailed description of this process can be found in the methodology section.

My results show that while emissions decrease for all firms over time significantly, being part of the SBTi does not lead to significant change in emissions. The general drop of CO_2 emissions could be the result of recent growing awareness of climate related issues that is also reflected in increasing regulations around this topic. With mandatory emission targets firms regardless of SBTi adoption will want to decrease emission to mitigate scrutiny. The insignificance for SBTi firms means that while SBTs can be used as a signalling tool for sustainability commitment this does not necessarily translate into action. It could even strengthen claims that pledges like these are simply used for greenwashing purposes. The second set of results concerning ESG-metrics finds that while ESG and environmental innovation rises for all firms over the years compared to 2013, both scores slightly decrease for SBTi companies. Again, the overall rise in score is possibly due to increased awareness and companies wanting to attract sustainability conscious customers. Negative development of ESG and environmental innovation matters can be explained through several factors. This includes the stricter regulations of the SBTi uncovering environmental issues, time lags in the made progress or lack of resources after paying expensive SBTi fees that can reach up to 14,500 US$. It could even stem from unsubstantial sustainability claims of firms, supporting the greenwashing narrative. Generally, the findings underline critiques of the SBTi and suggest that resources could be used more efficiently than on the approval process. In case firms do want to increase credibility of their SBTs and counteract a drop in scores they will have to communicate reduction strategies and actions clearly to stakeholders.

The rest of the paper will be structured as follows: Section 2 will look at different literature on the topic, first elaborating on the Science Based Target initiative and their process, then diving deeper on what characterizes companies setting SBTs and what behavioural changes were observed so far for firms committing to SBTi. This will then lead us to our Hypothesis Development. Section 3 describes data sources and the methodology I execute in order to test my hypotheses. Results are presented in Section 4, including a discussion with the arising recommendations and limitations of this research. Finally, the conclusion can be found in Section 5 and the Appendices in Section 6.

2 Literature Review And Hypothesis Development

2.1 The Science Based Target Initiative

First launched in 2014 (Bolton & Kacperczyk, 2022), the SBTi is a joint initiative of the United Nations Global Compact, the World Wide Fund for Nature (WWF), the WRI and the CDP (SBTi, 2023a). The initiative developed a framework supporting companies to align their emission targets with decarbonization pathways that limit global warming to 1.5°C above pre-industrial levels. Since July 2022 this replaced the previous “well below 2°C" target (SBTi, 2021a) for scope 1 and 2 emissions, which will be phased out from the framework due to increased urgency for climate action.

Generally, companies can not only set reduction targets aligned with 1.5°C emission scenarios but also determine long-term net-zero targets that will enable net-zero value chain emissions by 2050 (SBTi, 2022). The emission goals set by the SBTi can address all three scopes including scope 1, the ones that stem from sources the company owns or controls directly; scope 2, emissions caused indirectly when e. g. the purchased energy is produced; and scope 3, that companies are indirectly responsible for up and down its value chain. Emissions and their targets can also vary in their way of being calculated. Absolute emissions simply look at physical amount of GHG emitted while intensity-based metrics evaluate volume of emission per a certain chosen unit of output. The latter can then also decrease if the unit of output increases, classifying intensity-based targets often as a weaker measure of target difficulty (Bolton & Kacperczyk, 2022). Currently, the use of offsets is not counted as emission reduction towards the progress of a company’s science-based targets (Raynaud, 2020).

In order to become part of the SBTi, a company must go through several steps which include commitment, development of targets, submission, communication and disclosure. First the company submits a letter, establishing they are committing to set SBTs, which they have time to develop in the following two years. Using SBTi methodologies, companies first independently assess emissions and identify possible starting points for reduction. Depending on the industry and its core operations, the firm can set targets for different emission scopes with scope 3 targets only being required if these make up 40% of total emissions (SBTi, 2021b). Since this scope is less easily quantified it can be replaced by a supplier/customer engagement target (Raynaud, 2020). Altogether, the two main target-setting methods currently used by the SBTi include the Absolute Contraction Approach (ACA) and the Sectoral Decarbonization Approach (SDA). The first one, ACA, does not take any change in business activity or growth into account since it assumes all companies reducing absolute emissions by the same proportion. SDA on the other hand is suitable for companies in carbon-intensive sectors taking into consideration that different industries like e.g. aviation decarbonize slower and others faster than the global average (SBTi, 2021c).

The developed SBTs are then independently assessed and validated by the initiative itself. For some sectors like for example the oil and gas or transport sector methods are still under development (SBTi, 2023c). Those companies can commit to the SBTi but will have to wait for finalization of methodologies before being able to submit targets. An easier validation process for small and medium enterprises was also recently developed. After the final approval of SBTs, targets are communicated to stakeholders and published on the SBTi website with the company's emission progress encouraged to be disclosed annually (SBTi, 2023d). The initiative doesn't pose any penalties if no progress is made.

Figure 1: annual cumulative number of all companies with approved targets and commitments to the SBTi (SBTi Progress Report, 2020).

As of right now around 4,700 companies, which make up over a third of the global economy's market capitalization, have set or committed to set targets with the SBTi with rising numbers over the years that can be observed in Figure 1. Around 2.400 of set targets are approved including major companies like Coca-Cola, Nestlé or Walmart (SBTi, 2023b). The initiative is funded by several organizations as well as by the target verification fees.

2.2 Opposing Views On The Effectiveness Of SBTs

Literature has shown different viewpoints on the effectiveness of science-based targets. A critical paper of Trexler & Schendler (2015) dismiss SBTs as a tool to achieve global emission goals and “voodoo economics”, since the authors perceive them as a distraction from making meaningful progress concerning global emission policies. In addition, firms often set targets that are not possible or that they don’t aim to achieve (Crilly et al., 2012, 2016), rendering SBTs as useless. This would support greenwashing concerns of for example Chrobak (2021) that claim pledges like these are just a marketing opportunity and good for business. In contrast, Marland et al. (2015) argue that the effects of corporate action as grass-root support is underrated and problems best being addressed at different scales since the governmental top-down approach did not yield promised results yet. This is also in line with the diffusion of innovations theory which states that adoption of innovation or in this case SBTs by a smaller, critical mass leads the others to follow rapidly, where SBTi aims to target at least 20% of companies within a given sector or industry (SBTi Progress Report, 2020) to mainstream SBTs.

Taking this into consideration, Bjørn et al. (2022b), Giesekam et al. (2021) and the SBTi Report (2020) warn about current emission accounting practices, governance and a lack of reporting quality that prevents outsiders to take in the full picture and progress that companies make. Bjørn et al. (2021) then criticise the initiative for the inability to understand which of the different target setting methods is used to arrive at the SBTs and how they affect global allowable emissions differently. Several papers expand on this in depth for different countries (Schweitzer et al., 2023) and methodologies (Hadziosmanovic et al., 2022), finding an overshoot of emission budget with sensitivity depending on calculation method. This is critical since it might lead to wrong emission reporting by companies, especially concerning scope 3 emissions, and could result in insufficient climate action. Manuel (2021) also criticises that SBTi should tailor their approach substantially since many of their targets imply global emission goals while the initiative consists mostly of industrialized nations that are required to reduce GHG emissions even faster. Bjørn et al. (2022a) further question the integrity of the initiative by criticizing the use of renewable energy certificates that are used to report emission reductions and show that this leads to an inflated estimate of the effectiveness of mitigation efforts.

2.3 Companies Committing To SBTs And The SBTi

To be able to fully analyse if companies are changing their ESG-behaviour after becoming part of the Science Based Target initiative, one first needs to understand which companies are committing to SBTs and what drives them to do so. This will also help later when I match SBTi firms to similar non-committing companies. Freiberg (2021) finds a significant number of companies in Japan, the UK and US setting SBTs, that especially operate in the industrial, information technology and financial sector. Generally, these firms are often larger, more visible, located in higher-income countries and are more likely to be part of the MSCI global index (Bjørn et al., 2022b & Bolton & Kacperczyk, 2022). Drivers for companies to commit to SBTs can then be grouped into four different categories: legitimization of targets, risk mitigation, external pressures and internal organizational structure prior to commitment.

Due to greenwashing concerns ambitious targets without external validation might not be believable to stakeholders, who have recently shown increasing interest in sustainability (Eccles& Klimenko, 2019). This is why assessment through SBTi can believably signal commitment and retribute greenwashing concerns. Signalling and legitimization is mentioned in several streams of literature including Van Hilten (2022) and Bjørn et al. (2022b) and has shown to be an important driver when trying to navigate the delicate topic of sustainability. Interviews by Piper & Longhurst (2021) of sustainability company leaders on their carbon management also mention credibility and standardization across companies as main drivers to set SBTs.

The findings that SBTs are often set by firms with more volatile stock returns (Bolton & Kacperczyk, 2022) and higher perceived business risk due to climate change (Freiberg et al., 2021) then go hand in hand with Bjørn et al. (2022b) inferring substantive and symbolic motives for commitment since they find companies wanted to mitigate reputational risks through commitments. This would introduce the concept of “financial self-serving characteristic[s]” (Van Hilten, 2022, p.19) as a new driver, which refers to having lower expected costs and higher expected benefits through SBTi. Piper & Longhurst (2021) underline the notion that a firm’s target setting ambition mostly stems from economic incentives instead of actual climate concerns.

The concepts of legitimization and potential reputational losses as drivers for SBTi participation are further expanded by Van Hilten (2022) through the concept of overall organizational culture. Since leadership is especially important in sustainability decision-making (Linnenluecke & Griffiths, 2010; Zammuto, 2000), the board and CEO are crucial in determining if the company joins SBTi. Bolton & Kacperczyk (2022) find that a high fraction of female, nonexecutive and independent board members increases the probability of commitment to the initiative, while larger boards, higher tenure of board members and existence of more anti-takeover devices have the opposite effect. General company culture and previous efforts towards sustainability such as being part of the CDP (Bolton & Kacperczyk, 2022) and an existing sustainability committee (Van Hilten, 2022) positively influence SBTi membership. Prior to adoption, Giesekam et al. (2021) also record already high CDP scores, which identify leading companies on environmental action and transparency. Freiberg et al. (2021) then find that SBTi companies often already have experience with ambitious targets, the reputation to complete past targets and manage risks successfully.

Van Hilten (2022) especially stresses pressure of stakeholders such as competitors, investors, or governments to achieve market success through successful sustainability management as a determinant for participation. National and peer effects are studied in Bolton & Kacperczyk (2022), who conclude that commitments are taken more seriously in Europe since higher emissions do not deter companies from committing here. The paper also identifies existing industry pressures meaning that companies in industries with a greater fraction of committed firms were more likely to commit in the next year. Other external factors like greater analyst coverage, lower amount of institutional ownership, higher ownership concentration and previous positive media coverage positively influence SBTi commitments. The latter driver supports the view that the SBTi appeals to "truly good firms" (Bolton & Kacperczyk, 2022, p. 19) attracting positive media attention prior. Concerning governmental pressures their analysis finds intended national commitments to increase company's science-based target setting, while once intentions become national commitments it is not significantly influenced. This could be due to the perceived urgency for the company to take things into their own hands being lower after NDCs. This missing connection between SBTs and NDCs is also discussed in Giesekam et al. (2018), who look at the construction sector in the UK.

Besides these four drivers for commitment, it is also important to take a closer look at a company's emissions since Comello et al. (2021) show goal setting can be based on their carbon footprint and whether they are able to offset them. SBTi companies more often than not already disclose emissions prior to commitment with possibility of participation in SBTI increasing if their scope one emissions rise (Bolton & Kacperczyk., 2022). This was underlined by Freiberg et al. (2021) who see emissions to sales ratio driving adoption and hence a higher likelihood of firms with carbon-intensive operations becoming part of the initiative. The latter effect was reversed in Bolton & Kacperczyk's (2022) analysis when adding industry or firm fixed effects, so, within a given industry it is the firms with lower emissions that are more likely to make commitments. High levels of scope 2 & 3 emissions then negatively affect a company's willingness to commit, leading Bjørn et al. (2022b) to conclude SBTi commitments being more likely if a firm has lower absolute levels of emissions. This would mean that only the best-in-class companies within an industry are willing to commit while ideally the highest emitters are the ones being targeted.

2.4 Observed Behavioural Change After Adopting SBTi So Far

Literature such as Lui et al. (2021) has shown promising results of the effect ICIs have on corporate climate action. By taking 17 initiatives into consideration (including the SBTi) the authors conclude that these ICIs could successfully lower global emission levels in line with a pathway that will limit global warming to 2°C by 2030 if initiatives meet their goals. While collaboration will be a crucial step in this process, here I will solely focus on the SBTi and its effects on corporate behaviour. Overall, literature finds mixed results with Bjørn et al. (2022b) suggesting increased climate action after adopting science-based targets while others disagree (Coen et al., 2022).

Firstly, behavioural change is examined through the development of corporate GHG emissions. Bolton & Kacperczyk (2022) find that SBTi commitments lead to decreased scope 1 emissions with the internal target setting method of the CDP having less influence on reductions than the externally validated ones of the SBTi, which can be explained through their stricter assessment process. The amount of reduction also depends on the method used to measure emissions. For emission intensity Bolton & Kacperczyk (2022) see a steeper decline compared to absolute emission, solidifying that this might be a less difficult target to achieve, whereas the SBTi Progress Report (2020) did not find significant difference here. Largest emission reductions are found for firms with lower emissions to begin with, suggesting that SBTi is mostly addressing already best-in-class companies, while the goals set by high emitters seem to have less bite. All together Bolton & Kacperczyk (2022) find reduction effects decrease in amount and significance when looking at emissions one year versus three years after commitment. This could be due to companies already taking significant action prior to target approval (SBTi Progress Report, 2020) which materializes in the first year after commitment. Pressure on reduction efforts then decrease as targets have been approved and less actions are taken. Scope 2 and 3 emissions are less evaluated in academia but for example Rauramaa (2022) finds scope 3 emissions after SBTi commitment to be reduced at a slower rate than the other two. Just like Bolton & Kacperczyk (2022) he sees positive development towards emission reduction compared to the average company in Europe with most overachievers being located in the utility sector. The SBTi Progress Report (2020) states SBTi companies have collectively reduced emissions by 25% over the timespan from 2015 – 2019. While research of Maia & Garcia (2023) did also find emission reduction, the authors warn of a causal relationship between the SBTi and emissions as reductions could simply stem from regulatory pressures.

Secondly, literature looks at target-setting and if commitment leads to changes on this front. An analysis of CDP targets by Bolton & Kacperczyk (2022) shows a general increase of global targets from the average scope 1 target in 2011 being 18.5% to 30.5% in 2019 reflecting the increased urgency of combating global warming. Lower percentages were more common in energy-intensive sectors (Manuel, 2021). Even though one can observe a rise in difficulty, target horizons increased significantly from 5 to 11 years (Bolton & Kacperczyk, 2022), suggesting a trade-off between ambition and horizon that would negatively affect progress on CO_2 reduction compared to more near-term targets. Focusing back on the SBTi, Freiberg et al. (2021) find several effects on target difficulty and investments after a firm commits. An increase of complexity is perceived, which would disprove previous concerns of "cheap talk" and companies simply relabelling existing objectives. Targets are then not only set to add legitimacy but result in real ambition and resolve previous uncertainties of firms on optimal targets. Relative to firms not adopting SBTs, targets rise 21 - 25% in magnitude, depending on target coverage, making them more challenging. This is accompanied by higher investments in projects reducing existing carbon emission that then lead to emissions and monetary savings. Further analysis on firms with similarly ambitious reduction targets by Freiberg et al. (2021) reveal the SBTi to be a driver of these investments, probably due to the increased external pressure and accountability that comes along with the initiative. The paper suggests increased expenditures on climate change initiatives by 60-64%, CO_2-savings of 17-19% and annual monetary savings of 22-33% post adoption. For similar non-SBTi companies no increased carbon-reduction investments and carbon or monetary savings from projects are recorded. Bjørn et al. (2022b) point out SBT commitments being less substantive compared to approved ones, which is supported by Manuel (2021) with emissions actually increasing for firms that only committed and were not approved. However, the small sample size of 27 companies in the latter study may deter from generalizing this finding. Besides this, an analysis by Coen et al. (2022) specially compared "climate talk" to "climate walk" and finds the latter to be lacking with SBTi commitments simply concealing poor environmental performance.

If one looks at other effects commitments could have on firms, Kacperczyk & Peydró (2021) find that banks committing to SBTi relative to ones without commitments tend to restrict credit provision to firms with high scope 1 emissions, which shows increased awareness of sustainability of committers. On the other hand, Tuhkanen & Vulturius (2022) find and Bjørn et al. (2022b) criticize that SBTi firms issuing green bonds not sufficiently link reporting and capital raised through the bond to emission reduction, showing less awareness. Freiberg et al. (2021) mention possible increased collaboration across several functions such as finance and sustainability departments as an outcome of SBTi adoption. Larger excess returns post SBTi adoption are found by Dahlström et al. (2023) especially in CO_2 intensive industries. Commitment to SBTs in general (not only through SBTi) will positively affect carbon management reputation (Kuo & Chang, 2021) showing that adoption can be used as a legitimate tool to increase credibility. This could not only be due to commitment but also stem from spillover effects since adoption will probably affect other types of corporate climate action, too.

2.5 Are Companies Setting SBTs On Track?

A general study done by Giesekam et al. (2021) showed that just under half of firms were failing at least one of their emission goals. The paper records companies being on track with 44% of targets, behind with 35%, and 21% of targets (most of them short-term) were already achieved. Data analysis done by the SBTi (SBTi Progress Report, 2020) suggests slightly different numbers with 49% on track, 42% behind and 9% already achieved, which is due to different sample sizes and time frames (Bjørn et al., 2022b). Alignment of corporate action with targets is highly dependent on target scopes (Giesekam et al., 2021) since most companies are on track with scope 1 and 2 goals while falling behind on scope 3. This could result from lower control a company has over their scope 3 emissions. The positive progress for the first two scopes was underlined by the SBTi Progress Report in 2020 that states these were on average reduced by 6.4% linearly per year for companies with approved targets. With global emissions needing to be reduced by 4.2% annually in order to limit global warming to 1.5°, the SBTi exceeds this target. Other sources such as Rauramaa (2022) disagree with this as they only found alignment with a 2.5°C reduction. The high variance could be due to Rauramaas restricted dataset since this only included European companies and timeframes may differ. In total 23% of companies were behind on all of their targets (Giesekam et al., 2021) with the comparatively small number indicating that most companies don't just resume actions after submission.

2.6 Hypothesis Development

The aim of this paper is to address the question: *How does corporate ESG-behaviour change when companies become part of the SBTi relative to firms not committing to the initiative?*. For this I first examine the development of emissions over time to examine if claims of Lui et al. (2021) are correct in assuming GHG emission might decrease after becoming part of corporate initiatives. As part of the SBTi process, businesses need to evaluate current emissions which will lead them to fully understand sources of their emissions along the value chain. This will reveal overlooked opportunities concerning for example efficient use of GHGs inciting more targeted action and subsequently reducing emissions. Understanding could also uncover previously ignored climate-risks that will incite action especially since risk mitigation was recorded as one of the SBTi commitment drivers (Van Hilten, 2022). Furthermore, guidance of the initiative throughout target development might help companies to create GHG management strategies to implement actions. The high standards of the SBTi will then increase clarity and measurability of goals aiding in achievement. If a firm sets SBTs this requires management and CEOs to direct focus towards sustainability, making emission reductions a vital part of the decision-making processes. This is underlined by the fact that concerning sustainability, literature as Linnenluecke & Griffiths (2010) and Zammuto (2000) showed leadership being the driver of change. Additionally, since being part of the SBTi consists of target disclosure on their website it will make it easier for stakeholders to hold a firm accountable, especially with recent ESG-sensibility (Eccles & Klimenko, 2019). It also facilitates benchmarking against peers which Bolton & Kacperczyk (2022) found to be affecting company behaviour. If targets are not met or underperform compared to competitors, it could lead to reputational damages that will have far reaching impacts such as a decrease in sales or difficulties in attracting and retaining customers and employees. Disapproval of investors could lead to boycotts significantly impacting stock price and consequently also enterprise value. Firms would be affected financially as well if other businesses do not want to collaborate, banks refrain from providing access to capital as stated in Kacperczyk & Peydró (2022) or regulatory fees increase. These consequences will want to be avoided by taking necessary action such as the investments recorded by Freiberg et al. (2021) towards emission goals. This could lead one to hypothesize lower emissions post SBTi adoption as seen in Bolton & Kacperczyk (2022). On the other hand, commitment could be used as a greenwashing tool as Giesekam et al. (2021) showed many firms being behind target and Coen (2022) found the initiative to mask inadequate environmental performance. The approval of the SBTi could then give firms a sense of security leading them to even increase emissions as seen in the analysis by Manuel (2021). Temporarily the approval process could also put a financial strain on companies, leading firms to not be able to commit proper resources to emission reduction in the short-term. Taking these points and previous literature into account the first hypothesis is as follows:

H1: Relative to non-SBTi firms, companies that are part of the SBTi will have a significant change of emissions post commitment.

I will apply the hypothesis to all three emission scopes since there is evidence for this effect in literature before.

Secondly, I examine how ESG-behaviour changes after commitment through ESG-Scores. As mentioned before, SBTi adoption will bring sustainability to the forefront of manager’s minds and actions. This could increase scores, especially since literature found ESG-Scores to be linked to managerial belief (Clementino & Perkins, 2021). The higher numbers of female and independent board members in SBTi firms (Bolton & Kacperczyk, 2022) then additionally are found to positively affect ESG disclosure and hence scores (Gurol et al, 2022). Moreover, employee, shareholder and supplier engagement could improve significantly since commitment would align values for company and stakeholders, creating more loyal and committed relationships and therefore addressing the social factor of ESG-Scores. Achieved emission reductions as hypothesized above will then improve their ESG rating on the environmental side. The previous reasoning for reducing emissions can then also apply to general increased efforts towards climate action as in Lui et al. (2021), improving not only the E but also S factor in the score since communities are influenced by their environment and ecosystems. Adopting SBTs through the initiative will also increase transparency due to the set rules of the SBTi, which in turn would positively affect a company's governance. This is underlined by literature like Santamaria et al. (2022) as they find transparent disclosure practices positively affecting ESG-Scores. As seen in the literature review many companies also use SBTi as a signalling tool to communicate commitment (Van Hilten, 2022; Bjørn et al., 2022b), stating that actions will be taken to achieve necessary goals through for example increased target difficulty as in Freiberg et al. (2021). Strengthening commitment and the increased carbon management reputation that comes with setting SBTs (Kuo & Chang, 2021) then affects ESG-Scores as they measure a company's management regarding future climate risks. Again, one could also argue for the opposing side with firms using SBTi as a marketing tool (Chrobak, 2021) by setting goals they don't aim to achieve (Crilly, 2012). Approval could only bind resources that can then not be used to support material ESG-issues, supporting views of Trexler & Schendler (2015) of the initiative being a distraction. Additionally, stricter guidelines concerning ESG-disclosure through the SBTi process could uncover previous inefficiencies that are only recorded afterwards and would lead to a decrease in scores. For this reason, the second hypothesis is formulated:

H2: Relative to non-SBTi firms, companies that are part of the SBTi will display a significant change in ESG-Scores post commitment.

With the increased focus on sustainability after adoption, firms will have to implement new technologies and practices to be able to achieve their new science-based targets. Simply stopping previous activities that are counteractive to the environment and the set targets is not always a possibility so environmental innovation is needed to increase effectivity. This could entail investing in renewable energy, energy efficient equipment or general emission-reduction projects as in Freiberg et al. (2021), which would increase the Environmental Innovation Score. Another point is that the SBTi fosters collaboration between adopters, but also internally with suppliers or customers. This effect can also be found in the analysis of Freiberg et al. (2021). Literature has shown that discourse between stakeholders and knowledge sharing will increase innovation and the development of novel solutions (Trevor, 1991), contributing positively to the score. But since the innovation process is very time and resource intensive, it could also be negatively affected by money being used on SBTi fees instead of innovation.

The SBTi does not specifically foster environmental innovation as such, and commitment could lead to other emission reducing activities than innovation. In summary the hypothesis reads:

H3: Relative to non-SBTi firms, companies that are part of the SBTi will display a significant change in Environmental Innovation Scores post commitment.

3 Data and Methodology

3.1 Data Collection

The data I am investigating includes panel data of all companies that provide data on ESG-Scores from 2013-2021 on the financial data and analytics platform Refinitiv Eikon. Since the SBTi was launched in 2014, and consequently 2015 constitutes the first year that companies were able to join, looking back two years seems a good timeframe to assess performance prior to commitment. Most data do not cover scores or emissions from 2022, so I stick to data until 2021. The reason I take ESG-Score data and not emissions data into account first is that many companies only started to report emissions data recently, while more companies on Refinitiv have ESG-Score data available, effectively expanding our dataset. The companies disclosing consistent ESG-Score data for the mentioned timeframe are 3141 companies on Refinitiv. This is the base-dataset which mostly consists of Asian and North American firms in the consumer as well as the energy, resources & industrials industry as displayed in Figure 2.

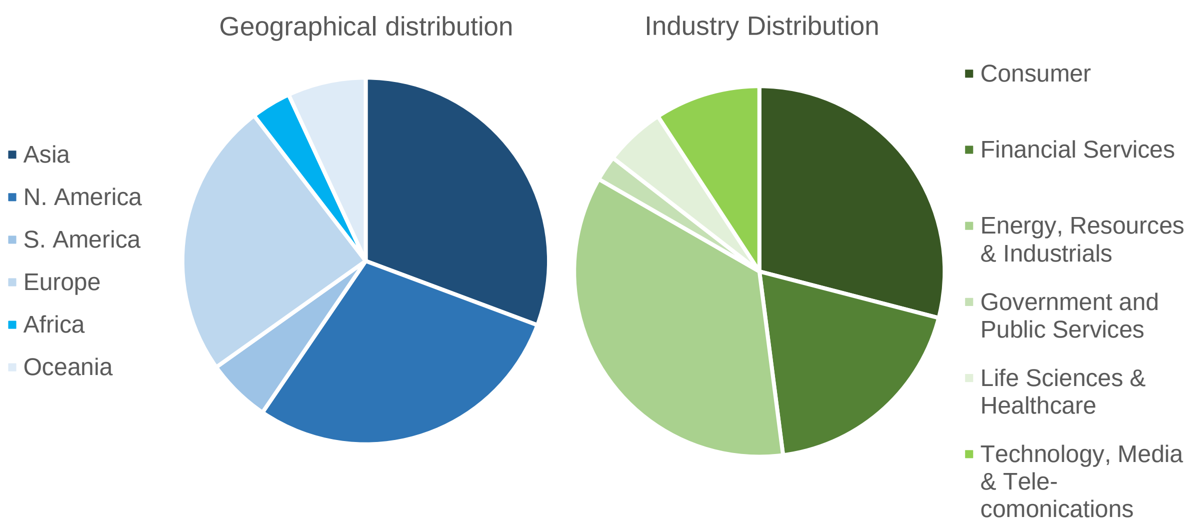

Figure 2: Geographical and industry distribution for all companies in the base-dataset.

I also add data concerning firm size by extracting Total Assets data in million US dollar for the nine respective years from FactSet. I then collect 2013-2021 scores for just the E-Pillar and for the Environmental Innovation to better understand the results on hypothesis two and address hypothesis three which slightly decreases the dataset.

Score range	Grade	Description
0.0 <= score <= 0.083333	D -	'D' score indicates poor relative ESG performance and insufficient degree of transparency in reporting material ESG data publicly.
0.083333 < score <= 0.166666	D	
0.166666 < score <= 0.250000	D +	
0.250000 < score <= 0.333333	C -	'C' score indicates satisfactory relative ESG performance and moderate degree of transparency in reporting material ESG data publicly.
0.333333 < score <= 0.416666	C	
0.416666 < score <= 0.500000	C +	
0.500000 < score <= 0.583333	B -	'B' score indicates good relative ESG performance and above-average degree of transparency in reporting material ESG data publicly.
0.583333 < score <= 0.666666	B	
0.666666 < score <= 0.750000	B +	
0.750000 < score <= 0.833333	A -	'A' score indicates excellent relative ESG performance and high degree of transparency in reporting material ESG data publicly.
0.833333 < score <= 0.916666	A	
0.916666 < score <= 1	A +	

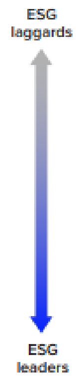

Figure 3: Descriptive table of Refinitiv ESG-Scores. For the data used in this analysis one has to multiply the scores by 100 (Refinitiv, 2022).

For considering our first hypothesis on emissions the dataset contains 1447 firms. I am interested in the CO_2 Equivalent Emissions Total data given in Refinitiv, so consolidated scope 1-3 emissions in tonnes, that include carbon dioxide, methane, and nitrous oxide among others. In this research I want to measure their development after SBTi adoption compared to non-committers. I gather data on scope 1 and 2 until 2013 as well which is available for around a thousand companies, suggesting that most firms disclose only consolidated emissions and less on the separate scopes. As described in the previous chapters, scope 3 emissions are even less reported, with the insufficient dataset making it impossible to analyse scope 3 emissions separately and drawing reasonable conclusions. For this reason, I will exclusively focus on the first two scopes.

In the analysis I want to find differences in behaviour pre and post adoption, so from the companies in the above dataset I identify which firms are part of the SBTi, as seen on their website (SBTi, 2023b, May 24). This will give a sample of SBTi adopters and firms that have not adopted SBTs for comparison. The initiative also provides information from 2015 - 2023 about a company's net zero, near term and long-term targets including their approved degree of temperature alignment or if they simply committed. The dataset consists of 4763 companies in total that committed, with 2430 having approved targets. Due to a lack of data concerning ISINs for about half of the firms on the SBTi website as of 10.05.23, this could influence the identified SBTi firms. Nevertheless, I identify 962 SBTi companies in the base-dataset. For these companies the year of SBTi adoption and data on whether the firm approved or only committed their targets is used.

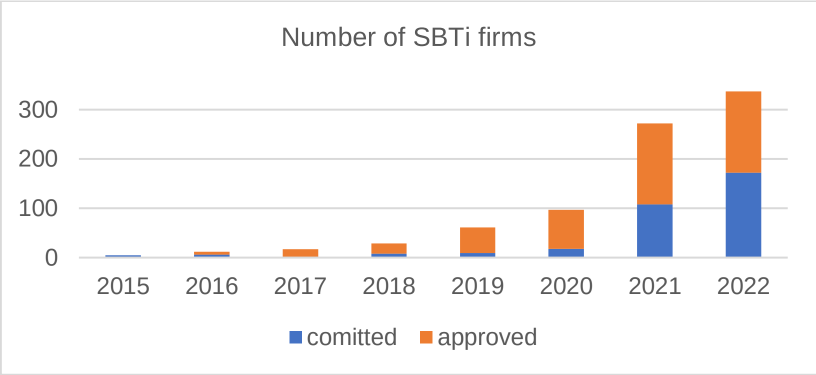

Figure 2: Year of SBTi adoption for all companies in the base-dataset.

The previous dataset possibly would not be able to fully represent companies similar to the SBTi firms, while a control group that is as comparable as possible ex ante is necessary to find deviations in behaviour between the two groups. For example, an airline might have more difficulties in reducing emissions, since these are core to their business, than e. g. a bank would have, and firm size might drive the change in ESG-behaviour due to different amounts of resources. This is also grounded in the literature review since industry does affect emissions reductions and often larger firms commit to the initiative (Bolton & Kacperczyk, 2022) with size impacting environmental performance (Younis & Sundarakani, 2020). For this reason, I match each of the SBTi companies in the base-dataset with a non-SBTi company, taking into consideration the data on GIC industry names and market capitalization with the matching approach following the methodology performed by Flammer (2021). For the matching I first find for each of the 962 SBTi firms all firms in the base-dataset that are in the same industry but did not commit to the SBTi. In the second step I compare the market capitalization of the SBTi company to the non-SBTi ones in the same industry with the final matched company being the firm closest to in market cap. The matching with consistent ESG-data contains 535 SBTi and their respective match of 535 non-SBTi companies, a total dataset of 1070. As several SBTi firms were matched to the same non-SBTi firm and I want to avoid duplicates to not bias the analysis not all 962 firms found a match. This total matched dataset then decreases for the E-Pillar, Environmental Innovation Score and the emissions with the smallest sample for the two respective scopes containing around 200 firms.

3.2 Methodology

To be able to fully grasp change in behaviour post SBTi adoption I construct two groups, as described in the data chapter: a treated group that becomes part of the initiative during the timeframe from 2013-2021 and a control group that does not. Implementing a two-way firm fixed effects research design will compare a firm's behaviour before and after setting SBTi targets with the control group that did not receive treatment or in this case did not become part of the initiative. Freiberg et al. (2021) conducted a similar analysis when looking at development of target difficulty for SBTi firms, Flammer (2021) when studying firm outcomes after green bond issuance, and Bolton & Kacperczyk (2022) performed pooled regressions when looking at emissions and the SBTi. This paper will incorporate different parts of their methodologies with all regressions being performed with Stata.

Firstly, I want to address hypothesis one on how commitments drive overall emission reduction through a firm fixed effects regression. Following the firm-fixed effect model in Allison (2009) and Bolton & Kacperczyk (2022), the total CO_2 emissions, $Emis_{i,t}$, are regressed on a dummy variable $SBTI_{i,t}$ that takes the value of one in the year a company *i* commits to the SBTi and every following year. The latter variable is 0 if a firm is never part of the initiative or we look at a firm in years prior to adoption. I control for size with Total Assets since literature such as Nasih et al. (2019) and Younis & Sundarakani (2020) has found that size impacts environmental performance (such as emissions) and disclosure. Several variables could be used as a proxy for size but referring to Dang et al. (2018) Total Assets are taken. Same as in Bolton & Kacperczyk (2022) the logarithm is applied to the size indicator. The time variable *t* corresponds to the timeframe of 2013 until 2021. For the first emission dataset *i* corresponds to companies 1 until 1447. The formulated equation is as follows:

$$Emis_{i,t} = \alpha_i + \beta_1 * SBTI_{i,t} + \mu_t + log\ (TotalAssets)_{i,t} + \varepsilon_{i,t}\ . \quad (1)$$

With…

$Emis_{i,t}$= Total emissions of company *i* at time *t.*

α_i = fixed effects for each individual firm

$SBTI_{i,t}$= a dummy variable assigned 1 as soon a firm *i* becomes part of the SBTi, so it has committed/approved SBTs, at time *t* and onwards and 0 if not.

μ_t = controls for time effects

$log\ (\text{TotalAssets})_{\text{i,t}}$ = controls for size with Total Assets of company *i* at time *t.*

$\varepsilon_{i,t}$= the error term

This model is then expanded through explanatory variables that might give clarification on differences between SBTi commitments and approved targets and their effect on emission reduction as Bjørn et al. (2022b) claimed the first to be less substantive. One can observe through the variable of interest $\beta_{1,t}$ if a firm that is part of the SBTi and has approved SBTi targets ($SBTIA_{i,t}$ = 1) does have higher emissions reductions compared to non-SBTi and non-approved SBTi firms. This consists of including an explanatory variable as follows:

$$Emis_{i,t} = \alpha_i + \beta_1 * SBTIA_{i,t} + \mu_t + log\ (\text{TotalAssets})_{\text{i,t}} + \varepsilon_{i,t}.$$

With same variables as in equation (1) and… *(2)*

$SBTIA_{i,t}$= a dummy assigned 1 as soon as a company *i* got a near-term, long-term or net-zero target approved in year *t*, and 0 in years it has only committed SBTs or is not part of the SBTi at all.

A similar analysis as in equation (1) and (2) can also be conducted for not only total emissions but scope 1 and 2 separately, replacing $Emis_{i,t}$ as dependent variable.

To address the second hypothesis on the development of ESG-Scores post SBTi commitment, I consider ESG-Score given in Refinitiv. Higher numbers translate to an overall better performance on ESG-metrics with 100 being the maximum score. Similarly as above, now ESG-Scores instead of emissions are regressed on the dummy variable measuring commitment to SBTi:

$$ESG_{i,t} = \alpha_i + \beta_1 * SBTI_{i,t} + \mu_t + log\ (TotalAssets)_{i,t} + \varepsilon_{i,t}.$$

With same variables as in equation (1) and… *(3)*

$ESG_{i,t}$ = ESG-Score of company *i* at time *t*

Then same analyses as in equation (2) on SBTi commitment versus approval will be performed with $EmisC_{i,t}$ being replaced by $ESG_{i,t}$ to test differences between commitment and adoption.

Since SBTi adoption would mostly affect the environmental pillar of the ESG-Score the same regression as in (1) and (2) is performed now with isolating the environmental score of the ESG rating. This will lead to a better understanding if and how the social and governance pillar influences the previous results. The same is then also done to test for hypothesis three, the environment innovation:

$$EnvIn_{i,t} = \alpha_i + \beta_1 * SBTI_{i,t} + \mu_t + log\ (TotalAssets)_{i,t} + \varepsilon_{i,t}.$$

With same variables as in equation (1) and… *(4)*

$EnvIn_{i,t}$ = Environmental Innovation Score of company *i* at time *t*

As stated in the above model and in Bolton & Kacperczyk (2022) I do include time and firm fixed effects in all regressions with the latter removing any time constant effects. This controls for omitted variable bias due to possibly unobserved and constant heterogeneity over time with the model assuming individual-specific effects being correlated with the independent variables. For each regression a Breusch Godfrey and Breusch Pagan test is performed to test for autocorrelation and heteroscedasticity, as this would otherwise lead to incorrect standard errors. Since I do find evidence for both in all my samples, I cluster standard errors at the firm level. The latter is done to account for the within-firm correlation of the SBTi firms and the ESG or emissions data respectively since company culture, but also other external factors such as regulations could affect firm ESG-Scores and emissions from within. After a Hausmann test as an additional robustness check I did run regressions for environmental innovation and emissions with random instead of fixed effects but since results did not yield any significantly different outcomes these results are omitted in this paper. Instead, the validity of outcomes is underlined with the following matching.

In our sample the control group consists of very general data which could possibly affect findings. Consequently, the analysis is subjected to a robustness check by reducing the dataset through performing a company matching as described in the data section. The goal is to build a plausible counterfactual of how the variables of interest, including emissions, ESG-Scores and Environmental Innovation would have evolved in absence of SBTi commitment. For the matched dataset the control variable for size is dropped since it is already taken into consideration in the matching. Otherwise, all same regressions for the different dependent variables are performed.

4 Results And Implications

4. 1 Results

I obtain results concerning emissions, ESG-Scores and Environmental Innovation that can be found in Tables 2 until 7 to answer the hypotheses stated in section 2.6. A summary and basic statistics of the variables and control variables used in my regressions can be found in Table 1. One can observe that while the mean ESG, E and Environmental Innovation Score rises for the matched dataset, the mean emissions (regardless of scope) do also increase. Standard deviation, minimum and maximum values stay around the same magnitude in both datasets with one slight difference being the higher standard deviations for the matched dataset in the *Emis* and *EmisOne* variables and lower standard deviation in *EmisTwo*.

Table 1: Summary

The sample spans from 2013 until 2021. *SBTI* is one as soon as a firm becomes part of the SBTi, zero otherwise. *SBTIA* is one as soon as a firm has approved targets by the SBTi, zero otherwise. *ESG* is the ESG-Score, *EnvPillar* the E-Pillar of the ESG-Score and *EnvIn* the Environmental Innovation Score, all three ranging from 0-100. *Emis* are total CO_2 equivalent emissions in tonnes, *EmisOne* equals scope one emissions and *EmisTwo* scope two emissions. *TotalAssets* are a firm's total assets in millions of US$.

Base dataset

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Observ.**	**firms**
SBTI	0.033	0.177	0	1	28,269	3,141
SBTIA	0.023	0.150	0	1	28,269	3,141
ESG	52.0	20.781	0.686	95.992	28,269	3,141
EnvPillar	53.155	25.126	0.786	99.094	24,057	2,673
EnvIn	56.818	25.409	0.427	99.888	12,987	1443
Emis	3,989,124.0	1.31e+07	1	2.32e+08	13,023	1447
EmisOne	3,298,585.0	1.23e+07	0.014	1.80e+08	9,621	1069
EmisTwo	677,455.4	2,611,985	1	1.75e+08	9,549	1061
TotalAssets	35,460.25	2,327,387	-3.9e+08	5,098,789.0	28,269	3,141

Matched dataset

Variable	Mean	Std. Dev.	Min	Max	Observ.	firms
SBTI	0.057	0.232	0	1	9,630	1,070
SBTIA	0.036	0.186	0	1	9,630	1,070
ESG	56.928	19.328	1.359	95.495	9,630	1,070
EnvPillar	57.879	24.166	0.079	99.094	7,776	864
EnvIn	60.213	26.034	1.293	99.798	3,546	394
Emis	4,906,807.0	1.76e+07	131.1	1.95e+08	2,862	318
EmisOne	4,311,367.0	1.82e+07	4	1.80e+08	1,620	180
EmisTwo	821,668.7	1,955,896.0	19.95	2.10e+07	1,656	184

Firstly, I address my hypothesis number one on whether emissions are influenced by SBTi commitment. With total company emissions as dependent variable the coefficient on the *SBTI* variables is negative but insignificant after adding time effects, same applies to the *SBTIA* variable. For the matched dataset the decrease in emissions gets steeper but still stays insignificant, disproving my hypothesis. One can observe a time trend with emissions overall gradually decreasing in the years 2018-2021 compared to 2013 with varying significance levels. This means that for example for all companies in the dataset in 2018 emissions are lower by around 272,000 tonnes or in 2021 by 743,000 against the base year. Compared to the average emissions in 2013 of approximately 4,204,000 the time effects in 2021 alone would reduce emissions to 3,460,000 tonnes translating to a reduction of nearly 18% in the last eight years. With many firms such as Coca Cola aiming to reduce emissions by 25% or Walmart by 65% until 2030 compared to a base year of 2015 (CocaCola, 2023; Walmart, 2023) these results show a general move in the right direction of significant magnitude. Similar time effects or even a slightly steeper decrease can be found for the regression with the approved SBTi firms. In the matched dataset only the reduction in 2020 and 2021 is still significant. The positive effect of company size on emissions is demonstrated by the fact that an increase of Total Assets by one percent would increase emissions significantly by 9,673 units. For the sample average this would increase emissions to around 3,999,000 tonnes or by 2.4%, implying that bigger firms do emit more. The R^2 for the base dataset is of reasonable size and comparable to ones in Bolton & Kacperczyk (2022). It does get very low for the matched dataset meaning that the dependent variable is not very well predicted by the independent variables here.[2]

[2] A similar analysis to Table 2 was performed considering emission intensity (emissions/sales ratio) for 2013-2021 to address claims of Aswani et al. (2021) suggesting that emission intensity is the more suitable metric when assessing carbon performance. This would reveal if firms might only focus on achieving emission intensity instead of emission level targets with the latter often being perceived as less substantive (Bolton & Kacperczyk., 2022). Since the analysis with emission intensity as dependent variable found insignificant coefficients for SBTi adoption and did not yield different results, it is omitted here.

Table 2: Total Emissions

The dependent variable is the total CO_2 equivalent emissions in tonnes. The first four columns report regressions for the base-dataset, the last four regressions for the smaller matched dataset. The year coefficient describes the change compared to 2013. All regressions include firm fixed effects and clustered standard errors at the firm level. The robust standard errors are reported in parenthesis. ***1% significance, **5% significance, *10% significance.

	Base-dataset				Matched dataset			
Variable	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat
SBTI	-43905.5	-0.16			-701168.9	-0.76		
	(268301.5)				(926635.1)			
SBTIA			-32108.8	-0.11			-889645.4	-0.69
			(305681.2)				(1289789)	
year								
2014	43113.2	0.96	43115.1	0.96	-2811.8	-0.03	-2811.8	-0.03
	(44846.0)		(44848.1)		(81405.9)		(81405.9)	
2015	-34282.0	-0.41	-34431.6	-0.41	98356.34	0.39	98356.3	0.39
	(83406.3)		(83295.2)		(252463.7)		(252463.7)	
2016	-140592.5	-1.27	-140981.1	-1.28	-10872.4	-0.05	-14689.6	-0.07
	(110712.9)		(110330.2)		(219021.5)		(219452.5)	
2017	-158168.5	-1.27	-158695.6	-1.28	-61568.1	-0.25	-64199.9	-0.26
	(124297.9)		(123763.8)		(249642.3)		(250216.8)	
2018	-272369.0*	-1.75	-273193.7*	-1.77	-135630.9	-0.51	-138689.5	-0.52
	(155407.8)		(154175.1)		(264156.5)		(264444.1)	
2019	-391144.2**	-2.16	-392488.7**	-2.20	-351834.4	-1.08	-356766.3	-1.10
	(180829.3)		(178550.5)		(324381.3)		(323497.4)	
2020	-785825.1***	-2.71	-787910.4***	-2.76	-892492.4**	-2.28	-895907.2**	-2.33
	(289979.5)		(285497.5)		(390708.2)		(384991.5)	
2021	-743142.1**	-2.05	-748149.6**	-2.13	-667615.8*	-1.75	-694550.9*	-1.89
	(363389.0)		(285497.5)		(380626.0)		(367278.2)	
log(Total Assets)	967296.0**	2.25	967136.2**	2.25				
	(429398.6)		(429662.6)					
constant	-4898125.0	-1.23	-4896621.0	-1.23	5168742.0***	22.58	5168742.0***	22.57
	(3973094.0)		(3975552.0)		(228939.4)		(228968.9)	
Obsv.	13,023		13,023		2,862		2,862	
firms	1,447		1,447		318		318	
R-sq.	0.0437		0.0436		0.0007		0.0004	

Compared to the Total Emissions, when isolating scope one emissions the coefficients of both datasets for the SBTI and SBTIA now have a positive sign but are still insignificant at any reasonable level. Again, a time trend can be observed when adding time effects, this time significant for the years 2017-2021 and steeper than for the total emissions. For 2021 the scope one emissions for all companies in the dataset declined by around 840,000 tonnes which is significant at the 1% level. This would bring the 2013 average emissions of around 3,574,000 to 2,734,000 tonnes a decrease by 23.5% over the years. For the regression with firms approved by the initiative the decrease is slightly steeper again. The size proxy still affects scope one emissions positively and is of similar, maybe slightly smaller, magnitude compared to combined emissions. A one percent increase leads to a significant increase of 9,191 units in scope one emission. Neither the *SBTI, SBTIA* nor the time variables show any significance in the matched dataset anymore. This dataset has a very low R^2 of 0.0001 but also a very small sample size.

Table 3: Scope One Emissions

The dependent variable is the Scope One Emissions in tonnes. The first four columns report regressions for the base-dataset, the last four regressions for the smaller matched dataset. The year coefficient describes the change compared to the base year of 2013. All regressions include firm fixed effects and clustered standard errors at the firm level. The robust standard errors are reported in parenthesis. ***1% significance, **5% significance, *10% significance.

	Base-dataset				Matched dataset			
Variable	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat
SBTI	43770.8	0.15			669219.6	1.29		
	(291296.5)				(517776.0)			
SBTIA			88868.3	0.25			761466.5	1.58
			(352725.5)				(482531.2)	
year								
2014	-49025.2	-1.12	-49014.1	-1.12	5078.8	0.06	5078.8	0.06
	(43909.1)		(43913.4)		(89867.0)		(89867.0)	
2015	-49567.6	-0.60	-49351.3	-0.60	334452.0	1.00	334452.0	1.00
	(82252.0)		(82236.9)		(333863.5)		(333863.5)	
2016	-164157.8	-1.30	-163935.9	-1.31	156073.0	0.59	159278.4	0.60
	(126099.7)		(125443.9)		(266010.7)		(264737.9)	
2017	-262102.2*	-1.73	-262235.9*	-1.74	33001.9	0.08	35694.8	0.09
	(151769.7)		(151005.7)		(394921.2)		(392850.0)	
2018	-410701.4**	-2.10	-410992.6**	-2.11	-200268.6	-0.37	-194882.7	-0.37
	(195997.9)		(194619.6)		(534607.9)		(529380.0)	
2019	-503392.1**	-2.22	-504688.7**	-2.25	-267428.6	-0.44	-256144.4	-0.43
	(226433.3)		(223971.6)		(612891.2)		(602152.3)	
2020	-832074.9***	-2.95	-835582.4***	-3.01	-893931.0	-1.29	-878285.9	-1.30
	(282028.0)		(277771.8)		(690824.6)		(674271.4)	
2021	-840046.5***	-2.74	-845772.3***	-2.86	-1022764.0	-1.29	-979165.2	-1.31
	(306198.6)		(295784.0)		(792230.4)		(745302.5)	
log(Total Assets)	919076.5**	2.46	918444.2**	2.46				
	(373807.9)		(374039.1)					

constant	-5172294.0	-1.49	-5166277.0	-1.48	4481213.0***	12.73	4481213.0	12.73
	(3479486.0)		(3481658.0)		(352054.9)		(352054.4)	
Obsv.	9,621		9,621		1,620		1,620	
firms	1,069		1,069		180		180	
R-sq.	0.034		0.034		0.0001		0.0002	

SBTI and SBTIA show negative but insignificant signs when regressing them on scope two emissions. This changes to a positive sign for the matched dataset but results are even more insignificant. For the base dataset of scope two emissions the time trend only picks up on a significant decrease in emission for the years 2015 and 2016: In 2015 scope two emissions are lower by around 29,000 tonnes compared to 2013, in 2016 by 53,000. These results are significant at the 10% an 5% level respectively. Using SBTIA as independent variable emissions over time are even a bit lower. Interestingly the positive coefficient on the size proxy variable loses significance for the scope two emission dataset. The matched dataset has a very low R^2 again and doesn't show any significant results.

Table 4: Scope Two Emissions

The dependent variable is the Scope Two Emissions in tonnes. The first four columns report regressions for the base-dataset, the last four regressions for the smaller matched dataset. The year coefficient describes the change compared to the base year of 2013. All regressions include firm fixed effects and clustered standard errors at the firm level. The robust standard errors are reported in parenthesis. ***1% significance, **5% significance, *10% significance.

	Base-dataset				Matched dataset			
Variable	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat
SBTI	-162032.2	-1.21			40203.9	0.36		
	(133861.4)				(112626.9)			
SBTIA			-184459.9	-1.45			15694.4	0.12
			(127047.7)				(136326.4)	
year								
2014	-7025.4	-0.70	-7037.1	-0.70	917.9	0.03	917.9	0.03
	(10030.5)		(10028.9)		(31468.9)		(31468.9)	
2015	-29156.5*	-1.74	-29933.2*	-1.81	16488.6	0.37	16488.6	0.37
	(16763.8)		(16499.8)		(44340.9)		(44340.9)	
2016	-53066.1**	-1.97	-54491.2**	-2.02	-29506.7	-0.56	-29155.0	-0.56
	(26900.1)		(27009.0)		(52286.8)		(51972.9)	
2017	-45545.2	-1.47	-46828.13	-1.53	-49821.0	-0.90	-49336.0	-0.90
	(30972.5)		(30561.3)		(55220.8)		(54830.7)	
2018	-52093.2	-1.09	-54123.8	-1.17	-83381.2	-1.32	-82411.4	-1.33
	(47855.5)		(46191.1)		(62959.2)		(62121.9)	
2019	-50202.9	-0.86	-52552.1	-0.95	-58257.0	-0.63	-56450.6	-0.62
	(58095.4)		(55499.6)		(93180.2)		(91231.5)	
2020	1047.6	0.01	-850.7	-0.01	-123210.9	-1.10	-120035.1	-1.10
	(152596.0)		(148426.9)		(112063.3)		(108892.9)	

2021	82424.8	0.31	75077.1	0.30	-133655.5	-0.95	-125460.0	-0.95
	(265137.8)		(254126.4)		(140858.4)		(131588.6)	
log(Total Assets)	46261.5	0.18	46930.0	0.18				
	(2644257.2)		(264124.5)					
constant	261375.4	0.11	255025.0	0.10	870593.6***	15.12	870593.6***	15.12
	(2481890.0)		(2480629.0)		(57574.5)		(57581.6)	
Obsv.	9,549		9,549		1,656		1,656	
firms	1,061		1,061		184		184	
R-sq.	0.021		0.019		0.0005		0.0007	

Next, I address hypothesis two, which is supported by the following findings. Looking at the results from the pooled regression with ESG-Scores as dependent variable one can see that after adding controls for time effects, commitment to the SBTi actually decreases the ESG-Score significantly by 2.5 points. Still, this is a relatively small number when taking into consideration that the score ranges from 0 to 100. With the whole sample average ESG-Score being 52, this downgrades a firm to 49.5 or in ESG-Score grades from B- to C+. With one step increase in the Refinitiv score grade for example from A to A+ being the same as an increase by 8.33 points (see Figure 2), a score grade rating might not even pick up on this decline in rating. In industry benchmarking or comparative analysis ESG-Scores are also often grouped which could dilute the 2.5 decrease even more when considering an investment. Results are similar for the matched dataset with a decrease of around 2.6. When considering stricter regulations, so firms that not only committed to SBTi targets but were approved by the initiative, ESG-Scores decreased even by around 3.3 for the base and matched dataset. The highest change in score can be observed on the coefficients for the specific years. Overall, compared to the base year of 2013 the ESG-Score for all companies increased gradually and significantly over time and for all observed years. In 2021 the score is higher by around 18.3 points, significant at the 1% level. With the average sample score being 42.9 in 2013 simply the time effects would increase the score to 61.2 for 2021, a material ESG-Score upgrade. Referring to the ESG-Score grades this would lift scores from C+ to a B. In the robustness check with the matched dataset, where differences between SBTi and non-SBTi firms should be seen more clearly due to intentional matching, ESG-Scores in 2021 even increased significantly by 20.3 compared to 2013. One can also as expected observe a positive correlation between firm size and ESG-Score, since an increase of Total Assets by one percent would increase scores by 0.04 units. In other words, if the mean of Total Assets (which is around 35,460) would increase by 25% or to 44,325, a firm would have one point higher ESG-Scores. This relation shows that economically the recorded size effect is of relatively small magnitude. The R^2 on both the unmatched and matched dataset are still of acceptable size.

Table 5: ESG-Scores

The dependent variable is the ESG-Score with the score ranging from 0 to 100. The first four columns report regressions for the base-dataset, the last four regressions for the smaller matched dataset. The year coefficient describes the change compared to the base year of 2013. All regressions include firm fixed effects and clustered standard errors at the firm level. The robust standard errors are reported in parenthesis. ***1% significance, **5% significance, *10% significance.

	Base-dataset				Matched dataset			
Variable	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat
SBTI	-2.496***	-6.11			-2.557***	-4.31		
	(0.408)				(0.593)			
SBTIA			-3.300***	-7.69			-3.385***	-5.33
			(0.429)				(0.635)	
year								
2014	1.624***	12.23	1.624***	12.23	2.248***	9.43	2.248***	9.43
	(0.133)		(0.133)		(0.238)		(0.238)	
2015	4.133***	24.35	4.130***	24.33	5.010***	16.73	4.998***	16.70
	(0.170)		(0.170)		(0.300)		(0.299)	
2016	6.582***	33.51	6.575***	33.47	7.333***	21.35	7.309***	21.27
	(0.196)		(0.196)		(0.343)		(0.344)	
2017	9.033***	39.22	9.030***	39.20	9.909***	25.08	9.891***	25.03
	(0.230)		(0.230)		(0.395)		(0.395)	
2018	10.711***	42.66	10.706***	42.64	12.041***	28.20	12.013***	28.15
	(0.251)		(0.251)		(0.427)		(0.427)	
2019	13.059***	48.95	13.062***	48.93	14.454***	32.57	14.433***	32.53
	(0.267)		(0.267)		(0.444)		(0.444)	
2020	15.528***	54.32	15.537***	54.29	17.189***	36.64	17.165***	36.59
	(0.286)		(0.286)		(0.469)		(0.469)	
2021	18.308***	59.21	18.275***	59.52	20.289***	39.47	20.193***	39.94
	(0.309)		(0.307)		(0.514)		(0.506)	
log(Total Assets)	4.012***	10.50	4.010***	10.50				
	(0.382)		(0.382)					
constant	7.328**	2.16	7.346**	2.16	47.244***	157.15	47.244***	157.09
	(3.394)		3.393		(0.301)		(0.301)	
Observ.	28,268		28,268		9,630		9,630	
firms	3,141		3,141		1,070		1,070	
R-sq.	0.260		0.259		0.097		0.098	

To further specify where exactly changes are stemming from or if the previous decrease after SBTi commitment is due to social or governance issues I also consider the isolated Environmental-Pillar instead of the whole ESG-Score. This regression yields similar results with the E-Score this time dropping significantly by 3.6 points after SBTI commitment and around the same when looking just at approved SBTi firms. This indicates environmental scores being even more negatively affected by SBTi with S- and G-Pillars tipping the consolidated score in a positive direction. For the matched dataset these numbers decline again to around 5 and 4 points. Still these results are in roughly the same range as the ESG-Score in Table 5. Same as the latter, the E-score generally increased over the years with 2021 scores being around 16.5 points higher than 2013 or 19 for the matched dataset. Again, this is slightly worse than the total score but still around the same magnitude. Total Assets positively influence scores again since an increase of by one percent would increase Scores by 0.05.

Table 6: Environmental Pillar Score

The dependent variable is the E-Pillar of the ESG-Score with the score ranging from 0 to 100. The first four columns report regressions for the base-dataset, the last four regressions for the smaller matched dataset. The year coefficient describes the change compared to the base year of 2013. All regressions include firm fixed effects and clustered standard errors at the firm level. The robust standard errors are reported in parenthesis. ***1% significance, **5% significance, *10% significance.

	Base-dataset				Matched dataset			
Variable	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat
SBTI	-3.647***	-6.66			-4.927***	-6.01		
	(0.548)				(0.819)			
SBTIA			-3.714***	-6.24			-4.028***	-4.53
			(0.595)				(0.887)	
year								
2014	1.156***	6.93	1.151***	6.93	1.063***	3.81	1.063***	3.81
	(0.166)		(0.166)		(0.279)		(0.279)	
2015	3.953***	17.19	3.946***	17.16	3.970***	10.07	3.941***	10.00
	(0.230)		(0.230)		(0.394)		(0.394)	
2016	6.887***	25.04	6.872***	25.00	6.551***	13.41	6.484***	13.29
	(0.275)		(0.275)		(0.488)		(0.488)	
2017	6.293***	18.81	6.277***	18.76	7.232***	12.62	7.150***	12.47
	(0.335)		(0.335)		(0.573)		(0.573)	
2018	8.188***	22.02	8.163***	21.96	9.867***	15.52	9.748***	15.34
	(0.372)		(0.372)		(0.637)		(0.635)	
2019	11.294***	28.37	11.261***	28.31	13.094***	19.53	12.928***	19.32
	(0.398)		(0.398)		(0.670)		(0.669)	
2020	13.787***	32.34	13.738***	32.26	15.957***	22.47	15.711***	22.20
	(0.426)		(0.426)		(0.710)		(0.108)	
2021	16.508***	35.36	16.331***	35.41	19.302***	24.73	18.721***	24.54
	(0.467)		(0.461)		(0.780)		(0.763)	
log(Total Assets)	5.108***	7.34	5.096***	7.32				
	(0.696)		(0.696)					
constant	-1.040	-0.16	-0.929	-0.15	49.616***	117.21	49.616***	116.80
	(6.329)		(6.324)		(0.423)		(0.425)	
Obsv.	24,056		24,056		7,776		7,776	
firms	2,673		2,673		864		864	
R-sq.	0.213		0.21		0.048		0.0534	

Since environmental innovation is taken into account in the ESG-Score, we do see similar results when regressing *SBTI* on this variable. Firms that commit to the initiative have a 1.9 lower Environmental Innovation Score than non-SBTI firms, significant at the 5% level which confirms hypothesis three. So, compared to the E-Pillar the SBTi firms exhibit slightly superior performance. If one looks at only approved firms' innovation lowers to 2.2, significant also at the 5% level. Significance for these coefficients is lost when narrowing it down in the matched data sample. For the unmatched dataset the time effects are significant at the 1% level from 2015 onwards. In 2021 the Environmental Innovation Score increased by 8.2 points in total compared to 2013, in the matched dataset by 11.3. Note that apparently environmental innovation did not have as steep of an increase over the time as the E- or ESG-Scores. Again, one can observe significant size effects with an increase of Total Assets by 1% increasing the score by 0.04 units.

Table 7: Environmental Innovation

The dependent variable is the Environmental Innovation Score with the score ranging from 0 to 100. The first four columns report regressions for the base-dataset, the last four regressions for the smaller matched dataset. The year coefficient describes the change compared to the base year of 2013. All regressions include firm fixed effects and clustered standard errors at the firm level. The robust standard errors are reported in parenthesis. ***1% significance, **5% significance, *10% significance.

	Base-dataset				Matched dataset			
Variable	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat	**Coef.**	t-stat
SBTI	-1.931**	-2.10			-2.026			
	(0.917)				(1.529)			
SBTIA			-2.234**	-2.14			-1.874	-1.02
			(1.045)				(1.833)	
year								
2014	0.225	0.67	0.225	0.67	0.737		0.737	1.24
	(0.336)		(0.336)		(0.596)		(0.596)	
2015	1.749***	3.78	1.742***	3.77	3.184***		3.179***	3.74
	(0.462)		(0.462)		(0.850)		(0.850)	
2016	3.310***	6.38	3.296***	6.36	3.946***		3.923***	3.73
	(0.519)		(0.519)		(1.052)		(1.052)	
2017	4.088***	7.23	4.075***	7.21	5.978***		5.950***	5.39
	(0.566)		(0.566)		(1.104)		(1.104)	
2018	5.075***	8.09	5.058***	8.07	7.503***		7.462***	6.45
	(0.627)		(0.626)		(1.158)		(1.157)	
2019	6.373***	9.52	6.359***	9.50	8.542***		8.487***	6.91
	(0.670)		(0.669)		(1.229)		(1.229)	
2020	7.264***	10.22	7.248***	10.21	10.312***		10.231***	8.09
	(0.711)		(0.710)		(1.268)		(1.265)	
2021	8.225***	10.41	8.157***	10.48	11.298***		11.116***	8.25
	(0.790)		(0.779)		(1.371)		(1.347)	

log(Total Assets)	4.258***	4.71	4.269***	4.73				
	(0.903)		(0.902)					
constant	12.188	1.42	12.084	1.41	54.619***		54.619***	66.09
	(8.562)		(8.554)		(0.827)		(0.264)	
Obsv.	12,986		12,986		3,546		3,546	
firms	1,443		1,443		394		394	
R-sq.	0.065		0.065		0.018		0.019	

In summary, while I do find a general decrease of emissions over time the adoption or commitment to SBTi does not trigger emission reductions significantly. For ESG-Scores and environmental innovation the initiative even had a negative effect, although I observed general increased scores over the years for all firms in the sample.

4.2 Discussion

The insignificant results concerning emissions support recent criticism of initiatives like SBTi as discussed by e. g. Coen et al. (2022), indicating that while the companies do signal their environmental commitment this does not need to translate to concrete actions. The SBTi does not follow up or verify actions after approving a target and consequently companies may establish ambitious or even unattainable goals without any intention of actually pursuing them as claimed by Crilly et al. (2012). SBTi approved targets could be used as greenwashing tool with insufficient prioritization of necessary environmental adjustments in operations and the initiative simply concealing poor performance like Coen et al. (2022) warned. Since lowering carbon footprint is a resource and time intensive task, the absence of implemented change will result in a lack of significant emission reduction as seen in the analysis of Giesekam et al. (2021) by companies being behind target. This lack of action is also in line with Bolton & Kacperczyk (2022) finding companies to increase target horizons which would postpone responsibility and firms having to take actions. Results then raise the question whether the expensive approval fees that depending on company type can reach up to 14,500$ are a waste of resources. Redirecting these funds towards generating real change may be a more prudent approach. On the other hand, the insignificance of the findings simply speaks to the fact that the development of a firms' emissions and reduction efforts are not really affected by the initiative in either direction: environmentally unconscious firms will not intensify efforts after commitment, while conscious firms continue previous actions. As mentioned in Bolton & Kacperczyk (2022), the best-in class SBTi firms tend to have the biggest emission reductions and the SBTi Progress Report (2020) sees many companies undertaking climate action already before adoption. This would therefore lead to adoption not substantially altering their course. The sustainable firms within the SBTi would use SBT targets as a communication tool, while brown firms exploit them as means of greenwashing. Moreover, the absence of emission reduction following a commitment does not have to imply that established targets may not be achieved. As highlighted by critiques of Hadziosmanovic et al. (2022) targets can be in line with requirements and still not necessitate additional action, particularly when firms opt for the most convenient base year or methodology for their emission targets. SBTi companies might have already achieved targets at approval, set easily attainable targets or the general reduction observed across all companies in the dataset over time could be sufficient. This shows that the main idea of the SBTi is on aligning targets with climate science while the specific means of attaining those targets remain unaffected by the initiative.

Next, I want to address the general decrease of carbon footprint across all firms in the dataset. This can be attributed to a general increase in sustainability awareness and climate change concerns in recent years triggered also by pivotal events such as the Paris Agreement. The initial years of the analysis might not show significant results due to delayed action and complex business processes that impede emission reductions in the short-term. Besides this, investors as mentioned in the literature review (Eccles & Klimenko, 2019) increasingly consider environmental concerns in their investment decision and risk analysis. This facilitates the attraction of capital for sustainable firms and therefore incentivizes firms to take action towards emission reduction. Mounting climate change awareness and implementation of governmental regulations such as imposed emission limits due to nationwide emission targets and net zero pledges then compel both SBTi and non-SBTi firms alike to lower CO_2 footprint. Policies entail reduction targets as well as emission disclosure which not only enable stakeholders to hold firms accountable but also facilitate benchmarking against competitors. Stakeholder pressure will drive all firms to invest in emission reducing technology and pursue action towards carbon neutrality. With the afore mentioned insignificance of the emission variables this would underline claims of Maia & Garcia (2023) that emission reductions might primarily stem from policies that among other objectives are designed to support the energy transition and achieve national climate targets and not from the SBTi itself. The dynamics surrounding scope one emissions can be explained similarly, while there is no significant reduction in more recent years concerning the second scope. This is in line with results by Giesekam et al. (2021) that showed different alignment of action concerning the separate scopes. The reason of this divergence could lie in the fact that the latter CO_2 emission are not directly controlled by the firm and encompass emissions generated when producing the necessary energy for production and achieving reductions could be more challenging here. The significance only in 2015 and 2016 might be due to the heightened awareness after the Paris agreement in 2015 that decreased again in subsequent years. Continuously lowering scope two emissions poses an ongoing challenge and may only occur as a result of sudden changes such as a company switching their energy provider or intentionally lowering these emissions. Scope one emissions on the contrary can be more easily and directly influenced by the firm.

The positive correlation between firm size and emissions is in line with expectations and Younis & Sundarakani (2020), as larger firms do have more intricate manufacturing processes and expansive operational scopes that would require higher energy consumption and burn more fossil fuels. Extensive supply chains might also require more transportation, further amplifying carbon footprint. Generally, a bigger product portfolio would increase emissions as the cumulative carbon footprint of each product compounds, making it harder to spot inefficiencies. The significance of size disappears concerning scope two emissions, which could be explained by the fact that firms have limited control over indirect emissions and energy depends more on the regional mix and availability of renewables instead of firm size per se. While size may affect emissions resulting directly from operations, more indirect emissions do not depend on it and both small and large firms possess equal opportunities to switch to renewable energy providers or apply energy efficiency measures equally, irrespective of their size.

For ESG-Scores the analysis revealed an albeit perhaps not substantial but nevertheless statistically significant negative trend after becoming part of the SBTi. This effect might stem from increased disclosure and transparency subsequent to the adoption of the SBTi. Before companies may have exhibited inadequate reporting procedures, whereas SBTi adoption prompted sufficient disclosure afterwards. Setting science-based targets requires to evaluate firm strategies and practices which might uncover previously unknown and unaddressed inefficiencies or problems. Discovering and reporting these would subsequently decrease ESG-Scores. The pressure for transparency is even higher for not only firms committing to the SBTi but among SBTi-approved ones, explaining the lower number of ESG-Scores for the SBTIA firms compared to the SBTI ones. Additionally, there could be a time lag in significant performance enhancements after commitment as addressing inefficiencies and implementing corporate policy changes will take years to work on and take effect. As the SBTi firms in my dataset mostly are committing in 2021 it is unclear how results would change considering a longer timeframe. Making meaningful progress could mean one has to invest in new innovations and growth of their sustainability divisions while relying on less environmentally friendly technology in the meantime. Market constraints and technological barriers could impede immediate progress. Consequently, despite actions being taken, these advancements could not adequately be reflected in the current ESG-Score. Moreover, the costs associated with SBTi approval could also put a financial strain on the firm leaving no resources left to address ESG concerns. This would support claims of Trexler & Schendler (2015) on initiatives like the SBTi simply being a distraction from genuine progress. Furthermore, these results could indicate that the SBTi initiative is potentially utilized as a form of greenwashing to signal sustainability commitment to stakeholders and gain sustainability conscious customers and investors as Chrobak (2021) criticised. Considering the SBTi doesn't verify actions, companies could make unsustainable claims and simply apply superficial changes or only take token actions that would lead to the decrease in ESG-Score. Lastly it is important to note that the ESG metric compromises three different pillars encompassing environmental, social and governance aspects. It could be plausible that SBTi companies heavily emphasize actions on the environmental side while there may be a trade-off with the social or governance side with companies neglecting these two pillars completely. An unbalanced approach like that would adversely affect the overall score.

The latter reasoning can be disproven by the similarly declining numbers on the isolated environmental score. In fact, the decline seems to be slightly steeper than that of the total score which would support the argument of stricter disclosure on environmental matters affecting the E-score negatively. However, it might also speak to the fact that action is only taken prior to SBTi adoption and decreases afterwards as the pressure of rejection by the SBTi is gone. Still, greenwashing concerns cannot be disproven as the worse E-score could mean unsustainable firms want to mitigate reputational risks through adoption. They might continue or even increase non environmentally friendly actions while feeling safe under the protection of SBTi approval which protects them from scrutiny. Same arguments as above apply to the directional effect for SBTi firms and environmental innovation. Especially the resource and time intensive nature of innovation could hinder short-term progress and is therefore not reported in these results. Additionally, the SBTi does not specifically foster environmental innovations so a company could focus more on other operational changes that will reduce emissions to achieve SBTs. Consequently, the focus on rapidly improving carbon footprint could overshadow the long-term innovation process.

The time effects on the improvement of ESG-Scores supports the data found for emissions decreasing over time. Again, this can most likely be largely attributed to general increased awareness of sustainability in our society. Additionally, recent regulation such as the SFDR does not only include emissions, but general ESG disclosure that would affect scores positively and exerts pressure on firms to act accordingly. NGOs, customers and other stakeholders, particularly in the age of the internet and globalisation, are becoming increasingly vocal about corporate sustainability and engage with firms on their impact on climate change, for instance. To mitigate these reputational and regulatory risks that could affect competitive performance, firms will want to align their actions. Other recent regulations such as renewable energy subsidies might even incentivise firms financially to enhance environmental practices. Furthermore, the increased demand for ESG measurements makes it possible for metrics to evolve and ESG progressive firms to showcase their strengths, resulting in higher ESG-Scores.

This reasoning is supported by the better E-scores, but the slightly lower increase compared to total scores showcases that social and governance pillars did positively influence the general score over the years, too. Same goes for environmental innovation where increase over the years is the lowest out of Table 5, 6 and 7. This could stem from the fact that R&D is very capital intensive and therefore harder to stay on track with and scale up rapidly for companies, while the ESG metric encompasses various other aspects that might be achieved more easily. Besides this, the general increase of innovation could not only be driven by environmental awareness but simply by financially self-serving purposes as it would increase resource efficiency, reduce waste and then inevitably save costs. Recent technological advances on cleaner energy sources and efficient processes in several industries then have made it easier and more accessible for companies to integrate innovations into their own firm.

The positive coefficient on the size proxy is in line with literature mentioned before (Nasih et al., 2019; Younis & Sundarakani, 2020) and could be due to larger firms generally having more access to capital and benefiting from favourable borrowing terms. With more capital, general resources and expertise at their disposal remaining money can be allocated towards sustainability conscious practices. Furthermore, larger firms might be subject to more media coverage and regulations as the latter often take effect from a certain firm size onwards. This increases stakeholder pressure and might incentivize action towards higher ESG, E and Environmental Innovation Scores.

4.3 Recommendations

The above-mentioned results have several implications for managers, investors, policies, the SBTi itself but also future research. This study shows the importance of incorporating time effects in research on ESG-Scores and emissions since it revealed that previously assumed positive effects of the initiative might just stem from broader sustainability awareness and action over time regardless of SBTi adoption. For firms it implies that simply becoming part of the SBTi does not have any significant positive effect on neither emissions nor ESG-Scores and environmental innovation. Therefore, money spent on approval fees could be saved and redirected for alternative purposes. Additionally, the approval process itself takes time and human resources that can be allocated more efficiently when not joining the SBTi. Instead, firms could prioritize financial support for environmental innovation or establish dedicated ESG teams to enhance performance tracking and foster real sustainable change.

However, if firms do still want to join the initiative, it is crucial to continue and not decrease their environmental efforts after commitment. To not let ESG-Scores drop firms will have to work on their environmental disclosure and communicate efforts clearly. This can be achieved through stakeholder engagement to understand expectations, address concerns promptly and spot opportunities for innovative solutions early on, thereby counteracting greenwashing claims. Furthermore, it could entail conversations with suppliers, investors but also employee trainings to foster a sustainable environment throughout the company. Steady and continuous efforts already before adoption might also counteract time lags in the ESG-Score and will uncover inefficiencies even before SBTi commitment. To avoid resource constraints, firms will have to identify material issues and establish clear targets and timeframes concerning reducing emission, for instance, making clear which actions need to be taken until when. Providing context and educating stakeholders on exactly how this will be achieved, and to which extend it will help to reach emission goals is crucial in this process. Then, one needs to identify which amount of monetary and human resources are needed to be able to account for these in the business plan and avoid shortcomings. External validation would be favourable as SBTi commitment alone does not guarantee subsequent action. A start would be aligning reporting standards with established frameworks such as the GRI or the SASB, but specifically action-based verification would counteract greenwashing critiques, so firms do not just define unreachable targets. This could be achieved through third party audits or certifications like the ISO 14001 that addresses environmental management. These are also signs for environmentally conscious investors to look out for since the SBTi approval according to these results are no indicator for increased climate action. They should consider sustainability track records such as long-term sustainability programs or collaborations with NGOs, general transparency and if and how firms react to stakeholder criticisms rather than relying on SBTi approval as indicator.

When considering general governmental and policy actions this could mean that mandating firms to set targets, even if they are aligned with climate science, will not lead to required actions on combating climate change. More action-based regulation is necessary to foster real change. The SBTi itself can work on facilitating the translation of targets into actions for participating firms, too. It could be clearer about target difficulty and progress to avoid firms setting overly easy targets that would have been achieved regardless or have already been achieved by the time of approval and thereby leading to firms not taking additional action. Regularly updating and mandatorily disclosing information on target progress compared to the expected trajectory could be one option. Firms that take SBTi commitment seriously have data on target progress at their disposal either way and the SBTi would provide the planned trajectory used in their approval analysis. Data like this as well as continuous monitoring and stricter target requirements could improve SBTi credibility. The latter could also entail the SBTi setting a certain base year for emission reductions across all firms which would prevent companies from choosing a base year that seemingly optimizes their performance, but minimizes required actions.

4.4 Limitations And Opportunities For Future Research

A limitation of this study is the limited amount of disclosure around sustainability especially when looking at emissions or more precisely scope 3 emissions that were not available for this analysis. Generally, a larger dataset would always solidify the found results. The dataset could also be object to sampling bias since it may not properly reflect all firms out there. The first data I downloaded included around fifty thousand companies but since not many of them disclose consistent ESG or emission data it could lead to the dataset being biased towards disclosing firms. These remaining companies might be more sustainable as it is already and consequently not properly represent the global economy. Similarly, the unmatched but also the matched dataset could not accurately serve as a match to an SBTi firm, with the company not being similar enough to draw conclusions concerning what would have happened without the adoption. The emissions and ESG-Scores could still be influenced by other things that differ between the two groups. Thirdly, SBTi not disclosing ISIN numbers on all of the participating companies reduces the dataset further. Future studies could have a closer look at the moment of adoption and the time effects around this event. At which point do the ESG sores drop specifically? And where does this decrease in scores stem from? This could entail looking at different industry groups or company sizes more in depth. It could just be that effects of adoption have not properly materialized yet, requiring future studies to span more years as a robustness check.

5. Conclusion

With climate change awareness rising in recent years and governmental regulations taking time to develop and implement, many firms take it on themselves to set emission reduction targets. As not all of them are aligned with actual climate science, meaning that the achievement of targets would lead to global emission reductions by 2° or 1.5°, the SBTi is seen as a credible tool to verify this trajectory externally. The purpose of this study was to identify if firms that commit to SBTi do change their ESG-behaviour post adoption. I do so by examining emission, firstly looking at consolidated emissions and then scope one and two separately. To further gain insight I also consider ESG-Scores, E-scores and a firm’s environmental innovation. This research builds herby on analyses such as Bolton & Kacperczyk (2022) and Freiberg et al. (2021) and expands it by considering data until 2021 instead of 2019. It will help companies, policy makers and future researchers understand if commitment to the initiative affects firm behaviour and how the SBTi can be utilized as an effective tool to combat climate change.

For this task 3,141 firms with consistent ESG data from 2013-2021 derived from Refinitiv are analysed including 962 SBTi companies. In a panel data analysis consisting of a firm-fixed effect model I then test for my three separate hypotheses on emissions, ESG-Scores and environmental innovation. To check data for robustness a matching procedure is performed that assigns each SBTi firm a non-SBTi firm in the same industry and to its closest match concerning market cap. Results lead to the rejection of my first hypothesis as SBTi commitment did not lead to a significant change in emission development. This could go to show that SBTi is simply used for signalling and does not translate to emission reducing action. I do find a general decrease of emissions in the whole dataset with emissions in 2021 being lower by around 743,000 tonnes against the base year of 2013, which is significant at the 5% level. This decrease could arise from recent global climate change awareness and resulting mandatory regulations incentivizing firms to lower emissions. Regressions with scope one and two emissions find similar results with the latter being less affected by time effects possibly due to less control over indirect emissions.

Concerning ESG-Scores the data yields a decrease of scores by 2.5 significant at the 1% level and a slightly steeper decrease if we isolate the firms approved by the initiative by 3.3 at same significance levels. Many factors could play into this development including stricter reporting guidelines, time lags, lack of resources or unsubstantial sustainability claims of firms supporting the greenwashing narrative. To exclude the possibility that the S- and G-Pillar influence the analysis I perform the same regressions for the environmental score separately. Coefficients are even slightly worse displaying a decrease of 3.6 and 3.7 at 1% significance level for SBTi commitment and adoption. Confirming hypothesis three Environmental Innovation Scores are slightly higher again but still display a decrease of 1.9 and 2.2 at the 5% level. As SBTi commitment might be expensive and time and resource intensive, it could hinder resource allocation towards environmental innovation in the beginning. Generally, the effect on scores even worsens when taking only approved firms into account suggesting that the stricter guidelines for these firms increases pressure of transparency and brings to light previously unaware inefficiencies. Again, one can observe time effects due to public awareness as well, this time through an increase of ESG and Environmental Innovation Scores for all firms. The former demonstrates an increase of 18.3 points at 1% significance levels in 2021 compared to 2013, E-scores are of similar magnitude and the innovation rises by 8.2. As R&D is very capital-intensive it could be harder for firms in general to increase environmental innovation efforts, explaining the 10-point difference in the two scores.

Results suggest that SBTi adoption does not have any significant or even slightly negative effects on a firms ESG-behaviour and supports rising criticism on emission reduction pledges. As it does not positively influence corporate action, investors will have to critically scrutinize SBTi firms since greenwashing concerns cannot be disproven. One could argue that SBTi adoption can be seen as a waste of resources and adopted firms will have to take precautions to credibly state their climate commitment. Limitations of this research include the lack of data on emissions and ESG matters and the SBTi's insufficient disclosure. Future studies could take a closer look at the recorded negative effects on ESG-Scores trying to reveal their source.

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7 Appendices

7.1 STATA Do Files

```
// load base dataset

reshape long SBTI SBTIA ESG TotalAssets, i(Identifier) j(year)
string

encode year, gen(time)

encode Identifier, gen(company)

xtset company time, yearly

sum

gen lTotalAssets = log(TotalAssets)

//codes and tests for SBTi committed and approved firms (SBTI
variable)

xtreg ESG SBTI i.time lTotalAssets

predict uhat

gen uhatsq = uhat^2

xtreg uhatsq SBTI i.time lTotalAssets

xtreg ESG SBTI i.time lTotalAssets, fe

est store fixed

xtreg ESG SBTI i.time lTotalAssets, re

hausman fixed, force

xtreg uhat l.uhat SBTI i.time lTotalAssets

xtreg ESG SBTI lTotalAssets, fe cluster(company)

xtreg ESG SBTI i.time lTotalAssets, fe cluster(company)

xtreg ESG SBTI i.time lTotalAssets, re cluster(company)

//codes and tests for SBTi approved firms (SBTIA variable)

xtreg ESG SBTIA i.time lTotalAssets

predict uhat

gen uhatsq = uhat^2

xtreg uhatsq SBTIA i.time lTotalAssets

xtreg ESG SBTIA i.time lTotalAssets, fe

est store fixed

xtreg ESG SBTIA i.time lTotalAssets, re

hausman fixed, force
```

```
xtreg uhat l.uhat SBTIA i.time lTotalAssets
xtreg ESG SBTIA lTotalAssets, fe cluster(company)
xtreg ESG SBTIA i.time lTotalAssets, fe cluster(company)
xtreg ESG SBTIA i.time lTotalAssets, re cluster(company)

//load matched dataset
reshape long SBTI SBTIA ESG, i(Identifier) j(year) string
encode year, gen(time)
encode Identifier, gen(company)
xtset company time, yearly
sum
//codes and tests for SBTi committed and approved firms (SBTI
variable)
xtreg ESG SBTI i.time
predict uhat
gen uhatsq = uhat^2
xtreg uhatsq SBTI i.time
xtreg ESG SBTI i.time, fe
est store fixed
xtreg ESG SBTI i.time, re
hausman fixed, force
xtreg uhat l.uhat SBTI i.time
xtreg ESG SBTI, fe cluster(company)
xtreg ESG SBTI i.time, fe cluster(company)
xtreg ESG SBTI i.time, re cluster(company)

//codes and tests for SBTi approved firms (SBTIA variable)
xtreg ESG SBTIA i.time
predict uhat
gen uhatsq = uhat^2
xtreg uhatsq SBTIA i.time
xtreg ESG SBTIA i.time, fe
est store fixed
```

```
xtreg ESG SBTIA i.time, re

hausman fixed, force

xtreg uhat l.uhat SBTIA i.time

xtreg ESG SBTIA, fe cluster(company)

xtreg ESG SBTIA i.time, fe cluster(company)

xtreg ESG SBTIA i.time, re cluster(company)

//the exact same codes are run for several dependent variables by
replacing all instances of ESG in the above code by EnvPillar,
EnvIn, EmissionTotal, EmissionScopeOne, or EmissionScopeTwo
```