The stock market effects of committing and setting GHG targets: evidence from the Science-Based initiative

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Abstract

Many companies are committing and setting ambitious targets to reduce their greenhouse gas emissions (GHG) in line with the Paris Agreement and with the help and guidance of the Science-Based Targets initiative (SBTi). However, there is limited evidence on the market effects of setting those targets. We analyze the effects of committing and setting GHG targets on such companies' stock price returns and price volatility using two methods. First, we apply a GARCH model with a trend to estimate differences between mean stock returns and volatility trends. Then we exploit the panel nature of our data set and estimate a fixed effects model on stock returns and monthly volatility. The results show a significant negative effect of committing to setting a GHG target on stock volatility but no impact on stock returns. Stock price volatility is estimated to decline between 4%-6%. The negative effect on volatility is more

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pronounced on firms that commit to a target rather than on firms that, provided they have committed, set a specific target. We conclude that while the lack of market gains in the short term from committing to setting a GHG target can constitute a barrier for companies to establish credible GHG mitigation strategies, those actions can lower market risks and, hence, maybe more valuable in the long-term.

Keywords: Stock returns, Volatility, GHG emissions, ESG, GARCH
JEL: C1, E1, I0, 04

1 Introduction

In 2015, 195 states and the European Union adopted the Paris Agreement, the most ambitious international treaty limiting global warming to below 2 degrees Celsius and preferably at 1.5 degrees relative to pre-industrial levels. Achieving the Paris Agreement goal will require bold action from both the public and private sectors. China, the United States, and the European Union, the three largest emitters of greenhouse gas emissions (GHG), have already committed to achieve net zero emissions by mid-century. Since the launch of the Paris Agreement, more than three thousand companies have adopted GHG emissions targets in line with Paris Accord goals based on independent and expert advice under the guidance of the Science-Based Targets initiative (SBTi).[1]

Companies' commitments to reduce GHG emissions and, more generally, the adoption and improvement of sustainability practices can produce important market and environmental benefits. Dahlmann et al. (2019) describes four main motivations for business involvement in environmental management practices: (1) anticipating or responding to regulatory changes, (2) reducing costs, (3) attracting environmentally conscious customers, employees, and investors, and (4) building sustainability legitimacy and reputation among stakeholders. Based on a comprehensive global survey of senior investment professionals, Amel-Zadeh and Serafeim (2018) found that the main reason investors focus on environmental, social, and governance (ESG) factors is because they consider it financially material. According to the authors, ESG information is mainly used to gain insights about company risks rather than their competitiveness.

Kuo et al. (2010) finds that corporate financial performance (CFP) improves with lower GHG emissions and attributes this result to productivity gains and more innovation directed at more efficient and cheaper manufacturing processes. Trinks et al. (2020) adds that investors' confidence is higher toward more eco-efficient companies and that, in some cases, institutional investors may pressure companies to adopt measures to reduce their GHG emissions. Also, firms can strengthen brand reputation via more environmentally friendly production, gaining consumers who avoid products from more pollutant firms (Hart and Ahuja (1996)).

In contrast, other studies show that reducing GHG emissions can harm CFP. Brouwers et al. (2018) states that, in some cases, the cost of investing in mitigating GHG emissions could overcome the benefits, negatively affecting CFP. Also, Fujii et al. (2012) mention that firms could lose competitiveness by deviating resources from core operations to cut emissions. However, most studies find a positive relationship between corporate environmental performance (CEP) and CFP.

Most of the literature on the subject concentrates on analyzing the impact of environmental,

[1] See https://sciencebasedtargets.org.

social, and governance (ESG) initiatives and actions on CFP (Friede et al. (2015), Das et al. (2018), and Zhang et al. (2018)) or on the financial impacts of reducing GHG (as in the studies cited above). The literature finds both positive and negative market effects of ESG scores and measures.

A meta-analysis conducted in 2015 of more than 2000 studies focusing on the link between ESG performance and CFP found a non-negative (either positive or neutral) relationship between ESG performance and CFP (Friede et al. (2015)).

Using data on Korean firms, Yoon et al. (2018) find a positive correlation between ESG scores and firms' stock prices. However, the effect is minor for firms in environmentally sensitive sectors.

Engelhardt et al. (2021) find that an increase in ESG ratings tends to improve stock market performance and reduce volatility for European firms, being the governance component the main driver for such results. Serafeim and Yoon (2022) find that the number of positive ESG news increases stock prices. Moreover, their results indicate that investors react mainly to unexpected news. Lastly, Shanaev and Ghimire (2022) assess the impact of changes in ESG ratings on stock returns of 748 US firms and find that higher scores are associated with higher stock returns.

A few studies have found opposite results. For example, Folger-Laronde et al. (2020) conclude that higher ESG ratings do not mitigate the impacts of adverse market shocks, while La Torre et al. (2020) investigate the impact of ESG scores on stock returns for the Eurostoxx50 over the 2010-18 period. Their results indicate that a higher score does not significantly affect returns mainly because investors receive information about how firms undertake ESG measures with some lag and because risk behavior dominates stock market volatility.

To our knowledge, the market performance of setting GHG targets is, for the most part, non-existent. Even though companies' ESG strategies are broader in scope than setting GHG targets, there are no unified guidelines and frameworks for rating ESG performance, making them difficult to assess empirically (Amel-Zadeh and Serafeim (2018); Florian et al. (2019)). In contrast, setting GHG targets focuses on a particular environmental aspect. Still, it is a specific action comparable across companies and, as noted before, tackles one of the most urgent planetary challenges: climate change.

This paper analyzes the effects of committing and setting GHG targets on companies' stock price returns and volatility. The focus is on those companies that have partnered with SBTi to commit and set GHG targets. The partnership with SBTi ensures that GHG targets are independently assessed and validated using scientific knowledge and based on plausible trajectories. Companies committing to a GHG target in partnership with SBTi follow several steps to set GHG targets (explained in detail in the next section). The first being the company signalling to SBTi its commitment to set a target and the last step being monitoring the alignment of its GHG emissions to the target.

Despite being the most recognised initiative worldwide to guide and help companies to reduce their GHG emissions in accordance to the Paris Agreement, to our knowledge, there are no studies assessing the market effects of committing and setting GHG targets under the SBTi initiative.

Our focus is on publicly traded companies with available stock price information (1379 companies in our sample). We employ two empirical approaches to estimate the market effects of committing and setting GHG targets. First, we apply a novel GARCH model with a trend to estimate differences between mean stock returns and volatility trends. Second, we exploit the panel nature of our data set and estimate a fixed effects model on stock returns and monthly volatility.

Additionally, we conduct the analysis using the whole sample and three sub-samples. First, we analyze the market effects of either committing to a target or setting a target using our full sample using a single dummy variable as SBTi only publishes the information on the current status of the companies that partnership with them, hence, a company that set a target will appear as having a target with the target date but no information on the date when the company committed to setting a target (announced its intention to setting a target) is provided. Second, we split companies according to their current status (either committed or target set) and perform the analysis on each of the sub-samples. Finally, we were able to collect information from SBTi in two time periods (May 2021 and May 2022). Using that information we were able to identify 117 companies for which we have both the commitment and the target set dates. Using those companies also test simultaneously the effects of committing and setting targets.

The results from both the GARCH with trend and the fixed effects model show no statistically significant impact of committing or setting a target on average stock returns. However, both models show negative and statistically significant effects of committing to a target on monthly stock price volatility. Setting a target appears to lower price volatility but this effect is not statistically significant. Hence, we conclude that committing to a GHG target has no statistically significant effect on stock returns but leads to lower price risk, as these companies may be perceived as less risky in line with investors' motivations for focusing on ESG strategies and, hence, more valuable in the long term.

2 The Science-Based Targets Initiative

The Science-Based Targets initiative is a partnership of international organizations that sets sector-specific guidelines and frameworks for companies that commit to setting GHG emissions targets in line with the Paris agreement goals.[2] SBTi also provides technical support to companies that set GHG emissions targets to help them achieve their targets and performs independent assessments and validation of targets. GHG targets cover scope 1 (direct emissions from sources owned or controlled by the company) and 2 (indirect emissions from the generation of purchased energy). If indirect emissions that result of an organization's operations, but are not owned or controlled by the company (scope 3) surpass 40% of scope 1, 2 and 3 emissions, the targets should also cover scope 3 emissions.

Companies who set a target undergo a five-step process: First, the submission of a letter that establishes their intent to place a science-based target (Commitment). Second, work with SBTi to define a target according to SBTi's guidelines (Development). Third, presentation of targets to the SBTi for official validation (Submit). Fourth, announce the target to stakeholders and the public (Communicate Target). Fifth, report company-wide emissions and track progress toward target annually (Disclose).

Setting a commitment is a relatively straightforward step requiring companies to submit a letter committing to a target. At that stage, the SBTi recognizes that company as committed, publishes it into its list of committed companies, and communicates its status to SBTi's partners (CDP and We Mean Business Coalition). Once committed, the company has 24 months to submit its targets to the SBTi. During that period, SBTi helps companies develop their emissions targets and the paths to achieve them. Targets can be defined in line with a 1.5 or 2-degree pathway. Once companies have set their targets, they submit them to SBTi for validation. This step can take a few months and could be subject to revisions and rejections. If the target is approved, SBTi publishes the company's name on its partners' websites. Companies must communicate to the public their targets within six months of approval. The last step requires companies to track their emissions and disclose them annually.

Hence, a company that sets a target under the SBTi signals stakeholders and the public that it is seriously committed to keeping its GHG emissions under control and aligned with the Paris Agreement goals.

SBTi is not the only initiative promoting business alignment with the Paris Agreement goals. Other initiatives include The Climate Pledge, SOS 1.5 initiative, and 1.5 C Supply Chain Leaders. We focus on SBTi because it is the initiative with most companies, focusing primarily on scope 1 and 2 GHG emissions. Initiatives like The Climate Pledge are relatively new, with only 200 members. In contrast, SOS 1.5 initiative and 1.5 C Supply Chain Leaders cover other aspects of

[2] These include CDP, the United Nations Global Compact, World Resources Institute (WRI), and the World Wide Fund for Nature (WWF).

sustainability and emissions along the supply chain (scope 3 GHG emissions).

3 Data

Setting a target under SBTi guidelines dates back to 2015 when only 11 companies committed and two had set targets. However, the number of companies incorporating GHG emissions targets has increased rapidly. On its most recent list of companies (accessed on May 2022), there are more than three thousand companies working with SBTi, of which around 48 percent have a GHG emission reduction target in place and 52 percent are committed to set a target.

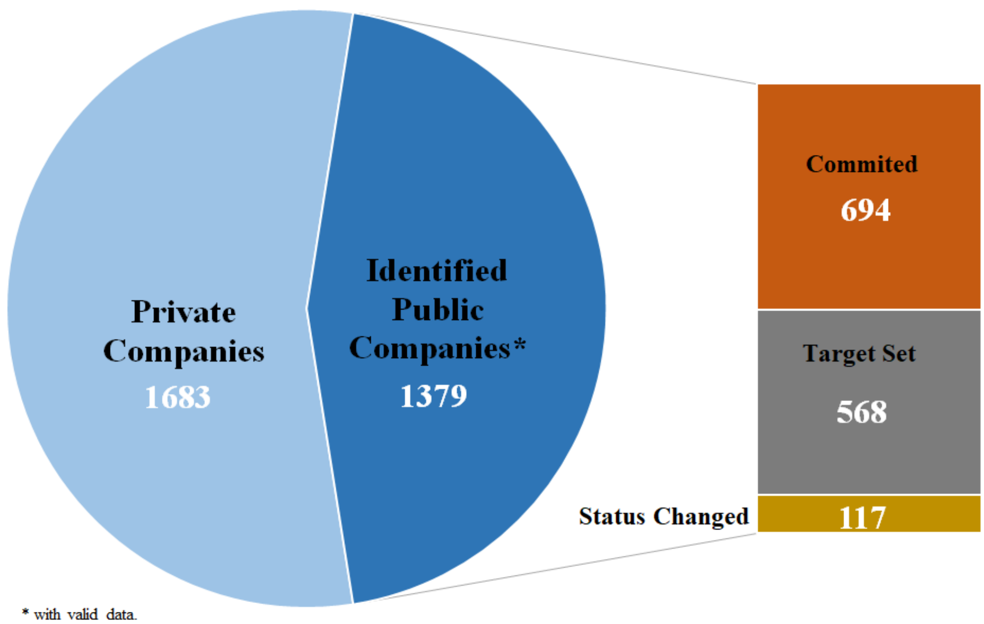
Unfortunately, the SBTi database does not provide a historical account of the evolution in the status of the partner companies. Hence, there is no way to identify when companies changed status committed to having a defined emission reduction target. To address this limitation, we collected the SBTi database in two different time periods spanning one year: May 2021 and May 2022. By combining these two lists, we were able to identify companies that appeared with a commitment status in May 2021 and that, by May 2022, had already set targets.

Regarding information on stock prices, out of the more than three thousand companies working with the SBTi we were only able to gather stock price data for 1379 of them (which we denominate as public). We arrived at this number after a long process that involved several stages: First, we selected the companies with a ticker in Bloomberg. Second, we identified those tickers that experienced changes since 2015 in the Bloomberg terminal. The changes were due to: (1) companies with suspended tickers, (2) limited stock trading frequency, (3) acquisitions and (4) companies whose tickers changed for other reasons. Companies within the first three cases were removed from the dataset. In the fourth case, we simply updated the price series with the new ticker.

Lastly, we excluded companies with missing price data within 30 days prior and after committing or setting a target. We found that this situation occurred for eight committed companies and for 15 with a defined target. It is important to highlight that in this step we treated companies for which we have information on the date they committed and later on the date the set a target as an especial case. This is because we had to ensure they had price data for both events (one company did not satisfy the criteria and was excluded). As a result, out of the 1379 firms in the dataset, 694 had committed, 568 had set a GHG target, and 117 had information on both commitment and target set date, see Figure 1.

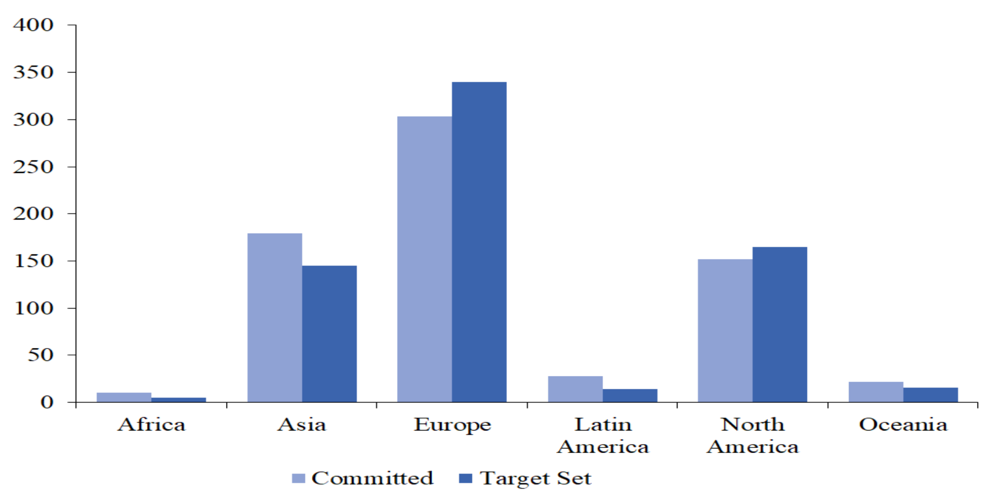
Most of the public companies in our sample are located in Europe, Asia, and North America; Latin America, Oceania and Africa have the lowest number of public companies either with a commitment or with a target set (Figure 2). The public companies in the SBTi database belong

Figure 1: Proportion of Public and Private Companies with GHG Commitments and Targets in SBTi



Source: Authors based on sbt (2022)

Figure 2: Number of Public Companies with GHG Commitments and Targets by Region



Source: sbt (2022)

to multiple sectors. The top five industries with the most significant number of committed companies are Computing, Financial Services, Transportation, Electrical Equipment and Machinery, and Construction and Building. The sectors with more firms with targets set are Food, Beverages and Tobacco, Real Estate, Computing, Construction and Building, and Electrical Equipment and Machinery (see Table 1).

Table 1: Number of Public Companies with GHG Commitments and Targets by Sector

Sector	Committed	Target Set	Total by sector
Chemicals	28	13	41
Computing	85	64	149
Construction and Building	51	56	107
Consumer Durables, Household and Personal Products	16	35	51
Containers and Packaging	5	10	15
Education Services	-	2	2
Electrical Equipment and Machinery	54	51	105
Financial Services	80	13	93
Food, beverages and tobacco	37	88	125
Forest and Paper Products - Forestry, Timber, Pulp and Paper, Rubber	12	12	24
Healthcare and pharmaceuticals	32	32	64
Hotels, Restaurants and Leisure, and Tourism Services	18	15	33
Media	11	10	21
Oil, Gas and Mining	17	11	28
Professional Services	26	28	54
Real Estate	34	69	103
Retail	28	26	54
Specialized Consumer Services	7	2	9
Telecommunications	15	35	50
Textiles	31	27	58
Trading Companies and Distributors, and Commercial Services and Supplies	16	6	22
Transportation	59	46	105
Utilities	32	34	66
Total general	694	685	1379

Source: Authors based on sbt (2022)

4 Methodology

We adopt two approaches to test the market effects of committing and setting GHG targets. First, we implement a novel methodology that allows us to simultaneously test for changes in the drift and the variance of returns based on the trend-GARCH model developed by Guerrero et al. (2016) and Uribe-Richaud et al. (2018). This approach is appropriate to test for changes in price returns and volatility trends since it proposes a structural form on the error terms and explicitly incorporates a drift within the conditional variance of a classical GARCH(1,1).

Our second approach exploits the panel structure of our data and implements a fixed effects model on returns and monthly volatility, separately. While this approach does not impose any particular structure on the error terms, it allows us to control for time-invariant firm-level characteristics that could influence the commitment and target set timing, as well as for sector trends.

4.1 GARCH with trend

Our aim with this approach is to test if returns and stock price volatility are stable within a time interval. In particular, if they are stable after committing or setting a target. The stock returns are modelled as a geometric Brownian motion:

$$S_t = S_0 \exp\left\{\sum_{j=1}^{t} \varepsilon_j\right\} \tag{1}$$

where S_t is the stock price at time t and S_0 is the drift. In particular, a process ε is stable within a time interval $t \in [1,\ldots,n]$, assuming it has the following dynamics:

$$\varepsilon_t = \mu + \sigma_t w_t \qquad\qquad w_t \overset{i.i.d}{\sim} \mathcal{N}(0,1). \tag{2}$$

where μ is the mean of ε_t and σ_t is its standard deviation.

Hence, for each firm, we test whether the changes in the mean and volatility of stock prices before and after a commitment or a target were set are significant. For the period before a firm commits or sets a target we estimate the model:

$$\sigma_t^2(\beta_1,\mu_1) = \alpha_0 + \alpha_1(\varepsilon_{t-1} - \mu_1)^2 + \beta_1 t + \gamma\sigma_{t-1}^2(\beta_1,\mu_1) \tag{3}$$

For the period after a firm commits or sets a target, we estimate the model:

$$\sigma_t^2(\beta_2,\mu_2) = \alpha_0 + \alpha_1(\varepsilon_{t-1} - \mu_2)^2 + \beta_2 t + \gamma\sigma_{t-1}^2(\beta_2,\mu_2) \tag{4}$$

We then plot the differences between the parameters μ_1 and μ_2, as well as β_1 and β_2.

A clear advantage of this approach is its structural form that allows us to simultaneously estimate changes in both the level and the volatility of stock returns.

4.2 Fixed effects model

Notwithstanding the GARCH with trend method allows us to test for changes in the mean and volatility of stock prices, those changes could be explained by other events related to firms´ characteristics. To control for those factors we also estimate a fixed effects model that controls for time-invariant firm-level characteristics. For testing changes in stock returns, we estimate the following model:

$$r_{i,t} = \alpha_i + \lambda_m y + \sum_{j=1}^{8} \beta_j W_j + \sum_{k=1}^{3} \gamma_k MS_k + \sum_{s} Sec_s * Trend + e_{it} \tag{5}$$

where r denotes stock returns ($log(price_{i,t}) - log(price_{i,t-1})$) and subscripts i and t represent company and transaction day, respectively. α_i stands for firm fixed effects, $\lambda_m y$ are vectors of month by year dummies. To capture the effects of committing or setting targets, we create eight dummies W_j with $j = 1 \dots 8$ representing the number of weeks after a company committed or set a target. We also estimate those effects separately by splitting the sample in those companies that appear with a commitment status in SBTi database and those that appear with target set status. Given the time span of our sample, we control for some important financial and macroeconomic events occurring since 2015. Particularly, the crash of the Chinese stock market in 2015, the drastic fall in oil prices in early 2016, the Volpokalipse episode in 2018, and the COVID-19 pandemic in 2020. These are represented by the dummies MS_k with $k = 1 \dots 3$.[3] Finally, we also take into account sector trends by introducing interactive dummies of trends and sector: $Sec_s * Trend$.

To test the effect of either committing or setting GHG targets on price volatility, we also exploit the panel structure of our data and estimate a fixed effects model of the monthly standard deviation of stock returns as follows:

$$vol_{i,t} = \alpha_i + \lambda_t + \beta GHG + \sum_{k=1}^{3} \gamma_k MS_k + \sum_{s} Sec_s * Trend + e_{it} \tag{6}$$

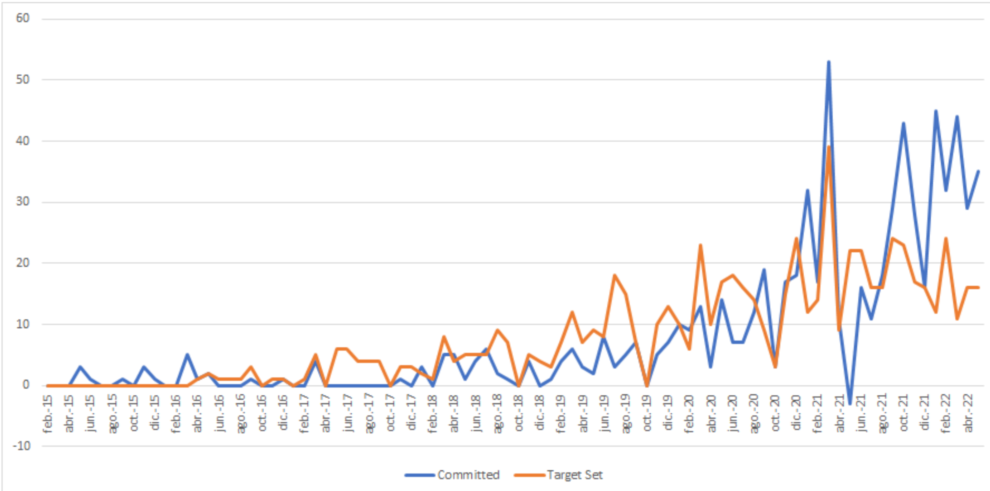
where vol represents the monthly standard deviation of returns as represented by the dependent variable in equation (4). Subscripts i and t denote firm and time (month of the year). α_i stands for firm fixed effects, λ_t are month by year dummies. In contrast to the weekly dummies we used in the specification of daily returns, in this specification we only include a dummy variable (GHG) that takes a value of one for the period after a company committed or set a target and zero

[3] We dated the Chinese stock market crash from June 12 to August 31 2015; Oil prices fall drastically from January 6 to February 21 2016; the Volpokaplipse episode from February 5 up to March 1 2018; and the pick of the COVID-19 pandemic from February 20 up to March 24 2020.

otherwise. Macroeconomic shocks that affected stock markets are represented by the dummies MS and trend-by-sector dummies are included in the vectors $Sec_s * Trend$.

As discussed in the introduction, multiple factors can induce a company to commit or set a target. Since we are only focusing on those companies that either committed or set a target, our estimated parameters represent average treatment effects on the treated (ATT). The identification assumptions of this empirical strategy rely on the timing at which companies either commit or set targets. As stated by sbt (2022), both actions seem to have increased over time, obeying a growing awareness of the climate crisis in the private sector, global climate meetings such as the conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) and the capacity of SBTi to process and guide companies when committing and setting a target. Figure 3 shows the monthly change in the number of companies either setting a target or committing to a target. The growth rate of the change is increasing, indicating that the number of companies working in partnership with SBTi exhibits an exponential growth. Figure 3 also reveals that the change in the number of companies is cyclical and that there are two dates where the activity increased. The first is March 2021 and the second October 2021. It is not clear what particular event may have triggered the increased activity in the first date but the second date is likely to be in anticipation of the COP26 event in Glasgow, reaffirming our hypothesis that climate awareness and major global initiatives may be a major driver for companies setting and committing to GHG targets. To the extent that growing awareness varies by sector and characteristics inherent to firms, controlling for trends by sector dummies and firm fixed effects should be sufficient to identify the parameters in equations (5) and (6). Global events are captured by month by year dummies. Companies could, however, manipulate and decide when announcements on targets are made. For example, they could decide to announce setting the targets right after a bad day or week in the stock market. Part of those biases could be alleviated via the inclusion of time dummies, but we acknowledge those may not be sufficient to reduce all biases stemming from firms' market motivations.

Figure 3: Monthly Change in Number of Companies Setting and Committing to Targets



Source: sbt (2022)

5 Results

This section discusses the effects that committing or setting a GHG emissions target has on average returns and stock price volatility. The results are reported separately, first, for companies with only information on their current status with the SBTi. Second, we describe the findings for the small number of companies with information on when they committed with the SBTi and when they adopted a specific GHG emission target.

5.1 Stock Returns

Results from our GARCH with trend model show that there is no statistically significant difference in mean stock returns parameters before and after either companies commit or set a GHG target (Figure 4). A *t*-test for the difference of means of average returns before and after the change in status was carried out and confirms that there are no statistically significant differences between average returns for any of the status analysed (Table 2).

Without making any difference in companies' status, the results from the fixed effects model suggest that neither committing nor setting a target has a statistically significant effect on stock returns in the following weeks after the status was made public, see Table 3. In particular, most of the weekly dummies are not statistically significant. Distinguishing between firms that have only committed from those that set a GHG emission target, does not change the results as most weekly dummies are not statistically significant (Tables 4 and 5). Apart from this, the macroeconomic shocks of COVID and VOL2018 show statistically significant effects with opposite signs. As

Figure 4: Difference in Mean Stock Returns Parameters (μ_1 and μ_2)
After commitment/target vs Before commitment/target

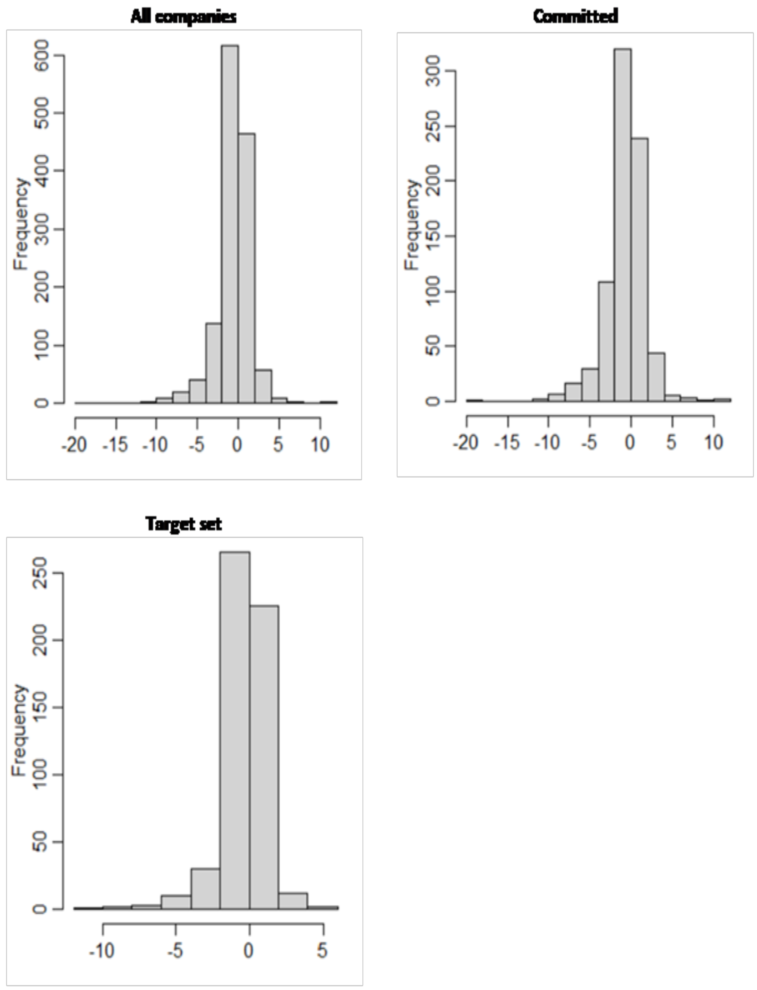


Table 2: P-values of Mean Differences in Volatility and Mean of Stock Price Returns

	Volatility F-test	Mean t-test
All	$< 0.001\%$	9.53%
Target Set	$< 0.001\%$	10.21%
Committed	$< 0.001\%$	9.01%

expected, the COVID effect is negative.

Table 3: Impact of Committing or Setting a GHG Target on Stock Returns

	(1)	(2)
Week 1	−0.000458	−0.000526*
	(0.173)	(0.100)
Week 2	−0.0000307	−0.0000514
	(0.889)	(0.804)
Week 3	−0.0000758	−0.0000861
	(0.848)	(0.830)
Week 4	−0.000654*	−0.000505
	(0.094)	(0.172)
Week 5	−0.000319	−0.000335
	(0.372)	(0.328)
Week 6	0.000141	0.0000633
	(0.704)	(0.859)
Week 7	−0.000526	−0.000566
	(0.180)	(0.167)
Week 8	0.000151	0.000104
	(0.698)	(0.778)
CRASH2015		−0.000283
		(0.300)
OILfall		−0.000589*
		(0.090)
VOL2018		0.00652***
		(0.000)
COVID		−0.0306***
		(0.000)
R-squared	0.00789	0.0163
Observations	2501596	2501596
Groups	23	23

p-values in parentheses

Month by year and sector by trend dummies included in all specifications. Clustered standard errors at sector level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

For those companies for which we can identify the date when they changed status from committed to setting a target we modified the model specification (5) and we include four time dummies for the weeks after a company committed to setting a target and four dummies for the weeks after a company changed status from committed to target set. Results of this specification are shown in Table 6. The results are consistent with the previous findings and we find no evidence of a positive or negative effect on stock returns of either action. All macroeconomic shocks, except for the VOL2018, adversely affected average returns, with the effect of COVID being the most relevant negatively affecting stock returns.

Table 4: Impact of Committing to a GHG Target on Stock Returns

	(1)	(2)
Week 1	-0.000534	-0.000644
	(0.233)	(0.133)
Week 2	0.000477	0.000414
	(0.324)	(0.381)
Week 3	0.000834^{*}	0.000781^{*}
	(0.067)	(0.087)
Week 4	-0.000974^{*}	-0.000870^{*}
	(0.070)	(0.092)
Week 5	-0.0000325	0.0000497
	(0.949)	(0.916)
Week 6	0.000115	0.000145
	(0.820)	(0.777)
Week 7	0.000502	0.000483
	(0.316)	(0.375)
Week 8	-0.0000673	-0.0000934
	(0.895)	(0.846)
CRASH2015		-0.000397
		(0.397)
OILfall		-0.000516
		(0.137)
VOL2018		0.00666^{***}
		(0.000)
COVID		-0.0313^{***}
		(0.000)
R-squared	0.00776	0.0157
Observations	1443870	1443870
Groups	23	23

p-values in parentheses

Month by year and sector by trend dummies included in all specifications. Clustered standard errors at sector level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Impact of Setting GHG Targets on Stock Returns

	(1)	(2)
Week 1	−0.000342	−0.000358
	(0.406)	(0.399)
Week 2	−0.000710	−0.000677
	(0.168)	(0.187)
Week 3	−0.00123**	−0.00118**
	(0.027)	(0.030)
Week 4	−0.000222	−0.0000188
	(0.513)	(0.955)
Week 5	−0.000694	−0.000834
	(0.172)	(0.102)
Week 6	0.000173	−0.0000349
	(0.760)	(0.953)
Week 7	−0.00176***	−0.00183***
	(0.005)	(0.004)
Week 8	0.000497	0.000424
	(0.482)	(0.546)
CRASH2015		−0.000128
		(0.637)
OILfall		−0.000686
		(0.179)
VOL2018		0.00632***
		(0.000)
COVID		−0.0296***
		(0.000)
R-squared	0.00848	0.0178
Observations	1057726	1057726
Groups	23	23

p-values in parentheses

Month by year and sector by trend dummies included in all specifications. Clustered standard errors at sector level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Impact of Committing and Setting a GHG Target on Stock Returns for Firms with Identified Date of Status Change

	(1)	(1)
Week 1 committed	0.000434	0.000116
	(0.712)	(0.925)
Week 2 committed	0.00186	0.00163
	(0.146)	(0.183)
Week 3 committed	−0.000594	−0.000800
	(0.419)	(0.283)
Week 4 committed	0.000153	0.000292
	(0.923)	(0.852)
Week 1 target	−0.000495	−0.000516
	(0.457)	(0.441)
Week 2 target	0.00158*	0.00157*
	(0.057)	(0.058)
Week 3 target	0.00110	0.00111
	(0.232)	(0.232)
Week 4 target	−0.00221*	−0.00221*
	(0.060)	(0.061)
CRASH2015		−0.000286
		(0.505)
OILfall		−0.000487
		(0.533)
VOL2018		0.00577***
		(0.000)
COVID		−0.0259***
		(0.000)
R-squared	0.00820	0.0152
Observations	219366	219366
Groups	20	20

p-values in parentheses

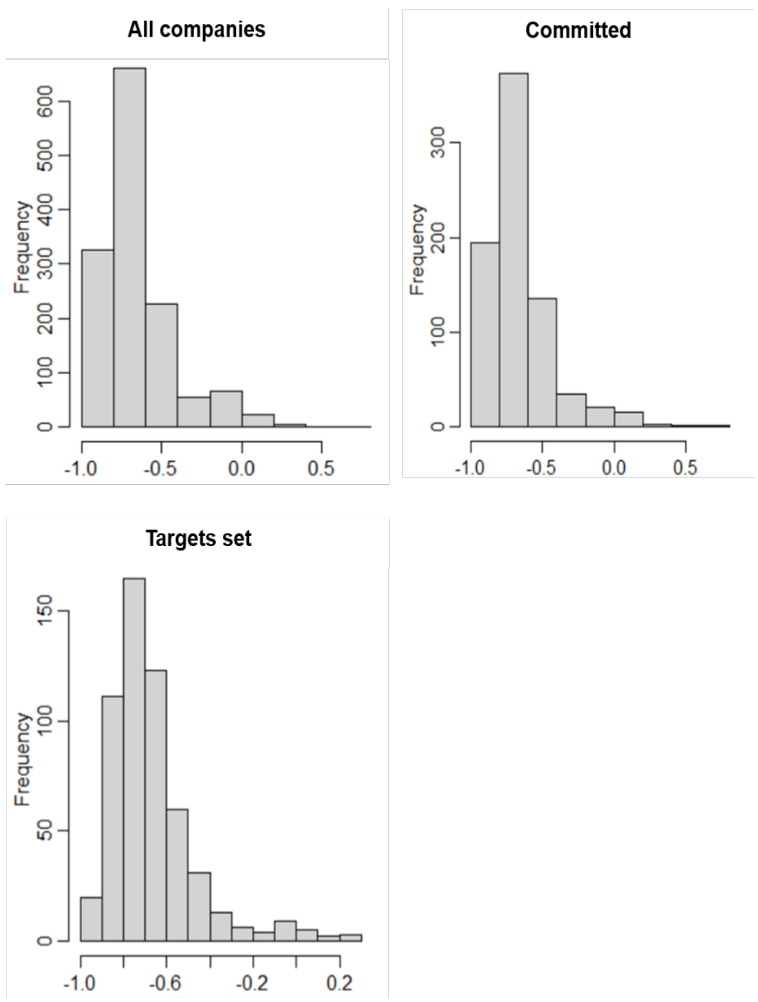
Month by year and sector by trend fixed effects included but not reported. Clustered standard errors at sector level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.2 Volatility

The GARCH with trend estimates show that, on average, there is a significant reduction in volatility trends after companies commit or set a target (see Figure 5). In particular an F-test was carried out to detect a change in the variance before and after for: All companies, Committed, and Targets set. The p-value was significant in the 3 cases at a 99.5% level (see Table 2).

Figure 5: Difference in trend volatility parameters(After commitment/target -Before commitment/target)



The fixed effects model results show a significant adverse effect on stocks' volatility of committing or setting a GHG emission target (Table 7). However, when we differentiate between the companies that committed from those that set targets, we found that there is no significant effect on stock volatility for the latter, (see Tables 8 and 9). This contrast with our GARCH results where both setting targets and committing to a target resulted in negative and statistically significant effects on stock returns volatility. The relative magnitude of the estimates indicate that the effect of committing to a target induced a 6% decline in the volatility of stock returns for committed firms and a 4% decline relative to all firms in the sample. In contrast with their effects on average returns, the macroeconomic shocks had differentiated effects on stock volatility. While the plummet of oil prices in early 2016 and the COVID-19 pandemic period resulted in higher stock volatility, the Asian stock market crash and the Volpokalipse episode unexpectedly had a negative and significant effect coefficient suggesting that stock volatility of companies working with the SBTi decreased during these events. When differentiating by status, we find positive effects of all macroeconomic shocks on the volatility of stock returns. In all specifications the COVID effect is positive and has the largest magnitude.

Table 7: Impact of Committing or Setting a GHG Target on Volatility of Stocks Returns

	(1)	(2)
GHG	-0.000707^{***}	-0.000707^{***}
	(0.004)	(0.004)
CRASH2015		-0.00343^{***}
		(0.000)
OILfall		0.00570^{***}
		(0.000)
VOL2018		-0.00168^{***}
		(0.005)
COVID		0.0394^{***}
		(0.000)
R-squared	0.308	0.308
Observations	115353	115353
Groups	23	23

p-values in parentheses

Month by year and sector by trend dummies included in all specifications.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel estimations for companies that move from committed to having a target set show that

Table 8: Impact of Committing to a GHG Target on Stocks Volatility

	(1)	(2)
GHG	-0.00107^{**}	-0.00117^{***}
	(0.011)	(0.007)
CRASH2015		0.00227^{***}
		(0.000)
OILfall		0.0101^{***}
		(0.000)
VOL2018		0.00570^{***}
		(0.000)
COVID		0.0193^{***}
		(0.000)
R-squared	0.131	0.185
Observations	66584	66584
Groups	23	23

p-values in parentheses

Month by year and sector by trend dummies included in all specifications.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Impact of Setting a GHG Target on Stocks Volatility

	(1)	(2)
GHG	-0.000607^{*}	-0.000446
	(0.064)	(0.132)
CRASH2015		0.00104^{***}
		(0.000)
OILfall		0.00955^{***}
		(0.000)
VOL2018		0.00589^{***}
		(0.000)
COVID		0.0182^{***}
		(0.000)
R-squared	0.156	0.219
Observations	48769	48769
Groups	23	23

p-values in parentheses

Month by year and sector by trend dummies included in all specifications.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

committing had a negative effect on stock volatility but it is statistically significant at the 10% level and no statistically significant effect is detected when companies change status from committed to target set. In this subset, all macroeconomic shocks except for VOL2018 increased stock volatility, see Table 10.

Table 10: Impact of Committing and Setting a GHG Target on Stock Returns Volatility for Firms with Identified Date of Status Change

	(1)	(2)
Committed	-0.00171^{*}	-0.00171^{*}
	(0.059)	(0.059)
Target Set	0.00119	0.00119
	(0.316)	(0.316)
CRASH2015		0.00476^{***}
		(0.000)
OILfall		0.00401^{***}
		(0.000)
VOL2018		-0.000408
		(0.597)
COVID		0.0366^{***}
		(0.000)
R-squared	0.338	0.338
Observations	10114	10114
Groups	20	20

p-values in parentheses
Month by year and sector by trend fixed effects included but not reported. Clustered standard errors at sector level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Conclusions

Many companies are committing and setting ambitious targets to reduce their greenhouse gas emissions (GHG) in line with the Paris Agreement to limit global warming below 2 degrees Celsius. Since adopting the Paris Agreement, more than three thousand businesses and corporations have adopted GHG emissions targets in line with Paris Accord goals and under the guidance of the Science-Based Targets initiative (SBTi). Besides tackling global warming, reducing GHG emissions presents opportunities and challenges for businesses and companies. Companies' commitments to reduce GHG emissions and, more generally, their sustainability practices can produce important market and environmental benefits.

This paper analyzes the effects of GHG targets on companies' stock price returns and volatility. The focus is on those companies that have set GHG targets in partnership with SBTi, provided those targets are independently assessed and validated using scientific knowledge and based on plausible trajectories. In doing so, we intend to gather evidence on the market effects of committing and setting GHG targets.

We employ two empirical approaches to estimate the effects of committing and setting GHG targets to achieve our goal. First, we apply a GARCH model with a trend to estimate differences between mean stock returns and volatility trends. Then we exploit the panel nature of our data set and estimate a fixed effects model on stock returns and monthly volatility. We also split our sample into two cases: First, we analyze companies for which we only observe whether they are committed or have a specific GHG target; i.e., we only have information on their current status with the SBTi. Second, we study companies with information about the date they committed and when they adopted a GHG emission target (unfortunately, the number of companies in this category represents less than ten percent of our sample).

The results from both the GARCH with trend and the fixed effects model show no significant impact of being committed or having a target on average stock returns in the 8 weeks following the status announcement. This result may reflect that committing and setting GHG targets does not generate short-term market gains, which could constitute a limitation for companies to seriously commit to reducing their GHG emissions.

Regarding stock volatility, the GARCH with trend model suggests that both committing and setting a target had a significant negative effect. The fixed effects model finds a negative impact on stock volatility if we do not differentiate between companies committed and those with a target. This effect seems to be driven by the companies that commit to setting a target. Once they have committed, setting a target does not alter price volatility in a significant way. This result is more consistent with the fact that ESG factors, particularly GHG mitigation strategies reduce market risks and, hence, may be more important for long-term investing opportunities.

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A Appendix. SBTi Database Collection Process

Since 2015, more than three thousand companies and financial institutions have joined the Science-Based Targets (SBTi) initiative to reduce emissions. The registry of all companies that have joined the initiative is available to the public on SBTi's website. Among the included information, perhaps the most important is the status of the companies' short-term targets. Companies are divided into two categories: target set and committed. A company that has set a target has defined clear pathways to reduce its greenhouse gas emissions, which SBTi has validated.

On the other hand, a company in the committed category has demonstrated its intention to develop a target and submit it for validation in less than 24 months. As mentioned in Section 3, we accessed the SBTi's dataset twice, first in May 2021 and again in May 2022. It allowed us to build a historical account of the evolution of member companies' status when they transition from being committed to having a defined emissions reduction target. This record is an essential contribution of our research, especially given that SBTi does not track such changes. In order to harvest the information for our research purpose, we made certain modifications.

First, since our work focuses primarily on the market effects of SBTi target setting or commitments, our interest was limited to publicly traded companies and information available from January 1st, 2015, to May 30th, 2022. When accessed in May 2021, we identified 796 publicly traded companies with a Bloomberg ticker and available price information. Subsequently, in May 2022, the SBTi's base contained 3062 companies. Of these, 1459 firms satisfied the criteria to be part of our dataset; 796 were the same firms identified a year earlier, and 663 were new firms. For the 796 companies, namely the old database, we updated the price series and status if changed from committed to having a target. For the other 633 companies, we retrieved the entire price series. Upon closer examination, we removed 56 companies from the 1,459 in our sample because they either had suspended tickers or a minor trading frequency or were acquired by another company. In addition, we detected that for three companies, the Bloomberg ticker had changed over time; in this case, we updated the price series with the new ticker.

Next, we ensured that there was no missing price data for the remaining companies in the 30 days before and after their commitment, target setting, or change from commitment to having a target. Among our sample, 24 companies did not satisfy the criteria and were excluded from the dataset. As a result, our final sample consists of 1379 firms.

Finally, the SBTi database includes 52 different sectors. We grouped these sectors using the two-digit classification of the International Standard Industrial Classification of All Economic Activities (ISIC) and obtained a list of 23 different aggregated sectors across our sample.