

Corporate net zero targets: have they achieved anything?

Simon Dietz and Nikolaus Hastreiter

April 2026

**Grantham Research Institute on
Climate Change and the Environment
Working Paper No. 446**

ISSN 2515-5717 (Online)

The Grantham Research Institute on Climate Change and the Environment was established in 2008 at the London School of Economics and Political Science. The Institute brings together international expertise on economics, as well as finance, geography, the environment, international development and political economy to establish a world-leading centre for policy-relevant research, teaching and training in climate change and the environment. It is hosted by the Global School of Sustainability at LSE and is funded by the Grantham Foundation for the Protection of the Environment.

www.lse.ac.uk/granthaminstitute

This working paper is intended to stimulate discussion within the research community and among users of research, and its content may have been submitted for publication in academic journals. It has been reviewed by at least one referee before publication. The views in this paper are those of the authors and do not necessarily represent the position of the Grantham Research Institute's senior management or funders. Any errors and omissions remain those of the authors.

Authors' declaration of AI use: ChatGPT and Claude were used for ideation, helping refine the research design, coding and editing text. All outputs were reviewed by the authors, who take full responsibility for the content of this paper.

This paper was first published in April 2026 by the Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science.

© The authors, 2026

Licensed under [CC BY-NC 4.0](https://creativecommons.org/licenses/by-nc/4.0/)

Suggested citation:

Dietz S and Hastreiter N (2026) *Corporate net zero targets: have they achieved anything?* Grantham Research Institute on Climate Change and the Environment Working Paper 446. London: London School of Economics and Political Science

DOI: [10.21953/researchonline.lse.ac.uk.00138242](https://doi.org/10.21953/researchonline.lse.ac.uk.00138242)

Corporate Net Zero Targets: Have They Achieved Anything?*

Simon Dietz[†] Nikolaus Hastreiter[†]

April 28, 2026

Abstract

Corporate commitments to achieve net zero greenhouse gas emissions by mid-century have proliferated rapidly in recent years. These represent a novel form of corporate climate target, requiring deep decarbonisation under long horizons, uncertainty, and potentially emissions outside firms' direct control. This paper examines whether adopting long-term net zero commitments is associated with observable changes in corporate climate action in the near term. We overcome measurement challenges by combining multiple datasets on emissions and climate governance, including several novel measures, and we exploit staggered variation in adoption timing using difference-in-differences methods with matching to address selection into treatment. We find little evidence of large or immediate reductions in emissions or of broad shifts in climate governance following adoption. At the same time, emissions estimates are generally negative and consistent with gradual reductions, and we observe selective improvements in more demanding, strategic management practices that often begin prior to formal adoption. Overall, the results suggest that long-term net zero commitments are neither purely symbolic nor immediately transformative, but are embedded within a gradual process of organisational change, with implications for how such commitments are interpreted and designed to support near-term action.

*We are grateful to Gregor Singer for comments, to FTSE Russell for sharing their data with us, and to Robert Ingham and Jon Ward for their assistance in data cleaning.

[†]London School of Economics & Political Science (LSE) – s.dietz@lse.ac.uk, n.l.hastreiter@lse.ac.uk

1 Introduction

Corporate commitments to achieve net zero greenhouse gas (GHG) emissions by around mid-century have spread with remarkable speed. Figure 1 shows that out of a global sample of 1,972 large companies, the number of such commitments increased from 70 in 2019 to 1,236 (63%) in 2024. This rapid diffusion has made long-term net zero (LTNZ) commitments a central feature of corporate climate strategy.

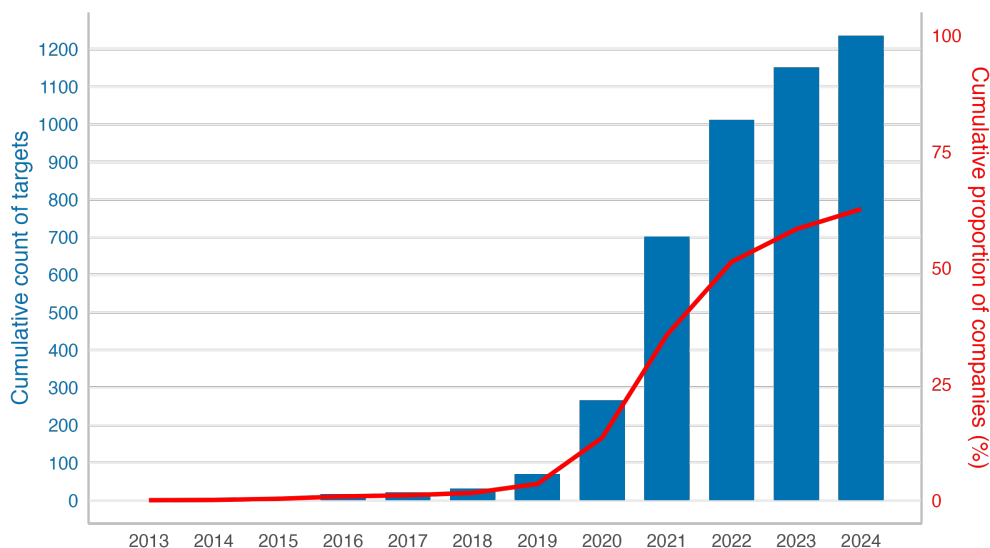


Figure 1: The figure shows the cumulative count and proportion of a sample of 1,972 companies announcing long-term net zero (LTNZ) targets or similar commitments. The company sample corresponds to the Transition Pathway Initiative (TPI) Management Quality (MQ) universe, which comprises 2,016 publicly traded firms and 27 large private companies from the highest-emitting sectors. Information on LTNZ targets is available for 1,972 companies sourced from Refinitiv Workspace.

The prominence of LTNZ derives from scientific assessments by the Intergovernmental Panel on Climate Change (IPCC), particularly its 2018 Special Report on 1.5°C, which

identified global net zero carbon dioxide emissions by mid-century as broadly consistent with limiting warming to 1.5°C (Masson-Delmotte et al., 2018). This scientific rationale was subsequently reinforced by national net zero pledges and legislation, which helped institutionalise LTNZ as a focal point for long-term climate ambition (Van Coppenolle et al., 2023). LTNZ targets have since become embedded in corporate climate governance, supported by major investors and by initiatives such as the Science Based Targets initiative (SBTi), the UN Race to Zero, and the Glasgow Financial Alliance for Net Zero (GFANZ). Today, these targets are routinely used to benchmark corporate climate leadership, shape investor expectations, and structure firm-stakeholder dialogues about the low-carbon transition. Their rapid and broad diffusion makes LTNZ targets an important organisational development with potentially significant long-term implications.

LTNZ targets also represent a distinct type of corporate environmental commitment. Earlier climate pledges typically focused on operational improvements to 2025 or 2030. In contrast, NZ targets require firms to articulate a pathway to deep decarbonisation over multiple decades, spanning leadership cycles, technological uncertainty, and evolving market conditions (Fankhauser et al., 2022). They should also encompass the challenge of reducing Scope 3 emissions, which reach beyond firms' direct control.¹ As such, LTNZ targets are not simply extensions of traditional environmental goals but embody a long-term strategic orientation that interacts with multiple areas of organisational decision-making.

Crucially, the long-term strategic orientation of LTNZ targets means it is not obvious whether they should lead to observable changes in corporate behaviour in the near term. One perspective is that LTNZ targets are primarily symbolic. Because they are highly visible but not easily verifiable in the near term, some firms may adopt them to address stakeholder

¹Scope 1 refers to direct emissions from owned or controlled sources, Scope 2 to indirect emissions from purchased energy and Scope 3 to indirect emissions across the value chain (GHG Protocol Initiative, 2004)

expectations without initiating substantive changes, a concern often framed in terms of “greenwash” (Montgomery et al., 2024; Fuoli and Beelitz, 2025). Alternatively, limited near-term change may reflect rational hedging under uncertainty rather than a lack of intention *per se*. From a real-options standpoint, an LTNZ target establishes an end-state while allowing firms to defer concrete decisions until information improves (e.g. about whether politicians and public policy are committed to decarbonising) or low-carbon technologies become more cost-effective.² A third possibility points in the opposite direction. Drawing on theory from organisational psychology, setting difficult yet attainable goals can enhance performance by directing attention, mobilising effort, and sustaining organisational focus (Locke and Latham, 1990, 2002). LTNZ targets may therefore act as a bridgehead for more concrete near-term obligations, prompting firms to introduce new governance arrangements and management practices that induce earlier operational changes and emissions reductions (Anagnostopoulou, 2025). These distinct mechanisms differ in intent and interpretation, but they all lead to our central empirical question:

do LTNZ targets influence firms’ emissions and climate-related management practices in the years immediately following adoption?

Addressing this question involves two empirical challenges. The first is measurement. Corporate climate action is difficult to quantify. Emissions data are often noisy – whether self-reported or vendor-estimated – and many datasets lack consistent coverage of materially relevant Scope 3 emissions. Measures of climate management and governance present similar challenges: prior studies typically rely on broad ESG indicators or disclosure-based measures, which do not fully capture the specific management systems, oversight arrange-

²However, delaying emissions reductions in the short to medium term while reaching the same end-state delivers worse climate outcomes, because global temperatures are proportional to *cumulative* carbon emissions.

ments, and planning processes through which climate commitments are implemented. The second challenge is identification. Adoption of LTNZ targets is voluntary and plausibly endogenous, as firms may adopt such targets when they possess characteristics such as stronger governance capabilities, more advanced climate strategies, sector-specific opportunities, or greater stakeholder pressure, which would have led them to improve regardless. These omitted variables can bias simple comparisons of adopters and non-adopters. Differences in the timing of adoption further complicate inference, as early adopters may systematically differ from later ones.

The existing literature on voluntary corporate climate targets has taken initial steps towards addressing these challenges. Early contributions focusing mainly on short- to medium-term targets found that simple target adoption had limited explanatory power, but also found heterogeneous effects across target design and ambition – more demanding targets or targets for absolute emissions were more likely to be met or associated with emissions reductions (Ioannou et al., 2016; Dahlmann et al., 2019). More recent studies of SBTi have attempted to address identification concerns by using a Difference-in-Differences (DiD) approach (Bolton and Kacperczyk, 2025; Li et al., 2025; Salerno and Sampagnaro, 2025; Sun et al., 2025). These studies reveal substantial selection into target adoption and limited average impacts in the short term. Acharya et al. (2025) analyse net zero pledges specifically, finding firms with net zero pledges tend to emit less, albeit with a cross-sectional research design. From the perspective of our research question, the existing literature leaves several gaps. First, few papers focus specifically on LTNZ targets, despite their distinctive strategic implications. Second, although the literature is starting to take identification seriously,³ much of the existing evidence derives from designs vulnerable to endogeneity concerns. Third, the

³In particular, Salerno and Sampagnaro (2025) compare early adopters with late adopters, while Sun et al. (2025) combine DiD with matching.

literature looks largely at emissions, often drawn from self-reported or commercial datasets with limited treatment of Scope 3 emissions. And while some papers look beyond the existence of targets to consider target characteristics or investment (Dahlmann et al., 2019; Freiberg et al., 2021), they provide little direct evidence on whether target adoption leads to changes in firms’ climate management and governance.

In this paper, we aim to fill these gaps by examining whether the adoption of LTNZ targets is associated with observable changes in firms’ GHG emissions and climate management and governance in the near term. To address the measurement challenges noted above, we draw on multiple complementary data sources and construct outcome variables that better reflect both emissions performance and climate management practices. For emissions, we first draw on Trucost, which provides broad coverage of publicly listed firms and, by estimating emissions for those who do not voluntarily disclose them, reduces concerns about selection into reporting that affects peer data sets such as CDP. However, since large-sample data from commercial providers like Trucost have drawbacks such as measurement error, uneven coverage of material emissions categories, and the use of potentially volatile revenue-based intensity measures, we augment this with a high-quality data set on a smaller sample of firms from the Transition Pathway Initiative (TPI). These data are based on independently calculated,⁴ sector-specific Scope 1-3 intensity metrics constructed using a consistent methodology aligned with transition benchmarks. To measure climate management and governance, we use TPI data on firms’ climate management practices, and supplement them in a robustness check with structured disclosure data on management and governance from CDP. This multi-dataset strategy provides a more comprehensive representation of both emissions performance and the organisational practices through which climate strategy is governed

⁴That is, they are independently calculated based on publicly available financial, operational and sustainability data. They are not estimated statistically.

and implemented than is available in most prior studies.

To address identification challenges, we leverage the staggered timing of LTNZ target adoption, following a DiD approach that compares firms' trajectories before and after adoption. To improve the comparability of treated and control firms, we implement propensity score matching to construct a control group with similar pre-adoption characteristics. Together, these design choices allow us to assess whether LTNZ targets are followed by measurable changes in emissions and climate-related management practices, beyond what would be expected from pre-existing differences in firms' climate strategies.

We find little evidence that the adoption of LTNZ targets is followed by large or immediate reductions in corporate emissions or by broad-based changes in climate management and governance. Across multiple emissions measures, post-adoption estimates are generally negative but imprecisely estimated, consistent with gradual reductions that take time to materialise. Some climate management and governance measures show no clear post-adoption effects. Other measures exhibit negative post-adoption effects, a counter-intuitive result that we can attribute to LTNZ target non-adopters catching up with LTNZ target adopters on basic practices over time. Yet, we do observe selective improvements in more demanding, strategic practices after adopting LTNZ targets. These improvements often begin shortly before formal adoption and continue thereafter. The anticipation effect we detect for these strategic practices is also consistent with the results of our model predicting LTNZ adoption for the purposes of matching – firms with stronger existing climate management and governance are more likely to adopt LTNZ targets. Taken together, the results suggest that LTNZ targets are neither purely symbolic nor immediately transformative, but are embedded within a gradual process of organisational change.

The remainder of the paper is structured as follows. Section 2 describes the data, in-

cluding our measures of LTNZ targets, corporate emissions, and climate management and governance practices. Section 3 outlines the empirical strategy, examining selection into LTNZ adoption and presenting our staggered DiD design combined with matching. Section 4 presents the results, including extensions to analyse differences between early and late adopters, and convergence between adopters and non-adopters. Section 5 discusses the implications of the findings for understanding the role of long-term corporate climate commitments and outlines directions for future research.

2 Data

2.1 Company Universe

As a first step, we define a company universe suitable for assessing the effects of corporate LTNZ targets. Empirical studies on changes in corporate climate action often rely on broad stock market indices as their baseline universe (e.g. S&P 500, MSCI World), which has the advantage of focusing on economically important firms (Ilhan et al., 2023). However, index-based universes do not necessarily capture the largest corporate contributors to global GHG emissions. Many highly valued firms, particularly in technology and services, have relatively small carbon footprints. While climate action across all sectors is important, linking corporate LTNZ targets to global temperature goals requires a focus on the firms with the highest absolute carbon emissions.

An alternative approach is to analyse samples drawn from climate disclosure or target-setting platforms, such as CDP or SBTi (e.g. Bolton and Kacperczyk, 2025; Salerno and Sampagnaro, 2025). These datasets provide detailed information on corporate targets, including LTNZ targets, but rely on voluntary participation of companies. As a result, they are

subject to selection concerns: disclosing through CDP or seeking validation of science-based targets is itself a strategic choice and has been studied as an outcome of interest (Cohen et al., 2023; Hastreiter, 2024). Firms that choose not to opt into these platforms may differ systematically from participating firms, both among adopters and non-adopters of LTNZ targets. This limits the representativeness of such samples for the wider economy.

We therefore adopt a different sampling strategy that prioritises emissions relevance and avoids self-selection. Specifically, we base our analysis on the company universe of TPI, which is an investor-led initiative aiming to promote better understanding of what climate action companies are taking.⁵ TPI partners with the London School of Economics and Political Science (LSE) and FTSE Russell to develop methodologies to assess corporate climate action. LSE hosts a public dataset based on these methodologies, which at the time of writing comprised approximately 2,000 publicly listed companies in the real economy operating primarily in high-emissions sectors. Sample selection is based on a combination of absolute GHG emissions and market capitalisation.⁶ As such, the TPI universe captures firms that are both economically significant and central to global decarbonisation. Furthermore, TPI determines which companies to assess, avoiding reliance on firms' voluntary decisions to opt into assessment.

2.2 Net zero targets

We identify LTNZ targets using data extracted from the Refinitiv ESG database on February 4, 2026. Refinitiv systematically collects and standardises information on firms' climate

⁵<https://www.transitionpathwayinitiative.org/tpi-ltd>

⁶Specifically, selection is first made over sectors, using Industry Classification Benchmark sectors and based on sectors' absolute emissions and market capitalisation. Once sectors have been selected, companies within sectors are selected based on a combined ranking of market capitalisation and absolute emissions, with equal weighting.

targets from public disclosures, including annual reports, sustainability reports, regulatory filings, CDP and company websites. For each firm, it records up to six climate-related emissions reduction targets, stored as distinct target sets. For each company, we use the earliest LTNZ target and extract the associated target characteristics (e.g. year set, target year) from that target set for use in our analysis.

Our main variable of interest is the year in which a firm first publicly announced an LTNZ target. We define an LTNZ target as a firm-level pledge to reach net zero emissions (or an explicitly equivalent formulation, such as carbon neutrality or climate neutrality) by around mid-century.⁷ We include all LTNZ targets regardless of the scope of emissions covered. However, we use Refinitiv’s “emissions scope” variable to identify companies that include Scope 3 emissions in their targets, so that we can test whether such targets have different effects. Firms that do not announce an LTNZ target during the sample period are treated as never-adopters.

2.3 Corporate carbon emissions

We begin by assessing the most meaningful form of corporate climate action that LTNZ targets could plausibly affect: reductions in firms’ GHG emissions. Given ongoing debates in the literature about the best way to measure emissions, including the relative merits of absolute emissions versus emissions intensities, and reported versus estimated emissions data (Bolton and Kacperczyk, 2025; Aswani et al., 2024), we employ several complementary measures of corporate emissions, drawing on two distinct data sources.

⁷The vast majority of firms with net zero commitments target 2050. However, other target years are observed, ranging from 2035 or even earlier to 2060. We include all net zero commitments in our main analysis on the grounds that many of the novel features of net zero targets such as uncertainty and emissions outside firms’ direct control are orthogonal to the target year. As shown in a robustness check, our results hold when excluding companies with target years prior to 2035.

(i) Trucost Our primary emissions dataset is provided by Trucost, which offers broad coverage of large publicly listed firms and consistent time-series data. Trucost combines company-reported emissions with model-based estimates for firms that do not voluntarily disclose. Our measure includes Scope 1 and 2 emissions, as well as upstream Scope 3 emissions. We analyse both absolute emissions and emissions intensities scaled by firm revenue, expressed in logarithms to reduce the influence of extreme values and to facilitate interpretation in relative terms. The resulting panel comprises approximately 1,600 firms observed annually from 2015 to 2023.

Despite their broad coverage, emissions data from commercial providers such as Trucost have important limitations. First, uniform emissions measures do not account for sector-specific decarbonisation challenges, such as differences in the materiality of emissions categories across industries. Second, Scope 3 emissions remain subject to substantial measurement uncertainty (Busch et al., 2022). In particular, downstream emissions, which are highly relevant in many high-emissions sectors such as fossil fuel extraction and transport, are often unavailable over longer time horizons. Third, intensity measures that rely on financial denominators such as revenue can be sensitive to fluctuations unrelated to firms' underlying carbon efficiency. For example, increases in sales prices can mechanically reduce revenue-based carbon intensities even when neither absolute emissions nor emissions per unit of physical output decrease.

(ii) TPI To address these limitations, we complement the Trucost data with sector-specific carbon intensity measures from TPI. TPI provides independently calculated carbon intensity metrics for a smaller sample of approximately 200 companies over the period from 2015 to 2022 (the company list shown in Appendix A). These measures are based on sector-specific

methodologies that identify the most relevant emissions from a lifecycle perspective (including upstream or downstream Scope 3, as appropriate) and normalise emissions by physical output measures rather than financial variables. For example, in energy and materials sectors, emissions are scaled by energy sold or tonnes of output. This allows for more stable and meaningful comparisons than revenue-based intensities. Since TPI carbon intensity measures vary by sector, we standardise them using z-scores, reflecting differences in standard deviations from the sector mean in 2015. Although the sample is small, it comprises the largest global companies in the highest-emitting sectors, such as electricity, oil and gas, and steel.

By combining Trucost and TPI emissions data, we aim to balance breadth and measurement precision. The Trucost data allow us to study a large and economically important set of firms over a relatively long time horizon, while the TPI data provide more reliable, sector-adjusted emissions measures, albeit for a smaller subsample. Using both datasets therefore strengthens confidence that our results are not driven by measurement artifacts specific to any single emissions source. Neither dataset is based on voluntary participation by companies.

2.4 Management and governance

Since operational changes that reduce GHG emissions often require substantial investment and time to implement, it may be too early to see effects on emissions. This is particularly relevant for LTNZ targets. We therefore turn to changes in firms' climate management and governance, which may be implemented more rapidly and plausibly respond earlier to such commitments. However, measuring these changes presents its own set of challenges.

Studies examining broader corporate sustainability outcomes often rely on aggregated ESG ratings (Dyck et al., 2019; Barko et al., 2022). While these composite measures provide

broad coverage, they can obscure changes in specific dimensions of sustainability performance, as effects in individual areas may be diluted through aggregation across a large number of indicators. Moreover, ratings for the same firm frequently diverge substantially across data providers (Berg et al., 2022). These concerns persist when focusing on readily available aggregate “climate” scores rather than broader ESG ratings.

Other studies analyse changes in firms’ climate-related disclosures, most prominently the type and extent of information firms report to CDP (Flammer et al., 2021; Ilhan et al., 2023). These studies typically rely on binary or count-based measures to capture whether firms disclose emissions data and how many categories of climate-related risks (e.g. regulatory, physical) they report. As such, they provide important insights into changes in firms’ transparency and communication strategies – what information firms report and how extensively they do so. However, disclosure-based count measures may not fully capture the quality of firms’ climate-related management and governance, in particular how climate considerations are embedded in organisational decision-making. Discrepancies may arise between reported disclosures and actual organisational practices. A central concern in this context is greenwashing, whereby firms strategically emphasise favourable aspects of their environmental activities while downplaying or omitting others (Lyon and Maxwell, 2011; Callery, 2023).

These limitations highlight the need for multidimensional measurement approaches that capture changes in disclosure alongside more substantive organisational practices. To address this challenge, we primarily use data from the TPI Management Quality (MQ) framework. The TPI MQ dataset is based on raw information collected by FTSE Russell from publicly available sources, which is then converted into 19 standardised indicators. Companies are given the opportunity to provide feedback. The fact that FTSE Russell, an external data

provider, collects the raw information mitigates concerns about strategic self-reporting by companies that can affect survey-based datasets.

The 19 MQ indicators each correspond to specific climate management practices, such as disclosing emissions data, setting targets, assigning board-level responsibility, aligning executive pay, and internal carbon pricing. While the more basic indicators capture the presence of specific disclosures, the more advanced ones assess the quality of concrete organisational practices. The framework is analogous to the World Management Survey (Bloom and Van Reenen, 2007). We exclude indicators directly related to target-setting to avoid endogeneity with LTNZ adoption, as well as two lobbying indicators for which the assessment methodology changed over time. This yields a sample of approximately 1,400 firms observed from 2019 to 2023 across 13 indicators. Appendix B provides a detailed description of each indicator and its assessment criteria.

To summarise firm-level climate management and governance, we aggregate the individual indicators into company-level scores using four alternative aggregation approaches. While all approaches aim to capture the same latent construct – the quality of firms’ climate management and governance – they differ in how they weight indicators with respect to implementation difficulty, normative interpretation and thematic focus.

(i) Count We begin with a simple unweighted count of the 13 retained indicators. This measure has the advantage of ease of interpretation, as each indicator represents a concrete climate management practice. However, it implicitly assumes that all indicators are equally informative about firms’ underlying climate management quality, whereas, for example, some practices are more difficult to implement than others.

(ii) Hierarchy of levels Second, we use TPI’s ready-made “MQ staircase” framework, which organises individual indicators into five levels representing increasing climate management quality (from Level 0, “Unaware of Climate Change as a Business Issue” to Level 5, “Transition Planning and Implementation”). Progression up this staircase is cumulative: to move to a higher level, a firm must satisfy all indicators associated with lower levels. This structure gives the level measure a clear normative interpretation, as higher levels correspond to substantively more advanced climate management. However, the measure is ordinal – moving from one level to the next requires satisfying varying numbers of indicators with varying ambition and organisational complexity.

(iii) Difficulty-weighted score To address the limitations of both the unweighted count and the MQ level measure, we construct a weighted score as a third aggregation approach. The intuition for this measure is that indicators which fewer firms satisfy plausibly reflect more demanding or costly governance practices and should therefore receive greater weight. Specifically, we assign each indicator a weight that is inversely related to the share of companies that satisfy the indicator in the 2023 cross-section. Formally, the weight assigned to indicator i is given by

$$w(i) = \log \left(\frac{N + a}{n(i) + a} \right), \quad (1)$$

where N denotes the total number of firms in the sample, $n(i)$ is the number of firms satisfying indicator i , and a is a small smoothing constant, equalling 0.5. The log transformation ensures that the influence of rarity on the weighting function increases at a decreasing rate. This prevents extremely rare indicators from dominating the index, while still allowing the score to reflect differences in implementation difficulty across indicators. The weighted aggregate score is then computed as the sum of weighted indicators satisfied by a firm in a

given year. This approach allows the index to reflect differences in implementation difficulty while remaining interpretable as a composite measure of firms' climate-related management quality.

(iv) Thematic Finally, as a fourth aggregation method, we group the indicators thematically, using their alignment with the Task Force on Climate-related Financial Disclosures (TCFD) framework: (i) Governance, (ii) Strategy, (iii) Risk Management and (iv) Metrics and Targets. We assign each MQ indicator to its corresponding TCFD theme and compute within-theme averages. This approach allows us to explore whether LTNZ targets have different effects on different areas of firms' climate management and governance. Appendix B includes a mapping of the indicators to the TCFD themes.

CDP robustness analysis These four scores constitute our primary measures of firms' climate management and governance. In line with our multi-dataset measurement strategy and to facilitate comparison with prior studies, we additionally draw on data from the CDP database. Specifically, we use firms' overall CDP climate scores from 2015 to 2022, which take eight ordinal values (D-, D, C-, C, B-, B, A- and A). Because the overlap between the CDP and TPI universes is limited when restricting the CDP dataset to complete time series, we include all approximately 1,400 firms with available CDP scores for this analysis. As discussed above, participation in CDP is voluntary and may therefore introduce selection concerns. Hence, the CDP-based analysis does not necessarily focus on the largest corporate polluters and may be less representative of the firms most central to global decarbonisation. We therefore interpret the results based on CDP scores primarily as a robustness check.

2.5 Descriptive statistics

Table 1 reports descriptive statistics for all outcome variables. Firms in the sample exhibited substantial variation in Trucost log absolute emissions and log emissions intensity. In 2019, this dispersion corresponded to roughly five- to six-fold differences in emissions across firms for a one standard-deviation difference, likely reflecting differences in sector and production technology. Over the period 2019 to 2023, Trucost absolute emissions declined by c. 7% on average, while Trucost emissions intensities declined by c. 25% on average, consistent with reductions in emissions per unit revenue being partly offset by increases in firm scale. The sector-adjusted TPI emissions intensity measure, expressed in z-scores, also declined on average.

Climate management and governance practices similarly exhibited considerable dispersion and improved over time. The average MQ count increased by approximately 2.8 between 2019 and 2023, the average MQ level rose by nearly one full level, and the difficulty-weighted MQ score increased by a similar magnitude (corresponding to c. 90% of the 2019 mean). The CDP climate score increased more modestly over the sample period. Together, these patterns suggest that firms not only adopted more practices but also more demanding ones.

| Variable | N | 2019 Mean | 2019 SD | 2019 Min | 2019 Max | Δ Mean | Δ SD | Δ Min | Δ Max |
|---------------------------|-------|-----------|---------|----------|----------|---------------|-------------|--------------|--------------|
| Trucost log GHG absolute | 1,571 | 14.527 | 1.755 | 6.981 | 20.205 | -0.067 | 0.575 | -3.046 | 5.524 |
| Trucost log GHG intensity | 1,571 | 5.345 | 1.712 | 0.956 | 10.672 | -0.267 | 0.531 | -3.233 | 4.238 |
| TPI intensity (z-score) | 200 | -0.151 | 0.972 | -2.872 | 3.553 | -0.137 | 0.539 | -2.452 | 3.245 |
| MQ count | 1,398 | 6.527 | 3.662 | 0 | 13 | 2.840 | 2.408 | -4 | 11 |
| MQ level | 1,398 | 2.627 | 1.363 | 0 | 5 | 0.940 | 1.052 | -2 | 4 |
| MQ weighted score | 1,398 | 1.213 | 1.230 | 0 | 5.887 | 1.094 | 1.188 | -3.493 | 5.838 |
| CDP score (numeric) | 1,377 | 5.940 | 1.565 | 1 | 8 | 0.399 | 1.281 | -4 | 5 |

Table 1: This table reports descriptive statistics for the outcome variables used in this study. The left panel reports the mean, standard deviation, minimum and maximum in 2019. The right panel reports the mean, standard deviation, minimum and maximum for changes between 2019 and 2023 for Trucost and the TPI MQ indicators, and between 2019 and 2022 for TPI carbon intensities and CDP scores.

3 Empirical strategy

3.1 Selection into net zero target-setting

The adoption of LTNZ targets is voluntary, implying that firms self-select into treatment and that adoption is plausibly endogenous. The first step of our empirical strategy is therefore to examine systematic differences between firms that adopt LTNZ targets and those that do not. To that end, we estimate a linear probability model to analyse which firm characteristics predict the adoption of an LTNZ target. We use a linear model because nonlinear fixed-effects estimators can be biased in short panels, and alternative approaches such as conditional logit would rely only on firms that change adoption status over time, excluding firms that never adopt (Wooldridge, 2010).

Our dependent variable is an indicator equal to one if firm i announces an LTNZ target in year $t+1$, and zero otherwise. Using a one-year lead ensures that explanatory variables are measured prior to adoption and mitigates concerns about reverse causality. Building on prior work on voluntary climate commitments (Freiberg et al., 2021; Acharya et al.,

2025), we include predictors capturing firm size and firms’ prior performance on climate change. We estimate models with firm or sector fixed effects. The former exploit within-firm variation, while the latter exploit cross-sectional differences between firms in the same sector. All specifications include year fixed effects to account for common time trends in target adoption. To avoid post-treatment contamination, we restrict the sample for adopting firms to observations up to one year prior to the target announcement.

Formally, we estimate the following model:

$$\begin{aligned} \text{LTNZ}_{i,t+1} = & \alpha + \beta_1 \log(\text{MarketCap}_{i,t}) + \beta_2 \log(\text{AbsoluteEmissions}_{i,t}) \\ & + \beta_3 \log(\text{EmissionsIntensity}_{i,t}) + \beta_4 \text{MQ}_{i,t} + \gamma_t + \mu_i \text{ or } \delta_s + \varepsilon_{i,t}. \end{aligned} \quad (2)$$

$\text{LTNZ}_{i,t+1}$ is an indicator equal to one if firm i announces an LTNZ target in year $t + 1$. $\log(\text{MarketCap}_{i,t})$ denotes the logarithm of firm i ’s market capitalisation, sourced from Refinitiv, and $\log(\text{AbsoluteEmissions}_{i,t})$ and $\log(\text{EmissionsIntensity}_{i,t})$ are taken from Trucost. $\text{MQ}_{i,t}$ denotes the firm’s TPI MQ score and is measured using the indicator count, hierarchical level, or weighted score.⁸ γ_t represents year fixed effects, μ_i firm fixed effects, δ_s sector fixed effects, and $\varepsilon_{i,t}$ is an error term.

Table 2 presents the results with columns (1)–(3) showing the firm fixed-effects models and columns (4)–(6) the sector fixed-effects models. We find that market capitalisation does not robustly predict LTNZ adoption, but firms’ emissions profiles do. In the firm fixed-effects models, higher absolute emissions are negatively associated with LTNZ adoption, while higher emissions intensity is positively associated with adoption. In the sector fixed-effects models, the sign on absolute emissions reverses, suggesting that, within sectors, firms

⁸We do not include individual indicators as predictors, since management practices are unlikely to be implemented in isolation (Dietz et al., 2018). As a result, individual indicators are likely to be correlated, raising concerns about multicollinearity.

with higher emissions are more likely to adopt LTNZ targets. By contrast, emissions intensity is not significantly associated with adoption in the sector fixed-effects models.

The MQ measures are generally associated with a higher probability of adoption. In the firm fixed-effects models, the weighted score is a strong positive predictor of adoption, suggesting that stronger climate management and governance within firms tends to precede LTNZ targets. In the sector fixed-effects models, all three measures are positively and statistically significantly associated with adoption.

| Dependent Variable: Model: | LTNZ target set in the next year | | | | | |
|-------------------------------------|----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| MQ indicator count | 0.0011 (0.0065) | | | 0.0265*** (0.0021) | | |
| MQ level | | -0.0132 (0.0134) | | | 0.0636*** (0.0056) | |
| MQ weighted score | | | 0.0459*** (0.0143) | | | 0.0646*** (0.0060) |
| log MarketCap | 0.0083 (0.0287) | 0.0089 (0.0290) | 0.0078 (0.0284) | -0.0038 (0.0076) | -0.0029 (0.0077) | -0.0014 (0.0077) |
| log GHG absolute | -0.0990** (0.0424) | -0.0971** (0.0422) | -0.0997** (0.0425) | 0.0169** (0.0070) | 0.0214*** (0.0071) | 0.0178** (0.0071) |
| log GHG intensity direct first tier | 0.0864** (0.0430) | 0.0863** (0.0429) | 0.0873** (0.0430) | -0.0100 (0.0086) | -0.0124 (0.0088) | -0.0119 (0.0087) |
| <i>Fixed-effects</i> | | | | | | |
| Company | Yes | Yes | Yes | | | |
| Sector | | | | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 3,115 | 3,115 | 3,115 | 3,115 | 3,115 | 3,115 |
| R ² | 0.56 | 0.56 | 0.57 | 0.11 | 0.094 | 0.10 |
| Within R ² | 0.01 | 0.01 | 0.01 | 0.05 | 0.04 | 0.05 |

Standard errors clustered at the company-level, *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 2: This table reports linear probability models estimating the likelihood that a firm announces a LTNZ target in the subsequent year.

3.2 Matching and staggered Difference-in-Differences

To answer our core research question, we estimate the effects of adopting an LTNZ target using a staggered DiD design that exploits variation in the timing of adoption across firms, comparing changes in outcomes before and after adoption to contemporaneous changes among firms that have not yet adopted. However, the results from the previous subsection indicate that LTNZ adopters differ systematically from non-adopters in their pre-adoption emissions, and climate management and governance. To mitigate concerns about selection into treatment, we therefore combine our staggered DiD design with propensity score matching to construct a more comparable control group prior to estimation and strengthen the credibility of the parallel trends assumption.

Our choice of matching variables is informed by the selection analysis in Section 3.1, as well as theory and previous literature. In particular, we match on log market capitalisation, log absolute emissions, log emissions intensity, the weighted TPI MQ score, region, and sector cluster. We include log market capitalisation despite it not emerging as a statistically significant predictor in the previous analysis, because there are still good conceptual reasons to believe that firm size matters for net zero target-setting ([Acharya et al., 2025](#)). As a robustness check, we also implement an alternative matching specification that includes leverage, return on equity and capex-to-assets (all sourced from Refinitiv) as additional covariates, as in e.g. [Bolton and Kacperczyk \(2025\)](#). The results are reported in Appendix C.

Implementing matching in a staggered adoption setting poses specific challenges, as firms transition from untreated to treated status at different points in time and may serve as controls prior to adoption. To address this, we perform matching at the cohort level. For

each adoption cohort, we construct pre-treatment covariate averages using only information observed prior to the year of adoption. We then estimate propensity scores using a logistic regression and match treated firms to nearest-neighbour control firms based on these cohort-specific scores, applying a caliper of 0.2 to avoid poor matches.

Figure 2 shows the resulting propensity distributions for unmatched and matched samples by cohort. The matched distributions overlap neatly. Table 3 reports pre-treatment covariate balance for treated and control firms in both the unmatched and matched samples. Following matching, differences across all covariates are small and statistically insignificant, indicating that the procedure achieves good balance. Details on the construction of the stacked sample and the balance tests are provided in Appendix C.

We combine all firms that appear in any cohort-specific matched sample into a single matched panel, which includes 906 firms. Firms may serve as controls prior to adoption and as treated units thereafter, consistent with the staggered DiD framework. We then apply the Callaway and Sant’Anna (2021) estimator to this matched sample. We prefer propensity score matching to inverse probability weighting because it allows for a transparent assessment of covariate balance and avoids reliance on model-based extrapolation in regions and sectors of limited overlap. While matching does not eliminate all endogeneity concerns, it reduces observable differences between adopters and non-adopters, thereby strengthening the credibility of the DiD design.

We perform the matching procedure once and use the resulting matched firm sample across all subsequent outcome analyses. As data availability varies across datasets, this leads to different effective sample sizes across outcomes, but ensures consistency in the set of firms used in the matched analysis wherever feasible. However, the matched sample becomes very small for the sector-specific TPI emissions intensities and CDP scores. For these outcomes,

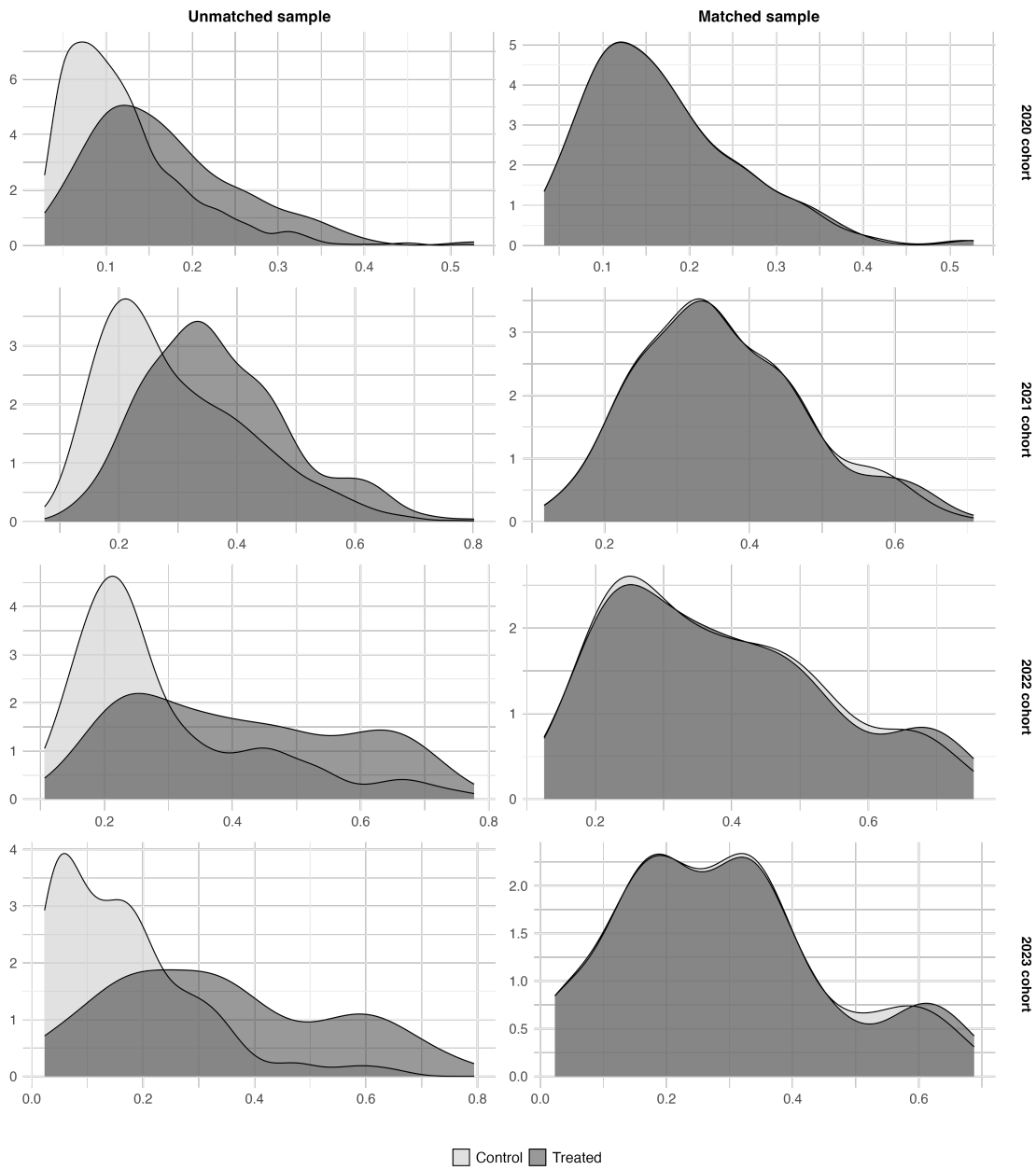


Figure 2: This figure shows the distribution of propensity scores before and after matching for each adoption cohort. The y-axis reports density values and the x-axis reports propensity scores.

| Covariate | Full sample | | | Matched sample | | |
|----------------------------|-------------|---------|------------------------|----------------|---------|------------------------|
| | Treated | Control | Diff ($\hat{\beta}$) | Treated | Control | Diff ($\hat{\beta}$) |
| Log market cap | 23.441 | 23.261 | 0.196*** | 23.429 | 23.384 | 0.045 |
| Log GHG absolute | 14.672 | 14.396 | 0.31*** | 14.646 | 14.655 | -0.009 |
| Log GHG intensity | 5.351 | 5.342 | 0.011 | 5.356 | 5.383 | -0.027 |
| MQ weighted score | 1.835 | 1.209 | 0.64*** | 1.745 | 1.727 | 0.018 |
| Region: Africa | 0.019 | 0.010 | 0.01** | 0.017 | 0.016 | 0.002 |
| Region: Asia | 0.487 | 0.491 | -0.01 | 0.476 | 0.470 | 0.006 |
| Region: Australia | 0.035 | 0.026 | 0.01 | 0.037 | 0.037 | 0 |
| Region: Europe | 0.204 | 0.144 | 0.068*** | 0.205 | 0.225 | -0.02 |
| Region: North America | 0.230 | 0.308 | -0.082*** | 0.240 | 0.225 | 0.016 |
| Region: South America | 0.025 | 0.021 | 0.004 | 0.025 | 0.028 | -0.003 |
| Sector cluster: Energy | 0.178 | 0.164 | 0.017 | 0.177 | 0.183 | -0.006 |
| Sector cluster: Industry | 0.382 | 0.406 | -0.03 | 0.381 | 0.389 | -0.008 |
| Sector cluster: Services | 0.373 | 0.381 | -0.009 | 0.378 | 0.369 | 0.009 |
| Sector cluster: Transport | 0.067 | 0.048 | 0.021** | 0.064 | 0.059 | 0.005 |
| Observations (firm-cohort) | 686 | 2,160 | | 645 | 645 | |

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 3: This table reports stacked cohort means of baseline covariates for the full and the matched samples. The Diff columns report $\hat{\beta}$ from the cohort fixed-effect regressions.

we therefore rely on the unmatched samples. We also note that the Callaway and Sant’Anna estimator is primarily designed for continuous outcome variables, whereas the MQ indicator counts, hierarchical levels, and CDP scores are discrete and ordinal. Nevertheless, these variables exhibit sufficient variation over time to support meaningful analysis, and we also have the MQ weighted score, which is continuous.

4 Results

4.1 Net zero targets and GHG emissions

Trucost Figure 3 presents event-study estimates based on the matched sample using Trucost data on log absolute emissions and log emissions intensity. The pre-adoption coefficients are close to zero and statistically insignificant, which supports the plausibility of the parallel trends assumption in the matched sample. Turning to the post-adoption period, the point estimates are generally negative – particularly for log absolute emissions two to three years after adoption – suggesting a gradual decline in emissions relative to matched control firms. However, the estimates are imprecise, with wide confidence intervals that always include zero, implying that the data do not allow us to clearly distinguish between no effect and modest emissions reductions in the years immediately following adoption.

TPI Figure 4 presents event-study estimates using the sector-specific TPI carbon intensities. These estimates suggest a larger post-adoption decline in emissions intensity following LTNZ adoption. However, the estimates remain imprecise, and the TPI sample is not large enough to allow for the implementation of our matching procedure, so these findings should be interpreted with caution.

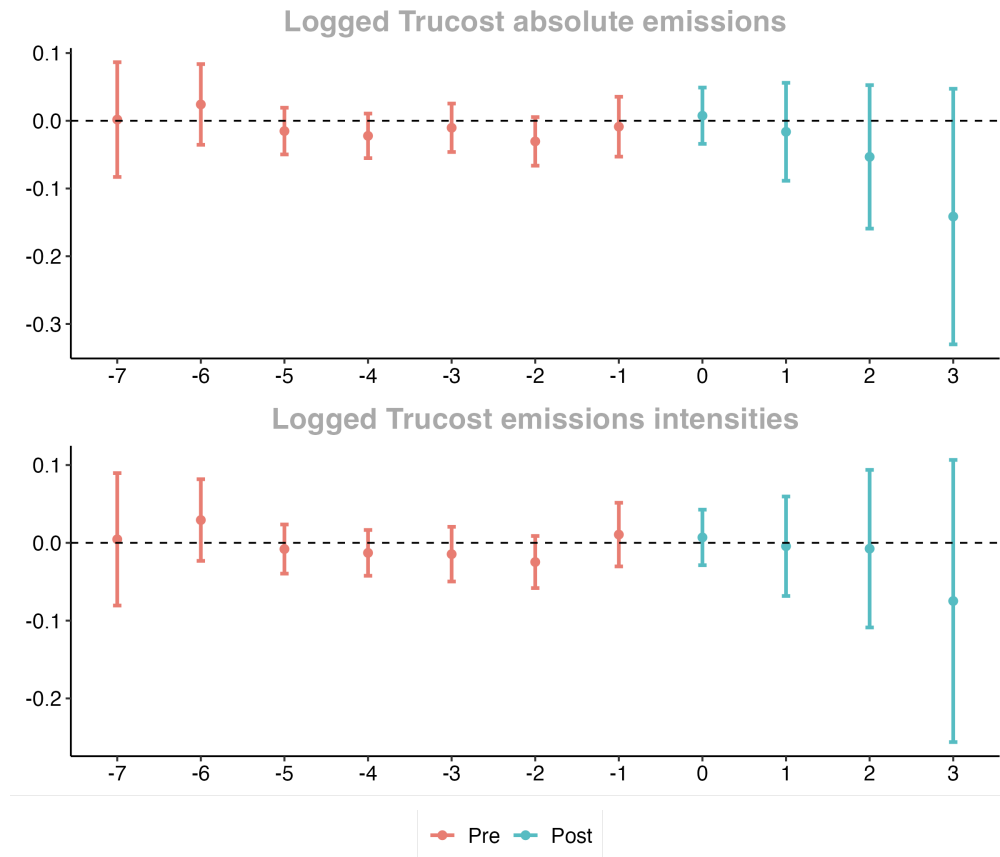


Figure 3: This figure shows the dynamic treatment effects of LTNZ announcements on logged absolute emissions and logged emissions intensities from Trucost, comparing LTNZ adopters with matched not-yet-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

Taken together, the emissions results point to a negative effect of LTNZ adoption on both absolute emissions and emissions intensity, but the evidence remains noisy and imprecisely estimated. As shown in Appendices D and E, the results are very similar when using the alternative matching procedure including leverage, return on equity and capex/assets, and when excluding LTNZ targets with target years prior to 2035, respectively. Appendix F tests whether firms adopting LTNZ targets that include Scope 3 emissions have reduced their emissions more than firms with LTNZ targets not covering Scope 3. Since reducing Scope 3 emissions to net zero involves eliminating emissions outside firms’ direct control, one hypothesis is that such LTNZ targets proxy for greater ambition. We do not find statistically significant differences in general, although the treatment effects are negative, providing weak evidence that LTNZ targets including Scope 3 emissions are associated with larger subsequent emissions reductions.

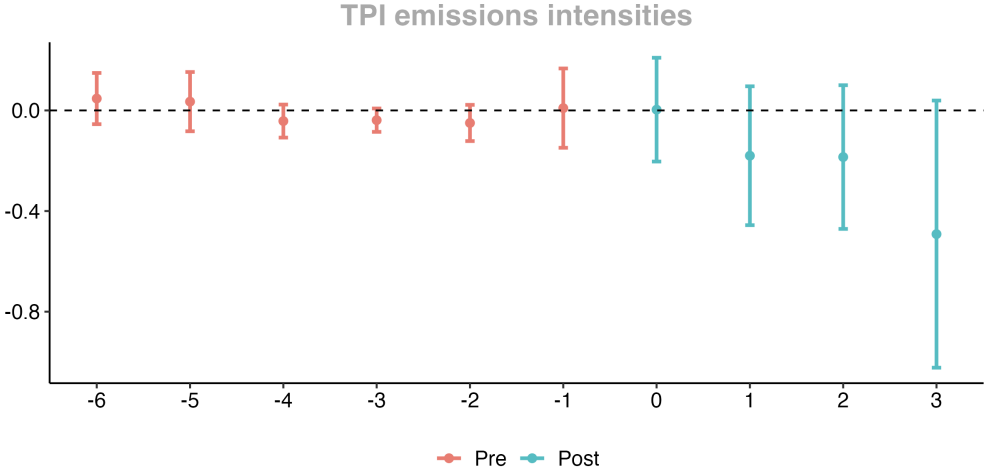


Figure 4: This figure shows the dynamic treatment effects of LTNZ announcements on sector-specific emissions intensities from TPI in z-scores, comparing LTNZ adopters with unmatched not-yet-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

4.2 Net zero targets and climate management and governance

We next examine whether the adoption of LTNZ targets has led to changes in firms' climate management and governance. Figure 5 shows the results for the MQ indicator count, level and weighted score.

MQ indicator count and level For MQ indicator count and level, pre-adoption coefficients do not indicate systematic differences in trends between adopters and matched controls. However, post-adoption coefficients exhibit a broadly negative pattern, with effects becoming more pronounced over time. While the estimates for the indicator count are not statistically significant, the effect for MQ levels becomes statistically significant at $t+3$. This finding is counter-intuitive, as one might expect climate management practices to improve following the adoption of LTNZ targets. We explore this pattern in more detail in Section 4.4, providing an explanation in terms of LTNZ non-adopters catching up with LTNZ adopters on basic management practices.

Weighted MQ score We see a different pattern for the weighted MQ score, however, which assigns greater weight to less commonly implemented and more demanding management steps. More in line with intuition, the post-adoption coefficients are positive, increasing and statistically significant. However, these estimates are preceded by a statistically significant coefficient in the year immediately prior to adoption. This pre-trend complicates causal interpretation, but is consistent with an anticipation effect, whereby firms begin implementing more demanding governance practices shortly before formally announcing an LTNZ target (and thus is consistent with the results in Section 3.1 on selection into LTNZ target-setting). A similar pattern is observed in the unmatched sample, suggesting that this behaviour is

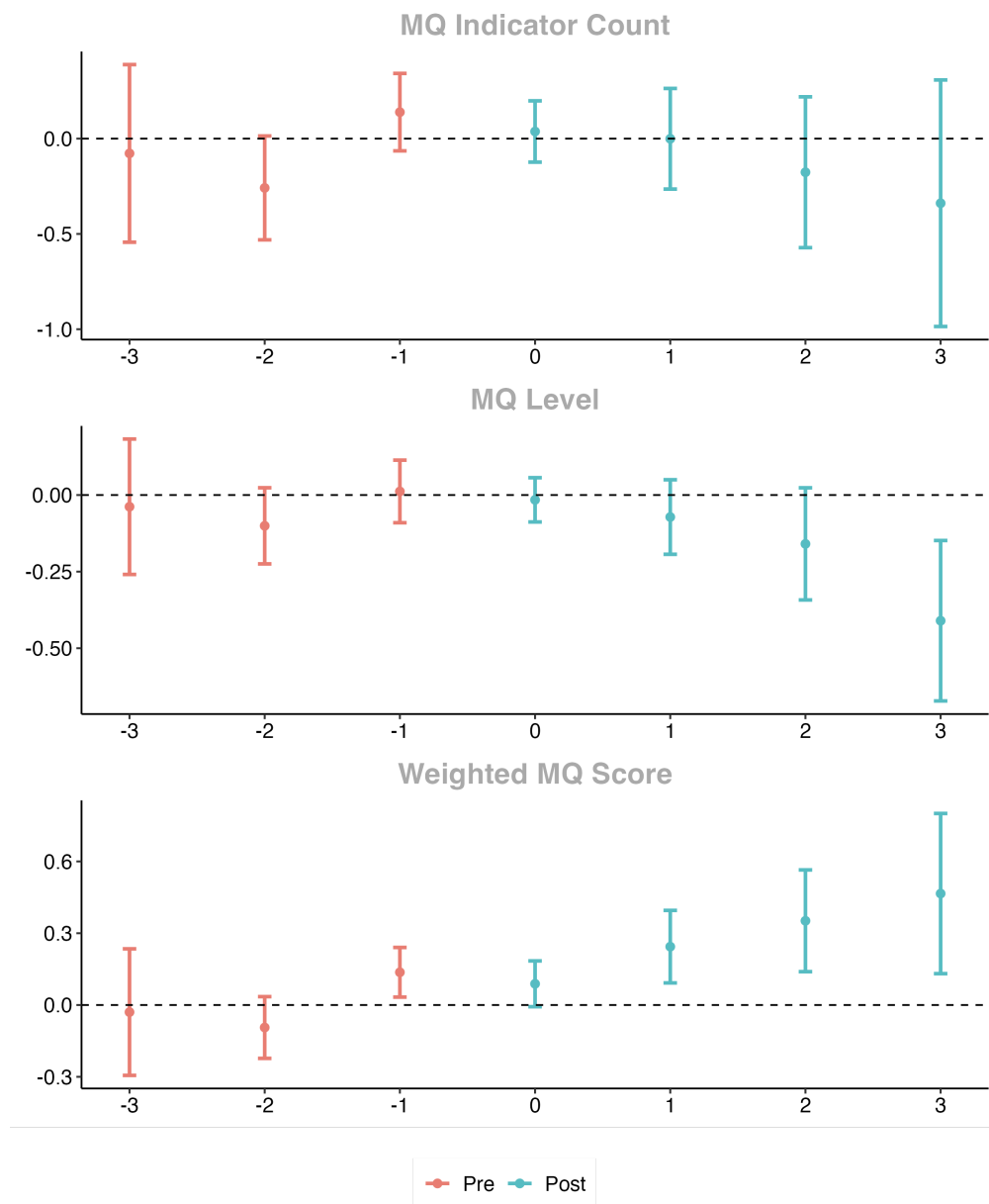


Figure 5: This figure shows the dynamic treatment effects of LTNZ announcements on the count of satisfied MQ indicators, hierarchical MQ levels, and weighted MQ score, comparing LTNZ adopters with matched not-yet-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

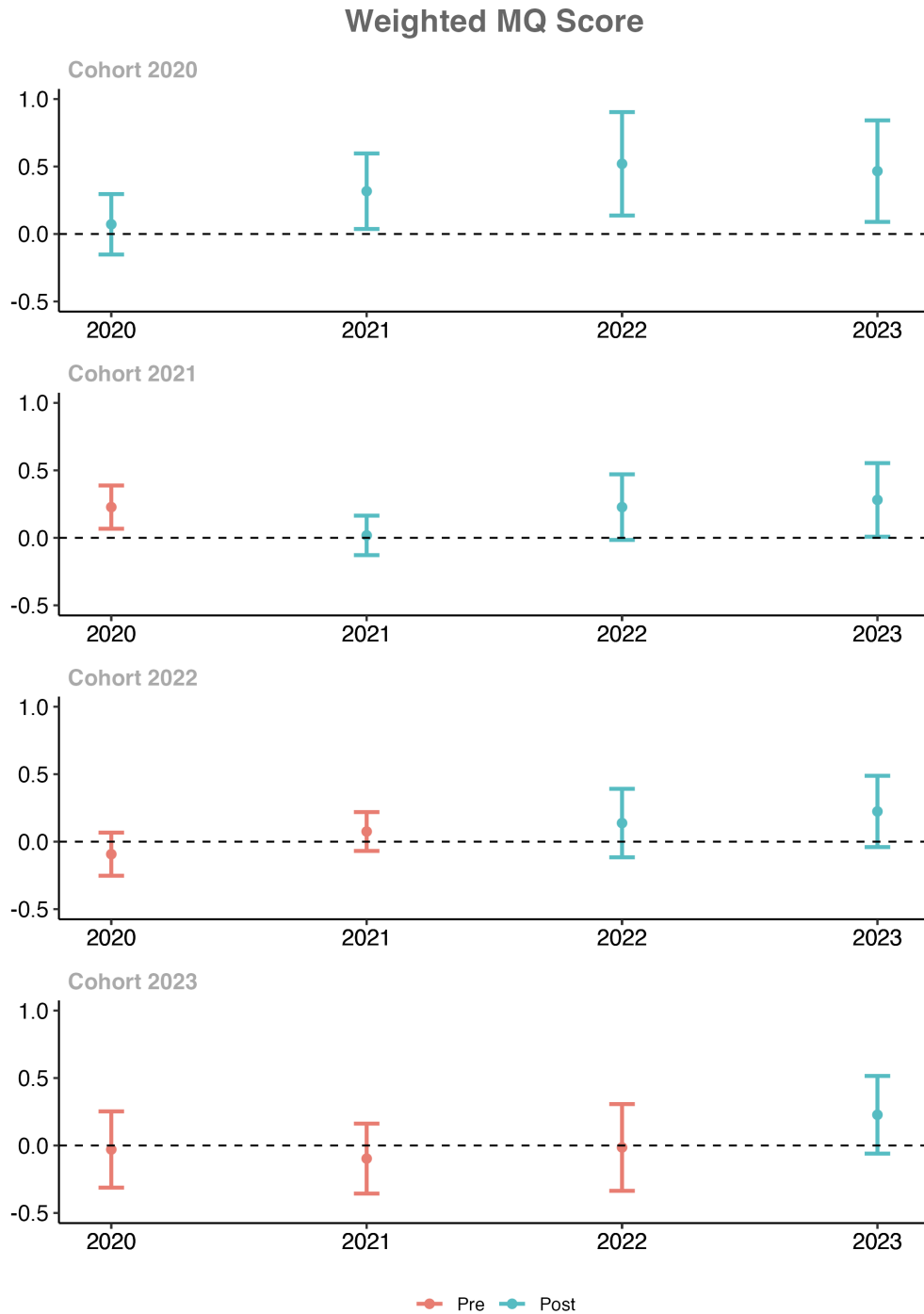


Figure 6: This figure shows the cohort-specific dynamic treatment effects of LTNZ announcements on the weighted MQ score, comparing LTNZ adopters with matched not-yet-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

not an artefact of the matching procedure.

Weighted MQ score: cohort-specific dynamic effects The presence of a significant $t-1$ coefficient raises the question of whether this apparent anticipation effect is a general feature of LTNZ adoption or is driven by heterogeneity across cohorts. To investigate the source of this pre-treatment effect, Figure 6 presents cohort-specific dynamic effects for the weighted MQ score. The results indicate that the significant $t-1$ coefficient is concentrated in the 2021 cohort. The 2020 cohort lacks a pre-treatment window, while no clear pre-trend is observed for the 2022 and 2023 cohorts. Taken together, these findings suggest that the pre-treatment effect observed in the aggregate results is not a uniform feature of LTNZ adoption, but instead reflects cohort-specific dynamics. At the same time, post-treatment coefficients are generally positive across cohorts, indicating that improvements in more demanding governance practices tend to follow adoption even in the absence of clear anticipatory behaviour.

Thematic groups Turning to the thematic groups of management practices using the TCFD framework, Figure 7 shows no robust evidence of systematic post-adoption changes in Risk Management or in Metrics and Targets. Like the MQ indicator count and levels, the Governance group exhibits negative post-adoption effects, while the Strategy group mirrors the pattern observed for the weighted MQ score: post-adoption coefficients are positive and increase over time, but are again preceded by a statistically significant effect in the year prior to adoption. As described in Appendix B, the Governance theme includes multiple less ambitious MQ indicators, whereas the Strategy theme mostly includes more demanding practices. The concentration of positive effects in the strategic dimension therefore suggests that LTNZ targets may be associated primarily with changes in forward-looking planning

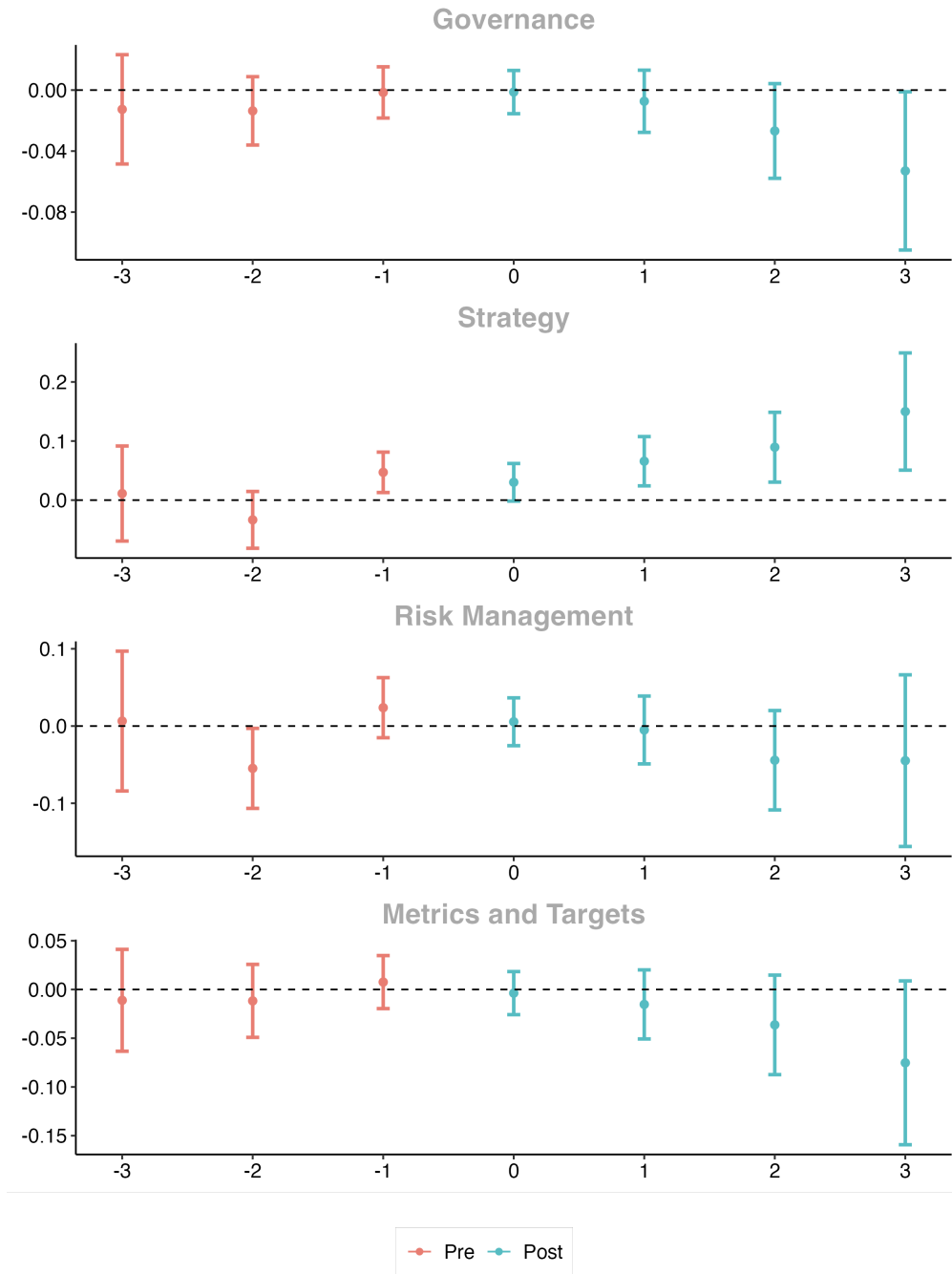


Figure 7: This figure shows the dynamic treatment effects of LTNZ announcements on Governance-, Strategy-, Risk Management-, and Metrics and Targets-related MQ indicators, comparing LTNZ adopters with matched not-yet-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

and ambitious processes, rather than with adjustments to more basic governance structures or risk management systems.

CDP scores Figure 8 shows event-study estimates for the CDP scores. Post-adoption effects are small and imprecise. Several features of the CDP data may help explain this: the analysis relies on an unmatched sample of firms, which limits the comparability of treated and control groups; CDP disclosure is voluntary, and participating firms are likely to be more engaged in climate-related activities, potentially reducing variation and attenuating treatment effects; the CDP score is an aggregated measure that combines multiple dimensions of climate performance and disclosure, such that changes in specific areas may not translate into detectable shifts in the overall score.

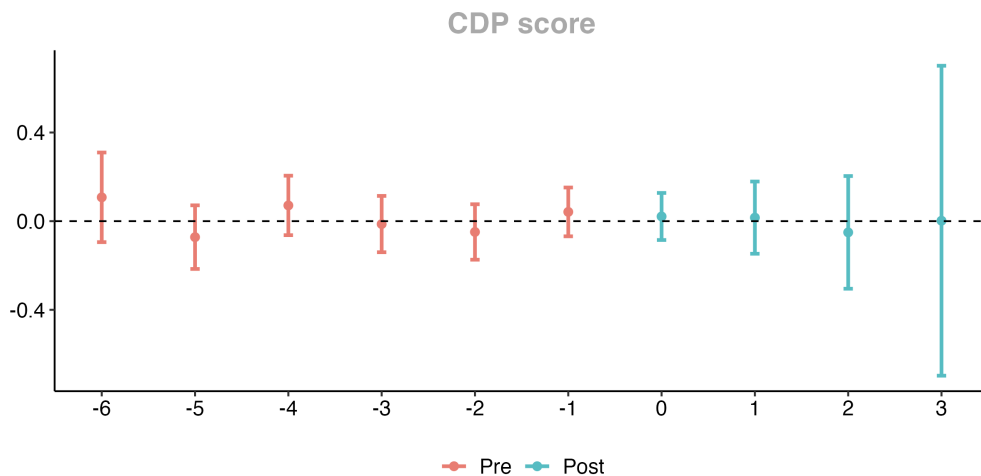


Figure 8: This figure shows the dynamic treatment effects of LTNZ announcements on the CDP score, comparing LTNZ adopters with unmatched not-yet-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

Further results As shown in Appendices [D](#) and [E](#), these results on management and governance are robust to using the alternative matching procedure and to excluding LTNZ targets with target years prior to 2035, respectively. Appendix [F](#) shows that some of the effects on MQ indicator count and MQ level also appear when comparing LTNZ adopters including Scope 3 emissions in their targets with those that do not. However, we do not find evidence that LTNZ adopters including Scope 3 emissions perform better on more ambitious management and governance practices, as proxied by the weighted MQ score or the Strategy theme. Appendix [G](#) reports further cohort-specific dynamic effects for the Strategy theme, corroborating the result for the MQ weighted score that the anticipation effect is coming from the 2021 cohort. Lastly, Appendix [H](#) shows that the estimated effects on climate management and governance are robust to restricting the control group to never-treated firms. This alleviates concerns about anticipation effects contaminating the control group when not-yet-treated firms are used, as some of these firms may already adjust behaviour prior to formal adoption.

Overall, the evidence does not indicate widespread or immediate improvements in firms' climate-related management and governance following LTNZ adoption. Most measures show either negative or statistically insignificant post-adoption effects. Yet, the positive and increasing effects observed for the weighted MQ score and the Strategy theme point to a more nuanced pattern: firms appear to strengthen more demanding, forward-looking management practices around the time of adoption. The presence of pre-treatment effects in these cases suggests that these changes may partly precede formal commitment announcements, and are not uniformly observed across cohorts. Taken together, the findings are consistent with LTNZ targets forming part of a broader strategic repositioning process, rather than acting as a discrete trigger for immediate organisational change.

4.3 Are there differences between early and late adopters?

Above we used cohort-specific dynamics to diagnose the pre-treatment effect observed for the weighted MQ score. However, the average event-study estimates may also mask more general heterogeneity in treatment effects across cohorts. To examine this, we estimate cohort-specific treatment effects for a wider set of outcome variables using the group-specific aggregated estimator by [Callaway and Sant’Anna \(2021\)](#). Figure 9 summarises the results for our three emissions measures, as well as three measures of climate management and governance: MQ indicator count, levels and weighted score.

Overall, the results demonstrate heterogeneity across cohorts, with a mixed picture depending on the outcome variable. For Trucost log absolute emissions and log emissions intensities, the estimated effects are statistically insignificant across cohorts, but the most negative effect is for the 2020 cohort, consistent with having a longer post-adoption period. For TPI sector-specific emissions intensities we find the opposite – the effects are insignificant for the 2019 and 2020 cohorts but are more negative and statistically significant for the 2021 and 2022 cohorts. The effect on the MQ indicator count is positive and statistically significant for the 2023 cohort, while the negative effect on MQ levels is driven primarily by the 2020 cohort. Improvements in the weighted MQ score are concentrated among earlier adopters, particularly the 2020 cohort (as the previous analysis also showed). Appendix I reports cohort-specific effects for the TCFD themes and shows that the positive effect on the Strategy theme is likewise driven by firms that announced LTNZ targets in 2020. Estimated effects for the remaining TCFD themes, as well as for the CDP score, are statistically insignificant across cohorts.

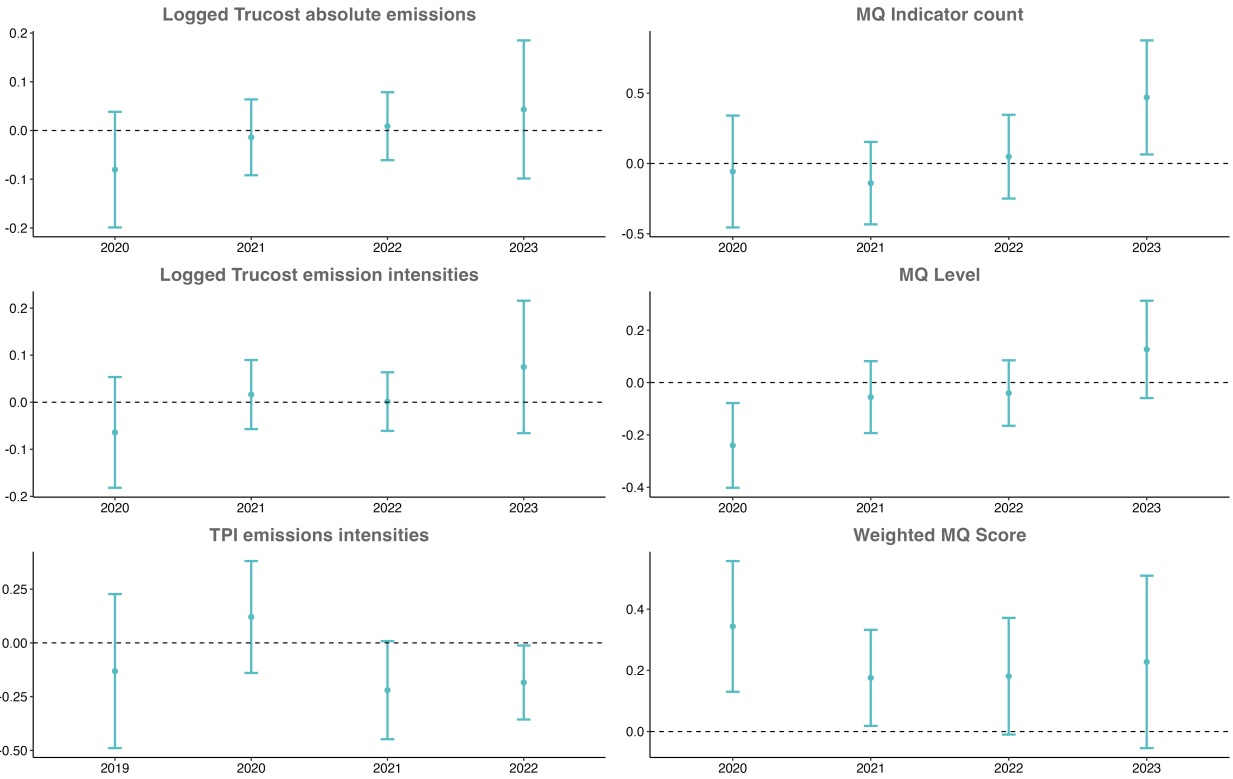


Figure 9: This figure shows the cohort-specific treatment effects of LTNZ announcements. The left panel presents, from top to bottom, the effects on logged absolute emissions and logged emissions intensities from Trucost, comparing LTNZ adopters with matched not-yet-adopters, and on sector-specific emissions intensities from TPI (expressed in z-scores), comparing LTNZ adopters with unmatched not-yet-adopters. The right panel presents the treatment effects of LTNZ announcements on the count of satisfied MQ indicators, hierarchical MQ levels, and the weighted MQ score by cohort, comparing LTNZ adopters with matched not-yet-adopters. Confidence intervals are set at 95%.

4.4 Are net zero target adopters stalling or are non-adopters catching up?

Results presented above show that several of our aggregate management and governance outcomes exhibit little evidence of post-adoption improvement, and in some cases the point estimates are negative. This leaves open an important interpretive question. One possibility is that this reflects stalling among adopters. An alternative, however, is that it reflects convergence driven by improvements among non-adopters over time, which would compress differences between adopters and non-adopters and mechanically attenuate DiD contrasts. We explore this possibility by examining the evolution of individual management practices underlying the TPI MQ framework.

Figure 10 shows the share of firms satisfying each MQ indicator separately for LTNZ adopters and non-adopters. These indicator-level comparisons reveal a clear pattern of convergence for a large subset of basic and widely implemented practices, such as publishing a company climate change policy (Q3), disclosing Scope 1 and 2 emissions (Q5), and nominating a board member/committee with responsibility for oversight of the climate change policy (Q6). For these indicators, adoption rates are already high at baseline and increase over time for both adopters but most especially non-adopters. As a result, differences between the two groups narrow, providing important context for the negative post-adoption trends seen in some of the previous analyses. Conversely, we do not see convergence between LTNZ adopters and non-adopters on the more demanding, less commonly implemented practices, such as incorporating climate change risks and opportunities in company strategy (Q16), climate scenario planning (Q17) and internal carbon pricing (Q18). This is also consistent with the effects observed in the previous analyses, particularly for the weighted MQ score and the

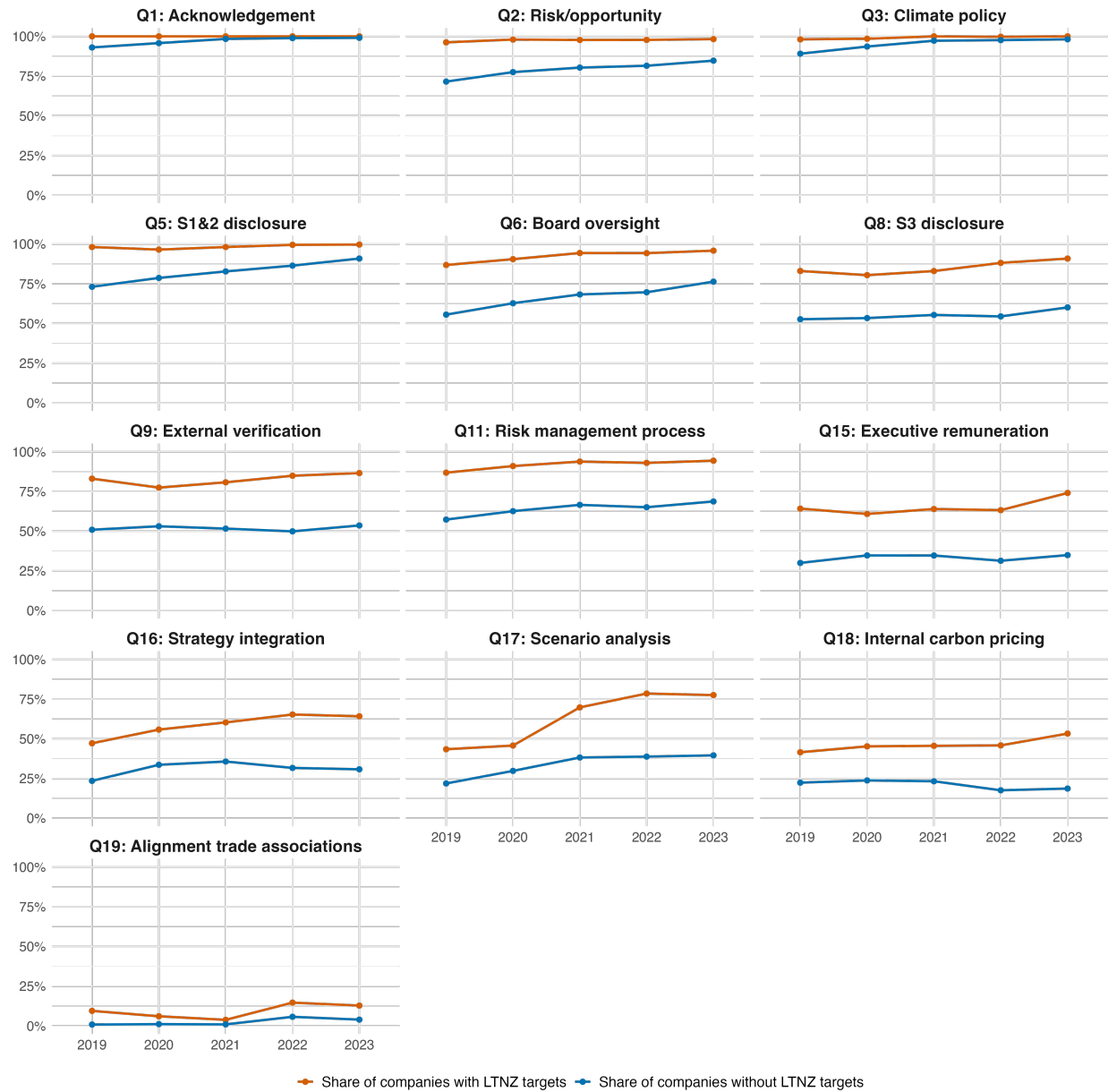


Figure 10: This figure shows the share of firms satisfying each individual TPI MQ indicator, separately for firms with and without LTNZ targets, from 2019 to 2023.

TCFD strategy area.

A similar convergence pattern emerges when examining the distribution of MQ hierarchical levels, as shown in Figure 11. Over time, an increasing number of firms become LTNZ adopters, but firms without LTNZ targets also move into intermediate MQ levels, reflecting the diffusion of basic climate management practices across the broader economy. Movement into the highest MQ levels remains uncommon and concentrated among a relatively small subset of firms, including some LTNZ adopters. Overall, the trends shown in these descriptive charts reflect a convergence process in which non-adopters catch up on basic climate management practices that may increasingly be viewed as minimum expectations, while adopters make more selective progress on advanced practices that are harder to implement and diffuse more slowly.

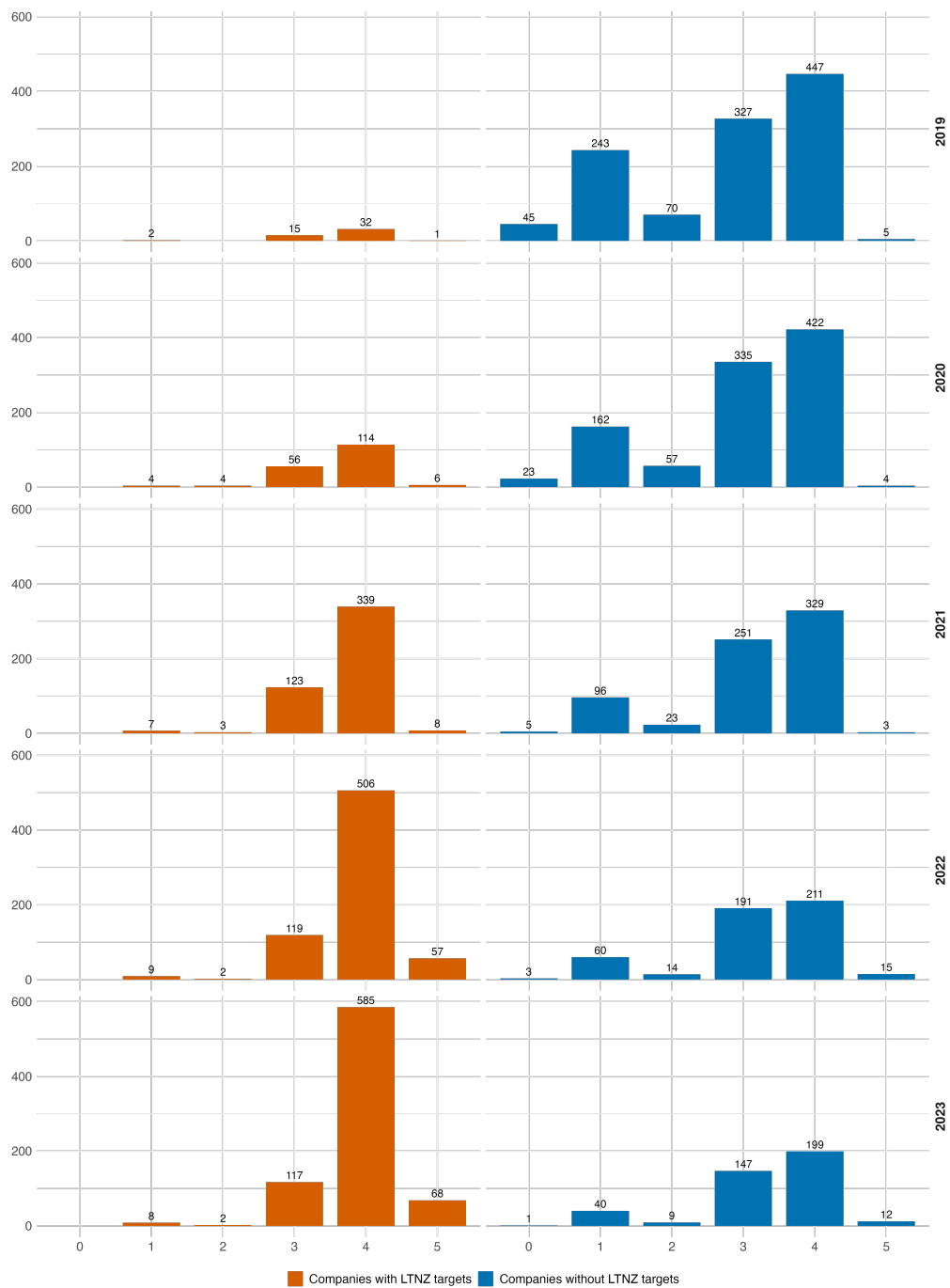


Figure 11: This figure plots the distribution of firms across TPI MQ levels for companies with and without LTNZ from 2019 to 2023.

5 Discussion

In this paper, we have examined whether LTNZ targets are associated with observable changes in firms' emissions and climate management practices in the years immediately following adoption. Our results suggest that LTNZ targets are not followed by large or immediate reductions in GHG emissions, nor by broad-based shifts in climate governance. At the same time, the findings do not support a simple null interpretation. Across multiple emissions measures, post-adoption point estimates are generally negative and consistent with gradual emissions reductions, although these effects are imprecisely estimated. For climate management and governance, most aggregate indicators show negative or little post-adoption movement, but more demanding and forward-looking measures – particularly those related to strategy – exhibit positive changes that often begin shortly before adoption and continue thereafter.

These findings help to adjudicate between the competing interpretations of LTNZ targets outlined in the Introduction. Both the greenwash ([Montgomery et al., 2024](#); [Fuoli and Beelitz, 2025](#)) and real-options perspectives predict limited near-term effects: firms adopt highly visible long-term commitments either to symbolically address stakeholder expectations, or to preserve flexibility by deferring costly decisions under uncertainty. The absence of large or precisely estimated near-term effects on emissions or on broad governance measures is consistent with this shared empirical prediction. However, the evidence also departs from a strong form of this prediction. The presence of negative effects on emissions (albeit imprecisely estimated) and selective changes in more demanding, strategic management practices suggests that LTNZ targets are not merely costless statements appended *ex post* to unchanged organisational structures.

Yet, as these changes are concentrated in forward-looking planning and governance domains, and as they do not translate into clear near-term emissions reductions, we do not find support for a strong version of the bridgehead theory either, in which commitments trigger immediate and widespread organisational change (Locke and Latham, 1990, 2002). Instead, the results point to LTNZ targets being embedded within a broader, gradual transition process, in which firms may begin adjusting strategy and governance shortly before announcing a commitment and continue to do so thereafter. For such firms, LTNZ targets neither simply precede nor merely follow organisational change, but appear to formalise, coordinate, or publicly lock in a strategic direction that is already emerging.

The convergence analysis provides additional context. The descriptive evidence points to convergence in many basic climate management practices, as non-adopters increasingly catch up on widely implemented practices that may have become minimum expectations across firms. This convergence helps explain why estimated average treatment effects on broad governance measures are often small and imprecisely estimated – and occasionally negative – because improvements among non-adopters compress differences between treated and control firms over time.

Taken together, these findings contribute to the literature on corporate climate commitments in several ways . First, they extend the literature from shorter-horizon or more operationally specific targets to LTNZ targets, which are associated with long horizons, deep decarbonisation and action across value chains. Second, they underscore the importance of measurement: comprehensively assessing the organisational implications of LTNZ targets requires attention to emissions outcomes using multiple measures and also to the specific management practices and strategic processes that underpin transition pathways. Third, the results suggest that evaluations of LTNZ targets should explicitly consider sequencing

and anticipation effects, as commitments may consolidate or formalise strategic shifts that begin prior to public announcement.

The findings also have implications for practice and policy. For firms, they suggest that announcing an LTNZ target is unlikely, by itself, to deliver rapid operational change; progress depends on the development of credible interim targets, governance mechanisms, and investment decisions. For investors, policy-makers, standard-setters and other stakeholders, headline net zero commitments should therefore be interpreted cautiously as indicators of near-term performance, with greater emphasis placed on interim targets, capex/investment disclosure, and transition planning, which can strengthen the link between long-term commitments and near-term action.

Several limitations point to directions for future research. Most obviously, although we believe the urgency of climate change makes it important to assess the effects of LTNZ targets now, longer horizons will ultimately be needed to assess whether the “green shoots” documented here translate into proper, sustained decarbonisation. Second, although this paper advances existing work by combining multiple emissions and governance datasets, further progress will depend on scaling high-quality emissions data to larger firm samples, as well as creating outcome measures that track firms’ real economic adjustments more directly, such as capex, asset reallocation, and technology adoption. Finally, future work could usefully examine how the effects of LTNZ targets interact with the regulatory environment. If firms adopt long-term commitments in part to hedge against policy uncertainty, the organisational and emissions responses to such commitments may differ systematically across jurisdictions with varying degrees of regulatory credibility and climate policy stringency. Studying these interactions would help clarify when LTNZ targets function primarily as options, when they act as credible commitments, and when they contribute to substantive transition outcomes.

References

- V. V. Acharya, R. F. E. Iii, and O. Wang. Strategic commitments to decarbonize: the role of large firms, common ownership, and governments. 2025.
- E. Anagnostopoulou. The mediating role of climate targets in corporate emission reductions. *Business Strategy and the Environment*, 2025.
- J. Aswani, A. Raghunandan, and S. Rajgopal. Are Carbon Emissions Associated with Stock Returns?*. *Review of Finance*, 28(1):75–106, Jan. 2024. ISSN 1572-3097. doi: 10.1093/rof/rfad013. URL <https://doi.org/10.1093/rof/rfad013>.
- T. Barko, M. Cremers, and L. Renneboog. Shareholder Engagement on Environmental, Social, and Governance Performance. *J Bus Ethics*, 180(2):777–812, Oct. 2022. ISSN 1573-0697. doi: 10.1007/s10551-021-04850-z. URL <https://doi.org/10.1007/s10551-021-04850-z>.
- F. Berg, J. Kölbel, and R. Rigobon. Aggregate Confusion: The Divergence of ESG Ratings*. *Review of Finance*, page rfac033, May 2022. ISSN 1572-3097. doi: 10.1093/rof/rfac033. URL <https://doi.org/10.1093/rof/rfac033>.
- N. Bloom and J. Van Reenen. Measuring and explaining management practices across firms and countries. *The Quarterly Journal of Economics*, 122(4):1351–1408, 2007.
- P. Bolton and M. Kacperczyk. Firm Commitments. *Management Science*, page mns.2024.07298, July 2025. ISSN 0025-1909, 1526-5501. doi: 10.1287/mns.2024.07298. URL <https://pubsonline.informs.org/doi/10.1287/mns.2024.07298>.
- T. Busch, M. Johnson, and T. Pioch. Corporate carbon performance data: Quo vadis? *Journal of Industrial Ecology*, 26(1):350–363, 2022. ISSN 1530-9290. doi: 10.1111/jiec.13008. URL <https://onlinelibrary.wiley.com/doi/abs/10.1111/jiec.13008>.
- B. Callaway and P. H. C. Sant’Anna. Difference-in-Differences with multiple time periods. *Journal of Econometrics*, 225(2):200–230, Dec. 2021. ISSN 0304-4076. doi: 10.1016/j.jeconom.2020.12.001. URL <https://www.sciencedirect.com/science/article/pii/S0304407620303948>.
- P. J. Callery. The Influence of Strategic Disclosure on Corporate Climate Performance Ratings. *Business & Society*, 62(5):950–988, May 2023. ISSN 0007-6503. doi: 10.1177/00076503221115715. URL <https://doi.org/10.1177/00076503221115715>. Publisher: SAGE Publications Inc.
- S. Cohen, I. Kadach, and G. Ormazabal. Institutional investors, climate disclosure, and carbon emissions. *Journal of Accounting and Economics*, 76(2):101640, Nov. 2023. ISSN 0165-4101. doi: 10.1016/j.jacceco.2023.101640. URL <https://www.sciencedirect.com/science/article/pii/S0165410123000642>.
- F. Dahlmann, L. Branicki, and S. Brammer. Managing Carbon Aspirations: The Influence of Corporate Climate Change Targets on Environmental Performance. *J Bus Ethics*, 158(1):1–24, Aug. 2019. ISSN 1573-0697. doi: 10.1007/s10551-017-3731-z. URL <https://doi.org/10.1007/s10551-017-3731-z>.

[//doi.org/10.1007/s10551-017-3731-z](https://doi.org/10.1007/s10551-017-3731-z).

- S. Dietz, C. Fruitiere, C. Garcia-Manas, W. Irwin, B. Rauis, and R. Sullivan. An assessment of climate action by high-carbon global corporations. *Nature Clim Change*, 8(12):1072–1075, Dec. 2018. ISSN 1758-6798. doi: 10.1038/s41558-018-0343-2. URL <https://www.nature.com/articles/s41558-018-0343-2>. Number: 12 Publisher: Nature Publishing Group.
- A. Dyck, K. V. Lins, L. Roth, and H. F. Wagner. Do institutional investors drive corporate social responsibility? International evidence. *Journal of Financial Economics*, 131(3): 693–714, Mar. 2019. ISSN 0304405X. doi: 10.1016/j.jfineco.2018.08.013. URL <https://linkinghub.elsevier.com/retrieve/pii/S0304405X18302381>.
- S. Fankhauser, S. M. Smith, M. Allen, K. Axelsson, T. Hale, C. Hepburn, J. M. Kendall, R. Khosla, J. Lezaun, E. Mitchell-Larson, M. Obersteiner, L. Rajamani, R. Rickaby, N. Seddon, and T. Wetzler. The meaning of net zero and how to get it right. *Nat. Clim. Chang.*, 12(1):15–21, Jan. 2022. ISSN 1758-6798. doi: 10.1038/s41558-021-01245-w. URL <https://www.nature.com/articles/s41558-021-01245-w>. Publisher: Nature Publishing Group.
- C. Flammer, M. W. Toffel, and K. Viswanathan. Shareholder activism and firms’ voluntary disclosure of climate change risks. *Strategic Management Journal*, 42(10):1850–1879, 2021. ISSN 1097-0266. doi: 10.1002/smj.3313. URL <http://onlinelibrary.wiley.com/doi/abs/10.1002/smj.3313>. _eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1002/smj.3313>.
- D. Freiberg, J. Grewal, and G. Serafeim. Science-Based Carbon Emissions Targets, Mar. 2021. URL <https://papers.ssrn.com/abstract=3804530>.
- M. Fuoli and A. Beelitz. Corporate buzzword or genuine commitment? A corpus-assisted analysis of corporate ‘net-zero’ pledges by major global corporations. *Applied Corpus Linguistics*, 5(3):100142, Dec. 2025. ISSN 2666-7991. doi: 10.1016/j.acorp.2025.100142. URL <https://www.sciencedirect.com/science/article/pii/S2666799125000255>.
- GHG Protocol Initiative. The Greenhouse Gas Protocol. 2004.
- N. Hastreiter. Can Investor Coalitions Drive Corporate Climate Action? 2024.
- E. Ilhan, P. Krueger, Z. Sautner, and L. T. Starks. Climate Risk Disclosure and Institutional Investors. *The Review of Financial Studies*, page hhad002, Jan. 2023. ISSN 0893-9454, 1465-7368. doi: 10.1093/rfs/hhad002. URL <https://academic.oup.com/rfs/advance-article/doi/10.1093/rfs/hhad002/6978207>.
- I. Ioannou, S. X. Li, and G. Serafeim. The Effect of Target Difficulty on Target Completion: The Case of Reducing Carbon Emissions. *The Accounting Review*, 91(5):1467–1492, 2016. ISSN 0001-4826. URL <https://www.jstor.org/stable/24907190>. Publisher: American Accounting Association.
- J. Li, X. Peng, and H. Zhang. The role of science-based targets on carbon mitigation: Addressing the tension between net zero anxiety and economic growth. *The British Accounting Review*, 57(2):101491, 2025.

- E. A. Locke and G. P. Latham. *A theory of goal setting & task performance*. Prentice-Hall, Inc, 1990.
- E. A. Locke and G. P. Latham. Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American psychologist*, 57(9):705, 2002.
- T. P. Lyon and J. W. Maxwell. Greenwash: Corporate Environmental Disclosure under Threat of Audit. *Journal of Economics & Management Strategy*, 20(1):3–41, 2011. ISSN 1530-9134. doi: 10.1111/j.1530-9134.2010.00282.x. URL <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1530-9134.2010.00282.x>. _eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1530-9134.2010.00282.x>.
- V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. World Meteorological Organization, Geneva, Switzerland, 2018. ISBN 978-92-9169-151-7. URL <https://www.ipcc.ch/sr15/>.
- A. W. Montgomery, T. P. Lyon, and J. Barg. No End in Sight? A Greenwash Review and Research Agenda. *Organ Environ*, 37(2):221–256, June 2024. ISSN 1086-0266. doi: 10.1177/10860266231168905. URL <https://pmc.ncbi.nlm.nih.gov/articles/PMC11288790/>.
- D. Salerno and G. Sampagnaro. Evaluating net-zero targets ’ impact on corporate GHG emissions. *Environ. Res. Lett.*, 20(8):084074, Aug. 2025. ISSN 1748-9326. doi: 10.1088/1748-9326/adeff8. URL <https://iopscience.iop.org/article/10.1088/1748-9326/adeff8>.
- X. Sun, X. Jia, and R. Oliva. The impact of carbon targets on firms’ carbon performance. *arXiv preprint arXiv:2508.05811*, 2025.
- H. Van Coppenolle, M. Blondeel, and T. Van de Graaf. Reframing the climate debate: The origins and diffusion of net zero pledges. *Global Policy*, 14(1):48–60, 2023. ISSN 1758-5899. doi: 10.1111/1758-5899.13161. URL <https://onlinelibrary.wiley.com/doi/abs/10.1111/1758-5899.13161>. _eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/1758-5899.13161>.
- J. M. Wooldridge. *Econometric analysis of cross section and panel data*. MIT press, 2010.

A Appendix – TPI emissions intensity (2015-2022) dataset

| Company Name | Geography | Sector |
|--------------------------|--------------|-------------|
| Alcoa | USA | Aluminium |
| Daido Steel | Japan | Steel |
| Hindalco | India | Aluminium |
| Hyundai Steel | South Korea | Steel |
| JFE | Japan | Steel |
| JSW Steel | India | Steel |
| Kobe Steel | Japan | Steel |
| Norsk Hydro | Norway | Aluminium |
| QAMCO | Qatar | Aluminium |
| Qatar Industries | Qatar | Steel |
| Tenaris | Italy | Steel |
| United States Steel | USA | Steel |
| Ambuja Cements | India | Cement |
| Buzzi Unicem | Italy | Cement |
| Cascades | Canada | Paper |
| Cementos Argos | Colombia | Cement |
| Cementos Chihuahua | Mexico | Cement |
| Clearwater Paper | USA | Paper |
| Dalmia Bharat | India | Cement |
| Hokuetsu | Japan | Paper |
| Klabin | Brazil | Paper |
| Mondi | UK | Paper |
| Sappi | South Africa | Paper |
| Shree Cements | India | Cement |
| Siam Cement | Thailand | Cement |
| Siam City Cement | Thailand | Cement |
| Stora Enso | Finland | Paper |
| Taiheiyo Cement | Japan | Cement |
| UPM-Kymmene | Finland | Paper |
| African Rainbow Minerals | South Africa | Coal Mining |
| Air Canada | Canada | Airlines |
| Air China | China | Airlines |
| Alaska Air | USA | Airlines |
| ANA Group | Japan | Airlines |

| | | |
|--------------------------------------|-------------|-------------|
| Aston Martin Lagonda Global Holdings | UK | Autos |
| Astra International | Indonesia | Coal Mining |
| BAIC Motor | China | Autos |
| Banpu | Thailand | Coal Mining |
| Bukit Asam | Indonesia | Coal Mining |
| BYD | China | Autos |
| Cathay Pacific Airways | Hong Kong | Airlines |
| China Airlines | China | Airlines |
| China Eastern Airlines | China | Airlines |
| China Southern | China | Airlines |
| Chongqing Changan Automobile | China | Autos |
| COSCO Shipping Energy | China | Shipping |
| DMCI | Philippines | Coal Mining |
| Dongfeng Motor Group | China | Autos |
| Easyjet | UK | Airlines |
| EVA Airways | China | Airlines |
| Geely | China | Autos |
| Great Wall Motor Company | China | Autos |
| Guanghui Energy | China | Coal Mining |
| Guangzhou Automobile Group | China | Autos |
| Guizhou Panjiang Refined Coal | China | Coal Mining |
| Hyundai | South Korea | Autos |
| IAG | UK | Airlines |
| IndiGo | India | Airlines |
| Indo Tambangraya Megah | Indonesia | Coal Mining |
| Inner Mongolia Yitai Coal | China | Coal Mining |
| Japan Airlines | Japan | Airlines |

| | | |
|---|-------------|-------------|
| Jardine Matheson | Hong Kong | Coal Mining |
| Jastrzebska Spolka Weglowa | Poland | Coal Mining |
| JetBlue | USA | Airlines |
| K Line | Japan | Shipping |
| Kia | South Korea | Autos |
| Korean Air | South Korea | Airlines |
| LATAM | Chile | Airlines |
| Lufthansa | Germany | Airlines |
| Mazda | Japan | Autos |
| Mitsubishi Motors | Japan | Autos |
| MOL | Japan | Shipping |
| New Hope | Australia | Coal Mining |
| NIO | China | Autos |
| NYK Line | Japan | Shipping |
| SAS Group | Sweden | Airlines |
| Semirara Mining and Power | Philippines | Coal Mining |
| Shaanxi Coal Industry | China | Coal Mining |
| Shanxi Lu'an Environmental Energy Development | China | Coal Mining |
| Singapore Airlines | Singapore | Airlines |
| Southwest | USA | Airlines |
| Subaru | Japan | Autos |
| Tesla | USA | Autos |
| Turkish Airlines | Turkey | Airlines |
| Wan Hai | Taiwan | Shipping |
| Whitehaven Coal | Australia | Coal Mining |
| Wizz Air | UK | Airlines |
| ADBRI | Australia | Cement |
| Air France KLM | France | Airlines |
| American Airlines | USA | Airlines |
| Arcelor Mittal | Netherlands | Steel |
| Bluescope Steel | Australia | Steel |
| BMW | Germany | Autos |
| Cemex | Mexico | Cement |
| China Steel | Taiwan | Steel |
| CRH | UK | Cement |
| Delta Air Lines | USA | Airlines |
| Ford | USA | Autos |

| | | |
|--------------------------------|-------------|-------------|
| General Motors | USA | Autos |
| Grupo Argos | Colombia | Cement |
| HeidelbergCement | Germany | Cement |
| Holcim | Switzerland | Cement |
| Honda | Japan | Autos |
| International Paper | USA | Paper |
| Mercedes-Benz | Germany | Autos |
| Nippon Steel | Japan | Steel |
| Nissan | Japan | Autos |
| Qantas | Australia | Airlines |
| Renault | France | Autos |
| SAIC motor | China | Autos |
| SSAB | Sweden | Steel |
| Suzano | Brazil | Paper |
| ThyssenKrupp | Germany | Steel |
| Toyota | Japan | Autos |
| UltraTech Cement | India | Cement |
| United Continental | USA | Airlines |
| Volkswagen | Germany | Autos |
| AES | USA | Electricity |
| AGL Energy | Australia | Electricity |
| Ameren | USA | Electricity |
| American Electric Power | USA | Electricity |
| APA Corporation | USA | Oil & Gas |
| Bharat Petroleum | India | Oil & Gas |
| Canadian Natural Resources | Canada | Oil & Gas |
| Capital Power | Canada | Electricity |
| Centrais Eletricas Brasileiras | Brazil | Electricity |
| CEZ | Czechia | Electricity |
| Chevron | USA | Oil & Gas |
| Chubu Electric Power | Japan | Electricity |
| Cia Paranaense de Energia | Brazil | Electricity |
| CLP | Hong Kong | Electricity |
| CMS Energy | USA | Electricity |
| ConocoPhillips | USA | Oil & Gas |
| Devon Energy | USA | Oil & Gas |
| Diamondback Energy | USA | Oil & Gas |
| Dominion Energy | USA | Electricity |

| | | |
|---------------------------------------|----------------------|-------------|
| Drax Group | UK | Electricity |
| Dubai Electricity and Water Authority | United Arab Emirates | Electricity |
| Duke Energy | USA | Electricity |
| E.ON | Germany | Electricity |
| Ecopetrol | Colombia | Oil & Gas |
| EDF | France | Electricity |
| Edison International | USA | Electricity |
| EDP | Portugal | Electricity |
| EGCO | Thailand | Electricity |
| Electric Power Development | Japan | Electricity |
| Emera | Canada | Electricity |
| Endesa | Spain | Electricity |
| Enel | Italy | Electricity |
| Enel Americas | Chile | Electricity |
| Engie | France | Electricity |
| Engie Brasil | Brazil | Electricity |
| Eni | Italy | Oil & Gas |
| Entergy | USA | Electricity |
| EOG Resources | USA | Oil & Gas |
| Equinor | Norway | Oil & Gas |
| Eversource Energy | USA | Electricity |
| Firstenergy | USA | Electricity |
| Formosa Petrochemical | Taiwan | Oil & Gas |
| Fortis | Canada | Electricity |
| Fortum | Finland | Electricity |
| Hawaiian Electric | USA | Electricity |
| Hess | USA | Oil & Gas |
| Iberdrola | Spain | Electricity |
| Idacorp | USA | Electricity |
| Idemitsu Kosan | Japan | Oil & Gas |
| Imperial Oil | Canada | Oil & Gas |
| Kansai Elec Power | Japan | Electricity |
| KEPCO | South Korea | Electricity |
| Marathon Oil | USA | Oil & Gas |
| Marathon Petroleum | USA | Oil & Gas |
| Mercury | New Zealand | Electricity |
| Meridian Energy | New Zealand | Electricity |

| | | |
|-----------------------|-----------|-------------|
| National Grid | UK | Electricity |
| Neste | Finland | Oil & Gas |
| NextEra Energy | USA | Electricity |
| NRG Energy | USA | Electricity |
| OGE Energy | USA | Electricity |
| Origin Energy | Australia | Electricity |
| Orsted | Denmark | Electricity |
| Ovintiv | Canada | Oil & Gas |
| Pemex | Mexico | Oil & Gas |
| Petrobras | Brazil | Oil & Gas |
| PG&E | USA | Electricity |
| Phillips 66 | USA | Oil & Gas |
| Pinnacle West Capital | USA | Electricity |
| PPL | USA | Electricity |
| PTT | Thailand | Oil & Gas |
| RWE | Germany | Electricity |
| Santos | Australia | Oil & Gas |
| Sempra Energy | USA | Electricity |
| Shell | UK | Oil & Gas |
| Southern Company | USA | Electricity |
| SSE | UK | Electricity |
| Suncor Energy | Canada | Oil & Gas |
| TotalEnergies | France | Oil & Gas |
| Valero Energy | USA | Oil & Gas |
| Verbund AG | Austria | Electricity |
| WEC Energy Group | USA | Electricity |
| Woodside Petroleum | Australia | Oil & Gas |

B Appendix – TPI Management Quality methodology

| LEVEL 0: UNAWARE OF (OR NOT ACKNOWLEDGING) CLIMATE CHANGE AS A BUSINESS ISSUE | |
|---|---|
| Question 1 | Does the company acknowledge climate change as a significant issue for the business? [If the company does not acknowledge climate change as a significant issue for the business, it is placed on Level 0] |
| TCFD category: Governance | Companies are assessed as Yes if they: <ul style="list-style-type: none"> • Recognise climate change as a relevant risk and/or opportunity for the business (Q2); or • Have a policy or an equivalent statement committing them to take action on climate change (Q3); or • Have set greenhouse gas emission reduction targets (Q4); or • Have published information on their operational greenhouse gas emissions (Q5). |
| LEVEL 1: ACKNOWLEDGING CLIMATE CHANGE AS A BUSINESS ISSUE | |
| Question 2 | Does the company recognise climate change as a relevant risk and/or opportunity for the business? |
| TCFD category: Governance | Companies are assessed as Yes if they demonstrate recognition of climate change as a relevant risk and/or opportunity to the business, or if they have incorporated at least two of the following, more advanced management practices, namely they: <ul style="list-style-type: none"> • Have a process to manage climate-related risks (Q11); • Have set long-term quantitative targets for reducing their greenhouse gas emissions (Q13); • Incorporate climate change performance into remuneration for senior executives (Q14); • Incorporate climate change risks and opportunities in their strategy (Q15); • Undertake climate scenario planning (Q16); • Disclose an internal price of carbon (Q17); • Ensure consistency between their climate change policies and the positions taken by trade associations of which they are members (Q23). |
| Question 3 | Does the company have a policy (or equivalent) commitment to action on climate change? |
| TCFD category: Governance | Companies are assessed as Yes if they have a published policy or commitment statement on climate change that commits them to addressing the issue, or to reducing or avoiding their impact on climate change (e.g. to reduce emissions or improve their energy efficiency). |
| LEVEL 2: BUILDING CAPACITY | |
| Question 4 | Has the company set greenhouse gas emission reduction targets? |
| TCFD category: Metrics and Targets | Companies are assessed as Yes if they have greenhouse gas emissions reduction targets. These targets may cover Scopes 1, 2 and/or 3, and they may be quantified or unquantified. This question is less demanding than Questions 7 and 14, which require companies to have set quantified targets and for those quantified targets to be long-term, respectively. Companies that are assessed as Yes on Question 7, or Yes on Questions 7 and 13, are automatically assessed as Yes on Question 4. |
| Question 5 | Has the company published information on its operational (Scope 1 and 2) greenhouse gas emissions? |

| | |
|--|--|
| TCFD category: Metrics and Targets | Companies are assessed as Yes if they report on their Scope 1 and 2, or their Scope 1, 2 and 3 emissions. Companies that only report Scope 1 emissions are assessed as No. |
| LEVEL 3: INTEGRATING INTO OPERATIONAL DECISION-MAKING | |
| Question 6 | Has the company nominated a board member or board committee with explicit responsibility for oversight of the climate change policy? |
| TCFD category: Governance | Companies are assessed as Yes if they provide evidence of clear board or board committee oversight of climate change, or if they have a named individual/position responsible for climate change at board level. |
| Question 7 | Has the company set quantitative targets for reducing its greenhouse gas emissions? |
| TCFD category: Metrics and Targets | Companies are assessed as Yes if they have set quantified targets to reduce greenhouse emissions in relative or absolute terms (Scopes 1, 2 and/or 3). This question is more demanding than Question 4, as companies must have set quantitative targets to reduce emissions. This question differs from Question 13, which asks whether companies have set quantified targets for reducing greenhouse gases over the long term (i.e. targets that are more than 5 years in duration). Companies that are assessed as Yes on Question 13 are automatically assessed as Yes on this question. |
| Question 8 | Does the company report on Scope 3 emissions? |
| TCFD category: Metrics and Targets | Companies are assessed as Yes if they report on Scope 3 emissions separately, either in total or in one or more categories, or if they provide a total for Scope 1, 2 and 3 emissions. |
| Question 9 | Has the company had its operational (Scope 1 and/or 2) greenhouse gas emissions data verified? |
| TCFD category: Governance Metrics and Targets | Companies are assessed as Yes if their operational greenhouse gas emissions have been independently verified by a third party, or if they state the international assurance standard they have used and the level of assurance. |
| Question 10 | Does the company support domestic and international efforts to mitigate climate change? |
| TCFD category: Strategy | Companies are assessed as Yes if they demonstrate support for mitigating climate change through membership of business associations that are supportive, and if they have a clear company position on public policy and regulation. |
| Question 11 | Does the company have a process to manage climate-related risks? |
| TCFD category: Risk Management | Companies are assessed as Yes if they have integrated climate change into multi-disciplinary company-wide risk management, or if they have a specific climate-related risk management process. |
| Question 12 (applicable to some sectors only) | Does the company disclose materially important Scope 3 emissions? |
| TCFD category: Metrics and Targets | Scope 3 emissions are diverse and many companies only disclose in a sub-set of categories. In some sectors, particular categories of Scope 3 emissions are materially important, in the sense of being a large share of lifecycle emissions. In these sectors, we require companies to specifically disclose emissions in the relevant category or categories: <ul style="list-style-type: none"> • For automobile manufacturing, coal mining, oil and gas production, and oil and gas distribution companies we require disclosure of Scope 3 emissions from use of sold products. • For food producers we require disclosure of Scope 3 emissions from purchased goods and services. |

| | |
|--|---|
| | <ul style="list-style-type: none"> For diversified miners we require disclosure of Scope 3 emissions from the processing of sold products. For chemicals companies we require disclosure of Scope 3 emissions from purchased goods and services and the use of sold products. |
| LEVEL 4: STRATEGIC ASSESSMENT | |
| Question 13 | Does the company disclose its membership and involvement in trade associations engaged in climate issues? |
| TCFD category: Governance | Companies are assessed as Yes if they have disclosed their memberships of trade associations that engage on climate-related issues, and if they have disclosed their involvement in these trade associations. |
| Question 14 | Has the company set long-term quantitative targets for reducing its greenhouse gas emissions? |
| TCFD category: Metrics and Targets | Companies are assessed as Yes if they have set quantified, long-term targets (i.e. more than 5 Years in duration) to reduce greenhouse emissions in relative or absolute terms (Scopes 1, 2 and/or 3). This question is more demanding than Question 7, as the targets must not only be quantitative, they must also be long-term. |
| Question 15 | Does the company's remuneration for senior executives incorporate climate change performance? |
| TCFD category: Governance | Companies are assessed as Yes if executive remuneration incorporates climate change performance. |
| Question 16 | Does the company incorporate climate change risks and opportunities in their strategy? |
| TCFD category: Strategy Risk Management | Companies are assessed as Yes if they detail how they incorporate climate change risks and opportunities in their strategy (mitigation, new products, R&D, etc.), and if they disclose the impact of climate change risks and opportunities on financial planning (OpEx, CapEx, M&A, debt). |
| Question 17 | Does the company undertake climate scenario planning? |
| TCFD category: Strategy | Companies are assessed as Yes if they mention the 2 degrees scenario in relation to business planning or confirm they have conducted climate related scenario analysis, and if they describe the business impact of one or more climate scenario analysis. |
| Question 18 | Does the company disclose an internal price of carbon? |
| TCFD category: Strategy | Companies are assessed as Yes if they have and disclose their internal carbon price. |
| Question 19 | Does the company disclose the actions planned to meet its emissions reduction targets? |
| TCFD category: Governance | Companies are assessed as Yes if they disclose the set of actions they intend to take to achieve their GHG reduction targets, including Scope 3 emissions where applicable. |
| LEVEL 5: TRANSITION PLANNING | |

C Appendix – Matching details and balance diagnostics

This appendix provides additional details on the construction of the stacked sample and the balance diagnostics reported in Table 3, as well as results from an extended matching specification.

To summarise covariate balance across adoption cohorts, we construct a stacked sample by combining the cohort-specific baseline samples for each adoption cohort from 2020 to 2023. Baseline covariates are defined as pre-treatment averages computed over all years prior to the cohort-specific adoption year. Each observation in the stacked dataset therefore corresponds to a firm-cohort pair rather than a unique firm. A never-treated firm may appear multiple times as an eligible control across different cohorts. A treated firm appears once as treated in its adoption cohort, but may also contribute as a control observation in earlier cohorts prior to adoption. The observation counts in Table 3 reflect this stacked structure.

The Diff columns in Table 3 report $\hat{\beta}$ from cohort fixed-effects regressions of the form:

$$y_{ig} = \alpha + \beta Treated_{ig} + \gamma_g + \varepsilon_{ig},$$

where y_{ig} is a covariate value for firm i in cohort g , $Treated_{ig}$ is an indicator for treatment status, and γ_g denotes cohort fixed effects.

This specification isolates within-cohort differences between treated and control firms while absorbing differences in covariate levels across cohorts. Significance stars are based on the p-value on $\hat{\beta}$. In the matched sample, where treated and control counts are equal within each cohort by construction, $\hat{\beta}$ closely approximates the difference in mean covariate values shown in the Treated and Control columns. For categorical covariates, means are reported as group shares.

Extended matching specification

As a robustness check, we augment the set of matching covariates to include leverage, return on equity, and capex-to-assets, following Bolton and Kacperczyk (2025). Table 4 reports the corresponding balance statistics, and Figure 12 shows the propensity distributions.

| Covariate | Full sample | | | Matched sample | | |
|---------------------------|-------------|---------|------------------------|----------------|---------|------------------------|
| | Treated | Control | Diff ($\hat{\beta}$) | Treated | Control | Diff ($\hat{\beta}$) |
| Log market cap | 23.441 | 23.261 | 0.196*** | 23.432 | 23.388 | 0.044 |
| Log GHG absolute | 14.672 | 14.396 | 0.31*** | 14.648 | 14.658 | -0.01 |
| Log GHG intensity | 5.351 | 5.342 | 0.011 | 5.352 | 5.323 | 0.03 |
| MQ weighted score | 1.835 | 1.209 | 0.64*** | 1.758 | 1.781 | -0.023 |
| Leverage | 0.289 | 0.285 | 0.004 | 0.290 | 0.291 | -0.001 |
| ROE | 14.061 | 17.327 | -2.626 | 14.309 | 11.538 | 2.771 |
| Capex/Assets | 0.046 | 0.043 | 0.004*** | 0.046 | 0.044 | 0.002 |
| Region: Africa | 0.019 | 0.010 | 0.01** | 0.018 | 0.020 | -0.002 |
| Region: Asia | 0.487 | 0.491 | -0.01 | 0.477 | 0.472 | 0.005 |
| Region: Australia | 0.035 | 0.026 | 0.01 | 0.037 | 0.028 | 0.009 |
| Region: Europe | 0.204 | 0.144 | 0.068*** | 0.207 | 0.236 | -0.029 |
| Region: North America | 0.230 | 0.308 | -0.082*** | 0.238 | 0.224 | 0.014 |
| Region: South America | 0.025 | 0.021 | 0.004 | 0.023 | 0.020 | 0.003 |
| Sector cluster: Energy | 0.178 | 0.164 | 0.017 | 0.179 | 0.167 | 0.012 |
| Sector cluster: Industry | 0.382 | 0.406 | -0.03 | 0.382 | 0.408 | -0.026 |
| Sector cluster: Services | 0.373 | 0.381 | -0.009 | 0.376 | 0.363 | 0.012 |
| Sector cluster: Transport | 0.067 | 0.048 | 0.021** | 0.063 | 0.061 | 0.002 |
| Obs. (firm-cohort) | 686 | 2,160 | | 652 | 652 | |

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 4: This table reports stacked cohort means of baseline covariates, including leverage, return on equity and capex/assets, for the full and the matched samples.

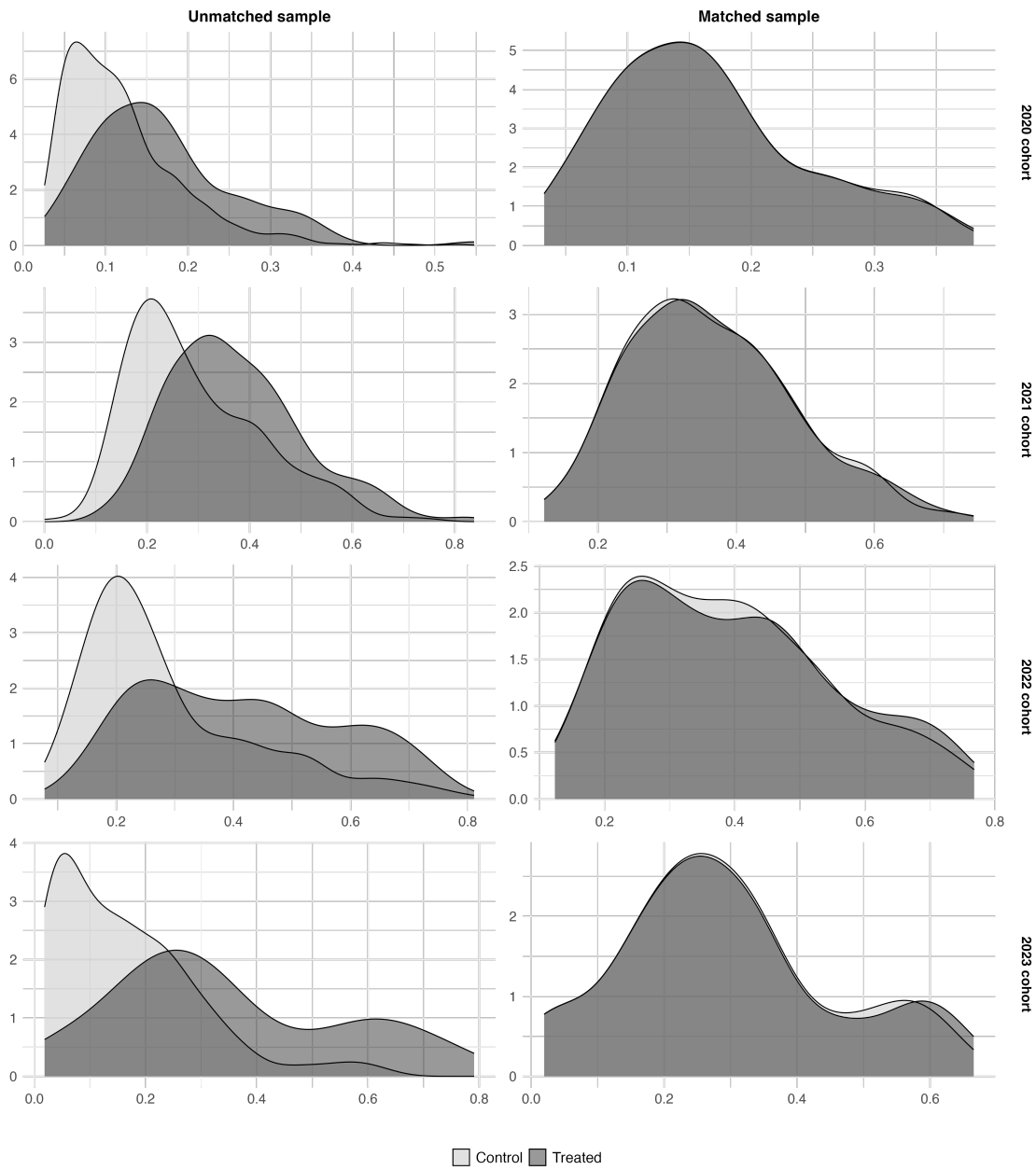


Figure 12: This figure shows the distribution of propensity scores, including leverage, return on equity and capex/assets in the calculation, before and after matching for each adoption cohort. The y-axis reports density values and the x-axis reports propensity scores.

D Appendix – Results from extended matching procedure

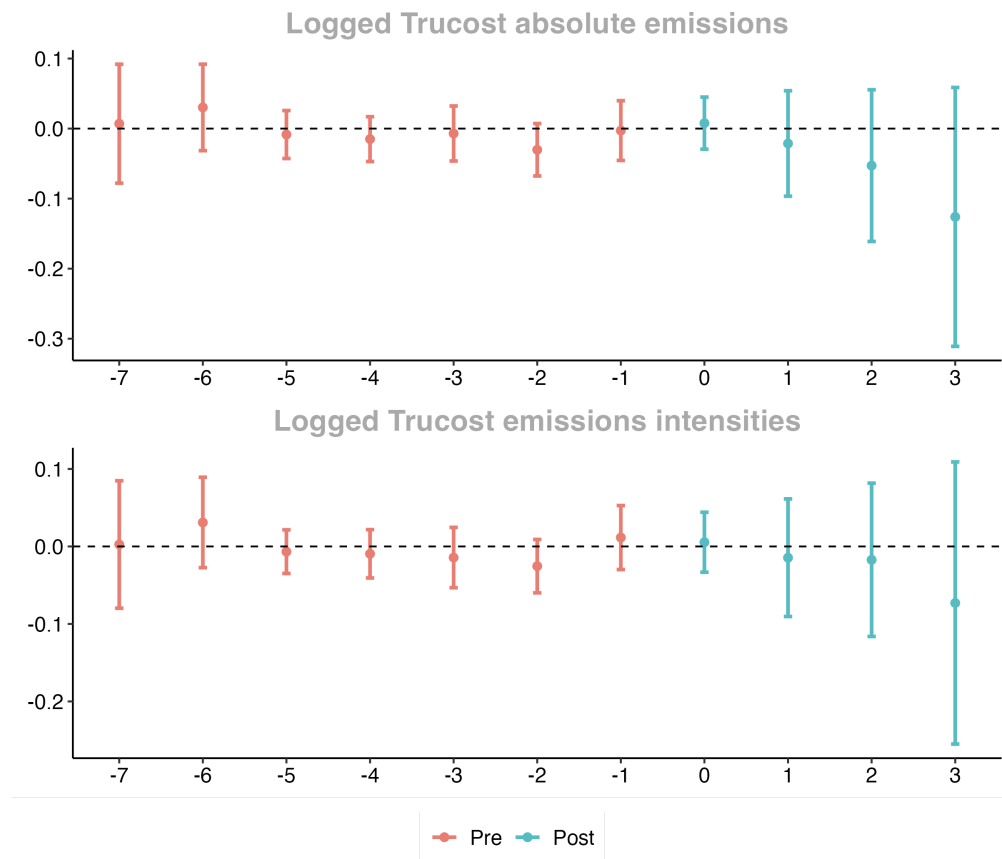


Figure 13: This figure shows the treatment effects of LTNZ announcements on logged Trucost absolute emissions and emissions intensities, comparing LTNZ adopters with matched not-yet-adopters. The matching procedure for this analysis includes leverage, return on equity and capex/assets. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

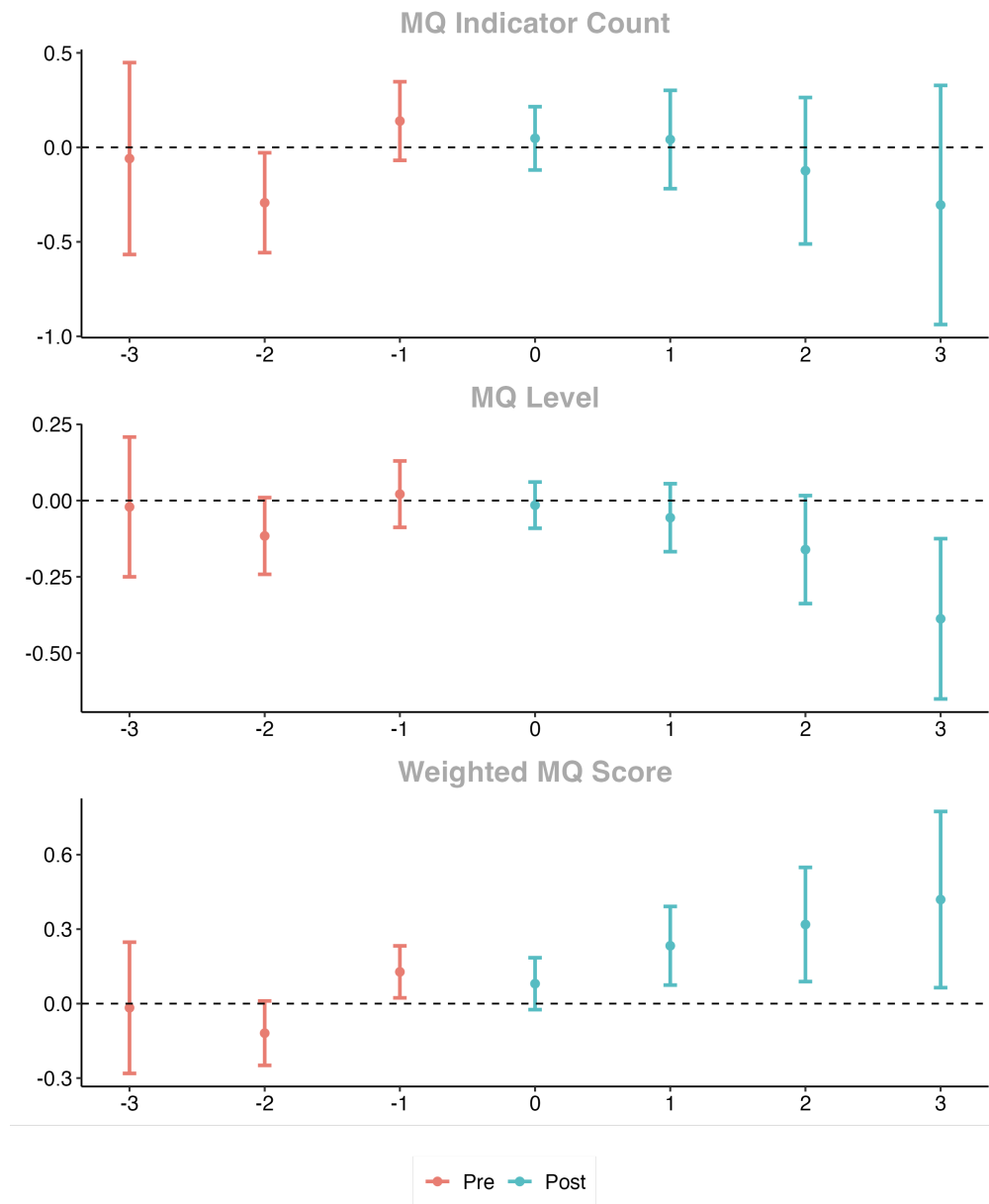


Figure 14: This figure shows the treatment effects of LTNZ announcements on the count of satisfied MQ indicators, hierarchical MQ levels, and weighted MQ score, comparing LTNZ adopters with matched not-yet-adopters. The matching procedure for this analysis includes leverage, return on equity and capex/assets. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

E Appendix – Exclusion of early target years

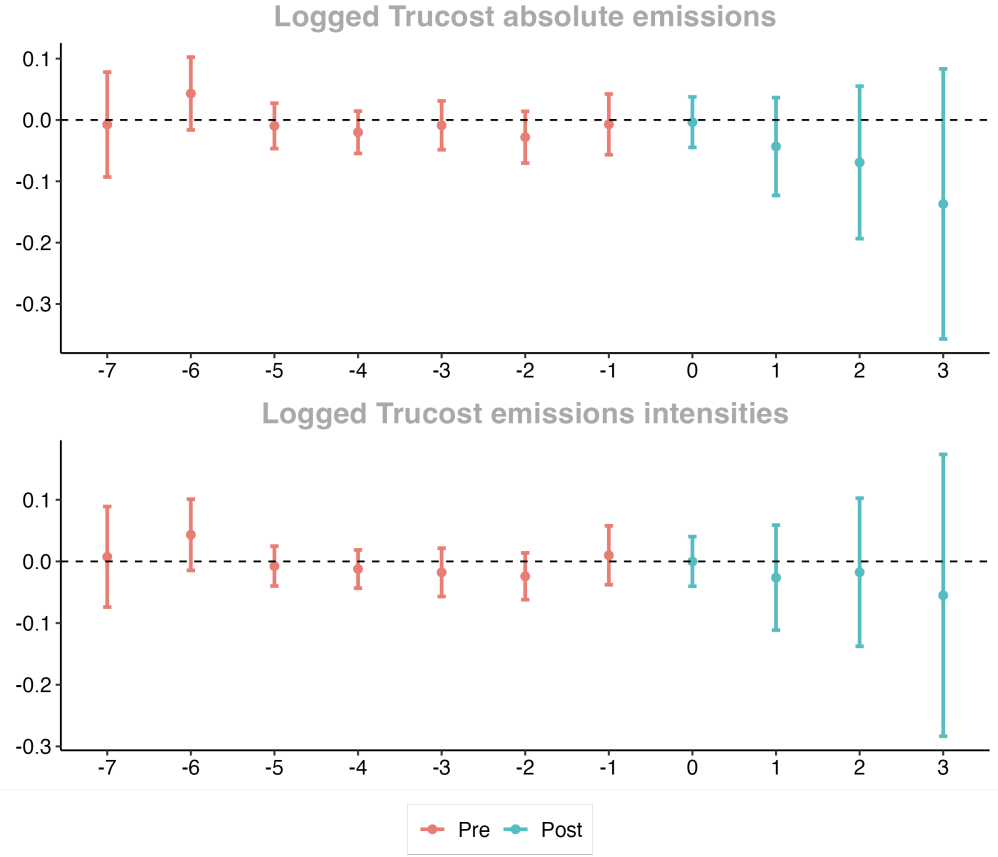


Figure 15: This figure shows the treatment effects of LTNZ announcements on logged Trucost absolute emissions and emissions intensities, comparing LTNZ adopters with matched not-yet-adopters. LTNZ targets with target years prior to 2035 are excluded from the analysis. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

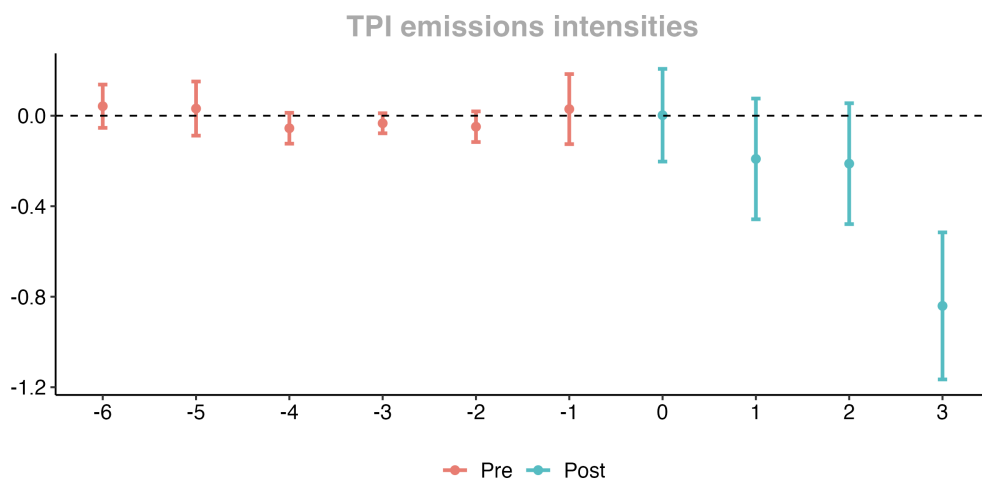


Figure 16: This figure shows the treatment effects of LTNZ announcements on sector-specific emissions intensities from TPI in z-scores, comparing LTNZ adopters with unmatched not-yet-adopters. LTNZ targets with target years prior to 2035 are excluded from the analysis. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

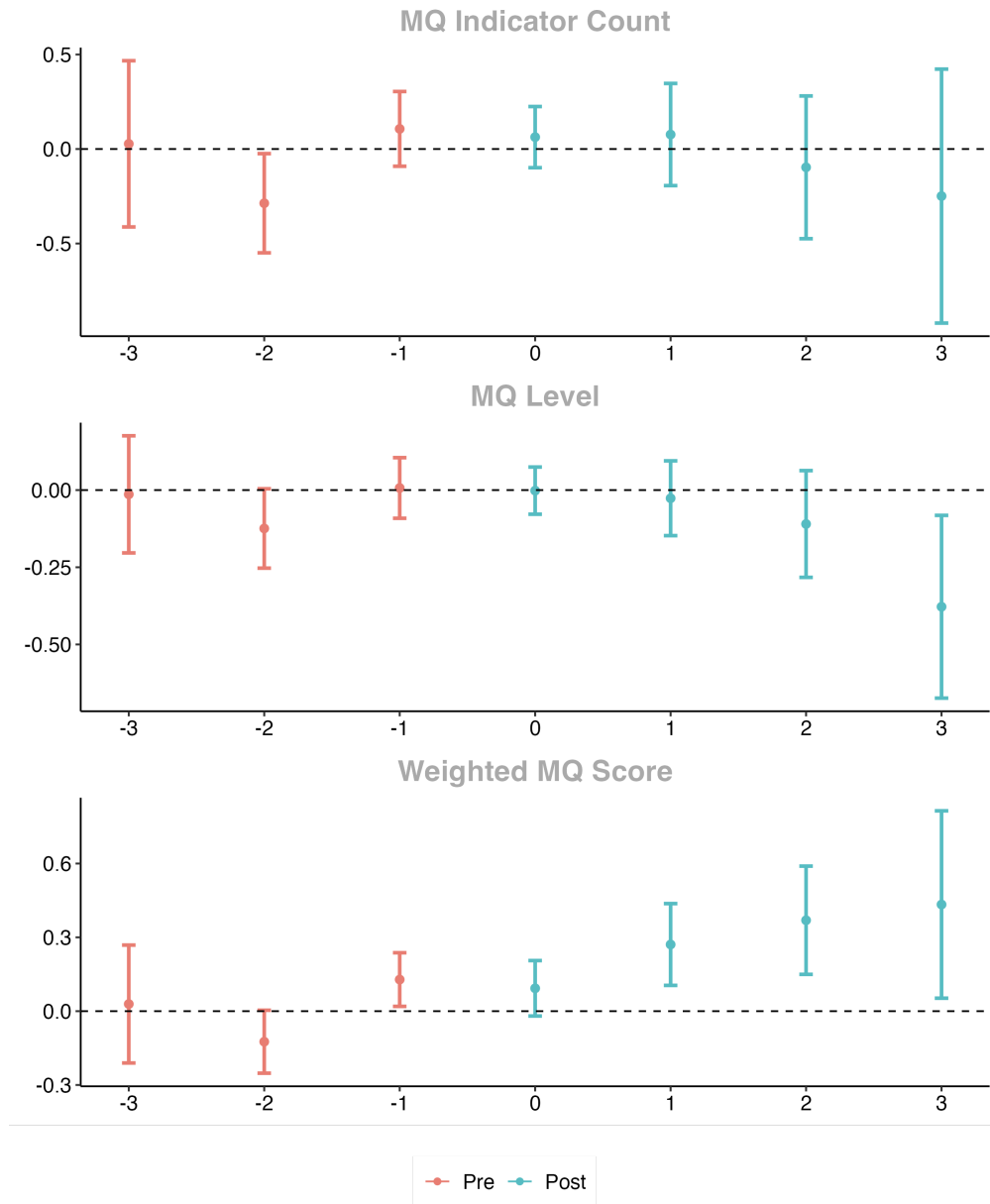


Figure 17: This figure shows the treatment effects of LTNZ announcements on the count of satisfied MQ indicators, hierarchical MQ levels, and weighted MQ score, comparing LTNZ adopters with matched not-yet-adopters. LTNZ targets with target years prior to 2035 are excluded from the analysis. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

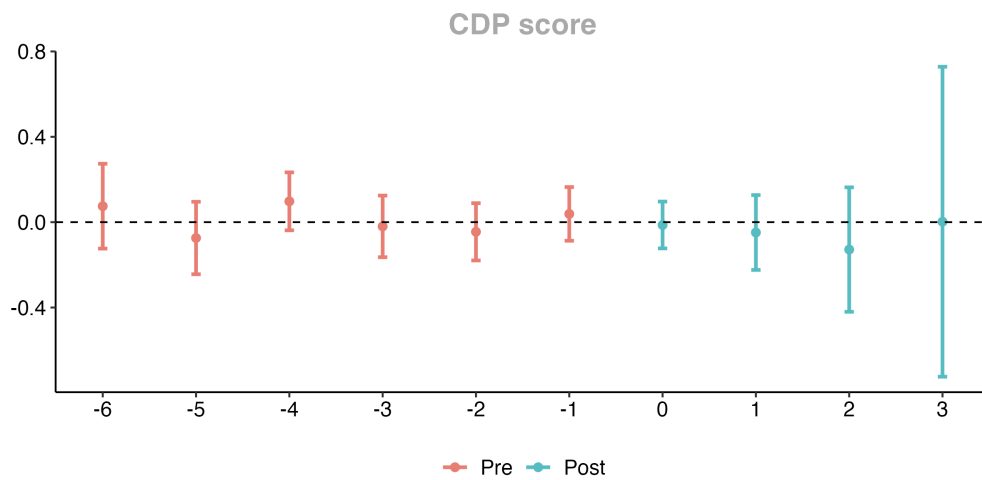


Figure 18: This figure shows the treatment effects of LTNZ announcements on the CDP score, comparing LTNZ adopters with unmatched not-yet-adopters. LTNZ targets with target years prior to 2035 are excluded from the analysis. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

F Appendix – Scope 3 coverage effects

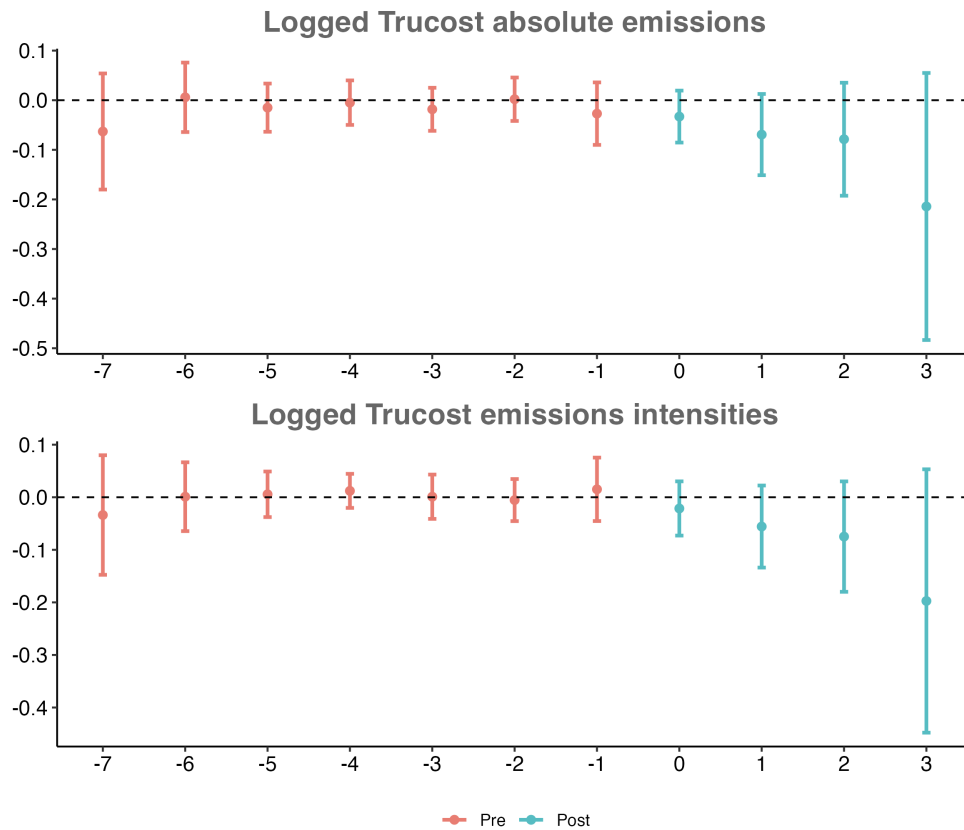


Figure 19: This figure shows the treatment effects of LTNZ announcements on logged Trucost absolute emissions and emissions intensities, comparing LTNZ adopters who include Scope 3 in their pledges with matched LTNZ adopters who do not include Scope 3 in their pledges. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

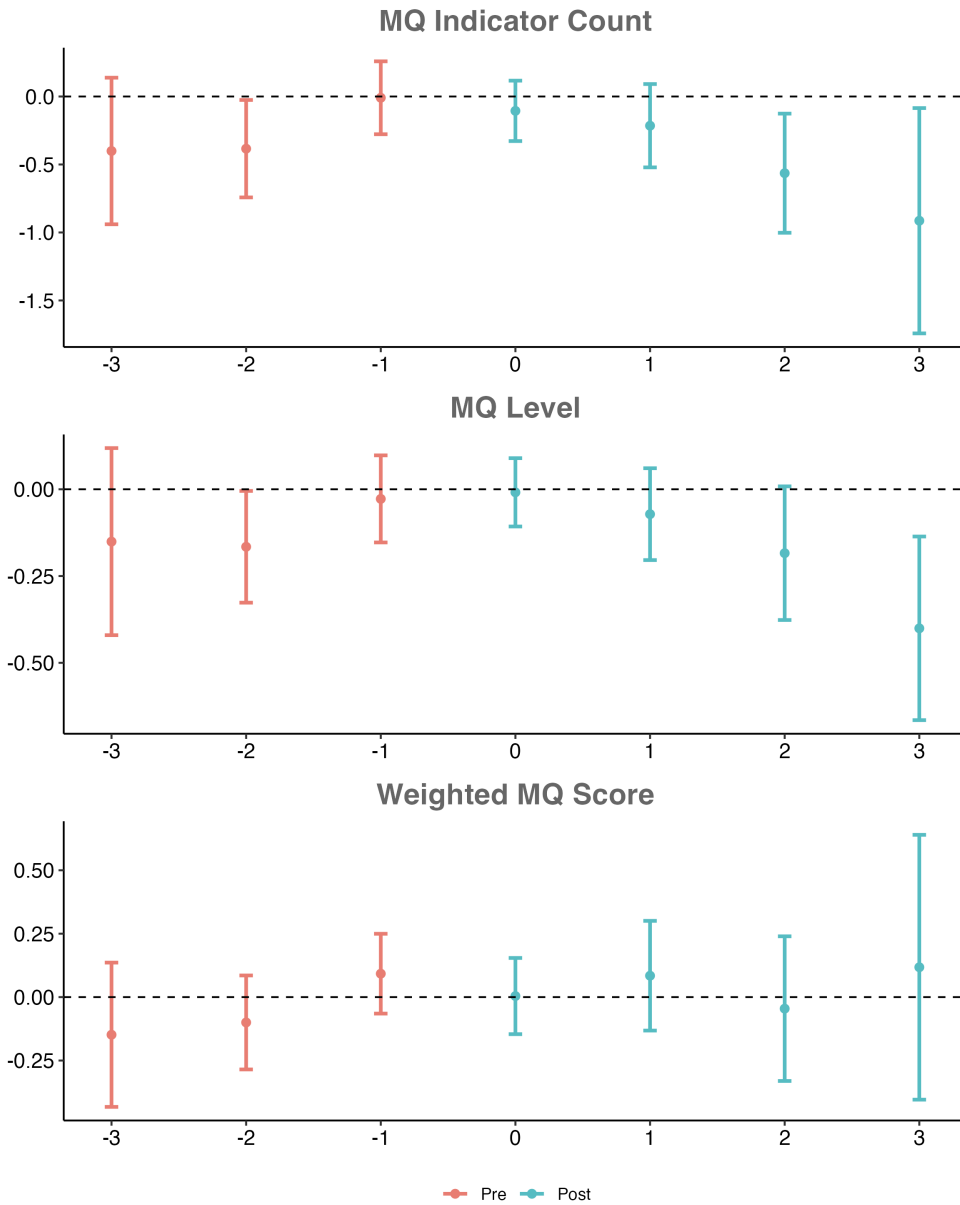


Figure 20: This figure shows the treatment effects of LTNZ announcements on the count of MQ indicators, MQ levels and weighted MQ score, comparing LTNZ adopters who include Scope 3 in their pledges with matched LTNZ adopters who do not include Scope 3 in their pledges. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

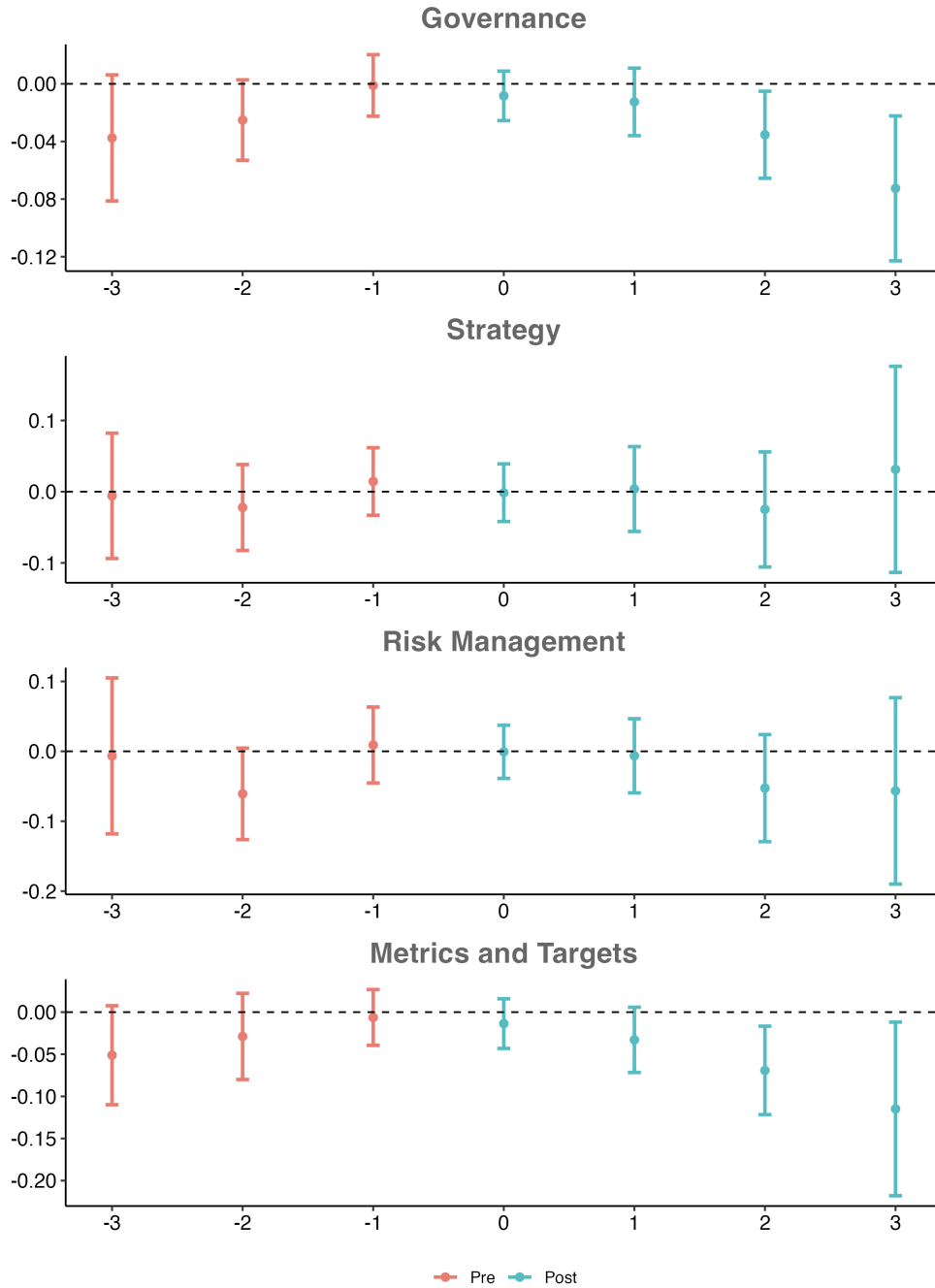


Figure 21: This figure shows the treatment effects of LTNZ announcements on Governance-, Strategy-, Risk Management-, and Metrics and Targets-related MQ indicators, comparing LTNZ adopters who include Scope 3 in their pledges with matched LTNZ adopters who do not include Scope 3 in their pledges. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

G Appendix – Further cohort-specific dynamic effects

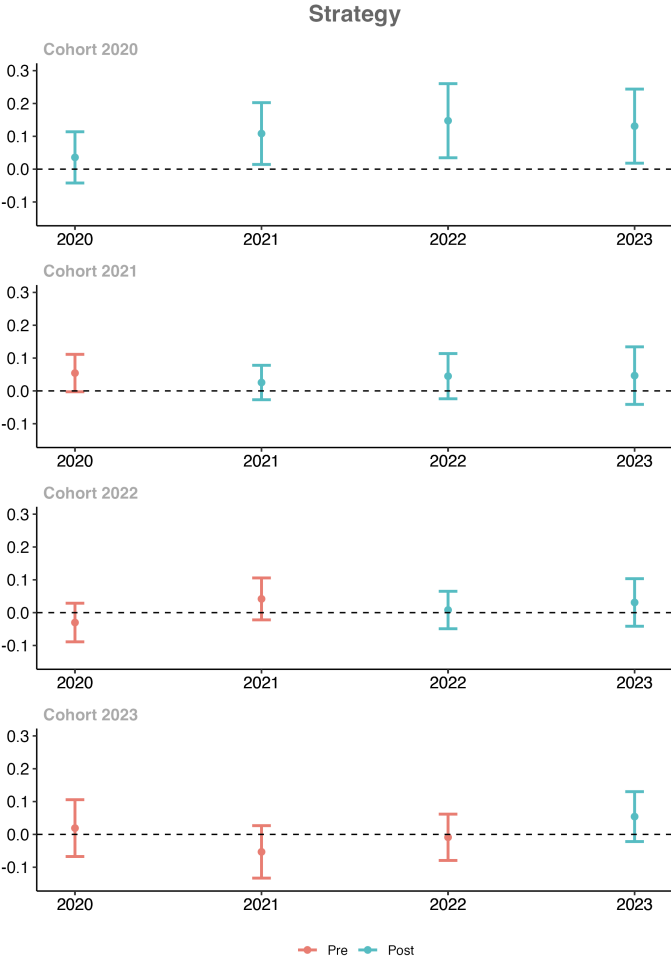


Figure 22: This figure shows the cohort-specific dynamic treatment effects of LTNZ announcements on the Strategy category, comparing LTNZ adopters with matched not-yet-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

H Appendix – Dynamic effects with never-treated firms as control group, only

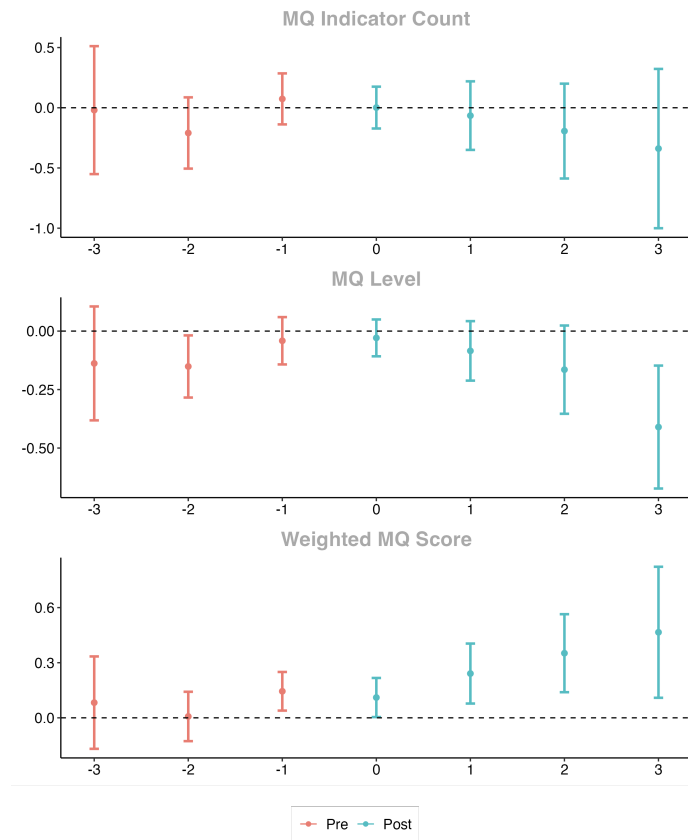


Figure 23: This figure shows the dynamic treatment effects of LTNZ announcements on the count of satisfied MQ indicators, hierarchical MQ levels, and weighted MQ score, comparing LTNZ adopters with matched never-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

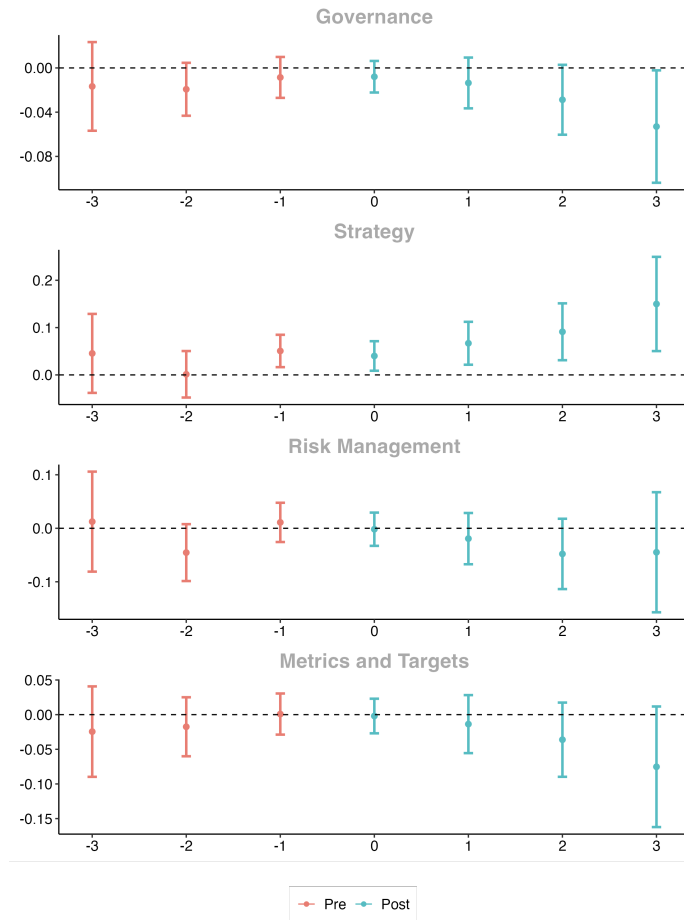


Figure 24: This figure shows the dynamic treatment effects of LTNZ announcements on Governance-, Strategy-, Risk Management-, and Metrics and Targets-related MQ indicators, comparing LTNZ adopters with matched never-adopters. Pre-treatment estimates are shown in red, post-treatment estimates in blue. Confidence intervals are set at 95%.

I Appendix – Further cohort-specific aggregate effects

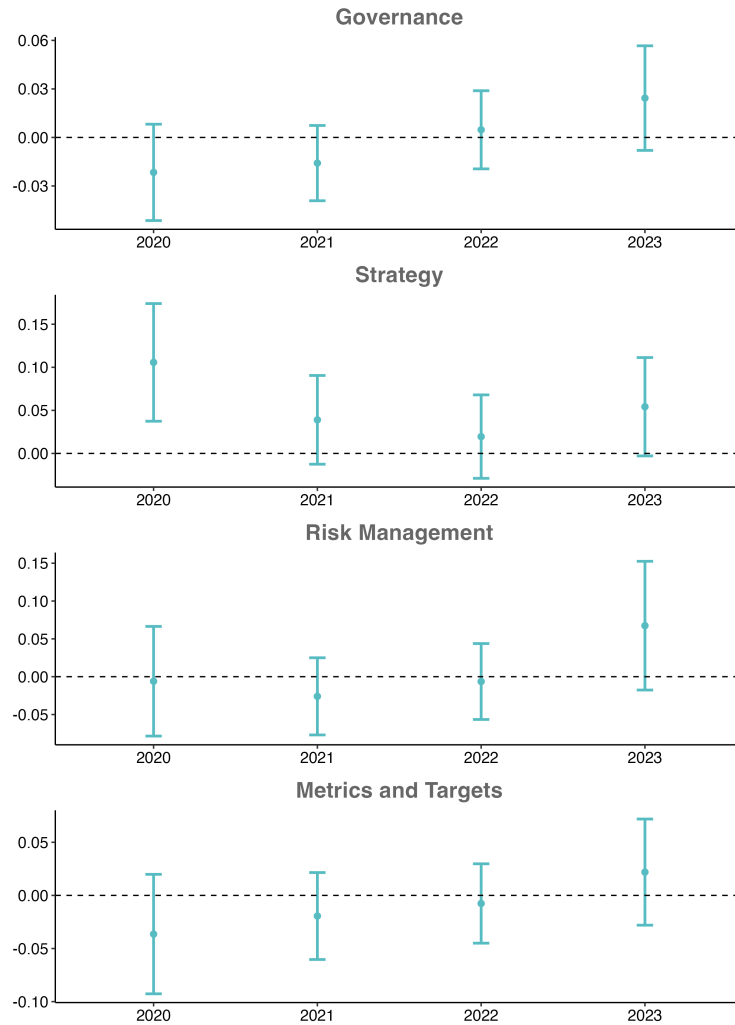


Figure 25: This figure shows the treatment effects of LTNZ announcements on Governance-, Strategy-, Risk Management-, and Metrics and Targets-related MQ indicators by cohort, comparing LTNZ adopters with matched not-yet-adopters. Confidence intervals are set at 95%.

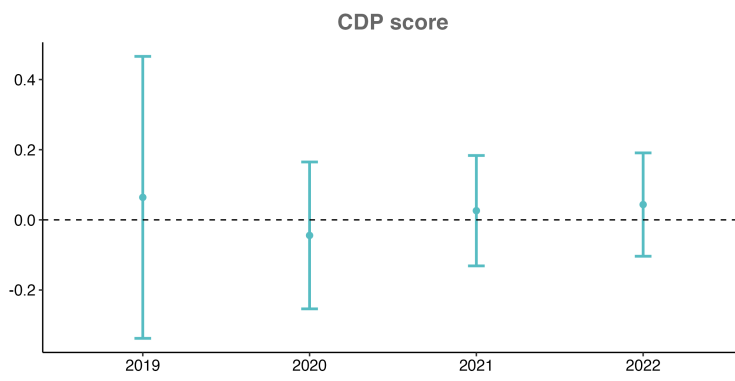


Figure 26: This figure shows the treatment effects of LTNZ announcements on the CDP score by cohort, comparing LTNZ adopters with unmatched not-yet-adopters. Confidence intervals are set at 95%.