Do carbon markets undermine private climate initiatives?

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ABSTRACT

We study commitments to reduce emissions by firms subject to the European Union Emission Trading System (EU ETS), the world's largest cap-and-trade program. Commitments are associated with a drop in the number of carbon allowances surrendered, consistent with firms taking actions to reduce their emissions. However, firms subsequently increase their sales of allowances on the secondary market, transferring the right to pollute to others and potentially leaving aggregate emissions unchanged. Despite this, firms benefit from commitments via higher ESG scores. Our results highlight the need for researchers, practitioners, and policymakers to consider the interaction between carbon markets and private climate initiatives.

Keywords: Climate Finance, Cap-and-Trade Scheme, EU ETS, Sustainability, Investor Engagement, CDP Targets, Waterbed Effect

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Recent years have seen increasing pressure on firms to reduce their greenhouse gas (GHG) emissions. Such efforts originate from a number of sources. Shareholders, for example, incorporate climate risk into their investment processes (Krueger, Sautner, and Starks, 2020) and take actions to induce ESG-friendly policies (Dimson, Karakaş, and Li, 2015, Dyck, Lins, Roth, and Wagner, 2019). Other stakeholders also influence environmental and ESG policies more generally, including customers (Dai, Liang, and Ng, 2021) and lenders (Houston and Shan, 2022). These efforts have achieved a degree of success, with an increasing number of firms voluntarily committing to reduce carbon emissions (Bolton and Kacperczyk, 2023).

In this paper, we examine whether firms' transactions in carbon markets undermine the effectiveness of their commitments to reduce GHG emissions. Firms often make such commitments not only to lower their own emissions but also to contribute to reducing aggregate emissions.[1] For example, Veolia, a French company that offers water and waste management services, touts its environmental program as "helping meet the climate challenge by acting to decarbonize our societies."[2] However, many firms, including Veolia, operate in jurisdictions with cap-and-trade programs that allow them to transfer the right to pollute to others via secondary markets. We examine whether firms making climate commitments engage in such transactions, effectively negating the impact of their reduction efforts.

Our analysis centers on firms' transactions in the secondary market for carbon allowances in the European Union Emissions Trading System (EU ETS), the largest cap-and-trade program in the world. Under this program, firms must surrender allowances each year based on their GHG emissions. If firms that commit to lower emissions succeed, they will, all else equal, need to surrender fewer allowances. If such firms sell their excess permits via secondary markets, the global benefits of unilateral commitments are undermined, since the right to pollute is simply transferred to another entity within the EU. In other words, to the extent that firms sell their excess permits, private climate initiatives affect who emits but

[1] Approximately 40% of firm commitments state an intention to reduce Scope 3 emissions, implying a goal of reducing aggregate GHG emissions above and beyond what is achieved by existing regulations.

[2] Source: Combating pollution and accelerating ecological transformation.

not the aggregate level of emissions under the EU ETS.

In environmental economics, this idea is referred to as the "waterbed effect," because, much like a waterbed, a decrease in one area mechanically leads to an increase in another (Perino, 2018, Perino, Ritz, and Van Benthem, 2019). While this idea has been explored theoretically, empirical evidence supporting it remains limited.[3] In this paper, we provide the first empirical evidence of the waterbed effect as it relates to firms' voluntary carbon-reduction commitments.

Our empirical strategy compares secondary market transactions for firms that made a commitment with a matched sample of firms that did not. We use a stacked difference-in-differences estimator to address issues arising from the staggered nature of these commitments (Goodman-Bacon, 2021). Commitment data are from the Carbon Disclosure Project (CDP) and Science-Based Targets Initiative (SBTi). The main outcomes of interest—verified emissions, surrendered allowances, and net sales of allowances—are derived from data provided by EUETS.info, a cleaned version of the European Union Transaction Log (EUTL), which offers historical allowance transactions with a four-year lag. Our sample begins in 2008, the start of Phase II of the EU ETS, and ends in 2020, the final year for which we have data and corresponding to the end of Phase III of the program.[4]

Similar to Bolton and Kacperczyk (2023), we find that the likelihood of firms in our sample undertaking a voluntary commitment correlates with firm-level characteristics, highlighting that these initiatives are firm choices and not randomly determined. For instance, firms with higher sales and R&D expenditures are more likely to make commitments. For our main analysis, we use a propensity score-matched sample to ensure that treated and untreated firms are balanced along observable dimensions.

We also find that commitments are associated with a reduction in future emissions of

[3]This idea is related to the notion that firms may shift emissions to other jurisdictions in response to environmental regulations (Bartram, Hou, and Kim, 2022, Ben-David, Jang, Kleimeier, and Viehs, 2021). However, the waterbed effect implies that emissions will remain unchanged within the same regulatory framework.

[4]Phase I of the program was largely experimental. See Section 1.2 for institutional background.

21 to 35 thousand tons per year, representing a decrease of 9% to 15% relative to the sample mean. While we cannot entirely rule out unobservable differences between treated and untreated firms, our analysis shows little evidence of a pre-trend in emissions before a commitment, supporting the parallel trends assumption. Additionally, this reduction in emissions is accompanied by a decrease in the number of surrendered allowances. The change in surrendered allowances closely matches the change in emissions. Although this alignment is expected—given that the ETS requires firms to surrender allowances equal to their GHG emissions—it is a necessary condition for observing the waterbed effect.

The key question we consider is how firms adjust their behavior in secondary markets following a reduction in surrendered allowances. One possibility is that firms increase their net sales of allowances, either by buying fewer or selling more. Managers of such firms may have "non-consequentialist" preferences, deriving a non-pecuniary loss from their own emissions but not from aggregate emissions. By boosting net sales, firms increase the supply of allowances available for purchase by others, potentially lowering the equilibrium price of carbon and incentivizing higher emissions by other firms. In this scenario, private initiatives to reduce emissions may not impact the overall level of emissions. We develop a stylized model to illustrate this logic. Alternatively, if firms internalize the spillover effects from secondary markets, they might choose to voluntarily cancel allowances. This would reduce the supply of allowances available on the secondary market and keep the price of carbon stable.

Our findings are consistent with the above framework. We find that commitments are associated with an increase in the net sales of allowances. This effect is robust to various specifications, including controlling for the number of free allowances granted to firms. We do not find evidence of differential trends for treated and untreated firms prior to commitments. The increase in net sales primarily results from higher sales rather than reduced purchases. The economic magnitude of the effect on allowance sales is approximately three times that of the reduction in surrendered allowances. This larger estimate for sales might indicate weaker incentives for firms to "bank" (i.e., store) allowances across years. However, both estimates have relatively wide confidence intervals, and we cannot reject the null hypothesis that they are equal. Additionally, we find no evidence that commitments lead to firms canceling allowances rather than selling them; the point estimates for voluntary cancellations are both economically small and statistically insignificant across most specifications.

Finally, we investigate why firms undertake commitments to reduce emissions but subsequently sell the right to pollute to others. One possibility is that managers receive either pecuniary or non-pecuniary benefits from lower emissions, even if they do not necessarily affect aggregate emissions. To explore this idea, we examine firms' ESG scores, focusing on MSCI ratings, which prior literature suggests are utilized by institutional investors and influence their behaviors (Berg, Heeb, and Kölbel, 2022, Pástor, Stambaugh, and Taylor, 2022). We find that commitments are associated with significant increases in MSCI ratings related to climate, as well as an overall increase in ESG ratings. Managers may benefit from these higher ratings, for instance, by attracting institutional investment (Gibson, Glossner, Krueger, Matos, and Steffen, 2022).

Overall, our findings suggest that firms' commitments to reduce GHG emissions may not achieve their intended goals. Private initiatives, though potentially well-intentioned, might be undermined by firms' actions in secondary markets for carbon allowances. Our results indicate that the reduction in emissions associated with commitments is entirely offset by increased selling of allowances. Without regulatory or market mechanisms to "puncture the waterbed," the welfare benefits of private emissions reduction initiatives remain uncertain (Perino, Ritz, and Van Benthem, 2019). These findings underscore the importance for researchers, practitioners, and policymakers to account for the interaction between carbon markets and private initiatives when designing or evaluating strategies to reduce corporate emissions.

Our work contributes to several areas of the literature. First, it advances the growing body of research on firm commitments to improve environmental performance and sustainability practices. Bolton and Kacperczyk (2023) is closely related to our study. They provide the first description of the rise and prevalence of firm commitments to decarbonize globally and suggest that such commitments lead to a reduction in carbon emissions. We successfully replicate their findings that firms' verified emissions fall in the EU, but show that the same firms reduce their usage of pollution allocations by an equivalent amount and sell off the permits they no longer use. Related research explores how decarbonization commitments impact bank lending (Kacperczyk and Peydró, 2022, Sastry, Verner, and Ibanez, 2024). Additionally, several studies studies use public commitments from the Carbon Disclosure Project or the Science Based Targets Initiative to measure climate ambitions (e.g., Dahlmann, Branicki, and Brammer, 2019) or use these commitments as proxies for future abatement activities (e.g., Ramadorai and Zeni, 2024). Our findings suggest that profit-maximizing behavior in the secondary market for carbon allowances can undermine the effectiveness of these commitments.

Another area of research examines the role of institutional investors in propagating ESG policies. Dyck, Lins, Roth, and Wagner (2019) provides evidence that institutional investors influence ESG scores, while other studies show that "socially-oriented" institutional investors are associated with lower emissions (e.g., Dasgupta, Huynh, and Xia, 2023, Naaraayanan, Sachdeva, and Sharma, 2021, Kim, Wan, Wang, and Yang, 2019, Kahn, Matsusaka, and Shu, 2023). Our results contribute to understanding the efficacy of investor actions to reduce emissions. Previous research has explored conditions under which shareholder engagement effectively reduces emissions (e.g., Gollier and Pouget, 2014, Chowdhry, Davies, and Waters, 2019, Broccardo, Hart, and Zingales, 2022, Oehmke and Opp, 2024), the interaction between government and firm policies (e.g., Biais and Landier, 2022, Bustamante and Zucchi, 2024, Hsu, Liang, and Matos, 2023, Bellon and Boualam, 2024), and the role of "green" financing in reducing corporate emissions (e.g., Zerbib, 2019, Flammer, 2021, Barbalau and Zeni, 2022, Green and Vallee, 2024). To the best of our knowledge, existing research has not yet explored the possibility that reductions in emissions could be offset by transactions in the secondary market for allowances, thereby mitigating their overall impact on the climate.

Another important strand of literature studies how the design and enforcement of environmental regulations affect firms' environmental behaviors. For example, Akey and Appel (2021) and Bellon (2021) study how various form of limited liability reduce firms' emissions. Other work concludes that cap-and-trade regulation impacts corporate policies and performance (Bartram, Hou, and Kim, 2022, Dang, Gao, and Yu, 2023, Dardati and Riutort, 2016, Bushnell, Chong, and Mansur, 2013, Commins, Lyons, Schiffbauer, and Tol, 2011) as well as bank lending (Ivanov, Kruttli, and Watugala, 2024). Work in environmental economics suggests that the EU ETS may engender a waterbed effect (e.g., Perino, 2018, Perino, Ritz, and Van Benthem, 2019), although empirical evidence supporting this phenomenon remains sparse.

Finally, this paper contributes to the literature studying how firms might outsource or divest pollution-intensive assets, potentially undermining efforts to reduce overall pollution. Ben-David, Jang, Kleimeier, and Viehs (2021) find that firms in countries with strict pollution regulations often relocate their emissions-intensive operations abroad. Similarly, Dechezleprêtre, Gennaioli, Martin, Muûls, and Stoerk (2022) and Känzig, Marenz, and Olbert (2024) show that carbon policies in developed countries can lead to increased emissions elsewhere due to economic shifts. Duchin, Gao, and Xu (2023) and Berg, Ma, and Streitz (2023) demonstrate that firms facing external pressure to improve environmental performance may sell off dirty assets to entities facing less pressure. Our work highlights a distinct mechanism by which emission reduction efforts may fall short: transactions in the secondary market for allowances can undermine firms' stated intentions to reduce aggregate emissions beyond would would happen anyway under current regulations.

1 Hypothesis development and institutional setting

We now develop a series of hypotheses about the interactions between private actions to reduce emissions and emissions trading that give risk to a waterbed effect and provide a brief overview of the EU ETS design.

1.1 Hypothesis development

The waterbed effect refers to unintended increases in emissions that result from actions taken by a subset of participants in a cap-and-trade system to reduce emissions. An emerging theoretical literature in environmental economics explores this concept in the context of the EU ETS, often focusing on the interaction between country-level regulations and emissions trading. This literature shows that, theoretically, laws or regulations intended to reduce emissions in one country can alter the relative costs and benefits of emissions reductions in other countries subject to the EU ETS, potentially leaving aggregate emissions unchanged. A similar spillover effect can occur when firms independently take actions to reduce their own emissions without considering how subsequent secondary market transactions might impact the emissions of peer firms. In Internet Appendix Section A1, we present a stylized model illustrating this idea and summarize two key testable implications.

We assume that firms operate in a cap-and-trade system where they are endowed with pollution rights. Firms maximize profits by either paying an increasing and convex abatement cost or by purchasing allowances on secondary markets. Firms take the carbon price as given. The carbon price equalizes firms' demand and supply of permits where the price of these rights is determined in equilibrium. One group of firms is purely profit motivated while the other group derives a non-pecuniary loss from its own emissions but not from aggregate emissions. Such preferences have been referred to as "non-consequentialist." Existing empirical evidence suggests that many investors exhibit such preferences (Bonnefon, Landier, Sastry, and Thesmar, 2022, Dangl, Halling, Yu, and Zechner, 2023).

Green but non-consequentialist firms choose to pollute less, even when they face higher marginal costs than firms without such preferences. Crucially, because they only derive utility for reducing their own emissions, they do not consider spillovers generated by selling excess pollution rights to other firms. As prices are an equilibrium quantity and green firms pollute less than is economically efficient while selling excess allowances, we observe an increase in the supply of allowances on secondary markets. This, in turn, lowers the price of emissions below the level that would be set in a world without such preferences or by a regulator.

This framework leads to two testable predictions: firms with green preferences will simultaneously (1) reduce their own emissions and (2) sell off an equivalent amount of allowances on secondary markets. Our empirical analysis uses emissions-reduction commitments as an event representing an increase in green but non-consequentialist preferences. We examine the effects of commitments on emissions and allowance transactions to test these predictions.

1.2 European Union Emissions Trading System

The EU ETS is a cornerstone of environmental policy in Europe. Introduced in 2005, the program aims to meet emission reduction targets established by the Kyoto Protocol. Emissions are regulated at the installation level, covering sites such as plants or factories that generate heat or electricity or operate in energy-intensive sectors, such as metal production, cement, glass, and paper manufacturing. The program encompasses over ten thousand installations across EU member states, as well as Iceland, Liechtenstein, and Norway, collectively accounting for approximately 40% of greenhouse gas emissions in Europe.[5]

The EU ETS implements a cap-and-trade scheme, which aims to incentivize reductions in emissions while providing flexibility in how reductions are achieved. Under this system, firms must surrender allowances (known as EU Allowances, or EUAs) corresponding to their GHG emissions each year, with one allowance equal to one ton of CO2. Firms both

[5] https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/what-eu-ets_en

receive free allowances and can purchase them via auctions or the secondary market. The aggregate number of allowances, and thus the aggregate emissions of regulated entities, decreases each year. Installations are required to submit an emissions report each year, with emissions measured using an approved monitoring plan. Reported emissions are verified by third-party auditors and monitored by regulators to ensure compliance, helping to address concerns related to "non-assurance" for carbon emission data (Berg, Oliver Huidobro, and Rigobon, 2023).

The emissions cap and the number of freely allocated allowances have undergone significant changes across the four phases of the ETS program:

- Phase I (2005 to 2007): Phase I was a trial period during which upwards of 95% of allowances were freely granted. Up to 5% of allowances could be auctioned off.

- Phase II (2008 to 2012): Phase II lowered the total cap on allowances by 6.5%. Freely allocated allowances totaled 90%, with up to 10% auctioned off.

- Phase III (2013 to 2020): In Phase III, the emissions cap was decreased by 1.74% per year, with the goal of reducing emissions by 21% in 2020 compared to 2005. The majority of allowances (57%) were auctioned, with the remaining freely allocated.

- Phase IV (2021 to 2028): In Phase IV, auctioned allowances remained at 57%, but the total number of allowances decreased at an accelerated rate (2.2%).

The methods used to determine free allowances have also evolved over the phases of the program. In Phases I and II, free allowances were allocated based on historical emissions, a method known as "grandfathering." Starting in Phase III, the ETS set benchmarks for carbon emissions for each product produced by ETS firms. These benchmarks were based on the GHG emissions of the most efficient 10% of installations for manufacturing a product. Additional free allowances were provided to industries at higher risk of "carbon leakage," where external competition from regions without comparable regulations could undermine the EU's climate policies. Phase IV continued the benchmarking approach but with a stronger emphasis on industries at risk of relocating operations outside the EU. During Phase IV, free allowances will be gradually phased out for sectors with a low risk of carbon leakage.

Firms with insufficient free allowances to cover the verified emissions of their installations can purchase additional allowances via primary market auctions. Allowances available for auction are allocated to member states based on historical emissions. Most countries use a common platform, the European Energy Exchange (EEX), for these auctions, which are held weekly on Mondays, Tuesdays, and Thursdays.[6] Prices are determined through a single-round uniform price auction, where all winning bidders pay the lowest price accepted. In 2019, auction revenues totaled EUR 14 billion. ETS rules stipulate that at least half of auction proceeds must be used for climate or energy-related purposes. In 2019, the EU started operating the Market Stability Reserve (MSR) to manage the number of allowances available for auction. Under this system, the difference between the total number of allowances issued and verified emissions since 2008 must fall within a range of 400 million to 833 million. If not, additional allowances can be withdrawn from auction volumes or released from a reserve fund. This policy was introduced to address a "supply overhang" of allowances caused by reduced economic output following the financial crisis (ICIS, 2020).

Firms can also obtain allowances via spot or futures markets. The bulk of trading occurs on exchanges. In 2019, for example, 5,823 million tons (equivalent to EUR 145 billion) of allowances were traded on exchanges (both spot and futures), compared to 360 million tons (EUR 9 billion) in OTC transactions and 589 million tons (EUR 14 billion) allocated via auctions. The Intercontinental Exchange (ICE) is the venue with the most liquidity, accounting for upwards of 95% of volume in 2019. Non-compliance entities (i.e., banks, brokers, hedge funds) potentially play an important role in secondary markets by providing liquidity and enhancing price informativeness. One study estimates that financial actors

[6]Germany and Poland use alternative platforms. Germany holds auctions every Friday, and Poland holds auctions every other Wednesday. See https://climate.ec.europa.eu/news-your-voice/news/2024-eu-ets-auction-calendars-published-2023-12-21_en

constitute up to 65% of participants in secondary markets.[7]

The effects of EU ETS, and cap-and-trade systems more generally, on emissions have received considerable attention in the literature. For example, Dechezleprêtre, Nachtigall, and Venmans (2023) and Colmer, Martin, Muûls, and Wagner (2024) find that the program is associated with drop in emissions of approximately 10% and 16%, respectively. A number of studies examine the effects of the ETS program across individual countries, finding mixed results (e.g, Calel and Dechezleprêtre, 2016, Petrick and Wagner, 2014). Bai and Ru (2024) provide cross-country evidence that emission trading programs reduce carbon emissions by 18%, an effect larger than that of carbon taxes.

2 Data and empirical strategy

2.1 Data

We obtain data from several sources. Our sample begins in 2008 and runs through 2020, which is the last year for which data from the EU ETS is publicly available. We overview each data source below and present summary statistics in Table 1.

2.1.1 Firm commitment data

We collect information on firms' commitment from two distinct sources: the Carbon Disclosure Project (CDP) and science-based targets (SBTi). The CDP started collecting this information in 2011 by asking participants several questions regarding potential CO2 reduction targets. More recently, SBTi started to collect more formalized Co2 commitments. A SBTi commitment is compatible with a net-zero path implied by the Paris Agreement. These commitments are subject to approval by an external committee, and companies must submit annual updates on their commitments. The CDP provides interesting information about why firms adopt these commitments. The pressure from external stakeholders, such as investors, and consumers, appear like an important factor. For instance, a company in our

[7] See https://www.europarl.europa.eu/RegData/etudes/STUD/2022/740052/IPOL_STU(2022)740052_EN.pdf

sample stated that “We recognize the climate-related risks and opportunities may impact our products; if we do not take action to address climate change, there may be less demand for our products (...) we set climate-specific goals through our Science Based Target (...), further demonstrating our commitment to combating climate change.”

We focus on commitments that aim to reduce pollution in the intensive and extensive margin. We do so for several reasons. The first reason is that conceptual: these commitments are multidimensional and therefore stronger and more verifiable by external stakeholders. This guarantees that the shock we are looking at is substantial enough to observe an effect. The second reason is measurement: without high-quality production data, it is difficult to measure a pollution reduction purely on the intensive margin. Moreover, this allows us to look at changes in pollution in ratio and level interchangeably.

We download the history of all committed firms from the SBTi and manually search the commitment year from the CDP by looking directly at the company disclosure forms. It is common for a company to start by disclosing a target in the CDP and then submitting an SBTi commitment. We use the first year of commitment as the year where a target was first submitted when this occurs. We have identified 100 firms that made a commitment during our sample period and had also an installation regulated by the EU ETS. Figure 1 shows the time series of commitments undertaken in our sample, both in terms of the number of firms (Panel A) and weighted by total assets (Panel B).

2.1.2 EU ETS

We obtained account-level EU ETS allocation (EUA), transaction, compliance, verified emissions, free allocations, and surrender data from EUETS.INFO, a pre-cleaned version of the original European Union Transaction Log (EUTL)[8]. The EUTL data is publicly available. Ownership details were retrieved from the Bureau van Dijk (BvD) Orbis database, while global firm-level accounting variables were sourced from Factset. Additionally, we collected

[8] European Union Transaction Log

data on firm commitments to reducing carbon emissions. Our sample period spans from 2005, marking the start of the EU ETS, to 2020, which marks the conclusion of its third phase. Every participant in the EU ETS must maintain at least one account within the EUTL, and in many cases, several (European Commission 2013). Each account type serves a distinct purpose. As outlined in Abrell (2022), we identify the account type through a numerical code that indicates the account's function. For instance, a company with multiple stationary installations might have a separate Operator Holding Account (OHA) primarily used for compliance purposes, along with additional accounts for trading and participating in auctions. Each account has an owner called the account holder.

When firms own several installations, they have multiple OHAs — one for each installation — but only one trading account to manage all carbon permits, usually all held by the same account holder. Each of these accounts must be embedded in the national registry of one of the participating countries, primarily to facilitate the accounting and administration of carbon permits. Other account types include Personal Holding Accounts (PHAs), which can be owned by financial institutions or individuals to participate in the EU ETS without necessarily being regulated. For completeness, although not directly relevant to this study, we also observe transactions involving Administrative Holding Accounts (AHAs), which are mostly used to manage the total supply of carbon permits in the market and for compliance activities such as surrendering units.

In total, the EU ETS data contains approximately 43,000 unique accounts held by 18,239 account holders. Several accounts are inactive, either because a participant closed the account, or due to a change in legislation between Phase 1 and 2 where accounts had to close at the end of Phase 1 in 2007 and reopen with a different account number starting in Phase 2. At the end of our sample period, around 15,500 accounts are open. We are able to link each OHA (active or not) to an installation, which allows us to keep track of all transactions and compliance activities of an installation and its owner over the full sample period.

2.1.3 Ownership

In our analysis, we focus on the buying and selling behavior of regulated installations. The Joint Research Centre (JRC) of the European Commission publicly provides a linking file between regulated installations and the firms that own them. This mapping is already included in the account data file from EUETS.INFO, and further information on the matching methodology is available directly on the JRC website. The firm directly owning an installation is identified by its Bureau van Dijk (BvD) Orbis number. For each firm, we download ownership information regarding the firm's direct shareholder, its domestic ultimate owner (DUO), and its global ultimate owner (GUO). In addition, we retrieve financial information for each firm and its owners. Finally, data identifying the firms, such as an ISIN number, help us match the EU ETS data with global Factset variables and the commitment data. We limit the analysis to publicly listed global ultimate owners.

2.1.4 Firm fundamental data

Using the ISIN number, we match installation-level EU ETS data and BVD Orbis ownership information with Factset to add firm-level control variables. Our matched sample containing data on EU ETS installations, Factset control variables and commitment data, includes 404 publicly listed global ultimate owners. One GUO can own more than one installation. The transaction behavior is likely impacted by the current price of carbon. Therefore, we download weekly EU ETS carbon prices and calculate the average price per year. Annual country-level GDP data is downloaded from the World Bank's website. Variables from Factset include accounting variables such as total assets, returns on assets, leverage, amongst others, and the market valuation of a GUO. Lastly, we obtain aggregate ESG ratings and scores for individual pillars such as climate change from MSCI.

2.2 Empirical strategy

Our goal is to understand the extent to which private initiatives to reduce emissions are associated with changes in firms' transactions in carbon markets. While, in principle, we could study any corporate policy aimed at reducing total emissions, we focus on changes in firms' actions related to carbon-reduction commitments for three key reasons. First, this setting provides a discrete event around which we can employ an event-based research design, with clear "pre" and "post" periods, rather than relying on cross-sectional changes in emissions activities and permit trading. Second, these commitments are publicly communicated to financial markets, and independent third parties verify the extent to which firms are making progress toward their stated goals, so they are likely to be salient to firms. Third, environmentally motivated shareholders and other stakeholders invest significant resources in engaging with firms to encourage them to make these commitments. Therefore, our findings have important implications for practitioners and regulators regarding efforts to influence firms' environmental behaviors.

We do not necessarily test the causal effect of firm commitments on emissions; rather, we aim to understand the extent to which firms' emissions reductions are offset by their transactions in the market for pollution permits. Clearly, commitments are firm choices, and unobservable, time-varying characteristics may correlate with firms' decisions to make a commitment. Moreover, such causal reasoning could be complicated by concerns of reverse causality: firms may have planned profit-maximizing future capital expenditures on cleaner technology and made a commitment knowing that emissions would have declined regardless.

Our empirical strategy compares the emissions of firms that made a commitment to a matched sample of firms that did not in the following years. We use a stacked differences-in-differences estimation methodology to avoid the problems with staggered implementation recently highlighted by Goodman-Bacon (2021) and De Chaisemartin and d'Haultfoeuille (2020) among others. Our analysis combines verified emissions data from individual facilities regulated by the EU ETS with carbon allowance transaction data, enabling us to directly study the extent to which reductions in verified emissions are offset by secondary market transactions. We control for a number of potential confounding factors, including the adoption of country-specific regulations that vary over time.

Specifically, we estimate the following regression:

$$y_{i,p,t} = \beta_1 \times Commitment_{i,t} + \beta_2 \times Free\ Allowances_{p,t} + \alpha_p + \alpha_{c,t,j} + \varepsilon_{i,p,t}. \tag{1}$$

$y_{i,p,t}$ represents emissions or trading behavior in the EU ETS for plant p, in year t, belonging to firm i. Our main variable of interest is $Commitment_{i,t}$, which takes the value of one in years after firm i made a CDP or SBTi commitment to reduce emissions volume and intensity, and is zero otherwise. $Free\ Allowances_{p,t}$ is a control variable for the (pre-determined) number of allowances that plant p was granted in year t. $\alpha_{c,t,j}$ is a fixed effect that controls for time-varying effects in industry j, and has been interacted with variable denoting the commitment cohort, c, which allows to estimate the stacked difference-in-differences model.[9] We augment this specification to include country times year fixed effects that are interacted with cohort to ensure that country-specific regulatory changes do not confound the analysis. We cluster standard errors by firm since commitments vary at the firm level.

While propensity score matching allows us to identify observationally similar control firms, it substantially reduces the number of firms in our sample. We verify the robustness of our findings by estimating our results on the full sample using the methodology of Borusyak, Jaravel, and Spiess (2024). The similar effects obtained using both methodologies collectively cast doubt on omitted variables or reverse causality as explanations for our results.

[9] See Cengiz, Dube, Lindner, and Zipperer (2019) and Gormley and Matsa (2011) for other examples of similar stacked difference-in-differences estimators.

3 Main results

Our analysis has three main components. First, we examine the characteristics of firms that make commitments to facilitate propensity score matching to identify control firms for our main analysis. Second, we test whether plant-level emissions decline following firms' commitments, which is a necessary condition to show that private actions to reduce emissions are potentially "undone" by the market for carbon allowances. Third, we test whether firms' transactions in the secondary market for allowances are consistent with the waterbed effect, focusing on changes in net sales and voluntary cancellations of allowances.

3.1 Determinants of commitments

We first examine the characteristics of firms that undertake commitments to reduce emissions. We compare the characteristics of firms that made a commitment to those that did not in Tables 2 and 3. Tables 2 presents a linear probability model comparing firm-level characteristics in the year prior to a commitment for firms that made a commitment versus the full sample of firms without a commitment. Firms that make commitments differ on several dimensions, although the overall economic magnitudes are relatively modest. For instance, they are slightly smaller, have slightly less cash, and lower R&D expenditures, but do not show significant differences in profitability or leverage. As we described in Section 2.2 we conduct propensity score matching using model (1) of Tables 2 to select firms that are the most similar along observable dimensions.

Table 3 presents univariate comparisons of firms that make commitments and those that do not before and after matching. The results in panel 3a largely confirm the findings of the OLS estimation in Table 2, while the results in Panel 3a show that the observable differences between treated and untreated firms disappear after matching, suggesting that the matched sample serves as a plausible control group, at least along observable dimensions.

3.2 Commitments and verified emissions

We next examine how verified emissions change in the years following a firm commitment. The results presented in Table 4 show that commitments are associated with a drop in plant-level emissions, a finding that is consistent with Bolton and Kacperczyk (2023). Panel 4a presents results for the level of emissions, while Panel 4b presents estimates for emissions that have been standardized and multiplied by 100 so that the coefficients can be interpreted as percentage points of a standard deviation. In panel 4a we find that facility emissions decline by an average of 21 to 35 thousand tons per year, about 9 to 15% relative to the sample mean. The decline is relatively stable across specifications with increasingly stringent fixed effects. Notably, the magnitudes are generally robust to the inclusion or exclusion of control variables. While the economic effect is substantial relative to the mean emissions, there is considerable dispersion in emissions across different facilities. Panel 4b reports results that are consistent in sign and statistical significance with panel 4a, but with a smaller economic interpretation owing to the large standard deviation in verified emissions. Specifically, emissions fall by 2.14 to 4% of a cross-sectional standard deviation of total emissions.

Given that we have constructed a matched sample in which there are no observable differences between our treatment and control groups we believe that it is plausible that their emissions and activities in the market for pollution permits plausibly followed parallel trends. We provide evidence that is consistent with this idea. Figure 2 presents the year-by-year difference in emissions for treatment and control firms in the years before and after a commitment. Emission levels remain similar between the two groups until the commitment is made, after which emissions begin to fall for treated firms. These results support the parallel trends assumption and cast doubt on the alternative interpretation that firms were already experiencing a downward trend in emissions unrelated to commitments.

3.3 Commitments and emissions trading

Having established that emissions fall after firms make commitments, we next turn our attention to how these commitments affect the use and trading of carbon allowances in secondary markets.

3.3.1 Carbon allowance surrender

We first show that the reduction in emissions documented above manifests in the data as a reduction in allowances surrendered. According to ETS rules, facilities must surrender a number of allowances corresponding to their GHG emissions in tons. Thus, a drop in emissions should mechanically lead to a drop in allowances surrendered. We find that this is indeed the case, with the reduction in surrendered allowances nearly identical to the reduction in emissions. Table 5 provides evidence that the statistical and economic significance are comparable, while Figure 3 shows that the dynamics for emissions and carbon allowance surrender are similar.

This result serves two purposes. First, as described above, the EU ETS trading data is a large and complex dataset, so this finding provides evidence that we correctly characterize firms' transactions in the market for carbon allowances. Second, it shows that private actions, such as firm commitments to reduce emissions, interact with the use of allowances. This interaction affects the supply of and demand for allowances and, consequently, the equilibrium price of carbon, which is a necessary condition for the waterbed effect.

3.3.2 Allowance sales and purchases

Having established that firms surrender fewer allowances after they credibly commit to reducing emissions, we next examine what firms do with the pollution allowances they no longer need. Each year, firms receive an annual endowment of allowances, which does not vary in the short term based on their emissions reduction commitments. There are several potential actions firms might take with these excess allowances. First, firms could sell their excess allowances to other entities, either for operational needs or financial gain. Second, they could cancel them, effectively destroying a valuable resource. Third, they could store ("bank") allowances for future use, as they generally have a long maturity, although the ability to store allowances varied across different phases of ETS implementation. Given that the stock of allowances is set by the European Commission, the third option is essentially the residual outcome of the first two. Our analysis of trading behavior focuses on the first two actions: whether firms increase their net sales of allowances or they increase their cancellation of allowances.

We first examine whether firms increase their net sales of allowances, as measured by number sold in a given year minus the number purchased. Table 6 reports the results of this analysis. Panel 6a indicates that plants increase their net sales of allowances by 79 to 89 thousand tons per year. On average, firms purchase approximately 15 thousand tons per year (Table 1), so this quantity represents approximately five times the average magnitude of net sales. Our estimates are consistently statistically and economically significant across a variety specifications that vary fixed effects and the inclusion of firm-level controls. Turning to panel 6b, the estimates remain statistically significant when we analyze net sales scaled by the sample standard deviation, implying that the increase in net sales represents 12 to 13% of a standard deviation (multiplied by 100). Figure 4 provides evidence that the dynamics of the effect are consistent with a parallel trends assumption, as with our previous analysis.

While our preferred measure of trading activity is net sales of pollution permits, we separately analyze both sales and purchases in Table 7. Panels 7a and 7b report results for purchases while 7c and 7d report results for sales. We find consistent evidence that sales increase while purchases remain flat after commitments. Thus, our results suggest that facility sell off at least some of their excess allowances following commitments. The economic magnitude of the effect on allowance sales is approximately three times that of the reduction in surrendered allowances. This larger estimate for sales might indicate weaker incentives for firms to "bank" allowances across years. However, both estimates have relatively wide confidence intervals, and we cannot reject the null hypothesis that they are equal.

Finally, we examine whether plants are more likely to cancel their emission rights after committing to reduce emissions. If firms making commitments (or their shareholders) have "consequentialist" preferences—meaning their objective is to reduce aggregate emissions beyond what could be achieved by a cap-and-trade system alone—they might opt to cancel their allowances rather than holding them or selling them to other parties. However, we note that such behavior is relatively uncommon; only 8.52 percent of facility-year observations involve a strictly positive number of cancellations. Our analysis finds little evidence of an increase in cancellations following commitments. The results reported in Table 8 are generally economically small and statistically indistinguishable from zero.

Collectively, our analysis suggests that after firms reduce emissions following their commitments, they monetize these reductions by selling off allowances. Such actions undermine any attempt to reduce aggregate emissions beyond what a cap-and-trade system would achieve on its own. These findings provide the first empirical evidence of the waterbed effect, where private initiatives to reduce carbon emissions are offset by transactions on secondary markets.

3.4 Robustness: Alternative estimator

Recent work has proposed a variety of methodologies to estimate differences-in-differences, although it remains an open question whether any estimator is best (De Chaisemartin and d'Haultfoeuille, 2023). Accordingly we verify that we obtain qualitatively similar results using the estimator developed by Borusyak, Jaravel, and Spiess (2024) applied to the full sample. This test serves to show that our estimates are robust both to widening the sample to include all facilities that operate within the EU ETS and that our estimates are not reliant on the stacked differences-in-differences estimator. Figures A1, A2, and A3 in the Internet Appendix present analogous results to our main results above. They confirm that we observe qualitatively similar findings using this methodology on the full sample.

4 Mechanism: ESG scores

Our findings suggest that both emissions and the use of allowances decrease after firms commit to reducing emissions. However, we also find that these firms sell their excess pollution permits to other entities via secondary markets, potentially reducing or even eliminating the impact of the commitment on aggregate emissions. This raises a natural question: why do managers adopt carbon reduction policies in the first place? One potential answer, as illustrated in our theoretical framework, is that these managers exhibit non-consequentialist preferences—meaning they internalize the benefits of reducing their own emissions but not those of aggregate emissions. In this section, we explore one potential benefit for firms undertaking these commitments: higher ESG scores.

Firms increasingly promote their environmental practices in response to pressure from investors and consumers. Indeed, previous work shows that third-party ESG scores inform decision-making by both shareholders (e.g., Berg, Heeb, and Kölbel, 2022, Gibson, Glossner, Krueger, Matos, and Steffen, 2022) and other important stakeholders (e.g., Albuquerque, Koskinen, and Zhang, 2019, Berg, Heeb, and Kölbel, 2022, Meier, Servaes, Wei, and Xiao, 2023) despite these scores being only weakly correlated (Berg, Koelbel, and Rigobon, 2022) and potentially subject to manipulation by the raters (Berg, Fabisik, and Sautner, 2021). We examine whether firms obtain a higher ESG score following their commitments despite the fact that their decrease in emissions is offset by their actions in the EU ETS market. Our analysis focuses on MSCI scores, as these are widely used by institutional investors (Pástor, Stambaugh, and Taylor, 2022).

Table 9 shows that firm-level MSCI ESG scores are, indeed, higher in years following a firm commitment.[10] Columns (1) and (2) provide suggestive evidence that ESG scores

[10] We note that, owing to the smaller number of firm-level observations than plant-level observations used in our main analysis, we perform this test at the firm level using the full sample of firms with EU ETS installations.

that are higher in the years following a commitment, though this effect is sensitive to the empirical specification. Columns (3) and (4) show that there is a statistically stronger effect for firms' climate scores. Specifically, climate scores increase by 0.45, about 6% relative to the sample mean or 20% of a standard deviation. Given that the scoring criteria of some ESG-rating providers explicitly consider climate or biodiversity commitments, it is perhaps unsurprising that such commitments are associated with higher ESG scores. Managers and firms may benefit from these increases, for example, by attracting institutional investment or new customers. However, our previous findings suggest that the increase in scores reflects private benefits and are not necessarily associated with positive welfare effects.

5 Conclusion

We examine firms' behaviors in carbon secondary markets following the adoption of climate initiatives. Consistent with Bolton and Kacperczyk (2023), we confirm that such commitments are associated with lower future emissions, leading to a reduction in allowances surrendered. In response to needing fewer allowances, we observe an increase in net sales of allowances, driven primarily by a rise in sales rather than a reduction in purchases. However, we find no evidence that firms voluntarily retire allowances.

The above findings are consistent with the waterbed effect—when firms reduce their GHG emissions through voluntary commitments but subsequently increase the sale of carbon allowances, this action effectively shifts the ability to pollute to other entities. Thus, while commitments appear to be successful at reducing emissions for the firms undertaking them, it is not clear that they have *any* effect on aggregate carbon emissions beyond what would be achieved by the EU ETS cap-and-trade policy alone. We find evidence that commitments are associated with an increase in ESG scores related to climate, suggesting that managers may be incentivized to undertake them (e.g., to attract institutional investment) even if these commitments do not lead to meaningful climate impacts.

Our findings have key implications for a wide range of stakeholders. They suggest that pushing firms to reduce GHG emissions does not necessarily lead to a decrease in aggregate emissions. To the extent that institutional investors and advocacy groups invest resources in encouraging firms to make emissions commitments, these efforts may have a net negative effect on welfare if the resources could be more productively used elsewhere. Effective climate policies must therefore account not only for firms' operational emissions but also for their activities in secondary carbon markets. This approach ensures that voluntary commitments translate into real, measurable reductions in global emissions, rather than merely shifting the burden between firms or markets.

Arguably, the ETS has made some progress in this regard. For example, Perino (2018) argues that rules adopted in 2017 for Phase IV of the ETS, which started in 2021—after our sample period—help to mitigate the waterbed effect by implementing changes to the Market Stability Reserve (MSR). However, Perino cautions that "this puncture, however, is incomplete: abating one ton of CO2 emissions results in an emissions reduction of less than one ton. It is also temporary. The full waterbed effect returns in a few years' time." Our findings underscore the potential benefits of effective regulatory interventions to mitigate the waterbed effect by enhancing the aggregate impacts of firms' private climate initiatives.

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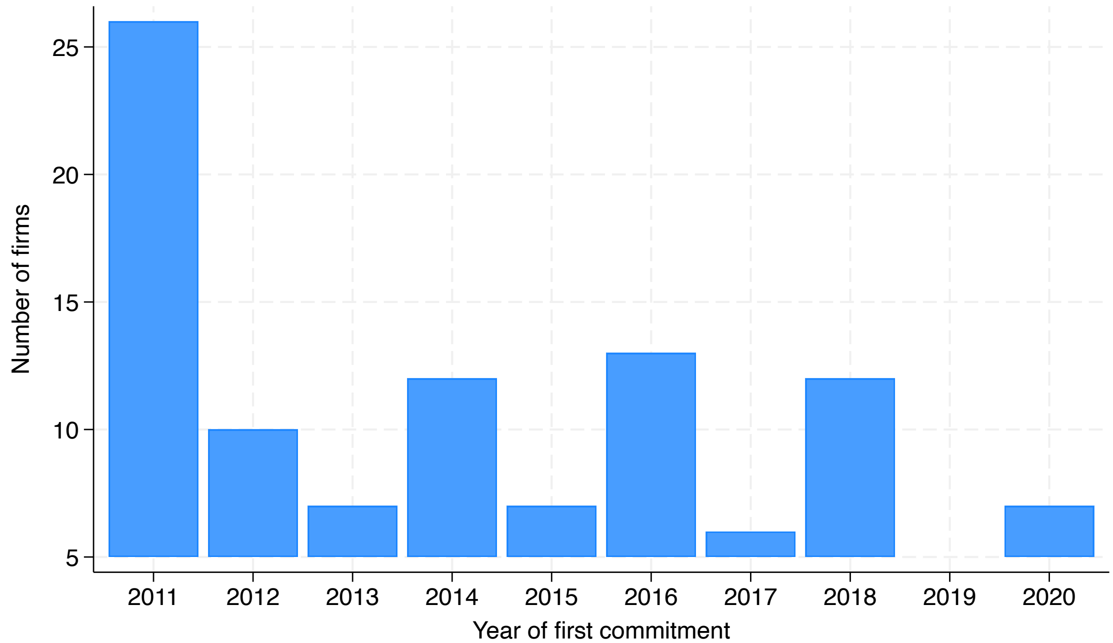
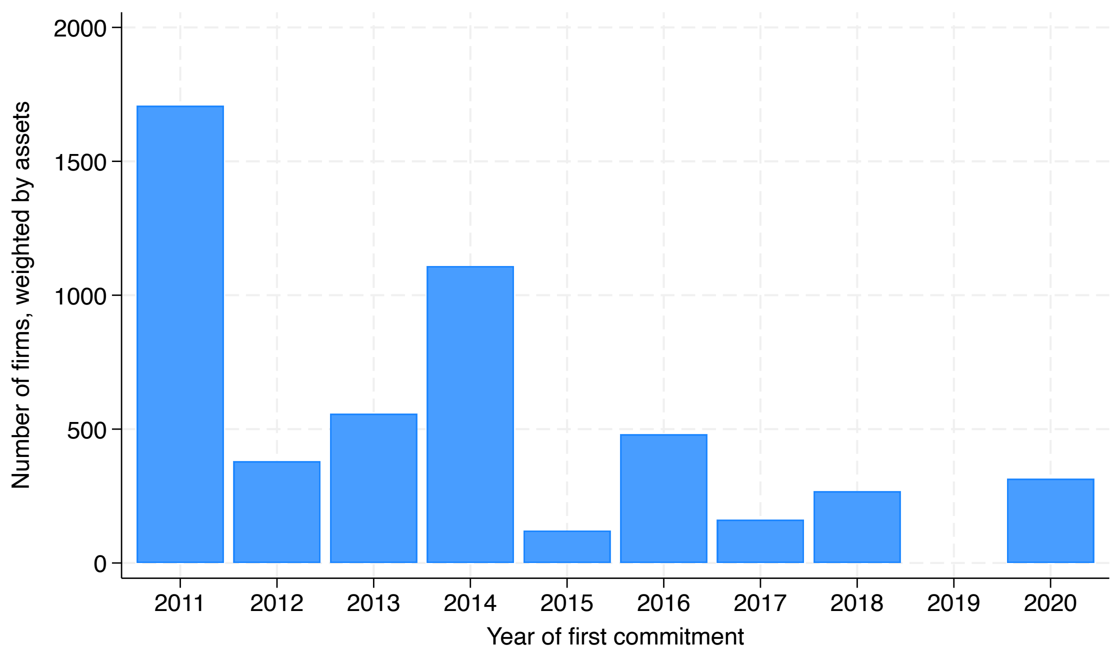
Figure 1. Commitment Time Series

Panel A:

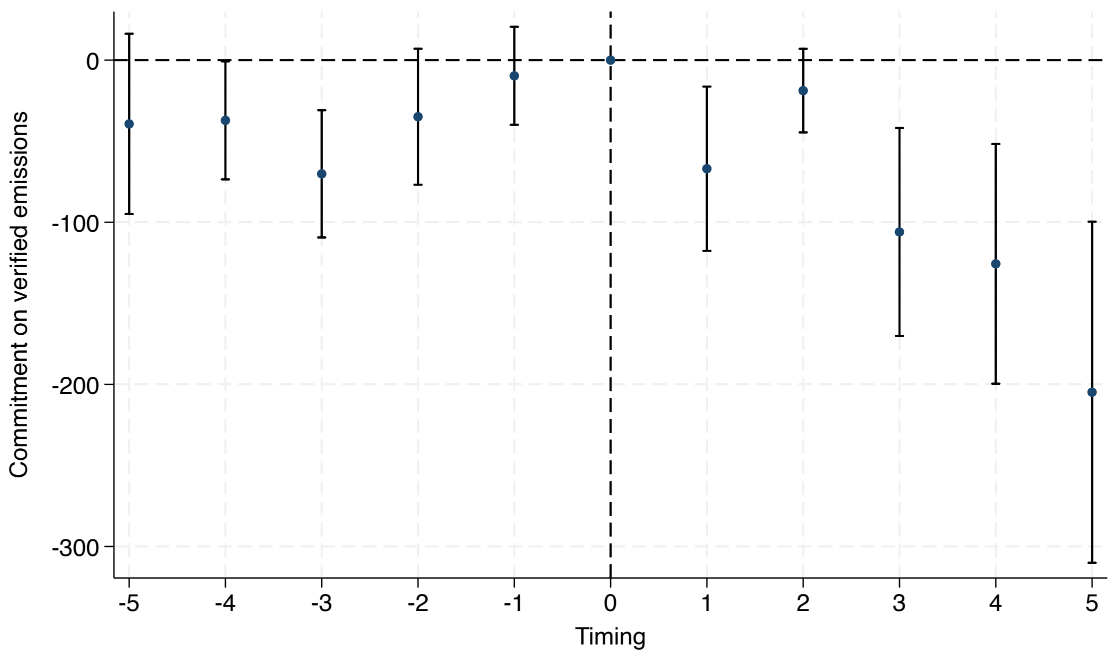


Panel B:



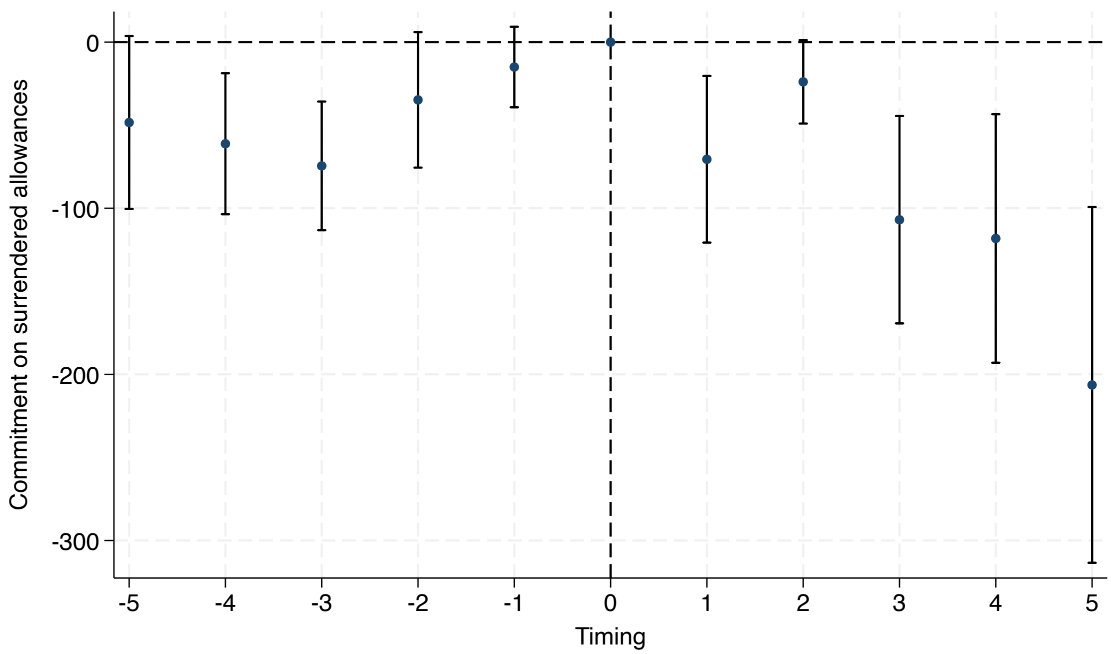
Note: This figure shows the time series of the number of firms in our sample making a commitment for the first time. Panel A shows the count of firms, while Panel B is weighted by total assets.

Figure 2. Effect of commitment on verified emissions: Dynamic trends



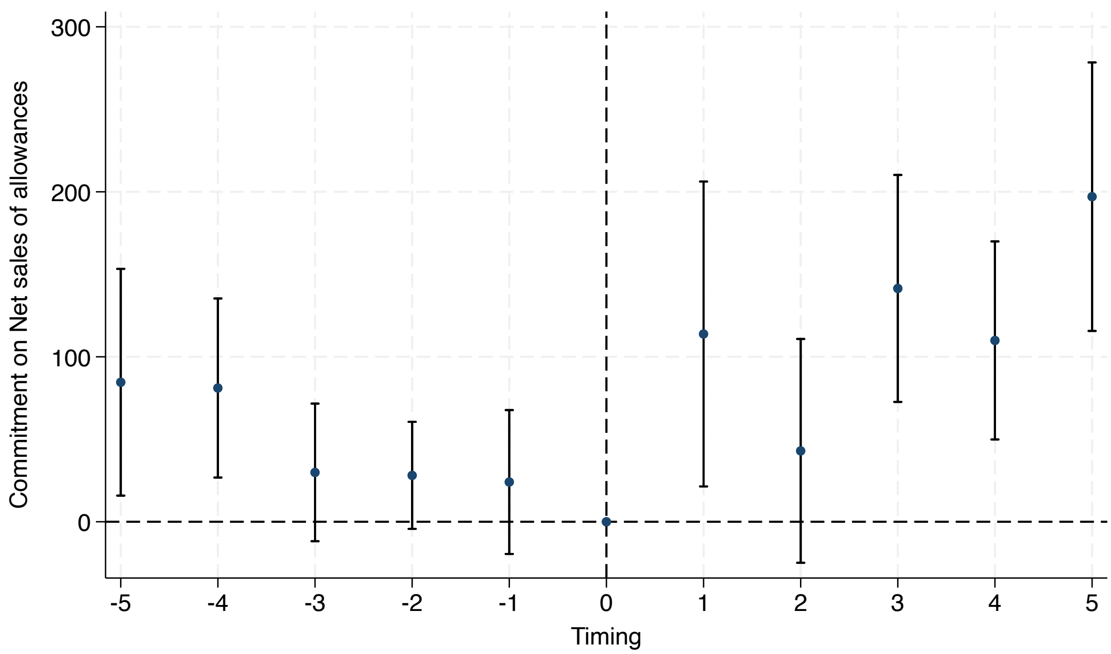
Note: This figure shows the dynamic impact of firm commitments on verified emissions from the EU ETS. Our sample runs from 2008 to 2020. The bars represent 95% confidence confidence intervals calculated using robust standard errors clustered by firm.

Figure 3. Effect of commitment on surrendered allowances: Dynamic trends



Note: This figure shows the dynamic impact of firm commitments on the number of surrendered allowances. Our sample runs from 2008 to 2020. The bars represent 95% confidence confidence intervals calculated using robust standard errors clustered by firm.

Figure 4. Effect of commitment on net sales of allowances: Dynamic trends



Note: This figure shows the dynamic impact of firm commitments on the net sales of allowances. Our sample runs from 2008 to 2020. The bars represent 95% confidence confidence intervals calculated using robust standard errors clustered by firm.

Table 1
Summary Statistics

Note: This table shows summary statistics of all main and control variables. EU ETS variables are at the installation-level.

Variables	N	Mean	SD	Min	Max
Installation-Level EU ETS Variables					
Net Sales	53,066	-15.49	439.80	-24,883.10	29,503.80
Free Allowances	53,066	129.86	605.02	0.00	19,979.76
Cancellations	48,988	24.51	2,429.57	0.00	486,264.00
Surrendered Permits	37,746	234.28	804.86	0.00	22,694.68
Net Purchase Ratio	48,984	-6.48	512.71	-61,018.00	41,266.00
Verified Emissions	39,071	228.58	795.86	0.00	22,694.68
Shortfall Permits	39,071	52.22	563.17	-13,016.49	20,317.58
Firm-Level Variables					
Market Value	44,431	28.95	56.95	0.00	1,555.79
Assets	51,958	77.97	220.91	0.00	3,117.70
Sales	51,990	34.40	48.99	-18.82	433.30
Tobin's Q	44,431	1.25	2.91	0.25	472.07
Leverage	51,958	0.30	0.15	0.00	2.60
ROA	51,800	0.07	0.05	-0.88	1.68
R&D Expenditures	37,509	0.01	0.02	0.00	0.23
Capex	51,908	0.05	0.03	0.00	0.53
PPE	51,870	0.34	0.18	0.00	0.96
Cash	50,656	0.09	0.07	0.00	1.00
M2B	44,431	1.33	27.76	-1972.88	759.62
Retained Earnings	49,912	0.05	19.66	-3189.32	1.78
Commitment	53,066	0.15	0.36	0.00	1.00
MSCI Climate Score	19,670	7.10	2.34	0.00	10.00
MSCI ESG Score	22,893	6.57	2.05	0.00	10.00
Macroeconomic Variables					
Carbon Price EU ETS	53,053	14.72	8.68	4.88	34.48
GDP	53,053	1,868.52	1,265.55	8.70	3,974.44

Table 2
Determinants of firm commitment

Note: This table shows the firm characteristics associated with firms making commitments to reduce carbon emissions. We estimate a linear probability model. The dependent variable takes the value of one if a firm made a commitment during our sample period and is zero otherwise. Covariates for firms that made a commitment are measured the year before the commitment was made and included only once, while covariates for firms that did not make a commitment are included each year they appear in the sample. Our sample runs from 2008 to 2020. By *, **, and *** we denote p-levels below 10%, 5%, and 1%, respectively.

	Dependent variable: Commitment			
Variables	(1)	(2)	(3)	(4)
Assets	0.228	0.242	0.0378	0.0688
	(0.175)	(0.173)	(0.201)	(0.199)
Market Value	-0.178**	-0.153**	-0.134*	-0.111
	(0.0692)	(0.0685)	(0.0760)	(0.0753)
Sales	0.443**	0.379*	0.708***	0.614**
	(0.215)	(0.214)	(0.273)	(0.271)
Tobin's Q	0.00443	0.00230	0.00495	0.00209
	(0.00629)	(0.00640)	(0.00648)	(0.00661)
Leverage	0.0277	0.0412	0.0323	0.0475
	(0.0287)	(0.0287)	(0.0303)	(0.0302)
ROA	0.111	0.0926	0.0690	0.0572
	(0.0760)	(0.0774)	(0.0794)	(0.0810)
R&D Expenditures	0.262*	0.273*	0.427**	0.446***
	(0.156)	(0.155)	(0.174)	(0.173)
Capex	0.192	0.271*	0.240	0.329**
	(0.151)	(0.150)	(0.158)	(0.157)
PPE	-0.0402	-0.0498*	-0.0327	-0.0436
	(0.0290)	(0.0288)	(0.0338)	(0.0336)
Cash	-0.0877*	-0.0921**	-0.0599	-0.0633
	(0.0465)	(0.0461)	(0.0493)	(0.0489)
M2B	36.80	36.06	21.17	22.71
	(72.80)	(72.09)	(72.91)	(72.25)
Retained Earnings	0.0319**	0.0336**	0.0356**	0.0370**
	(0.0155)	(0.0153)	(0.0163)	(0.0161)
Constant	0.00555	0.00616	-0.00612	-0.00550
	(0.0156)	(0.0155)	(0.0177)	(0.0176)
Observations	2,630	2,630	2,627	2,627
Adjusted R^2	0.016	0.041	0.020	0.044
Year FE	No	Yes	No	Yes
Industry FE	No	No	Yes	Yes

Table 3
Balance test

Note: This table presents a comparison of observable variables between the treatment and control groups. We conducted balance tests to examine whether the means of these variables differ significantly between the two groups. Panel (a) shows this comparison for the full sample, and panel (b) shows the balance test for the propensity score matched sample. Our sample runs from 2008 to 2020. By *, **, and *** we denote p-levels below 10%, 5%, and 1%, respectively.

(a) Full sample

	Treated	Untreated	Difference	P-Value
Market Value	0.03	0.02	-0.01***	0.00
Assets	0.08	0.06	-0.02	0.27
Sales	0.03	0.01	-0.02***	0.00
Tobin's Q	1.53	1.57	0.05	0.76
Leverage	0.28	0.29	0.01	0.53
ROA	0.09	0.08	-0.01	0.26
R&D Expenditures	0.02	0.02	-0.00*	0.08
Capex	0.05	0.04	-0.00	0.28
PPE	0.30	0.30	0.00	0.93
Cash	0.09	0.11	0.02***	0.00
M2B	0.00	0.00	-0.00	0.11
Retained Earnings	0.26	-1.01	-1.27	0.12

(b) Propensity score matched sample

	Treated	Untreated	Difference	P-Value
Market Value	0.04	0.03	-0.00	0.49
Assets	0.05	0.04	-0.00	0.56
Sales	0.04	0.03	-0.00	0.67
Tobin's Q	1.61	1.65	0.04	0.71
Leverage	0.28	0.24	-0.03	0.13
ROA	0.09	0.10	0.00	0.83
R&D Expenditures	0.03	0.03	0.01	0.16
Capex	0.05	0.05	-0.00	0.54
PPE	0.30	0.29	-0.01	0.52
Cash	0.10	0.11	0.01	0.23
M2B	3.00	3.00	0.00	1.00
Retained Earnings	0.31	0.31	-0.00	1.00

Table 4
Effect of commitment on verified emissions

Note: This table shows the impact of firm commitments on verified emissions from the EU ETS. The sample is a panel at the installation level. In panel (a), the dependent variable is the total amount of verified emissions in level and tonne of CO2. In panel (b), the dependent variable has been standardized, i.e. it has been rescaled to have a mean of 0 and a standard deviation of 100. The variable *Commitment* is a dummy variable that takes the value one in a year for a firm with an active commitment. The variable *Free Allowances* captures the number of allowances to emit one ton of carbon that were freely allocated to an installation. The regressions are estimated on a matched stacked sample, following the approach of Cengiz, Dube, Lindner, and Zipperer (2019). Robust standard errors clustered by firm are reported in parentheses. Our sample runs from 2008 to 2019. By *, **, and *** we denote p-levels below 10%, 5%, and 1%, respectively.

(a) Verified Emissions

Regression	(1)	(2)	(3)	(4)
Commitment	-35.39*	-23.00	-35.59***	-21.50**
	(19.40)	(13.90)	(10.76)	(9.517)
Free Allowances	0.382***	0.381***	0.385***	0.384***
	(0.0712)	(0.0712)	(0.0740)	(0.0742)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	21,415	21,415	20,875	20,875
Adjusted R^2	0.943	0.943	0.941	0.941

(b) Standardized Verified Emissions

Regression	(1)	(2)	(3)	(4)
Commitment	-4.013*	-2.608	-4.036***	-2.438**
	(2.200)	(1.576)	(1.220)	(1.079)
Free Allowances	0.0433***	0.0432***	0.0436***	0.0436***
	(0.008)	(0.008)	(0.0084)	(0.0084)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	21,415	21,415	20,875	20,875
Adjusted R^2	0.943	0.943	0.941	0.941

Table 5
Effect of commitment on surrendered allowances

Note: This table shows the impact of firm commitments on the number of surrendered carbon allowances from the EU ETS. The sample is a panel at the installation level. In panel (a), the dependent variable is the total amount of verified emissions in level and tonne of CO2. In panel (b), the dependent variable has been standardized, i.e. it has been rescaled to have a mean of 0 and a standard deviation of 100. The variable *Commitment* is a dummy variable that takes the value one in a year for a firm with an active commitment. The variable *Free Allowances* captures the number of allowances to emit one ton of carbon that were freely allocated to an installation. The regressions are estimated on a matched stacked sample, following the approach of Cengiz, Dube, Lindner, and Zipperer (2019). Robust standard errors clustered by firm are reported in parentheses. Our sample runs from 2008 to 2019. By *, **, and *** we denote p-levels below 10%, 5%, and 1%, respectively.

(a) Surrendered Allowances

Regression	(1)	(2)	(3)	(4)
Commitment	-38.78*	-26.67*	-34.02***	-20.88*
	(20.98)	(15.29)	(12.90)	(11.16)
Free Allowances	0.348***	0.348***	0.352***	0.351***
	(0.0774)	(0.0775)	(0.0802)	(0.0803)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	20,447	20,447	19,909	19,909
Adjusted R^2	0.942	0.942	0.940	0.940

(b) Standardized Surrendered Allowances

Regression	(1)	(2)	(3)	(4)
Commitment	-4.298*	-2.956*	-3.771***	-2.314*
	(2.325)	(1.694)	(1.430)	(1.237)
Free Allowances	0.0386***	0.0386***	0.0390***	0.0389***
	(0.0086)	(0.0086)	(0.0089)	(0.0089)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	20,447	20,447	19,909	19,909
Adjusted R^2	0.942	0.942	0.940	0.940

Table 6
Effect of commitment on net sales

Note: This table shows the impact of firm commitments on the number of net sales (sales minus purchases) of carbon allowances from the EU ETS. The sample is a panel at the installation level. In panel (a), the dependent variable is the total amount of verified emissions in level and tonne of CO2. In panel (b), the dependent variable has been standardized, i.e. it has been rescaled to have a mean of 0 and a standard deviation of 100. The variable *Commitment* is a dummy variable that takes the value one in a year for a firm with an active commitment. The variable *Free Allowances* captures the number of allowances to emit one ton of carbon that were freely allocated to an installation. The regressions are estimated on a matched stacked sample, following the approach of Cengiz, Dube, Lindner, and Zipperer (2019). Robust standard errors clustered by firm are reported in parentheses. Our sample runs from 2008 to 2019. By *, **, and *** we denote p-levels below 10%, 5%, and 1%, respectively.

(a) Net Sales

Regression	(1)	(2)	(3)	(4)
Commitment	88.61**	79.28**	79.16**	86.12***
	(42.55)	(33.82)	(34.12)	(32.01)
Free Allowances	0.369***	0.369***	0.364***	0.364***
	(0.0744)	(0.0743)	(0.0759)	(0.0759)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	26,208	26,208	25,668	25,668
Adjusted R^2	0.300	0.299	0.308	0.308

(b) Standardized Net Sales

Regression	(1)	(2)	(3)	(4)
Commitment	13.66**	12.22**	12.20**	13.27***
	(6.558)	(5.212)	(5.258)	(4.933)
Free Allowances	0.0568***	0.0568***	0.0561***	0.0561***
	(0.0115)	(0.0115)	(0.0117)	(0.0117)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	26,208	26,208	25,668	25,668
Adjusted R^2	0.300	0.299	0.308	0.308

Table 7
Effect of commitment on sales & purchases

Note: This table shows the impact of firm commitments on the number of sales and purchases of carbon allowances from the EU ETS. The sample is a panel at the installation level. In panel (a), the dependent variable is the total number of annual purchases. In panel (b), annual purchases have been standardized, i.e. rescaled to have a mean of 0 and a standard deviation of 100. In panel (c), the dependent variable is the total number of annual sales. In panel (d), annual sales have been standardized, i.e. rescaled to have a mean of 0 and a standard deviation of 100. The variable *Commitment* is a dummy variable that takes the value one in a year for a firm with an active commitment. The variable *Free Allowances* captures the number of allowances to emit one ton of carbon that were freely allocated to an installation. The regressions are estimated on a matched stacked sample, following the approach of Cengiz, Dube, Lindner, and Zipperer (2019). Robust standard errors clustered by firm are reported in parentheses. Our sample runs from 2008 to 2019. By *, **, and *** we denote p-levels below 10%, 5%, and 1%, respectively.

(a) Purchases

Regression	(1)	(2)	(3)	(4)
Commitment	15.01	14.12*	-11.77	-5.545
	(12.16)	(7.531)	(18.45)	(23.27)
Free Allowances	0.278***	0.278***	0.266***	0.266***
	(0.0886)	(0.0885)	(0.0784)	(0.0784)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	28,392	28,392	27,807	27,807
Adjusted R^2	0.511	0.510	0.513	0.513

(b) Standardized Purchases

Regression	(1)	(2)	(3)	(4)
Commitment	2.176	2.047*	-1.706	-0.804
	(1.763)	(1.092)	(2.675)	(3.374)
Free Allowances	0.0403***	0.0403***	0.0385***	0.0385***
	(0.0128)	(0.0128)	(0.0114)	(0.0114)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	28,392	28,392	27,807	27,807
Adjusted R^2	0.511	0.510	0.513	0.513

Table 7
Effect of commitments on sales & purchases (continued)

(c) Sales

Regression	(1)	(2)	(3)	(4)
Commitment	90.53*	86.31**	58.45	70.95*
	(47.87)	(36.05)	(38.30)	(37.57)
Free Allowances	0.658***	0.658***	0.642***	0.642***
	(0.157)	(0.157)	(0.149)	(0.149)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	28,392	28,392	27,807	27,807
Adjusted R^2	0.502	0.502	0.511	0.511

(d) Standardized Sales

Regression	(1)	(2)	(3)	(4)
Commitment	9.375*	8.938**	6.053	7.347*
	(4.958)	(3.733)	(3.966)	(3.891)
Free Allowances	0.0681***	0.0681***	0.0665***	0.0665***
	(0.0163)	(0.0162)	(0.0155)	(0.0155)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	28,392	28,392	27,807	27,807
Adjusted R^2	0.502	0.502	0.511	0.511

Table 8
Effect of commitment on voluntary cancellations

Note: This table shows the impact of firm commitments on the number of carbon allowances from the EU ETS that were voluntarily canceled. The sample is a panel at the installation level. In panel (a), the dependent variable is the total number of voluntarily canceled carbon allowances. In panel (b), the dependent variable has been standardized, i.e. it has been rescaled to have a mean of 0 and a standard deviation of 100. The variable *Commitment* is a dummy variable that takes the value one in a year for a firm with an active commitment. The variable *Free Allowances* captures the number of allowances to emit one ton of carbon that were freely allocated to an installation. The regressions are estimated on a matched stacked sample, following the approach of Cengiz, Dube, Lindner, and Zipperer (2019). Robust standard errors clustered by firm are reported in parentheses. Our sample runs from 2008 to 2019. By *, **, and *** we denote p-levels below 10%, 5%, and 1%, respectively.

(a) Cancellations

Regression	(1)	(2)	(3)	(4)
Commitment	-0.0138	-0.0121*	0.0119	0.0157
	(0.00850)	(0.00625)	(0.0229)	(0.0200)
Free Allowances	-0.0308	-0.0309	-0.0339	-0.0340
	(0.0385)	(0.0385)	(0.0424)	(0.0424)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	26,208	26,208	25,668	25,668
Adjusted R^2	0.002	0.002	-0.038	-0.039

(b) Standardized Cancellations

Regression	(1)	(2)	(3)	(4)
Commitment	-1.080	-0.944*	0.929	1.226
	(0.663)	(0.487)	(1.785)	(1.563)
Free Allowances	-2.404	-2.410	-2.647	-2.651
	(2.999)	(3.002)	(3.306)	(3.309)
Controls	No	Yes	No	Yes
Plant FE	Yes	Yes	Yes	Yes
Cohort × Year × Industry FE	Yes	Yes	Yes	Yes
Cohort × Year × Country FE	No	No	Yes	Yes
Observations	26,208	26,208	25,668	25,668
Adjusted R^2	0.002	0.002	-0.038	-0.039

Table 9
Effect of commitment on ESG ratings

Note: This table shows the impact of firm commitments on MSCI ESG and climate ratings, respectively. In column (1) and (2), the dependent variable is the industry-adjusted aggregate MSCI ESG score. In column (3) and (4), the dependent variable is the MSCI Climate Score. The sample is a panel at the firm level. The regressions are estimated using cohort stacks for the full sample. Robust standard errors clustered by firm are reported in parentheses. Our sample runs from 2008 to 2020. By *, **, and *** we denote p-levels below 10%, 5%, and 1%, respectively.

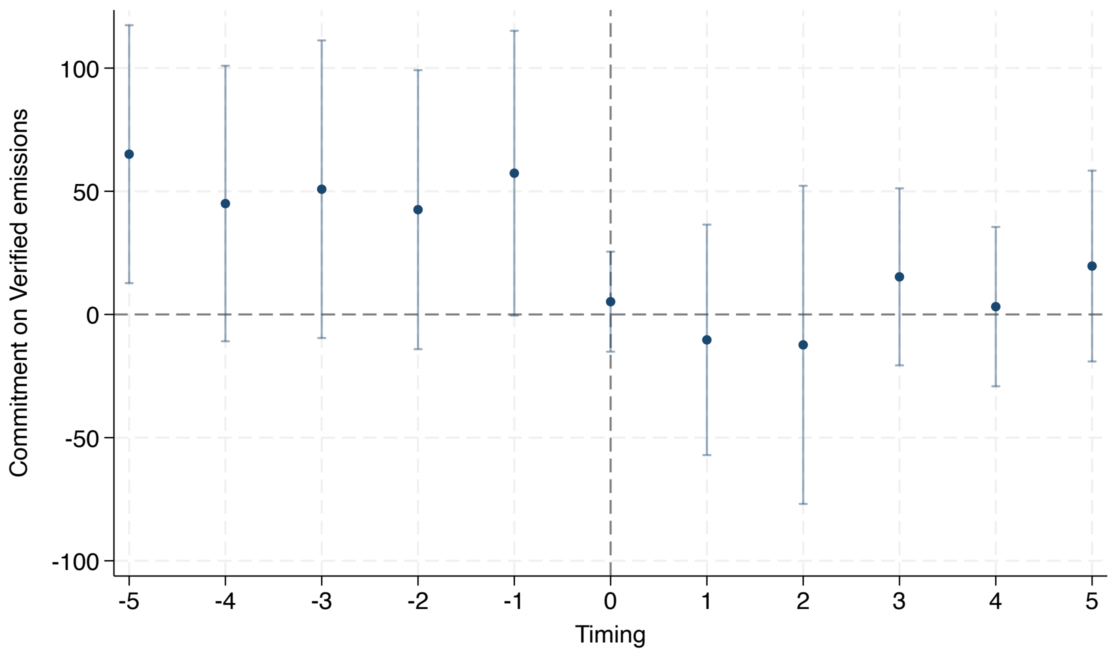
Dep. Variable	ESG Score		Climate Score	
Regression	(1)	(2)	(3)	(4)
Commitment	0.137	0.422**	0.452***	0.461**
	(0.106)	(0.185)	(0.151)	(0.203)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No
Industry × Year FE	No	Yes	No	Yes
Country × Year FE	No	Yes	No	Yes
Observations	1,257	907	1,080	768
Adjusted R^2	0.799	0.840	0.841	0.873

Supplementary Internet Appendix to

Do government policies undermine private climate initiatives?

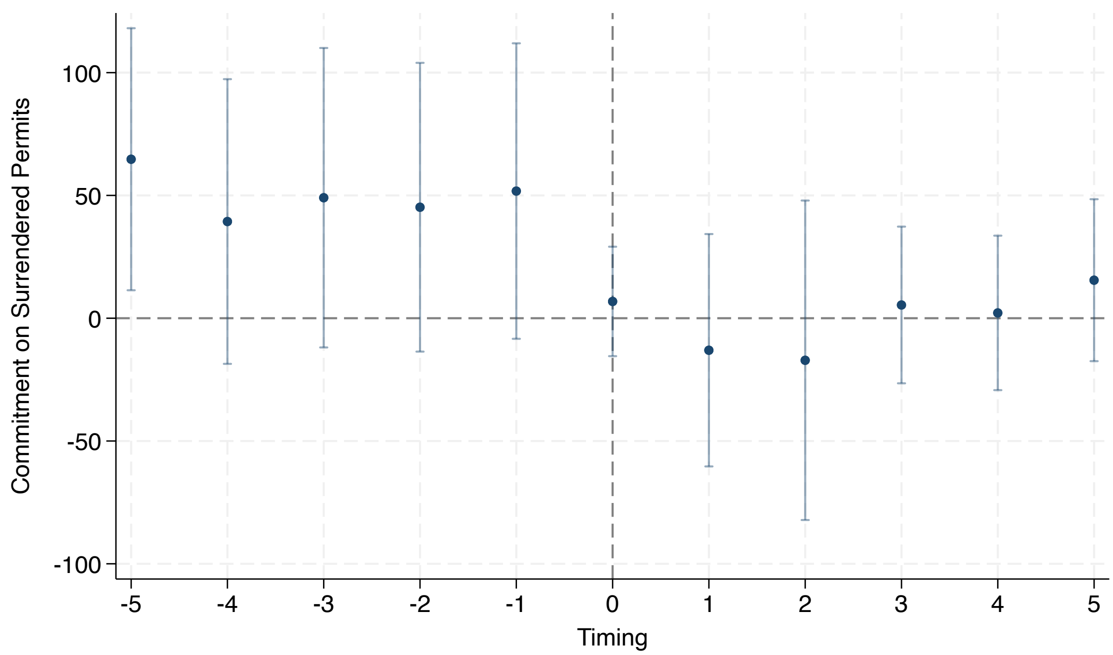
Intended for online publication.

Figure A1. Effect of commitment on verified emissions: Alternative estimator



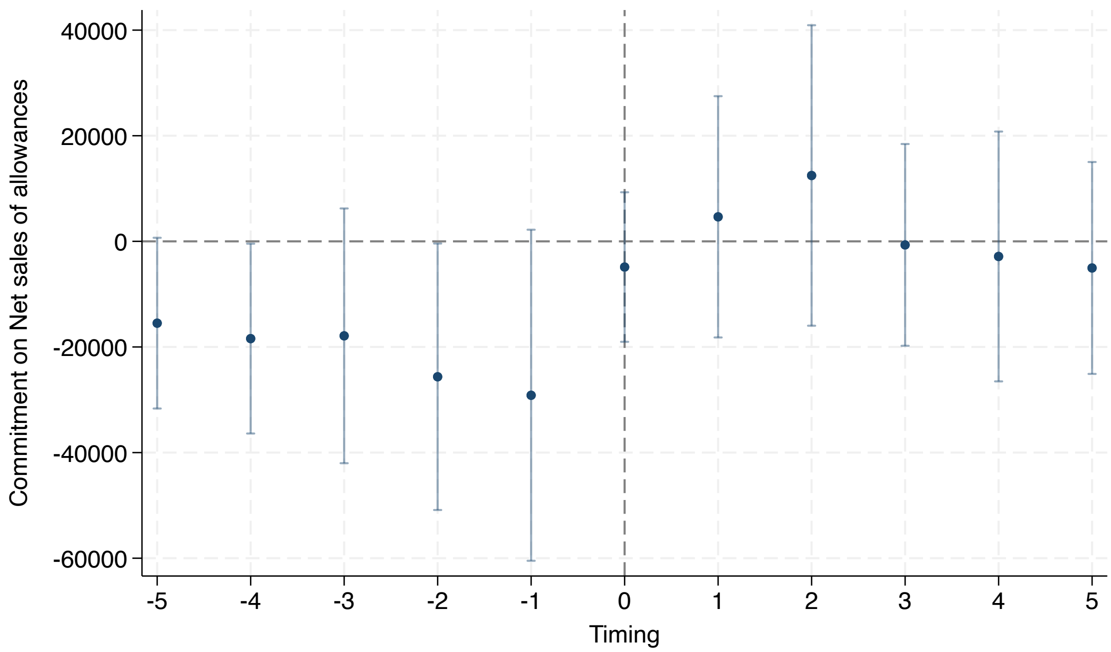
Note: This figure shows the dynamic effect of commitment on verified emissions using the estimator of Borusyak, Jaravel, and Spiess (2024). The specification is estimated in the full sample, controls for free allocation, and includes an installation fixed effect and a country year fixed effect. The bars represent 95% confidence confidence intervals calculated using robust standard errors clustered by firm.

Figure A2. Effect of commitment on surrendered permits: Alternative estimator



Note: This figure shows the dynamic effect of commitment on surrendered allowances using the estimator of Borusyak, Jaravel, and Spiess (2024). The specification is estimated in the full sample, controls for free allocation, and includes an installation fixed effect and a country year fixed effect. The bars represent 95% confidence confidence intervals calculated using robust standard errors clustered by firm.

Figure A3. Effect of commitment on net sales: Alternative estimator



Note: This figure shows the dynamic effect of commitment on net sales using the estimator of Borusyak, Jaravel, and Spiess (2024). The specification is estimated in the full sample, controls for free allocation, and includes an installation fixed effect and a country year fixed effect. The bars represent 95% confidence confidence intervals calculated using robust standard errors clustered by firm.

A1 A simple model of emissions trading with non-consequentialist investors

We develop a simple stylized model to illustrate the main intuition of the paper that guides our empirical analysis. Suppose a firm i pollutes $1 - c_i e_i$ and receives an endowment of free allowance a_i. This assumption implies that the net demand of allowance of firm i is $[a_i - (1 - c_i e_i)]$. Pollution is endogenous, and is a function of effort e_i. Effort is costly, and implies a loss of utility for the owner by $-\frac{e_i^2}{2}$. One could interpret effort as an investment in abatement activities. Abating more and more pollution requires more important investment or newer technologies, thus justifying the convex cost. Similarly, one could interpret e as the economic distortion created by abating pollution, such as a reduction in output. How efficiently the firm can reduce pollution depends on c_i. High value of c_i means that a small increase in effort leads to a large reduction in pollution $(1 - c_i e_i)$. Finally, we assume the allowances trade at an equilibrium price of τ. Given these assumptions, the firm's owner chooses the effort and takes the carbon price as given to maximize the following function:

$$\prod_i (e_i) = [a_i - (1 - c_i e_i)]\tau - \frac{e_i^2}{2}$$

Which gives the following first-order condition:

$$c_i \tau = e_i$$

This means that the optimal effort in reducing carbon increases as the price of carbon increases. Firms that are more productive in reducing pollution will reduce their pollution more when the price of polluting increases.

Next, we compute the equilibrium price of carbon. Suppose that the economy is made of 2 firms. Then, the market clearing condition implies that the price of carbon τ is such that:

$$a_1 + a_2 = (1 - c_1 e_1^*) + (1 - c_2 e_2^*) = (1 - c_1^2 \tau) + (1 - c_2^2 \tau)$$

Where $a_1 + a_2$ is the total pollution allowed in the cap-and-trade. This pollution cap decreases in the EU ETS following an exogenous factor. In Phase 4, the annual linear reduction factor is 2.2%. This market clearing condition and the firm optimal effort implies that: $\tau = \frac{2 - a_1 - a_2}{c_1^2 + c_2^2}$.

We can see the classical result of Montgomery (1972), who shows that a social planner can achieve the first best using either a cap-and-trade system or a tax system. Indeed, a cap-and-trade system with a cap of $a_1 + a_2$ provides the same allocation as a carbon tax of τ^*.

Next, we introduce a non-pecuniary dimension in the problem for firm 1: the owner incurs a utility cost B for each unit of pollution his firm generates. This non-pecuniary component can be interpreted in two non-mutually exclusive ways. The first interpretation is that the owner could have some deontological ethics; that is, he cares about the alignment of his portfolio holdings of green firms with his preferences for such firms, as in (Heinkel, Kraus, and Zechner, 2001, Pástor, Stambaugh, and Taylor, 2021, Pedersen, Fitzgibbons, and Pomorski, 2021). The second interpretation is that the owner cares about his environmental impact irrespective of his holding, as in Hart and Zingales (2017), Landier and Lovo (2020), Oehmke and Opp (2024), but takes the price of EU ETS allowances as given, without realizing that selling carbon allowances can have a price impact.

Without loss of generality, let's suppose that firm 1 has such value-alignment preferences, but not firm 2. The owner of firm 1 maximizes the following function:

$$\prod_1(e_1) = [a_1 - (1 - c_1e_1)]\tau - \frac{e_1^2}{2} - (1 - c_1e_1).B$$

Solving for the firm problem gives:

$$e^*_{1,B} = c_1\tau + c_1B$$

Firm 1's owner wants a cleaner firm, so he is willing to make additional efforts to reduce his company's pollution.

The optimal effort as a function of the price of carbon for firm 2 is the same as before, and is equal to: $e^*_{2,B} = c_2\tau$

The market clearing condition of the cap-and-trade system gives the following new price of carbon:

$$\tau^*_B = \frac{2 - a_1 - a_2}{c_1^2 + c_2^2 + c_1^2.B}$$

This price of carbon τ^*_B is lower than the price of carbon in the world with no value alignment τ^*. As a result, firm 2 optimal effort is lower: $e^*_{2,B} < e^*_{1,B}$, and the pollution of firm 2 is now higher. Firm 1 sells the surplus of allowances, which leads to a lower equilibrium price of carbon, thus incentivizing firm 2 to increase pollution.