Deep and Shallow Decarbonization in Supply Chains

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Abstract

This paper examines how suppliers adjust their decarbonization choices when major customers obtain validated emission-reduction targets. Using global supplier–customer links matched to firm-level emissions and project-level data from voluntary carbon registries, the analysis shows that downstream climate pressure elicits both real and symbolic responses, but in systematically different ways across suppliers. On average, treated suppliers become more likely to adopt climate targets of their own. High-emission suppliers subsequently reduce their emission intensity relative to comparable firms, indicating meaningful operational adjustments. Low-emission suppliers, by contrast, do not further reduce emissions; instead, they expand their use of carbon credits, sharply increasing offset intensity as a lower-cost alternative to additional physical abatement. These offsets disproportionately originate from lower-rated projects, suggesting that increased demand does not translate into pressure for higher-quality credits. Overall, downstream climate commitments induce a sorting in decarbonization strategies: high-emission suppliers undertake substantive reductions, while low-emission suppliers rely more heavily on market-based mechanisms to meet customer expectations.

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1 Introduction

Large corporations are increasingly adopting ambitious climate commitments, including science-based and net-zero targets. A defining feature of these ambitious commitments is that firms must account not only for their own operational emissions but also for those generated upstream in their supply chains. Against this background, an increasing share of buyers now ask, or explicitly require their suppliers to disclose emissions, adopt climate policies, or show measurable progress toward emissions reductions. Yet it remains unclear how suppliers respond when faced with such downstream climate pressure.

In principle, suppliers can pursue a range of adjustments: investing in abatement technologies, redesigning production processes, shifting energy inputs, or relying on external mechanisms such as carbon offset markets. Suppliers may engage in *deep* decarbonization—actions that materially reduce emissions—or adopt *shallow* responses that improve the appearance of alignment without changing core operations. These choices differ in cost, credibility, and scalability, raising the central question whether downstream climate commitments induce genuine decarbonization among suppliers or instead crowd in lower-cost, symbolic forms of compliance. However, despite the growing importance of supply-chain climate governance, systematic empirical evidence on this margin is still sparse.

This paper provides the first large-scale empirical analysis on how suppliers adjust their decarbonization strategies when facing credible, externally validated climate pressure. We employ a staggered difference-in-differences design that exploits the discrete, exogenous timing of customers' Science Based Targets initiative (SBTi) approvals. The SBTi approval constitutes a material shift in expectations of upstream decarbonization, allowing us to trace how suppliers reoptimize across real (operational) and market-based (offset) decarbonization channels using a novel combination of global supply-chain links, firm-level emissions data, and comprehensive carbon offset retirement records.

Our analysis yields four main findings.

First, suppliers whose customers obtain SBTi approval respond by adopting climate targets of their own, and for the average firm, these commitments are not merely symbolic. After a customer's target is validated, we find clear evidence of real decarbonization as treated suppliers experience measurable reductions in emission intensity relative to otherwise similar suppliers. The reductions emerge shortly after customer target approval and persist

over time, indicating that downstream climate pressure can generate measurable adjustments in suppliers' own production processes.

Second, suppliers also increase their use of carbon offsets following customer SBTi approval. Both the extensive and intensive margins of offset retirement rise, and offset intensity, measured relative to industry-year median emissions, grows persistently. Offsets thus become an active component of suppliers' decarbonization portfolios.

Third, the observed supplier response exhibits striking heterogeneity with regard to suppliers' initial emission profile that can reflect both differences in marginal abatement costs and the strength of downstream pressure. When faced with customers that obtain validated emission targets, suppliers with relatively low emissions intensity reoptimize by shifting toward market-based substitutes, increasing their use of carbon offsets rather than undertaking additional operational changes. This might be rooted in steep marginal costs of further abatement. Furthermore, low-emission suppliers may receive less oversight from customers who concentrate on the highest emitters in their supplier base.

High-emission suppliers, by contrast, begin from a much higher emissions baseline. For these firms, marginal abatement costs may be comparatively low, and operational reductions may be both technologically accessible and economically attractive. Importantly, high emitters are also more likely to face stronger scrutiny from customers once a science-based target is validated, creating an intensified need to demonstrate credible progress. Consistent with this combination of lower abatement costs and heightened pressure, high-emission suppliers deliver the largest declines in emission intensity and show only modest increases in offset use.

Fourth, the increased reliance on carbon offsets is concentrated in the lower end of the quality distribution. On average, the carbon credits retired after customer target approvals disproportionately come from projects with lower third-party quality ratings. Crucially, this low-quality reliance is greatest among the symbolic adopters: firms that undertake genuine emissions reductions rely relatively less on offsets to begin with, and when they do use them, they select higher-quality credits. This sharp divergence in offset quality highlights a distinction between more symbolic forms of alignment and more substantive operational decarbonization efforts.

Taken together, these findings reveal a systematic sorting mechanism in response to private climate governance. Downstream commitments induce suppliers to adjust their de-

carbonization strategies in ways that depend jointly on their marginal abatement costs and the strength of scrutiny they face. High-emission suppliers, those with potentially comparatively low marginal abatement costs and greater exposure to credibility concerns once a customer target is validated, respond with substantive operational changes, delivering the largest reductions in emission intensity. Low-emission suppliers, by contrast, may face steep marginal costs of further abatement and weaker pressure to demonstrate large absolute reductions. These firms shift toward market-based mechanisms, notably a large increase in voluntary carbon credit retirement.

This duality highlights that supply-chain pressure generates real decarbonization where it is technologically and economically inexpensive and due-diligence efforts are strongest, while inducing more symbolic, lower-quality forms of compliance where operational improvements are most costly and less scrutiny prevails. The resulting pattern underscores how private climate governance interacts with heterogeneous production technologies, reputational incentives, and the availability of financial substitutes to shape the trajectory of decarbonization across the supply chain.

Our paper contributes to two emerging strands of research: (i) the diffusion of climate policies and decarbonization strategies through supply-chain linkages, and (ii) firms' use of voluntary carbon offsets as part of their decarbonization mix.

Supply-chain transmission of climate policies. A growing literature examines how shocks propagate through supply-chain networks (Barrot and Sauvagnat, 2016) and how environmental or social practices diffuse across firms (e.g., Dai et al., 2021; Asgharian et al., 2023).[1] Homroy and Rauf (2025) show that climate-target announcements trigger upstream adjustments, with suppliers adopting climate and governance policies, though often without material emissions reductions. We extend this work along two dimensions. First, we introduce an unexamined channel: suppliers' use of voluntary carbon offsets as a strategic response to downstream pressure. Second, we exploit the precise timing of SBTi approvals—externally validated, standardized, and dated commitments—rather than relying on self-reported target disclosures documented in CDP. This allows us to identify supplier responses to discrete

[1]Related, Colmer et al. (2025) and Dechezleprêtre et al. (2022) study firms' response to carbon pricing policies and emission leakage within and across firm boundaries. Colmer et al. (2025) find no evidence of emission outsourcing, but increased investments into targeted measure to reduce the emission intensity of production. Similarly, Dechezleprêtre et al. (2022) observe no leakage within multinational enterprises towards subsidiaries located in jurisdictions with more lenient climate policies.

shifts in third-party verified downstream expectations.

Our empirical analysis reveals systematic differences in suppliers' adjustment margins. Downstream commitments shift suppliers toward different decarbonization channels, with some firms reducing emissions directly while others rely more heavily on offsets. This heterogeneity highlights how private climate governance interacts with underlying cost structures and reputational incentives, an aspect largely absent from prior work on supply-chain transmission.

Voluntary carbon offsets and the quality of corporate decarbonization. Most research on carbon credits focuses on supply-side integrity issues, such as, additionality, permanence, leakage, and over-crediting (e.g., Schneider et al., 2019; Calel et al., 2025; Chen et al., 2025). Far less is known about how corporations choose offsets or how offset use interacts with firm-level incentives. Kim et al. (2023) show that low-emission firms increase offset use after negative ESG shocks, relying on inexpensive credits to maintain perceived environmental performance.[2] We extend this demand-side perspective to the context of supply-chain pressure. Low-emission suppliers increase offset use precisely at the moment downstream pressure intensifies, suggesting a strategic reliance on market-based mechanisms rather than operational changes. Importantly, this shift is concentrated in lower-rated offsets, indicating that rising demand is not directed toward high-quality project development. Rather than supporting integrity in the market, suppliers meet customer expectations by retiring inexpensive, lower-quality credits.

In sum, our paper bridges these two literatures by showing that supply-chain transmission and offset use interact in systematic ways. Downstream climate commitments generate real decarbonization at the top of the emissions distribution but induce symbolic compliance among lower-emission suppliers, partly through increased reliance on low-quality offsets. This duality highlights how private climate governance can reshape firm behavior and where it falls short.

[2]See Bolton and Kacperczyk (2021) and Pástor et al. (2025) for investor-driven climate pressure.

2 Data and Downstream Pressure

2.1 Climate targets, Emissions, and Financial Data

We assemble firm climate targets, emissions, and financial information from several sources.

Customer Climate Targets. Information on customer climate commitments comes directly from the Science Based Targets initiative. To construct a consistent historical panel of SBTi commitments and validations, we combine official SBTi releases with archived snapshots of the *"Companies Taking Action"* webpage from the Internet Archive. This approach allows us to recover year-by-year information on whether a firm had committed to develop a target and whether that target had been formally validated, despite changes in reporting formats over time.

For each firm, we observe (i) the year in which the firm *commits* to develop an emissions-reduction target aligned with SBTi guidelines and (ii) the year in which that target is formally *validated* by SBTi.[3] SBTi approval provides a uniform, third-party assessment that a target aligns with science-based decarbonization pathways. Firms must submit standardized emissions inventories and reduction plans and pay a modest validation fee.[4] Scope 3 inventories and targets are required when Scope 3 accounts for more than 40% of total emissions. In contrast, unverified announcements or self-declared commitments—such as those reported in the Carbon Disclosure Project without SBTi validation—may lack comparable substance and can reflect strategic responses to stakeholder pressure rather than fully assessed decarbonization plans.

The time between a firm's initial commitment and the validation of its target varies substantially across companies. Figure A1 shows the distribution of delays between SBTi commitment and approval. The median firm receives validation within one year, but the process can be considerably longer in practice: more than 20 percent of firms secure approval only after two years, and another 20 percent after three years. These delays reflect both administrative factors—such as the time needed to prepare the required emissions inventories and supporting documentation—and strategic considerations, as firms may postpone submit-

[3]SBTi allows firms to set near-term (5–10 year) and long-term net-zero targets. After signaling intent, firms generally have up to two years to obtain validation. Once documentation is submitted, validation typically occurs within 30–60 business days.

[4]Validation fees range from USD 1,250 for SMEs to USD 14,250 for firms with annual revenue above USD 1 billion.

ting materials while reassessing feasibility, gathering internal data, or responding to evolving stakeholder expectations. The result is a wide dispersion in commitment-to-approval timelines, highlighting that an SBTi commitment does not immediately translate into a validated, science-based target.

Firm Emissions and Financial Data. Carbon emissions (Scope 1 and Scope 2), sales, and other firm characteristics are taken from ISS STOXX. We construct annual measures of emission intensity (emissions divided by revenue) and use these to characterize suppliers' baseline carbon profiles.

2.2 Carbon Offsets

Voluntary carbon offsets do not have centralized purchase data; instead, transactions become observable only when credits are retired, that is firms register their usage. We therefore assemble project-level retirement data from the four largest voluntary carbon market registries: Verra, Gold Standard, the American Carbon Registry, and the Climate Action Reserve. The combined dataset covers 3,656 projects and nearly 400,000 retirement transactions between 2009 and 2024.

To identify corporate users of offsets, we apply large-language-model text processing to unstructured fields describing the "retirement beneficiary," harmonizing names and mapping them to publicly listed firms. This procedure identifies 1,582 listed companies using offsets from 2,200 distinct projects across 91 countries, representing approximately 42% of all retirements in the combined registry dataset.

Offset Quality Ratings. To assess offset quality, we match each retired credit to MSCI's ex-post Carbon Project Ratings, which provide standardized evaluations of project additionality, permanence, leakage, and monitoring credibility. MSCI covers roughly 1,290 carbon offset projects and assigns each a letter rating ranging from AAA (highest integrity) through AA, A, BBB, BB, and B, down to CCC (lowest integrity). These categories map into a numerical integrity scale, with higher scores indicating higher-quality projects: for instance, AA projects receive scores of around 4.15, BB projects around 3.10, and CCC projects around 2.33. This rating system allows us to distinguish whether suppliers responding to downstream climate pressure rely on higher- versus lower-integrity offset projects.

Offset Intensity. We measure the scale of the use of carbon credits using a normalized

intensity metric. For each firm-year, offset intensity equals the total tons of CO_2 retired by the firm in a year divided by the median Scope 1+2 emissions of all firms in the same three-digit industry and year. This normalization allows comparisons across firms with different operational scales and across heterogeneous industries.

2.3 Supply-Chain Links

Supplier-customer relationship information comes from FactSet Revere, widely regarded as one of the most comprehensive sources for global supply chain information (Huang et al., 2023). The dataset compiles firms' supply chain relationships from multiple inputs—most notably official disclosures such as SEC filings (10-K, 8-K, 10-Q), as well as investor presentations, press releases, and corporate websites (FactSet, 2021). FactSet analysts standardize these inputs into consistent records with normalized relationship types, incorporating both links reported by a firm itself and "reverse" links reported by its counterparties. By continuously tracking additional sources and cross-verifying reverse matches, the database achieves broader coverage of supply chain connections than alternatives like Compustat Segment (Huang et al., 2023).

As of August 2025, the database covered relationship records for more than 64,000 reporting ("source") companies, resulting in over 2.5 million relationship links involving more than 480,000 entities. For consistency with the data on offset usage, we focus on the subset of publicly listed companies. The vast majority of these are actively monitored reporting companies, providing us with greater confidence that all their important customer and supplier linkages are observed. The resulting panel allows us to link each supplier to the climate-commitment status of its customers and to estimate both average and heterogeneous responses to downstream climate pressure.

2.4 Defining Downstream Treatment: Customer Target Approval

To measure downstream climate pressure, we rely on the timing of customers' adoption of *validated* emission-reduction targets. We define downstream pressure as beginning only once a customer's target has been formally approved by the SBTi.

For each supplier-customer pair, we construct an indicator that switches from 0 to 1 in

the first year in which that customer obtains SBTi approval. A supplier is treated in year t if any of its customers has an approved target in that year. This definition allows treatment to arise through two channels:

1. an existing customer receives target approval, or
2. the supplier forms a new relationship with a customer that already has an approved target.

Figures 1 and 2 document the rapid expansion of science-based climate commitments among major customer firms and the corresponding rise in the number of suppliers exposed to downstream pressure. SBTi approvals are absent before 2014 but scale quickly thereafter: 15 firms obtain validated targets in 2015, 446 by 2020, and 1664 by 2023. Because each customer is connected to many Tier 1 suppliers, exposure spreads even faster through the network. In 2015, 328 suppliers are linked to at least one customer with an approved target; by 2020, this number grows to 5,445, and by 2023 over 11,000 suppliers have direct relationships with climate-committed customers. This diffusion creates a setting in which downstream climate actions propagate broadly across production networks, affecting large numbers of firms that do not themselves set formal climate goals.

Two aggregate patterns emerge from these trends. First, suppliers connected to customers with validated targets experience a steeper decline in emission intensity relative to never-treated suppliers. Although these correlations do not establish causality, they are consistent with downstream commitments inducing operational adjustments upstream. Second, treated suppliers rely more heavily on carbon offsets: their offset intensity—retired offsets relative to emissions—is roughly five times that of never-treated suppliers by the end of the sample period.

Using our definition of downstream pressure, Table 1 reports summary statistics for treated (11,110 firms) and never-treated suppliers (13,285). For each variable, we first compute a firm-level average across all years the firm appears in the sample; the table then summarizes these values across firms. Suppliers linked to customers with SBTi-validated targets are substantially more likely to secure an approved target themselves (7% vs. 2%). They are also more likely to participate in voluntary carbon markets: 7% of treated suppliers use offsets at least once during the sample period, compared with 2% among never-treated suppliers.

Among firms that retire offsets, treated suppliers retire almost twice as many credits on average—about 18,000 tons of CO_2 per year versus 9,000 tons for never-treated suppliers—and exhibit offset intensities roughly three times as high (1.41 vs. 0.46). These differences indicate that downstream pressure affects not only the extensive margin of offset participation but also the scale of offsetting among active users. Offset quality differs little across groups: the average MSCI rating is close to 3 for both treated and never-treated suppliers, corresponding to a mid-tier "BB" assessment of credit integrity.

Taken together, these descriptive patterns suggest that downstream commitments diffuse through production networks and shape both the likelihood and the form of suppliers' decarbonization responses. On average, treated suppliers exhibit higher offset use alongside modest differences in emissions and emission intensity. To disentangle operational abatement from shifts toward market-based instruments, the next section introduces an event-study framework to examine the causal effects of downstream climate pressure on suppliers' decarbonization choices.

3 Empirical Strategy

Our goal is to identify how suppliers adjust their decarbonization strategies when their customers obtain validated climate targets. We exploit the staggered timing of customers receiving target approval and estimate dynamic treatment effects using difference-in-differences methods.

3.1 Baseline Specification

Let Y_{st} denote an outcome indicative of a supplier s's decarbonization strategy in year t (emission adjustments, own climate targets, offset behavior). Treatment is defined as $D_{st} = 1$ if supplier s has at least one customer whose climate target is *approved* by year t, and zero otherwise.

A natural starting point is a fixed-effects OLS specification:

$$Y_{st} = \alpha_s + \lambda_t + \theta_{jt} + \beta D_{st} + \gamma' X_{s,t-1} + \varepsilon_{st}, \tag{1}$$

where α_s are supplier fixed effects and λ_t are year fixed effects that account for any time-constant firm specific confounders and aggregate time trends. In some specifications we also include θ_{jt}, industry $\times$ year fixed effects, with j indicating the supplier's industry. This absorbs time-varying industry-level factors such as technological shifts, regulatory changes, or industry-specific disclosure norms that may influence both the adoption of targets and suppliers' decarbonization behavior. We also add a vector of lagged supplier controls $X_{s,t-1}$, such as firm size and the number of customer relationships, which capture differences in financial conditions and supply-chain structure that may be correlated with treatment timing or outcomes.

While providing a useful reference point, in settings with staggered treatment and potentially dynamic responses, standard two-way fixed effects (TWFE) estimators suffer from well-known biases because already-treated units implicitly serve as controls for later-treated units. When treatment effects evolve over time and differ across cohorts, TWFE mixes these heterogeneous effects and can assign negative or attenuated weights to some groups, producing contaminated comparisons (De Chaisemartin and D'Haultfoeuille, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2021; Baker et al., 2022; Roth et al., 2023). Diagnostic evidence confirms that these issues are empirically relevant in our setting, primarily towards the end of our sample. Appendix Figure A2 shows that negative TWFE weights arise for *treated* supplier-year observations, when a large share of suppliers have already been treated. This pattern reflects a mechanical feature of TWFE in staggered adoption designs: once most units are treated, the estimator increasingly compares recently treated suppliers to suppliers treated in earlier years, inducing negative weights.

The concerns regarding negative weights are compounded by the dynamic nature of supplier responses. As shown in Figure A3, the cumulative volume of offset retirements continues to rise steadily in the years following customer SBTi target approval, while emission intensity declines gradually rather than abruptly.[5] Treatment effects hence vary meaningfully over the event window, further violating the assumptions under which TWFE yields consistent estimates.

To address these issues, we rely on the estimator proposed by Callaway and Sant'Anna (2021), which computes cohort-specific average treatment effects of the treated (ATT) for

[5]This pattern is consistent with the underlying adjustment technology: operational decarbonization, capital upgrades, and shifts in procurement practices take time to materialize, and even the use of offsets requires internal due diligence, contracting, and eventual retirement as firms claim progress toward emission targets.

suppliers treated in cohort g at time t, denoted $ATT(g,t)$. For each cohort g, the estimator compares the change in outcomes between $g-1$ and t for suppliers whose customers obtain target approval in year g against a comparison group of suppliers that are *never-treated* throughout the sample period. This design explicitly avoids comparisons in which already-treated suppliers serve as controls for later-treated ones. Cohort-time effects are then aggregated using appropriate weighting schemes to recover overall average effects and dynamic event-study profiles.

3.2 Identification Assumptions

As with standard difference-in-differences designs, our identification strategy relies on two key assumptions. First, the *parallel trends* assumption requires that, in the absence of treatment, outcomes for treated suppliers and never treated suppliers would have evolved similarly. Second, the *no anticipation* assumption requires that suppliers do not adjust their emissions or offset use in advance of the year in which any of their customers receives SBTi target approval.

To assess these assumptions, we first examine whether there are statistically significant differences in pre-treatment trends between suppliers whose customers later obtain validated climate targets and those whose customers never receive such an approval. For our main outcome variables of interest - log emission intensity, offset use and offset intensity - we do not observe any statistically significant differences in the four years preceding a customer's target approval (Figure 3, panel d, e, and f).[6] While this assessment does not ensure parallel trends in potential outcomes post-treatment, it provides reassurance on the suitability of our control group.

To continue, we examine whether treatment timing is systematically related to pre-treatment differences in supplier's emission profiles. We estimate linear probability models in which the dependent variable equals one in the first year a supplier is exposed to downstream pressure (i.e., the first year any customer obtains SBTi target approval) and zero otherwise; further details are provided in Appendix B. For each supplier, we compute pre-treatment averaging emissions and emission intensity over the three years preceding treatment $(t-3, t-2, t-1)$. All specifications include year and industry fixed effects, as

[6] We see marginally statistically significant differences in the likelihood of suppliers receiving their own target approval, but these are several magnitudes smaller compared to the estimated post-treatment response.

well as controls for pre-treatment average sales and a firm's number of customers. Standard errors are clustered at the supplier level. The results show that neither baseline emissions nor emission intensity predict the timing of exposure, consistent with no anticipatory behavior. Regarding our controls, suppliers with greater sales appear to be treated earlier, suggesting that larger firms might be more exposed to downstream pressure. Furthermore, the number of customers appears to play a significant role. This pattern naturally arises from our treatment definition: everything else constant, larger firms and suppliers with broader customer portfolios are more likely to be connected to at least one customer that adopted SBTi targets early, increasing the likelihood of earlier exposure. Importantly however, exposure timing does not correlate with pre-treatment trends in emissions, and therefore does not threaten identification.

4 Results

4.1 Suppliers response to customer target approval

We begin by examining how suppliers adjust their climate-related behavior when downstream customers obtain third-party approval of their climate targets. Table 2 reports average treatment effects on the treated (ATT) estimated using the Callaway and Sant'Anna (2021) difference-in-differences framework. In this setting, the ATT captures the average change in an outcome for suppliers whose customers receive SBTi approval, relative to a comparison group of suppliers whose customers never obtained validated climate targets, while flexibly allowing for staggered treatment timing and dynamic responses. Column (1) summarizes these effects for the full sample.

On average, suppliers exhibit a clear strategic response following downstream target approval. First, they are substantially more likely to adopt climate commitments of their own. The probability that a supplier announces and obtains approval for climate target increases by 3.2 and 3.8 percentage points respectively—equivalent to a 97% and 150% rise relative to the baseline likelihood. Importantly, these commitments are not purely symbolic. Emission intensity (Scope 1 and 2 emissions divided by revenue) for the average firm declines by 8.8%, in the years following a customer's target approval. This pattern suggests that downstream climate pressure induces meaningful operational adjustments among suppliers.

Suppliers also demonstrate sizable shifts in offsetting behavior. On the extensive margin, the likelihood of retiring carbon offsets increases by 1.1 percentage points, corresponding to a 55% jump relative to the pre-treatment mean. On the intensive margin, carbon credit retirements rise sharply: offset intensity increases by 0.143, indicating that treated suppliers retire substantially larger volumes of credits relative to the emissions profile of their industry peers. This represents a 159% increase relative to the mean offset-intensity level. Taken together, the results indicate that suppliers respond along multiple dimensions: (i) announcing their own targets which are then approved, (ii) engaging in some real decarbonization, (iii) and substantially expanding their use of carbon offsets. The magnitude of these adjustments highlights the importance of supply-chain linkages in shaping firms' decarbonization strategies and the extent to which externally validated climate commitments diffuse upstream from customers to their suppliers.

For completeness, Table 3 reports TWFE estimates. The results are broadly in line with the ATT estimates, with similar magnitudes and signs across outcomes.

Figure 3 presents event-study estimates of supplier outcomes around the year of first exposure to a customer with an approved climate target. Panel (a) shows a sharp and persistent rise in the likelihood that suppliers commits to setting climate targets of their own. The increase begins the year after the customer's approval and continues to grow over the subsequent years, consistent with the average ATT effects reported earlier. Panel (b) highlights an even starker rise in the likelihood of a supplier obtaining a validated emission target in the years following their customer's target approval.

On emissions, Panel (c) shows that log total emissions experience a temporary decline in the approval year, but this drop is short-lived: emissions return to pre-treatment levels within two years. Interpreting total emissions in isolation is challenging, as firms may temporarily scale back production or sales in ways that mechanically reduce emissions without reflecting genuine abatement. Consequently, we mostly focus on emission intensity, reported in Panel (d). Emission intensity exhibits a sustained downward trajectory after treatment, indicating that at least part of the supplier response reflects real adjustments in the emissions-revenue profile rather than transitory fluctuations in activity.

Panels (e)-(f) document strong and growing adjustments in offsetting behavior. Suppliers become increasingly likely to retire carbon credits and raise the intensity of offset use relative to emissions. These effects accelerate over time, with offset use rising steadily in the years

following customer target approval. The shape of these dynamics suggests that offsets emerge as a flexible and relatively low-cost channel through which suppliers respond to downstream climate expectations. While some suppliers engage in real decarbonization, the aggregate pattern underscores the role of offsets as a scalable alignment mechanism for maintaining or strengthening supply-chain relationships with climate-committed customers.

4.2 Heterogeneity by Emission Intensity

Differences in production technologies and sectoral characteristics create substantial variation in suppliers' marginal abatement costs. Firms with relatively low emission intensity may have already implemented inexpensive adjustments and therefore face steep marginal costs of further operational decarbonization. Also, as customers might prioritize the biggest emitters in their supplier base, lower emission suppliers might encounter less attention. Taken together, when downstream firms adopt validated emission targets, these suppliers may find it more attractive to demonstrate responsiveness through readily deployable external mechanisms such as carbon offsets rather than through additional changes to their production processes.

In contrast, high-emission suppliers begin from a much higher emission profile and might consequently face comparably lower marginal abatement costs for initial in-house operational adjustments that are technologically within reach and financially attractive. At the same time, they are subject to stronger scrutiny from customers once a science-based target is approved, raising the credibility premium associated with real, measurable decarbonization. These firms therefore might have elevated incentives to reduce emissions directly, relying less on financial substitutes.

To test whether suppliers indeed adjust along these predicted margins, we split the sample at the median of the pre-treatment emission-intensity distribution and estimate treatment effects separately for below- and above-median emitters. Table 2 reports the ATT estimates for these two groups in columns 2 and 3 and the difference between the groups in column 4.

The comparison reveals a pronounced asymmetry in supplier responses. High-emission suppliers exhibit meaningful declines in emissions after their customers' targets are approved—total emissions fall by roughly 15%, and emission intensity declines by about 19% relative to never treated firms. Low-emission suppliers respond in a fundamentally different manner.

These firms do not reduce their total emissions or improve emission intensity following customer target approval. The results in column (4) confirm the statistically significant differences between the two groups. Both, high-emission and low-emission suppliers, become more likely to announce climate targets and obtain externally validated targets. Coefficient estimates are in a similar range to the full sample estimates and do not statistically significantly differ between the two groups. To continue, both types of firms increase their participation in offset markets once their first customer obtained an approved climate target. However, the offset activity of high emission firms remains modest. Offset intensity—benchmarking retirement volumes against the emissions profile of their industry peers—shows no meaningful change. Low emission suppliers on the other hand exhibit large increases in the relative use of carbon offsets. After one of their customers received a third-party validated emission target, their offset intensity rises sharply by 0.24. Relative to the pre-treatment mean, this represents an increase of roughly 267%, indicating a substantial expansion in offsetting activity.

Taken together, for high-emission suppliers, offsets are not the primary adjustment margin; rather, the evidence points to genuine reductions in operational emissions as the main channel through which these firms align with downstream climate expectations. Low-emission supplier, by contrast, show no adjustments towards increased in-house abatement, while carbon offsets play a significant role in their response to downstream climate targets. This divergence aligns with the mechanism proposed in Kim et al. (2023): when external climate pressure increases, firms with relatively high marginal abatement costs may rely more heavily on symbolic tools—such as carbon offsets—to signal environmental compatibility, rather than undertake costly physical decarbonization.

Figure 4 complements these average effects by showing how the dynamic responses differ between high- and low-emission suppliers. Low-emission suppliers display no meaningful reduction in emission intensity at the time of customer target approval or in the years that follow (panel b).[7] Instead, their offset behavior changes sharply. Both offset use (panel d) and offset intensity (panel f) rise steadily after treatment, with offset intensity reaching values on the order of 0.4 by year four—up from a baseline of roughly 0.09—representing an increase of more than 300% relative to pre-treatment levels. This pattern indicates a heavy reliance on offsets as a compensatory or symbolic mechanism rather than genuine

[7]Relative to low emission firms whose customer never received a validated climate target, treated low emission firms exhibit marginally lower emission intensity in the years preceding their customer's climate target approval.

decarbonization.

High-emission suppliers exhibit a markedly different trajectory. Emission intensity declines following customer target approval and remains below pre-treatment levels throughout the observed window, consistent with real operational adjustments (panel a).[8] Although these firms also increase their use of offsets (panel c), the magnitude of their offset intensity remains small relative to industry peer emissions and far below the levels observed for low-emission suppliers (panel e). Confirming the ATT results presented above, offsets do not appear to be the primary channel through which high-emission firms respond to downstream climate pressure.

4.3 Offset Quality and Decarbonization Strategies

So far, our results show that suppliers respond to downstream climate pressure along multiple margins. Treated suppliers become more likely to announce climate targets of their own and engage in both real and more symbolic forms of decarbonization. Ex ante high-emission suppliers reduce their emission intensity following customer target approval, indicating meaningful operational adjustments. Ex ante low-emission suppliers, by contrast, rely heavily on carbon offsets, expanding offset use on both the extensive and intensive margins. These patterns suggest that offsets function as a flexible, low-cost mechanism through which suppliers, especially those with relatively cleaner baseline operations, align themselves with climate-committed customers. This naturally raises the next question: when suppliers turn to offsets, what is the quality of the credits they rely on, and how does offset quality vary with the degree of downstream pressure they face?

To examine this question, we test how the average rating of carbon credits retired varies for firms with and without downstream pressure from customers with approved emission-reduction targets. In particular, within the sample of firms that use carbon offsets, we examine whether average MSCI quality ratings of a firm's retirements in a given year differ for suppliers that ever had a customer with a validated climate target.[9] Table 4 reports the

[8] Treated high emission firms show a marginally higher emission intensity in the two years leading up to their customer's climate target approval when compared to never treated high emission firms.

[9] Given that offset use increases sharply after customer target approval, we depart from a previous difference-in-difference set up, as this would only allow to assess offset quality considerations for the subgroup of firms that used offsets before and after their customer obtained a validated climate target. We rather test for an association between average quality and exposure to downstream climate pressure in standard OLS regressions, accounting for industry and time fixed effects.

results. Two patterns emerge:

Downstream Pressure and Offset Quality. Suppliers whose customers ever have an approved climate target tend to generally retire offsets of systematically lower quality. The coefficients in columns (3) and (4) are negative and statistically significant, indicating that downstream pressure is associated with lower-rated projects. This pattern suggests that when responding to external commitments, suppliers prioritize securing offset quantities rather than selecting projects with higher environmental integrity.[10]

Emission Reduction and Offset Selection. However, the average effect masks underlying heterogeneity in suppliers offset use. Suppliers on a steeper decarbonization path (i.e., those with above-median reductions in emission intensity), retire higher-quality offsets. Columns (2) and (4) show positive and significant estimates, consistent with the view that firms engaging in genuine abatement complement operational reductions with more credible offset choices, rather than relying on offsets as a substitute.[11]

Taken together with earlier results on offset intensity, these findings on offset quality are informative proxies for strategic intent. Suppliers facing customer-driven pressure tend to adopt more symbolic forms of alignment, retiring larger volumes of lower-rated offsets, while firms pursuing genuine emissions reductions combine operational abatement with better-quality offsets.

4.4 Customers' Targets Announcement

We next examine whether suppliers respond to downstream customers committing to develop an emissions-reduction target aligned with SBTi standards that has not yet been formally validated. Such announcements which are publicly recorded on SBTi's dashboard are increasingly common: many firms disclose new commitments to the SBTi before completing the technical validation process. If these announcements are interpreted by suppliers as the beginning of a credible decarbonization effort, they may trigger adjustments upstream, even

[10] Trencher et al. (2024) show that corporations often retire low-quality carbon offsets, particularly when facing reputational incentives to demonstrate climate action quickly. Their evidence suggests that firms use lower-integrity credits to meet short-term stakeholder expectations. Our results link this pattern to supply-chain dynamics: downstream pressure from climate-committed customers can induce suppliers to rely on similar low-quality offset strategies.

[11] Low-emission suppliers show no evidence of selecting higher-quality offsets. Their offset quality is statistically indistinguishable from that of other firms, indicating no systematic relationship between being a low-emission supplier and the credibility of the offsets they retire (Columns (1) and (4).

before customers receive official approval. On the other hand, announcements might also serve as a low-cost, strategic tool for the customer to signal some climate commitment, and a substantial number of firms never obtains target validation during our sample period.[12] Only by 2019, SBTi started to remove firms that announced commitments but did not seek approval within the next 24 months from their dashboard, with a few exceptions granted. Suppliers might to a certain degree anticipate more symbolic announcements, reacting with limited decarbonization efforts on their side.

To test whether customer commitment announcements induce supplier action, we repeat our baseline analysis, but define treatment as the first year in which a supplier becomes exposed to a customer that reports a target announcement in SBTi. We exclude all firms with a customer that has a validated target. This design allows us to isolate the effect of early-stage, not-yet validated commitments.

Table 5, column (1) presents the estimated average treatment effects derived from the Callaway and Sant'Anna (2021) estimator. Overall, customer target announcements do not induce meaningful decarbonization among suppliers. If anything, suppliers' total emissions increase by roughly 26%, while emissions scaled by revenue show no statistically significant change, indicating no improvement in operational carbon efficiency. Symbolic adjustments, however, are more common: suppliers become more likely to announce an emissions-reduction target of their own (a 2.2 percentage point increase). Suppliers are also slightly more likely to subsequently obtain SBTi validation, but the magnitude of this effect is considerably smaller than the response observed when customers receive validated SBTi targets Table 2). This underscores the substantially weaker downstream pressure generated by unvalidated announcements. These findings are consistent with Homroy and Rauf (2025), who document symbolic supplier responses to customer commitments based on self-reported CDP targets.

To continue, unlike downstream SBTi approvals, commitment announcements do not meaningfully affect suppliers' offset behavior. We detect no increase in either the likelihood of offset use or the intensity of offsets retired. This absence of offset responses stands in sharp contrast with the sizable increases documented in Table 2, in which validated targets induce large changes in both extensive and intensive margins of offsetting.

Testing for heterogeneous responses by suppliers' pre-treatment emission intensity reveals

[12] We observe about 450 customers in our data which committed to develop targets, but never obtained validation.

a muted version of the patterns observed in the SBTi-approval analysis. High-emission suppliers experience a modest but statistically insignificant decline in emission intensity, whereas low-emission suppliers show small, statistically insignificant, increases in offset intensity. The limited precision and smaller magnitudes, suggest that announcements alone generate only limited pressure for both low-emission and high-emission suppliers.

These results indicate that customer climate commitments begin to propagate upstream as soon as they are announced, but the strength and credibility of the commitment significantly influence the depth of the supplier response. Announcements without SBTi validation generate primarily symbolic adjustments, whereas validated targets produce sharper and more economically meaningful changes in suppliers' decarbonization strategies.

5 Conclusion and Policy Lessons

Our results show that externally validated downstream climate commitments meaningfully reshape suppliers' decarbonization strategies, but in sharply heterogeneous ways. When major customers obtain SBTi-validated targets, suppliers become more likely to adopt climate commitments of their own and adjust both their operational emissions and their use of carbon offsets. Ex ante high-emission suppliers reduce emission intensity in a sustained manner, indicating genuine operational decarbonization. By contrast, ex-ante low-emission suppliers rely heavily on offsets, sharply increasing both the likelihood and intensity of offset retirement. Analyzing average offset project quality for the sample of firms using carbon offsets reveals additional differences: firms that are ever exposed to customers with validated emission targets tend to select lower quality projects, while suppliers that also engage in operational decarbonization tend to purchase higher-rated projects. Taken together, these findings reveal that supply-chain climate pressure induces a mix of real and symbolic adjustments, with baseline emissions playing a central role in determining the response.

These patterns carry important implications for the design of supply-chain climate policies and the functioning of voluntary carbon markets. Downstream climate pressure can catalyze real abatement among high-emission suppliers, suggesting that corporate climate targets may generate decarbonization benefits beyond the firms that adopt them. However, the heavy reliance on offsets among low-emission suppliers—and the absence of systematic improvements in offset quality—raises concerns that part of the observed response may be

largely cosmetic, driven by inexpensive mechanisms that do not advance global mitigation. Policymakers and standard-setters may therefore wish to strengthen guidance on the role of offsets in corporate climate strategies, promote higher and more consistent quality standards in carbon offset markets, and encourage verification systems that distinguish between operational decarbonization and financial substitutes. Ensuring that supply-chain pressure translates into high-integrity climate action requires aligning incentives not only for target adoption, but also for credible, measurable, and high-quality emission reductions.

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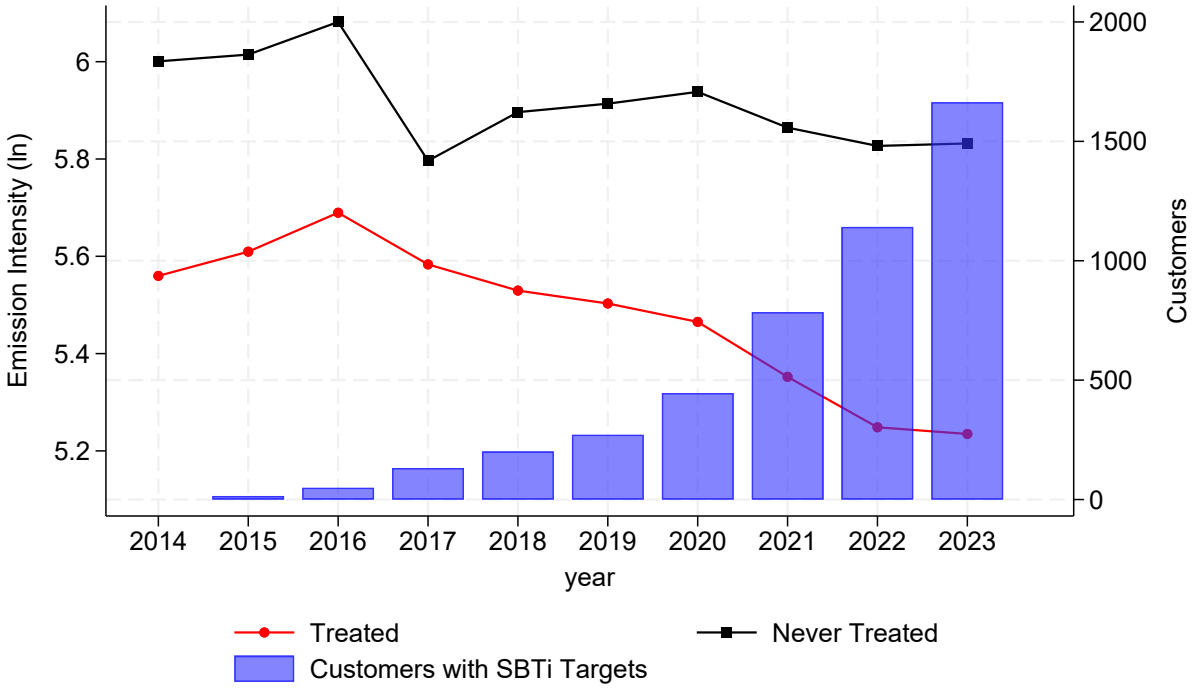
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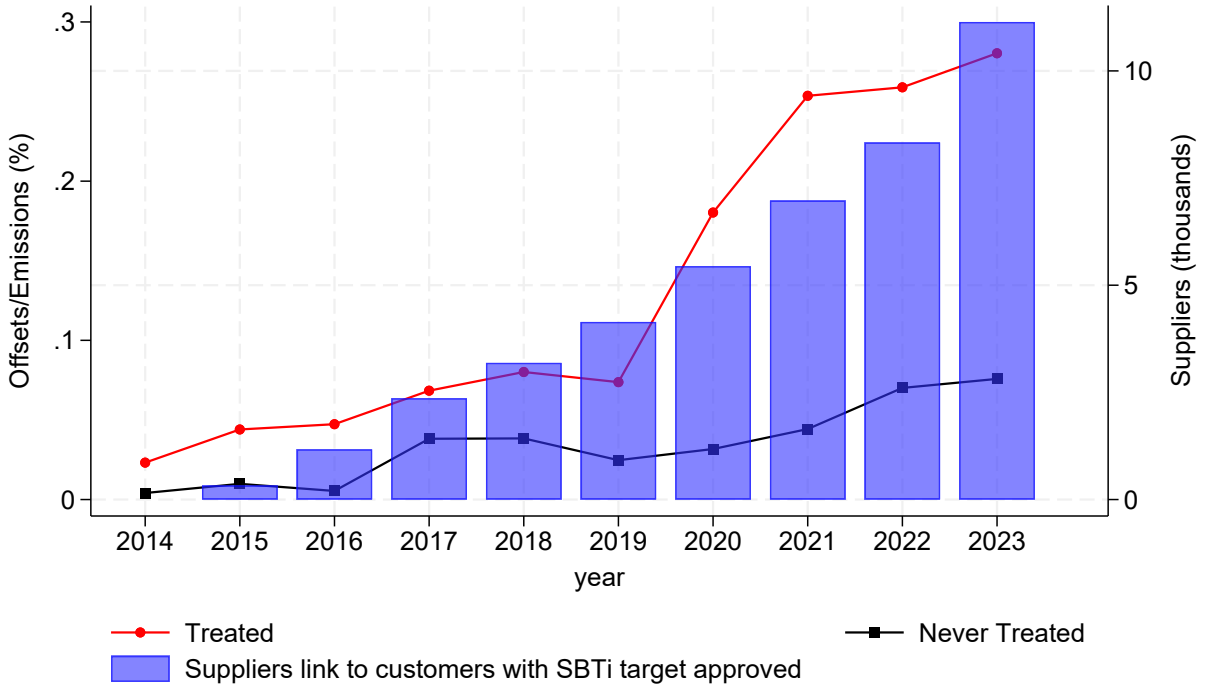
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Figure 1: **Targets and emissions in the Supply Chain**



Note: Bars (right axis) report the annual number of customers whose emission-reduction targets have been formally approved by the SBTi. Lines (left axis) plot suppliers' emission intensity, measured as Scope 1 and 2 emissions divided by revenue. Treated suppliers are those that at any point face downstream pressure from a customer with an approved target (red), while never-treated suppliers have no such customers throughout the sample period (black).

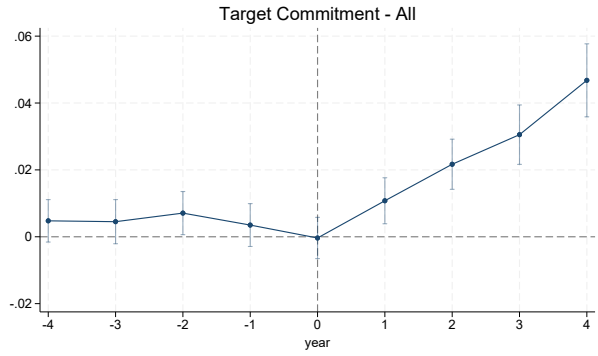
Figure 2: **Targets and Carbon Offsets in the Supply Chain**



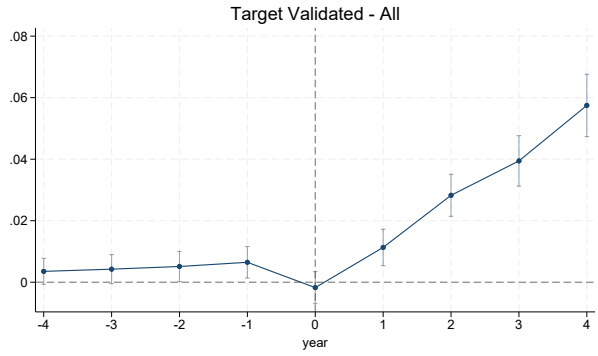
Note: Bars (right axis) report the number of suppliers that, in each year, are linked to at least one customer with an approved SBTi target. Lines (left axis) plot offset intensity defined as retired offsets divided by total Scope 1 and 2 emissions. Treated suppliers are those that at any point face downstream pressure from a customer with an approved target (red), while never-treated suppliers have no such customers throughout the sample period (black).

Figure 3: **Supplier Responses to Customer Climate Target Approval: Target Commitments, Emissions, and Offset Behavior.**

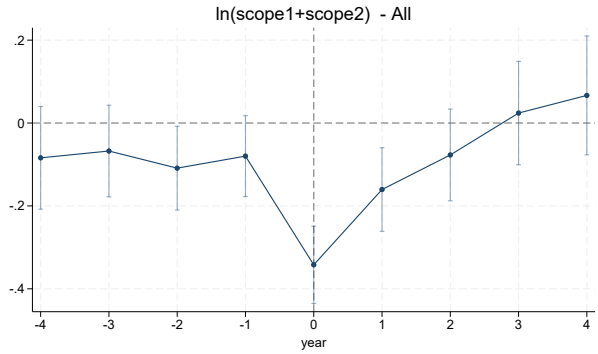
(a) Target commitment



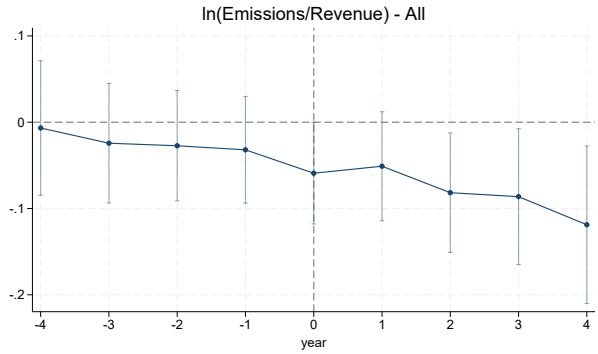
(b) Target Approved



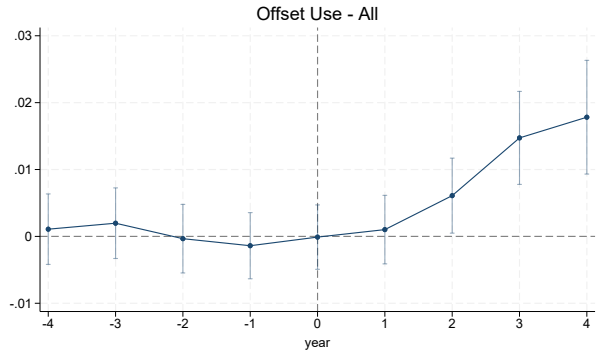
(c) Log total emissions



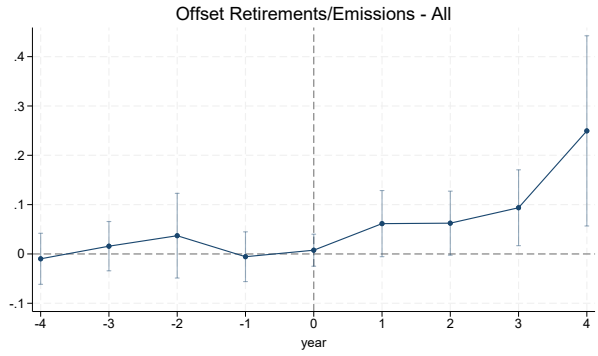
(d) Log Emission intensity



(e) Offset use



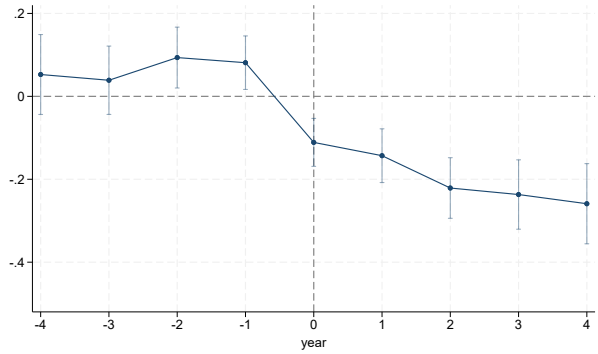
(f) Offset intensity



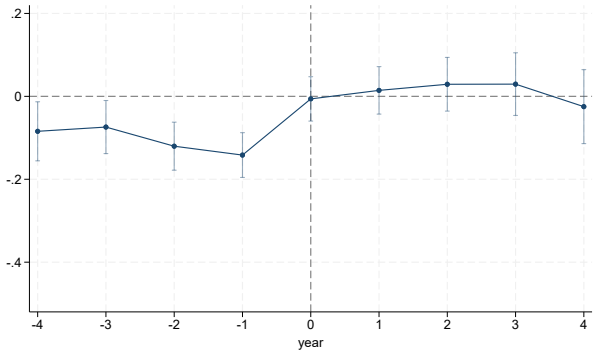
Note: This figure shows event-study estimates of supplier outcomes around customer target approval. Each panel reports Callaway and Sant'Anna (2021) difference-in-differences estimates relative to the year of first exposure to a customer with an approved climate target.

Figure 4: **Responses to Customer Climate Target Approval: High vs. Low Emission Firms**

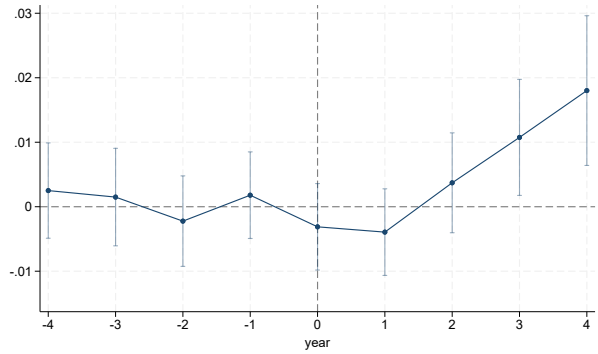
(a) Emission Intensity: High Emission Firms



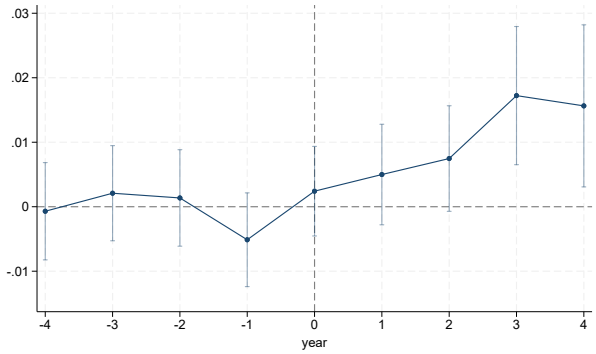
(b) Emission Intensity: Low Emission Firms



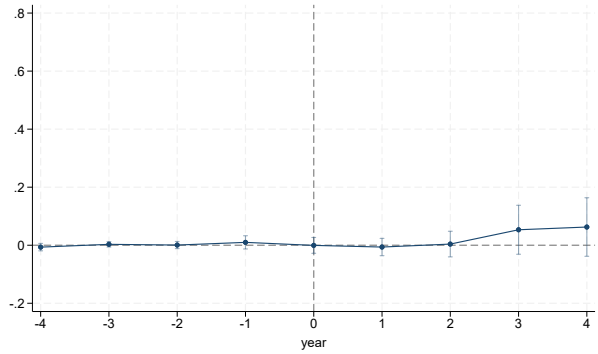
(c) Offset Use: High Emission Firms



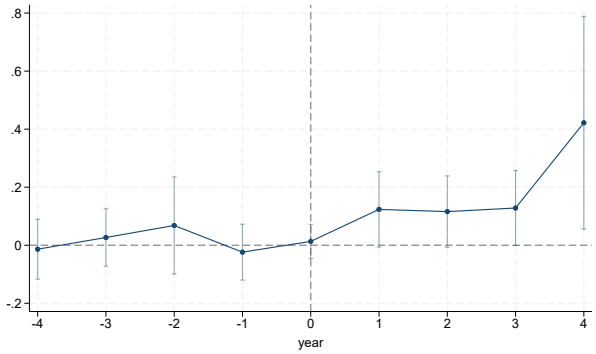
(d) Offset use: Low Emission Firms



(e) Offset Intensity: High Emission Firms



(f) Offset intensity: Low Emission Firms



Note: This figure shows event-study estimates of supplier outcomes around customer target approval comparing high emission vs. low emissions firms. Each panel reports Callaway and Sant'Anna (2021) difference-in-differences estimates relative to the year of first exposure to a customer with an approved climate target..

Table 1: Characteristic of Suppliers

This table reports summary statistics for suppliers facing downstream climate pressure ('Treated') and those without such pressure ('Never Treated'), where treatment is defined as having at least one customer with an approved Science Based Targets initiative (SBTi) emissions-reduction target. Sales are measured in billions of USD. Emissions correspond to Scope 1 and 2 greenhouse gas emissions and are reported in million tons of CO_2 equivalent. Emission intensity is the ratio of a firm's Scope 1+2 emissions to total sales. *SBTi Target Approved* is an indicator equal to one if the supplier has an approved SBTi target. *Using Offsets* equals one if the supplier retires any voluntary carbon offsets in any year of the sample. For the subsample of offset users in Panel B, *Retired offsets* are reported in thousand tons of CO_2 retired per year, and *Offset Intensity* is the ratio of a firm's offset retirements to the median Scope 1+2 emissions of all firms in the same three-digit industry and year. *Rating (MSCI score)* refers to the MSCI carbon-offset project rating averaged across the supplier's portfolio of retirements. Mean differences compare Treated minus Not Treated with corresponding t-statistics.

	Treated		Never Treated			
	Mean	Std. Dev.	Mean	Std. Dev.	Mean Diff.	t-stat
Panel A. All suppliers						
Sales (billion USD)	3.68	16.13	1.65	7.14	2.03	12.96
Emissions (million tons)	0.85	6.86	0.58	6.05	0.26	3.17
Emission Intensity	184.96	498.45	276.72	688.31	-91.76	-11.67
SBTi Target Approved	0.07	0.26	0.02	0.12	0.06	22.29
Using Offsets	0.07	0.25	0.02	0.16	0.04	16.28
Number of Suppliers	11,110		13,285			
Panel B. Suppliers using carbon offsets						
Sales (billion USD)	23.71	46.80	9.34	17.90	14.37	5.37
Emissions (million tons)	4.93	16.72	1.49	7.17	3.44	3.59
Emission Intensity	250.45	638.16	175.38	468.86	75.06	1.91
Retired offsets (thousand tons)	17.96	83.43	9.07	49.54	8.89	1.80
Offset Intensity	1.41	5.70	0.46	1.37	0.95	2.98
Rating (MSCI score)	2.95	0.43	2.97	0.43	-0.02	-0.81
Number of Suppliers	751		329			

Table 2: Supplier Responses to Customer Target Approval: ATT Effects

This table reports average treatment effects on the treated (ATT) estimated using the Callaway and Sant'Anna (2021) difference–in–differences estimator for each supplier-level outcome. Treatment is defined as the first year in which any customer receives SBTi approval of its emissions-reduction target. Column (1) reports estimates for the full sample. Columns (2) and (3) split suppliers into high- and low-emission groups based on pre-treatment emission intensity relative to the median across all firms. Column (4) reports the difference between the estimates for low- and high-emission suppliers. Standard errors are shown in parentheses and clustered at the supplier level. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Outcome Variable (Y)	Full Sample	High Emissions	Low Emissions	Diff. (3)-(2)
	(1)	(2)	(3)	(4)
ln(scope1+scope2)	-0.065	-0.149***	0.006	0.155**
	(0.044)	(0.058)	(0.052)	(0.078)
ln(Emissions/Revenue)	-0.088***	-0.189***	-0.020	0.169***
	(0.027)	(0.028)	(0.024)	(0.037)
Target Commitment	0.032***	0.033***	0.029***	-0.004
	(0.003)	(0.003)	(0.004)	(0.005)
Target Validated	0.038***	0.036***	0.039***	0.004
	(0.002)	(0.003)	(0.003)	(0.004)
Offset Use	0.011***	0.008***	0.012***	0.004
	(0.002)	(0.003)	(0.003)	(0.005)
Offset Retirements/Emissions	0.143***	0.040**	0.239***	0.199***
	(0.028)	(0.020)	(0.052)	(0.055)
Observations	111,889	60,071	51,618	

Table 3: Supplier Responses to Customer Target Approval: TWFE estimates

This table reports OLS estimates from the specification

$$Y_{st} = \alpha_s + \lambda_t + \theta_{jt} + \beta D_{st} + \gamma' X_{s,t-1} + \varepsilon_{st},$$

where Y_{st} denotes supplier s's outcome in year t, D_{st} is an indicator equal to one when at least one customer of supplier s has an approved climate target, and $X_{s,t-1}$ includes lagged supplier financial controls. The term α_s denotes supplier fixed effects, λ_t are year fixed effects, and θ_{jt} are industry-by-year fixed effects (included in even-numbered columns). Standard errors are clustered at the supplier level.
Outcome variables include: (i) total emissions, measured as ln(scope1 + scope2); (ii) emission intensity, defined as ln((scope1 + scope2)/revenue); (iii) *Target Commitment*, an indicator for whether the supplier announces an emissions-reduction target; (iv) *Target Validated*, an indicator for whether the supplier obtains SBTi approval; (v) *Offset Use*, an indicator for whether the supplier retires carbon offsets; and (vi) *Offset Intensity*, measured as the ratio of offset retirements to the median Scope 1+2 emissions of all firms in the same three-digit industry-year. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	ln(scope1+scope2)		ln(Emissions/Revenue)		Target Commitment		Target Validated		Offset Use		Retirements/Emissions	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Customer Target	-0.0435***	-0.0249*	-0.0452***	-0.0267*	0.0233***	0.0224***	0.0292***	0.0221***	0.0051***	0.0088***	0.0254	0.0249
	(0.013)	(0.013)	(0.013)	(0.014)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.026)	(0.038)
Observations	107,411	105,602	107,411	105,602	107,411	105,602	107,411	105,602	107,411	105,602	107,411	105,602
R-squared	0.9451	0.9532	0.8654	0.8847	0.5187	0.5694	0.4652	0.5265	0.4263	0.4687	0.2995	0.3144
Year FE	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Mean of Y	10.19	10.19	3.800	3.800	0.0333	0.0333	0.0254	0.0254	0.0204	0.0204	0.0898	0.0898

Table 4: Carbon Offset Quality

Columns (1)–(4) regress the *average rating* of carbon offset projects retired by suppliers on firm characteristics. *Low Emissions Supplier* indicates firms with below-median emission intensity; *Emission Reduction* equals 1 for firms with above-median five-year emission reductions within their industry; and *Customer with Target* identifies suppliers ever exposed to downstream pressure from a customer with a validated climate target. All regressions include year and industry fixed effects. Standard errors are clustered at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Average Rating			
	(1)	(2)	(3)	(4)
Low Emissions Supplier	-0.0337			-0.0339
	(0.044)			(0.044)
Emission Reduction		0.0694**		0.0731**
		(0.034)		(0.034)
Customer with Target			-0.0718*	-0.0769*
			(0.041)	(0.042)
Constant	2.9822***	2.9126***	3.0199***	2.9906***
	(0.028)	(0.026)	(0.035)	(0.047)
Observations	1,933	1,932	1,935	1,930
R-squared	0.2506	0.2533	0.2524	0.2561
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

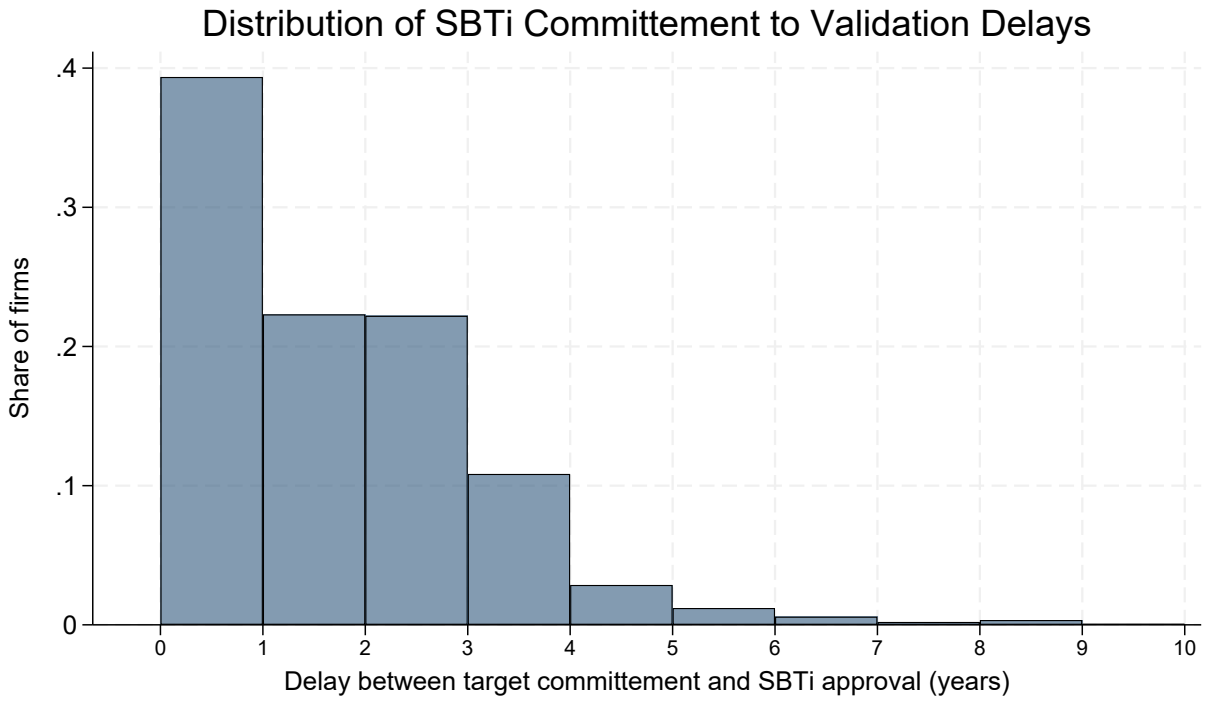
Table 5: Supplier Responses to Customer Target Announcement: ATT Effects

This table reports average treatment effects on the treated (ATT) estimated using the Callaway and Sant'Anna (2021) difference-in-differences estimator for each supplier-level outcome. Treatment is defined as the first year in which any downstream customer announces an emissions-reduction target. The sample excludes customers whose targets have been validated by SBTi. Column (1) reports estimates for the full sample. Columns (2) and (3) split suppliers into high- and low-emission groups based on pre-treatment emission intensity relative to the cross-firm median. Column (4) reports the difference between the coefficients in Columns (3) and (2). Standard errors, clustered at the supplier level, are shown in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Outcome Variable (Y)	**Full Sample**	**High Emissions**	**Low Emissions**	**Diff. (3)–(2)**
	(1)	(2)	(3)	(4)
ln(scope1+scope2)	0.262**	0.192	0.365***	0.172
	(0.130)	(0.182)	(0.138)	(0.228)
ln(Emissions/Revenue)	-0.023	-0.144	0.124	0.268**
	(0.099)	(0.097)	(0.085)	(0.129)
Target Commitment	0.022***	0.027***	0.015*	-0.012
	(0.005)	(0.006)	(0.009)	(0.011)
Target Validated	0.009***	0.016***	0.002	-0.014**
	(0.003)	(0.005)	(0.003)	(0.006)
Offset Use	0.003	0.003	0.002	-0.001
	(0.005)	(0.005)	(0.008)	(0.010)
Offset Retirements/Emissions	0.031	0.001	0.058	0.058
	(0.024)	(0.003)	(0.049)	(0.049)
Observations	40,856	24,595	16,137	

A Appendix Figures

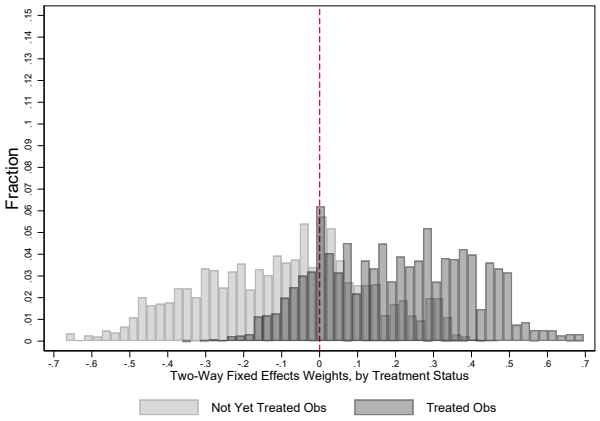
Figure A1: **Distribution of delays between target announcement and SBTi approval**



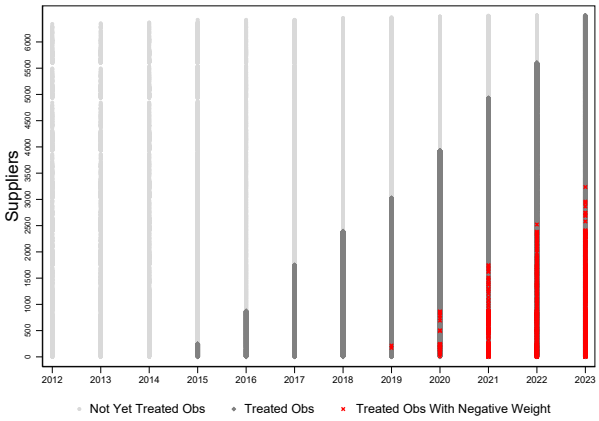
Note: The figure plots the distribution of the delay between the year a firm announces a target approved commitment and the year the target is validated by SBTi.

Figure A2: **Two-Way Fixed Effects (TWFE) weights**

(a) Distribution of TWFE weights

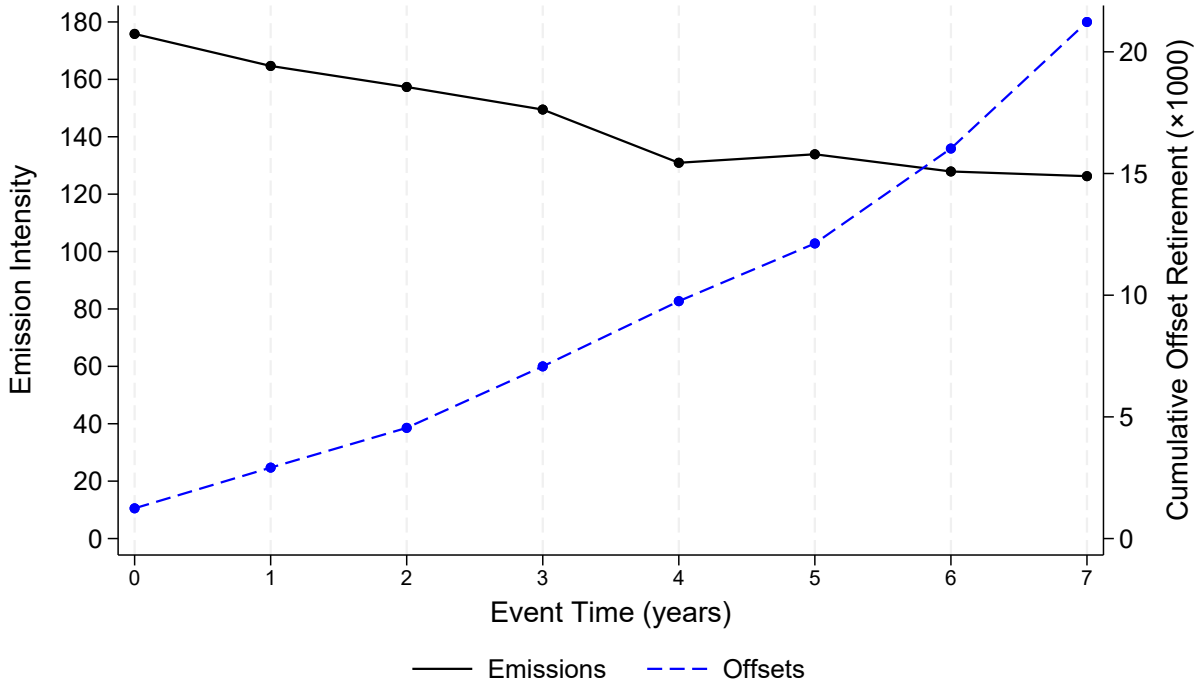


(b) Distribution of negative TWFE weights



Note: Panel A plots the distribution of TWFE weights for not-yet-treated and treated suppliers. Panel B plots the distribution of negative TWFE weights by supplier and year. Weights are calculated as the inverse of the residuals from a regression of the treatment variable on firm and year fixed effects.

Figure A3: **Emissions and Offset use after treatment**



Note: The solid line (left axis) shows the average emission intensity (Scope 1+2 emissions over sales) relative to the year in which the customer's target was formally approved by the Science Based Target Initiative. The dashed line (right axis) reports the cumulative volume of carbon offsets retired by suppliers over the same event window.

B Event study assumptions

To assess whether the timing of exposure to downstream climate pressure is systematically related to pre-existing supplier characteristics, we estimate a set of linear probability models in which the dependent variable equals one in the year a supplier is first treated—that is, the year in which any of its customers obtains SBTi target approval. For each supplier, we construct pre-treatment covariates by averaging emissions, emission intensity, sales, and number of customers three years preceding treatment $(t-3, t-2, t-1)$. All variables are in natural log. We then regress the treatment-year indicator on these pre-treatment averages, including year and industry fixed effects, and cluster standard errors at the supplier level.

Table B1: Estimating Treatment Year

The dependent variable equals one in the year a supplier is first exposed to downstream pressure (the first year any customer obtains SBTi target approval) and zero otherwise. Independent variables are averaged over the three pre-treatment years ($t-3, t-2, t-1$). All regressions include year and industry fixed effects, and standard errors are clustered at the supplier level.

Variables	(1)	(2)	(3)	(4)
Emissions	-0.0005		-0.0004	
	(0.001)		(0.001)	
Emission Intensity		-0.0006		-0.0005
		(0.001)		(0.001)
Sales	0.0024***	0.0020***	0.0016*	0.0012**
	(0.001)	(0.000)	(0.001)	(0.001)
Number of Customers			0.0033***	0.0033***
			(0.001)	(0.001)
Constant	0.0592***	0.0598***	0.0589***	0.0595***
	(0.005)	(0.005)	(0.005)	(0.005)
Observations	52,985	52,985	52,985	52,985
R-squared	0.0211	0.0211	0.0212	0.0212
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm