Chief Sustainability Officers and ESG Performance

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Abstract

We study the hiring of the first Chief Sustainability Officers (CSO) in S&P500 companies from 2004 to 2024. We construct a novel dataset on timing and characteristics of initial CSO appointments. We find that large firms with high ESG scores are more likely to appoint a CSO, and more than half of initial CSO appointments are filled by women. Following an initial CSO appointment there is an increase in total GHG Scope 1 and 2 emissions accompanied by a surge in voluntary carbon offsetting activities, with net emissions still higher for firms with a newly appointed male, but not female, CSO. Nevertheless, firms with recent CSO appointments are less likely to experience a downgrade in their ESG rating, including the "E" component. Our interpretation based on this evidence is that firms appoint a CSO when they anticipate an increase in their GHG emissions in order to manage ESG scores.

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1 Introduction

In recent years, substantial attention in the finance literature was devoted to the impact Environmental, Social, and Governance factors (ESG), including the importance of Chief Executive Officers (CEOs) or Chief Financial Officers (CFOs). In this context, it is puzzling that virtually no research has focused on Chief Sustainability Officers (CSOs) who are responsible for formulation and implementation of the ESG policies and objectives as well as their measurement and reporting.[1] We fill this gap by introducing a novel dataset on CSO appointments and investigating characteristics of firms that appoint CSOs and their subsequent environmental performance.

We hand-collect a comprehensive dataset of initial CSO appointments and characteristics of all S&P 500 firms from 2004 to 2024, to investigate the drivers, roles, and rationales behind the emerging appointments of Chief Sustainability Officers (CSOs). Our sample period begins in 2004 because this year marks the first widely recognized CSO appointment in a publicly traded U.S. firm: DuPont's nomination of Linda Fisher as its Chief Sustainability Officer.[2]

We conduct our analysis in two steps: first we evaluate the differences between firms that appointed a CSO and those that did not. We also document the characteristics of the individuals appointed as first CSOs in their respective firms. In a second step, we assess the corporate Greenhouse Gas (GHQ) emissions, the voluntary carbon offsetting strategies, as well as the ESG ratings and their individual components in the aftermath of an initial CSO appointment. By integrating these dimensions, our research aims to contribute to a deeper understanding of how ESG policies are practically embedded within corporate structures and their measurable outcomes.

The emergence of Chief Sustainability Officers (CSOs) in corporate leadership reflects increasing institutional and organizational pressures to integrate and manage sustainable business practices. The notable concentration of CSO appointments within the past five years (Figure 1) underscores the rapid pace of this development and highlights the pressing need for further scholarly investigation into the drivers and implications of this trend.

Investigating all first-time CSO appointments in S&P500 firms, we find that larger companies

[1] One of the first and only comprehensive discussions on the different roles and responsibilities CSOs take on is Miller and Serafeim (2014) who study CSO authority and responsibilities across organizations with survey data.

[2] For practitioner documentation on the early development and diffusion of the CSO role, see the Weinreb Group's industry report (https://weinrebgroup.com/wp-content/uploads/2021/05/Weinreb-Group-Sustainability-and-ESG-Recruiting-The-Chief-Sustainability-Officer-10-years-Later-The-Rise-of-ESG-in-the-C-Suite-2021-Report.pdf) and the analysis by IMD on the institutional rise of sustainability officers in the corporate C-suite (https://www.imd.org/ibyimd/sustainability/does-your-company-need-a-chief-sustainability-officer/).

in more GHG crucial industries with higher ESG scores and a more diverse board are more likely to appoint a CSO as part of their C-level top management team. Notably, we see that only 32% of first-time CSOs have prior ESG related experience but they are more likely to be female (57%). This is a stunning quota given that Jiang (2020) finds that in 2019 the proportion of female directors in US corporate boards was only 19% (risen from 8% in 2009). Furthermore, unlike Fos et al. (2024) show for diversity in US boards 2000-2022, female candidates have been more likely to be appointed as CSOs already at the beginning of our almost identical sample period (from 50% in 2004 to 55% in 2022).

Using a stacked event study methodology as well as local projections difference-in-differences, we find that companies that appoint a CSO significantly increase their GHG emissions in the following years. We also observe an increase in voluntary carbon offsetting activity by those companies that appointed their first CSO. While carbon offsetting helps reduce the net emissions of the company, we do not detect a statistically significant change in net emissions on average; increased offsets purchases counterbalance the rise in emissions to some extent, stabilizing net emissions but not achieving real decarbonization.[3]

Given that a substantially larger portion of first-appointment CSOs are women (more than half), compared to other C-suite appointments, we investigate the impact of the initial CSO hires by gender. We find that an increase in emissions is more substantial for firms that hire men as their first CSO, with the effect for women not statistically different from zero.

Turning to ESG performance, despite rising emissions, ESG ratings do not deteriorate for CSO firms. In contrast, we find that non-CSO firms with increasing emissions experience significant drops in ESG scores, whereas CSO adopters do not. These results support the hypothesis that CSOs are hired to manage or buffer ESG deterioration rather than to reduce emissions in the first place.

2 Related Literature

Most of the academic evidence on CSOs so far has been conducted by management scholars published not in economics or finance outlets and due to a lack of strong identification strategies does not offer a clear picture on the real impact of the CSO on firm behavior. Several studies have tried to explore the impact of CSOs on environmental, social, and governance (ESG) transparency, particularly in sustainability disclosure practices. Peters and Romi (2014) report that

[3]For our calculations we take carbon offset amounts at their face value, which may or may not in practice actually offset the effect of the GHG emissions.

the presence of a CSO, along with sustainability committees, increases the likelihood and quality of voluntary greenhouse gas (GHG) emissions disclosures. On the environmental performance front, results are more nuanced. Kanashiro and Rivera (2019) find that CSOs are associated with worse environmental performance unless firms are subject to high regulatory pressure, under which CSOs become more effective. Peters et al. (2019) find that appointing a CSO does not necessarily improve sustainability performance, but firms with prior strong performance and CSOs with relevant expertise show long-term gains.

CSO effectiveness seems to interact with other governance mechanisms. Dixon-Fowler et al. (2017) find that environmental committees and senior sustainability officers together contribute to stronger environmental outcomes, while stakeholder representation on the board has little effect. Walls et al. (2012) provide a broader view, suggesting that individual governance elements such as managerial incentives and board composition have varying effects on environmental performance, but their interactions may yield complementary or conflicting results.

While the scarce existing literature provides some insights into the role of CSOs in shaping corporate ESG outcomes, it is largely constrained by outdated datasets and indirect measures of environmental performance. Most empirical studies rely on firm-year observations from the early 2000s to around 2015 Peters and Romi (2014); Peters et al. (2019); Fu et al. (2020), creating a temporal gap given the rapid evolution of sustainability practices in recent years. To address this, our study compiles a novel and comprehensive panel dataset covering all non-financial S&P 500 firms from 2004 to 2024, offering a complete view of the first generation of CSOs and their evolving role over two decades.

Moreover, prior research typically evaluates environmental performance using aggregated ESG scores or reputation-based indices (e.g., KLD database, Thomson Reuters ASSET4 ESG database), which—while interesting in their own right—may not capture firms' actual environmental impacts. In particular, no study so far has rigorously assessed the direct relationship between CSO presence and firms' greenhouse gas (GHG) emissions, net-zero transition, or offsetting through the voluntary carbon market (VCM). Our study fills this critical gap by linking CSO appointment data with firm-level GHG emissions and VCM activities, offering more direct and objective measures of environmental performance. This approach allows us to assess whether CSO leadership translates into measurable reductions in environmental externalities, rather than improvements in perceived sustainability alone. Finally, we are also the first to look at the long-run stock performance of CSO appointments while early evidence on short-term announcement effects by Arora et al. (2020) shows no significant impact on shareholder value.

3 Hypothesis Development

The decision to appoint a Chief Sustainability Officer (CSO) is influenced by a combination of internal organizational characteristics and external institutional factors. Larger firms often face greater scrutiny from regulators, investors, and the general public, which increases the likelihood of adopting formal sustainability leadership structures to manage reputational risk and compliance demands. Additionally, firms with a strong baseline of ESG engagement may formalize these efforts by creating a CSO position, as part of a strategic institutionalization of sustainability practices Peters et al. (2019). We thus hypothesize the following:

- *H1a. Larger firms are more likely to appoint a CSO.*
- *H1b. Firms with more diverse boards are more likely to appoint a CSO.*
- *H1c. Firms with higher ESG scores are more likely to appoint a CSO.*

Although many studies suggest that CSOs are positively associated with sustainability outcomes, evidence regarding their actual environmental impact remains mixed. While one might expect that CSOs improve environmental performance over time, particularly when embedded within strong governance structures and supported by regulatory pressure, evidence suggests that CSOs may lead to symbolic rather than substantive change Kanashiro and Rivera (2019). Peters et al. (2019) show that CSO appointments do not necessarily lead to improvement in sustainability performance. Given this ambiguity of previous literature, we test the following hypothesis:

- *H2a. Following the first CSO appointment, corporate total GHG emissions increase.*
- *H2b. Following the first CSO appointment, corporate total GHG emissions decrease.*
- *H2c. Following the first CSO appointment, corporate total GHG emissions don't change.*

In response to mounting climate-related expectations, firms increasingly rely on carbon offsets mechanisms as part of their environmental strategies Kreibich and Hermwille (2021). Franklin Allen and Nowak (2025) show that this is perceived neutral to negatively by shareholders. CSOs, as sustainability champions, may facilitate the adoption or expansion of offsets initiatives to signal commitment or compensate for operational emissions. Conversely, a focus on internal emissions reduction might deprioritize offsets but the literature has not directly addressed this issue yet. Thus, we hypothesize:

- *H3. Following the first CSO appointment, firm carbon offsets will increase.*

Net emissions—defined as total emissions minus carbon offsets—offer a more comprehensive measure of a firm's true environmental footprint. Unlike ESG scores or qualitative assessments, net emissions reflect actual environmental externalities and can better indicate whether CSO leadership leads to substantive decarbonization. Prior studies largely rely on sustainability indices or third-party ratings Walls et al. (2012); Peters and Romi (2014), without addressing direct emissions. Our study addresses this gap by evaluating whether CSO appointments result in meaningful changes in net emissions. Therefore:

- *H4. Following the first CSO appointment, firm net emissions (total emissions – carbon offsets) will decrease.*

While our earlier hypotheses focus on objective and quantifiable environmental outcomes such as total emissions, carbon offsets, and net emissions, these measures alone may not fully capture how stakeholders perceive a firm's overall sustainability performance. ESG scores, though sometimes criticized for opacity and variation across rating agencies, remain a widely used benchmark in investment, media, and academic assessments of corporate responsibility. Given that CSOs often play both substantive and symbolic roles in shaping sustainability strategy and disclosure, their appointment could influence ESG ratings independently of—or in conjunction with—actual environmental performance Peters et al. (2019); Kanashiro and Rivera (2019).

In some cases, firms may experience immediate improvements in ESG scores following the creation of CSO positions, while in others, the ESG score response may lag behind or remain unchanged if the CSO role is symbolic or poorly integrated. To provide a more comprehensive understanding of CSO influence —including both perceived and actual outcomes—we include the following hypothesis:

- *H5. Following the first CSO appointment, firm ESG scores will increase.*

This additional test allows us to evaluate whether CSO appointments affect third-party sustainability assessments, complementing our analysis of emissions-based outcomes with a reputational dimension.

4 Data and Research Design

We begin by discussing the construction of the novel dataset we compiled on CSO appointments by firms in S&P 500 and present some stylized facts for these data. We then discuss other variables we use in our analysis.

4.1 CSO data

We hand-collect the first C-level sustainability officer appointment data from 2004 to 2024 for S&P 500, including 141 appointments. We report counts by GICS sector and by calendar year in Table 1 and Figure 1. The Communication Services sector exhibits the highest adoption rate, whereas the Energy sector shows fewer than 10% of firms appointing a CSO over our sample. On average, 28.1% of sample firms appointed a CSO at least once during 2004–2024. Broadening beyond C-level titles, 209 firms (42.3%) created sustainability-focused roles at the executive or board level. In line with prior work, we exclude financial firms (SIC 6000–6999) from the empirical analysis. Unless otherwise noted, we treat the first CSO appointment as the event and ignore subsequent title changes or reappointments.

We also collect prior experience for the CSO appointed, gender, and ethnicity. The 141 first-time CSO appointees are predominantly female (54.6%) and majority-minority by ethnicity (73.0%). Only 38.9% have prior ESG-specific role experience. These suggest that firms often draw CSOs from broader managerial pools rather than narrowly hiring ESG specialists, and that the role is associated with substantial gender and ethnic diversity.

We examine the heterogeneity within male and female CSOs in Table 2. More than one-third of female CSOs (35.1%) have prior ESG-related experience, compared to only approxiamtely one-quarter of male CSOs (28.1%). Put differently, among all CSOs with prior ESG experience, two-thirds are female.

We further highlight the ESG performance around the CSO appointment year by gender. As shown in Table 3, firms that appoint female CSOs exhibit a more pronounced increase in ESG scores—particularly in the environmental and governance dimensions—compared to those that appoint male CSOs following appointment. In contrast, changes in the social score appear relatively similar across gender groups.

4.2 Emissions and carbon offsets data

Firm-level greenhouse gas (GHG) emissions are obtained from the LSEG ESG database for 2003–2024 (Scope 1 and Scope 2, in metric tons of CO_2 equivalent). For robustness, we cross-check coverage with Bloomberg. We focus on absolute Scope 1+2 and work with the natural logarithm of emissions to mitigate right-skewness and to align with linear specifications.

Carbon offsets are assembled from the Berkeley Carbon Trading Project, covering major voluntary carbon market registries (Verra/VCS, CAR, and Gold Standard). Figure 3 plots the aggregate time series of total emissions and retired offsets. Emissions trend downward over the period, while offsets usage rises and peaks around 2021. In our final sample, 120 non-financial

S&P 500 firms are active in VCM; among them, 52 appointed a CSO between 2004 and 2024.

4.3 Control Variables

We follow the previous literature and include a set of firm-level control variables obtained from Compustat and LSEG ESG. Specifically, *Firm Size (log)* is defined as the natural logarithm of total assets; *ROA* is measured as net income divided by total assets; *Tobin's Q* is calculated as the market value of equity plus total liabilities divided by total assets; *Leverage* is the ratio of total debt to total assets; *Capital Expenditure Intensity* denotes capital expenditure scaled by total assets; and *Sales Growth*, defined as the percentage change in sales relative to the previous fiscal year, to control for the firm's financial dynamics. *Total emissions Percentage Change* is the percentage change of scope 1&2 emissions for the firm compared to previous year.

We also control for top management and board structure characteristics. *Board Gender Ratio* is defined as the proportion of female directors on the board; *Board Size* refers to the total number of board members; *CSR Committee (Dummy)* indicates whether the firm in that year has a CSR committee. In addition, *CEO Duality* and *Independent Board Members Ratio* are added in event study part following previous literature.

We present the summary statistics for these control variables separately for firms with and without a CSO in Table 4.

4.4 Research Design

Our empirical analysis consists of two parts. First, we investigate the "pre-appointment" difference between firms that were or were not going to appoint their first CSO. We conduct this analysis using Cox proportional hazard model and test the robustness of these result by estimating logistic regressions. Second, we evaluate the dynamics of environmental performance of the firms that appointed their first CSO vs. those that did not.

4.4.1 Cox and Logistic regressions

For Cox regression we stratify the baseline hazard h_{0s} by either industry or state, or both.

$$\log h_{i,t} = \log h_{0s}(t) + \beta_1 \log(\text{Size}_{i,t-1}) + \beta_2 \text{BoardGenderRatio}_{i,t-1} \beta_2 X_2$$
$$+ \beta_3 \text{ESGScore}_{i,t-1} + \beta_4 \log(\text{Emissions}_{i,t-1}) + \varepsilon_{i,t},$$

where $h_{i,t}$ is the probability of firm i appointing a CSO in year t conditional on not appointing a CSO previously, i.e. hazard of CSO appointment. All variables are defined above and lagged

by one year. *ESGScore* is sourced from LSEG ESG metrics.

For the logistic regression, we only include observations up to and including the year of the initial CSO appointment. We estimate the following equation, with $D_{i,t}$ indicating the year t of CSO appointment by firm i.

$$\begin{aligned}\Pr(D_{i,t}=1) = \Lambda\Big(&\alpha + \beta_1 \text{TobinQ}_{i,t-1} + \beta_2 \log(\text{Size}_{i,t-1}) + \beta_3 \text{ROA}_{i,t-1} + \beta_4 \text{Leverage}_{i,t-1} \\ &+ \beta_5 \text{BoardGenderRatio}_{i,t-1} + \beta_6 \text{BoardSize}_{i,t-1} + \beta_7 \text{ESGScore}_{i,t-1} + \beta_8 \Delta\text{Emissions}\%_{i,t-1} \\ &+ \beta_9 \text{SalesGrowth}_{i,t-1} + \beta_{10} \log(\text{Emissions}_{i,t-1}) + \beta_{11} \text{GHGCrucialIndustry}_{i,t} + \delta_i + \tau_t + \varepsilon_{i,t}\Big),\end{aligned}$$

where Λ denotes the logistic function. δ_i represents industry fixed effects based on 2-digit SIC code of firm i, and τ_t is year fixed effects. Only years and industries with both CSO appointments and no appointments within the same year are retained to avoid complete or quasi-complete separation.

All variables are defined above and lagged by one year. Apart from the control variables mentioned above, we add several variables that are related. *IndustryTrend* is the total number of CSO appointments within the same industry and year. *GHGCrucialIndustry* is a dummy variable indicating whether the industry is classified as greenhouse gas (GHG) crucial Matsumura et al. (2024), following the SASB (Sustainability Accounting Standards Board) classification. These industries are identified as having material GHG emissions risks or performance implications.

4.4.2 Stacked Event Study

We follow Cengiz et al. (2019); Deshpande and Li (2019); Wing et al. (2024) to use stacked event study and create cohort-year dummy for event study estimation. We use a stacked event-study rather than a conventional TWFE staggered event study because, under staggered adoption, standard TWFE/ES mixes already-treated and not-yet-treated units into the control group and assigns non-convex/negative weights across cohorts and event times, biasing dynamic coefficients even when parallel trends holds Goodman-Bacon (2021); Sun and Abraham (2020); De Chaisemartin and d'Haultfoeuille (2020); Wing et al. (2024). The stacked design treats each cohort's adoption year as a separate sub-experiment with a common window and clean controls (never-treated or sufficiently later treated), then pools the event-time coefficients across sub-experiments Cengiz et al. (2019). This eliminates contamination from already-treated units and makes the estimand explicit for each event-time k. Within the stacked regression, we include cohort-year fixed effects to absorb calendar-time shocks specific to each cohort window including macro shocks, policy anticipation around that cohort's adoption year, ensuring identification comes only from comparisons within the same sub-experiment and calendar year rather than

across different cohorts with different exposure profiles. We cluster standard errors at the unit level to accommodate repeated appearances of the same unit across stacks. To show robustness, we also show the result using local projection DiD Dube et al. (2025); Roth Tran and Wilson (2025).

For each cohort ω_d (same year first CSO appointment), we create a window $[\omega_d - \mathrm{L}, \omega_d + \mathrm{F}]$. We keep cohort ω_d treated observations in that window and controls that are never-treated or not-yet-treated, in the same calendar years. Run an OLS with event-time dummies for treated units in that cohort window, cohort*calendar-year fixed effects (absorb common shocks within each cohort window), industry fixed effects, controls, and firm-clustered SEs. We also show the results using vanilla TWFE event study for robustness.

Let $\Omega = \{\omega_d\}_{d=1}^{D}$ denote the set of possible initial CSO appointment years. Each ω_d defines a sub-treatment (cohort), and all sub-treatments are pooled together. For the pooled sample, we estimate the following event-study specification:

$$y_{itd} = \sum_{k \neq -1} \beta_k \underbrace{1\{i \in T_d\}1\{t - \omega_d = k\}}_{D_{itd}^k} + X_{i,t-1}'\gamma + \alpha_{s(i)} + \tau_{dt} + \varepsilon_{itd} \tag{1}$$

Notation and Definitions:

- $d \in \Omega$: Index for sub-treatment (here each sub-treatment is equivalent to a different event years when there are CSO appointments), where ω_d is the initial CSO appointment year for sub-treatment d.
- i: Index for firms; t is the calendar year.
- y_{itd}: Dependent variable (including total emissions, carbon offsets, net emissions, and ESG score) for firm i at year t for sub-treatment d.
- T_d: The set of treated units in sub-experiment d (i.e., units whose first treatment occurs in year ω_d).
- $D_{itd}^k = \mathbf{1}\{i \in T_d\}\mathbf{1}\{t - \omega_d = k\}$: Relative-time indicator variable for event time k (with $k = -1$ omitted as the reference period).
- β_k: Pooled event-time coefficients across all sub-experiments. These are the coefficients of interest that form the event study path.
- $X_{i,t-1}$: Vector of control variables, lagged to mitigate endogeneity.
- $\alpha_{s(i)}$: Industry fixed effects.

- τ_{dt}: Cohort-Year fixed effects. These ensure comparisons are made only within clean pre/post windows for each cohort.

To show the robustness of our results, and to account for differences between firms that did and did not appoint a CSO, we also estimate a local projection difference-in-differences regression Dube et al. (2025).

5 Results

We first report firms characteristics that are associated with the initial CSO appointment. We then evaluate the relationship between CSO appointment and environmental performance of the firms.

5.1 Which firms appoint a CSO?

Since each firm can only appoint their first CSO once, we estimate a Cox proportional hazard model to evaluate firm characteristics that are associated with the initial CSO appointment. We lag all expalanatory variables by a year and stratify the estimation either by year or by year and industry. We also evaluate the effects controlling for industry or state fixed effects, or both. The results are reported in log-hazard form in Table 5.

We find that CSOs are appointed by larger firms, firms with more gender diversity on their corporate boards, and firms with higher ESG score are more likely to appoint a CSO, indicating that firms with stronger sustainability performance or disclosure practices are more likely to formalize sustainability governance at the executive level. The pre-appointment emissions do not appear to play a role in the initial CSO appointment, once we control for these other factors.

To make sure our results are not driven by the selected specification, we repeat the analysis with logistic regression estimates, reported in Table A2. The specification is estimated at the firm-year level and includes year, state, and 2-digit SIC fixed effects. The Cox regression findings are confirmed. Moreover, we find that other firm charactertistics do not have a consistent effect on the probability of a CSO appointment.[4]

Therefore, the result supports H1a: firm size is positively and significantly associated with the probability of appointing a CSO, conditional on year and industry fixed effects and firm controls. Evidence for H1b is also supportive: board gender representation and a firm ESG score that reflects other aspects of firm governance are positively related to CSO appointment.

[4]One exception is the negative effect of sales growth. However, we suspect sales growth is negatively correlated with firm size.

Consistent with H1c, firms with stronger prior ESG performance are more likely to appoint a CSO. Overall, these results highlight the importance of firm size, governance structure, and ESG orientation in driving the adoption of C-suite sustainability leadership.

5.2 Carbon emissions

Next we conduct event studies with the event being an initial appointment of a CSO. Our first outcome variable is firm carbon emissions, which we measure as the sum of Scope 1 and Scope 2 emissions. We show the trends and the dynamics of the coefficient for event study in Figure 7 and stacked event study results for total emissions as well as emissoin intensities (emissions/total output) in Table A5. Different window size choices show very similar results and are discussed in Robustness section.

We find no evidence of differential pre-appointment dynamics. While emissions are higher for firms that will appoint a CSO, their growth rate is not statistically different from zero for both treatment and control groups. However, after year 2, we observe a statistically significant emission increase for firms that appointed a CSO. The magnitude of the increase is substantial, 28.3% in year 3 and 52.2% in year 4 following the initial CSO appointment.

Among covariates, larger firms and firms with higher capital intensity exhibit higher emissions, as one would expect. Tobin's Q is negatively associated with emissions. The specification includes cohort×year, state and, industry fixed effects to absorb common shocks and cohort-wide dynamics. Overall, the absence of significant lead effects strengthens identification, while the growing post-event coefficients document economically meaningful changes in reported total emissions in the years following CSO appointment.

Given the differences between the fims that did and did not appoint the CSO that we uncovered previously, we also estimate local projections difference in differences regressions (LPDID) Dube et al. (2025); Roth Tran and Wilson (2025). We plot results in Figure 5 and report regressions in Table A6. Because total emissions are larger for larger firms, we also present the results for emission intensities. We include the same control variables as in stacked event study.

We find that the patterns are generally the same as with the event study, but we reveal a statistically significant increase in emissions following an initial CSO appointment as early as in the first year following the appointment, especially when we restrict our sample to a balanced panel. The magnitudes of the effect are somewhat smaller than what we found for year 3 in the event study, but in the same ballpark — between 20 and 30%. Thus, the results support hypothesis $H2a$, and reject hypotheses $H2b$ and $H2c$.

5.2.1 Heterogeneity across high and low emitters

Recent studies show that not all industries are equally capable of reducing their emissions. In particular, Martinsson et al. (2024) demonstrates that firms operating in "hard-to-abate" sectors exhibit limited emissions reductions even when exposed to carbon pricing, whereas firms outside these sectors respond more elastically. These findings suggest that our analysis of all the S&P 500 firms may mask substantial heterogeneity in firms' decarbonization capacity and carbon-risk management behaviour.

In the context of CSO appointments, this heterogeneity is particularly relevant: if decarbonization is technologically constrained for high-emitting firms, then large post-appointment increases in total emissions—such as the 40% rise documented in the full sample—may be driven disproportionately by cleaner firms or by firms whose initial emissions levels place them far from technological or regulatory constraints.

To investigate this possibility, we plot the emissions trends separately by firms' pre-CSO appointment emissions rank. For each firm that appoints its first CSO in year t, we compute its baseline emissions level as total estimated emissions in $t-1$ and rank this value within the cross-sectional distribution of the S&P 500 in the same year. This yields firm–cohort-specific indicators for being in the top 10%, 20% of the emissions distribution prior to appointment. We then partition the treated sample into "high emitters" (top 10% or 20%) and "low emitters" (bottom 90% and 80%), and construct two sets of strata (10/90, 20/80). For each stratum, we run a stacked difference-in-differences event-study, stacking treated firms by their appointment cohort and using filtered never-appointed firms as the control group using 1:4 propensity score matching. Cohort-by-calendar-year fixed effects and industry fixed effects absorb time-varying shocks and persistent sectoral differences, while the dynamic coefficients trace the evolution of emissions relative to the appointment year separately for high- and low-emissions firms.

This design allows us to test whether the pre-trends and post-appointment dynamics differ systematically between high emitters—whose abatement opportunities are technologically limited—and low emitters, for whom operational expansion or changes in production mix may be associated with larger emissions increases. If the aggregate increase in emissions after CSO appointment is driven primarily by low-emissions firms, we would observe attenuated or negligible post-trends among high emitters but substantial positive effects among low emitters. Alternatively, strong pre-trends among the highest emitters would support the hypothesis that CSOs are appointed in anticipation of deteriorating carbon performance rather than as a response to ongoing decarbonization efforts. The stratified event-study therefore directly tests whether the heterogeneity in technological abatement constraints translates into heterogeneous CSO-related

emissions dynamics.

The results are plotted in Figure 6. A clear heterogeneity pattern emerges between high- and low-emitting firms. Among the top emitters, the emissions trajectories of CSO-appointers and their control counterparts remain broadly parallel around the appointment year. CSO firms in the top 20% of pre-appointment emissions exhibit a 64.9% increase in total emissions (from 15.9 at event year (k = 0) to 16.4 at the end of the window—a change of 0.5 in logs), while control firms show a smaller rise of 35% (from 13.9 to 14.2 in logs). Thus, among high emitters, CSO appointment is associated with a larger increase in emissions. The pattern for bottom emitters is even more drastic. Low emitters that appoint a CSO experience a steep increase in emissions of 122.6% (from 13.2 to 14.0 in logs), while the control group shows a slight decline of 18.1%(from 13.2 to 13.0 in logs).

Taken together, these dynamics suggest that although firms with CSO appointments generally display increasing emissions, the magnitude of the increase is substantially larger for low emitters, whereas high emitters show smaller post-appointment growth relative to their control group. This asymmetric pattern reinforces the interpretation that CSO appointments among low-emitting firms may be associated with expansion or structural changes that increase emissions, whereas high emitters remain closer to their baseline trajectories.

5.2.2 Female and Male CSO heterogeneity

To investigate whether the gender of the first-hired Chief Sustainability Officer (CSO) is associated with systematically different emissions, we partition the treatment into two mutually exclusive groups: firms that appoint a female CSO and firms that appoint a male CSO. Firms that never appoint a CSO or have not yet appointed one before the end of the time window serve as the control group. We estimate dynamic treatment effects using stacked event-study design and local projection difference-in-differences. Both approaches control for firm characteristics, industry, state, and year fixed effects, with standard errors clustered at the firm level. The results are illustrated in Figure 7, where we plot the dynamic effects for both methods, full regression results are reported in Table A7.

The results reveal a clear and consistent pattern across both empirical approaches. For firms appointing male CSOs, emissions increase relatively quickly following the appointment and become economically and statistically significant within one to two years. In both the stacked event study and the LP-DiD estimates, the post-appointment coefficients for male CSOs are positive and significant, with effects growing in magnitude over time. In contrast, firms appointing female CSOs exhibit a markedly different dynamic. Emissions do not increase significantly in

the short or medium run following the appointment, and statistically significant effects emerge only four years after the event. Importantly, pre-trend coefficients for both groups are small and statistically indistinguishable from zero (with only one exception), lending support to the parallel trends assumption underlying the identification strategy.

Taken together, these findings suggest that the observed increase in emissions following CSO appointments is primarily driven by firms appointing male CSOs, while female CSO appointments are associated with a more delayed and attenuated emissions response. This pattern is consistent with our earlier evidence showing that female CSOs tend to have more ESG-related prior governance experience and that firms appointing female CSOs achieve higher environmental performance scores after the appointment.

5.3 Carbon offsets

We examine how voluntary carbon offsets purchases evolve around the installation of a Chief Sustainability Officer (CSO). Using similar setup with carbon emissions analysis, we estimate dynamic effects on the (log) amount of offsets and inspect pre-treatment trends to assess identification. The results are displayed in Figure 8 with corresponding regressions reported in Table A8.

Pre-trends are individually imprecise, yet the event-time plot indicates that firms that will appoint a CSO already exhibit an upward trend in offsets before $k = 0$, whereas the control group pre-trend is flat. This pattern is consistent with selection and anticipation: more environmentally-oriented firms, or firms that expect an increase in emissions, may begin purchasing offsets earlier and subsequently formalize that strategy by appointing a CSO. Post-appointment coefficients are large and statistically significant, indicating a considerable increase relative to the pre-appointment baseline. Hypothesis $H3$ is thus supported: participation in carbon offset markets is intensified following an initial CSO appointment.

5.4 Net emissions

Following the same logic, we use net emissions (defined as log(total emissions − carbon offsets)) as the outcome. The results are displayed in Figure 9 with corresponding regressions reported in Table A9. The dynamic coefficients are small and statistically indistinguishable from zero until the third year after appointment, while the fourth year shows significant increase comparing to the firms without CSO appointments. This result is aligned with the previous results for a gradual increase gross emission and carbon offset pattern: after the new CSO appointment first, total emissions rise with positive and significant coefficients from after the first year; second, carbon offsets increase sharply even when compared with an increasing pre-trend; and therefore,

net emissions show no detectable change for the first three years after appointment.

These results indicate that, at least in the short run, CSO appointment is associated less with immediate operational abatement and more with ramped-up offsets that at least from carbon accounting point of view approximately compensate for higher reported emissions. Substantively, the CSO role appears to manage and potentially camouflage deteriorating carbon environmental performance, rather than delivering emission reductions.

5.5 ESG score

We continue to analyze ESG score to check indirect environmental performance association with CSO appointment. We show the parallel trend in Figure 10. Overall before the CSO appointment the ESG scores for S&P 500 firms are increasing, indicating that large firms are more concerned with ESG performance compared to the market. While the firms without a CSO appointment keep increasing, the firms which appointed a CSO have their ESG score slightly decreasing two years after appointment, which aligns with the event study result of total emissions - firms with CSO have their total emissions increasing and become statistically significant after 2 years.

The event study result for ESG score is shown in Figure 10 with corresponding regressions reported in Table A10. The Pre-trends are flat, consistent with the parallel trend figure. While the dynamic treatment coefficients are becoming more negative, they are still economically small and statistically indistinguishable from zero. As a result, we do not find evidence supporting hypothesis $H5$. Combined with earlier evidence—total emissions rise post-CSO, carbon offsets also rise, and net emissions show no detectable change — the ESG aggregate score does not exhibit an immediate deterioration around appointment.

Following our assumption that CSO are appointed to manage and potentially camouflage deteriorating carbon environmental performance, a naive way to test what happens to the firms which have total emissions increasing, but without CSO appointment. Therefore, we test the following regression with interactions:

$$\begin{aligned} \text{ESG}_{i,g,t} = \alpha + \beta_1 \text{CSO}_{i,g,t} + \beta_2 \text{GHGInc}_{i,g} + \beta_3 (\text{CSO}_{i,g,t} \times \text{GHGInc}_{i,g}) \\ + \mathbf{X}'_{i,t-1}\gamma + \theta_{g,t} + \delta_{s(i)} + \varepsilon_{i,g,t} \end{aligned} \tag{2}$$

$$\begin{aligned} \text{ESG}_{i,g,t} = \alpha + \pi_1 \text{NoCSOPost}_{i,g,t} + \pi_2 \text{GHGInc}_{i,g} + \pi_3 (\text{NoCSOPost}_{i,g,t} \times \text{GHGInc}_{i,g}) \\ + \mathbf{X}'_{i,t-1}\gamma + \theta_{g,t} + \delta_{s(i)} + u_{i,g,t} \end{aligned} \tag{3}$$

Where:

- i indexes firms, g is the cohort (first-appointment year), and t is calendar year.
- $\text{CSO}_{i,g,t} = \mathbf{1}\{i \in T_g\}\mathbf{1}\{k = t - g \geq 0\}$ is the post indicator for treated firms in cohort g in the stacked sample.
- $\text{GHGInc}_{i,g} = \mathbf{1}\{\log E_{i,g,t_{\text{last}}} > \log E_{i,g,t_0}\}$ flags firm–cohort pairs whose total emissions at the last observed event time exceed their level at $k = 0$.
- $\text{NoCSOPost}_{i,g,t} = \mathbf{1}\{i \notin T_g\}\mathbf{1}\{k = t - g \geq 0\}$ marks aligned post-period observations for non-treated units.
- $\mathbf{X}_{i,t-1}$ are lagged firm controls (Tobin's Q, log size, ROA, leverage, capex intensity, R&D dummy, board size, CEO duality, independent directors).
- $\theta_{g,t}$ are cohort–year fixed effects (one FE per (g,t) cell), and $\delta_{s(i)}$ are industry FEs.

The results are reported in Table A11. The coefficient on GHG Increase is negative and statistically significant (-0.019, $p < 0.05$), indicating that cohorts whose total emissions rise over the window have lower ESG scores, holding fixed firm controls and cohort–year and industry fixed effects. The CSO $\times$ GHG Increase interaction is positive but imprecise ($+0.018$, not significant), while the main CSO appointment effect for non-increasers is small and not significant ($+0.010$). Taken together, the point estimates suggest that appointing a CSO partly offsets the ESG penalty associated with becoming an emissions increaser ($\beta_3 < 0$), but the mitigation is not estimated precisely enough to reject zero at conventional levels. Consistent with prior results, where post-CSO total emissions increase, offsets increase, and net emissions do not rise, ESG scores for CSO firms do not deteriorate materially, which aligns with the view that CSOs are deployed to contain rather than reverse environmental headwinds.

The No-CSO Post $\times$ GHG Increase interaction is negative and statistically significant (-0.018, $p < 0.001$), while the No-CSO post main effect is small and not significant. This pattern implies that among firms without a CSO, those whose emissions rise experience a clear drop in ESG performance after the aligned post period. Compared with first regression, these results are consistent with the core hypothesis: firms anticipating rising operational emissions tend to appoint CSOs, who then help mitigate the ESG penalty so that net emissions do not worsen and ESG does not fall, whereas similar firms without CSOs suffer a measurable deterioration in ESG when emissions increase.

6 Robustness

6.1 Different window sizes

To show our results are robust, we change the size of the window from 2 years before and after CSO appointment to 5 years before and after CSO appointment and run analysis again. The results are shown in Table A12. It shows that our event-study estimates are highly robust to the choice of pre/post horizon. Across the three specifications including $[-5, +5]$, $[-3, +3]$, and $[-2, +2]$, pre-treatment coefficients are small and statistically indistinguishable from zero. Post-appointment effects are negligible on impact (D_0) and in the first year (D_1), but become positive and statistically significant from D_2 onward in last two column and from D_3 in the first column. The magnitudes are remarkably stable, and control coefficients retain their expected signs. The model fit ($R^2 \approx 0.83$) is effectively unchanged across windows.

Taken together, these patterns indicate a consistent dynamic response: emissions rise meaningfully only after a short implementation lag following the CSO appointment, and this trajectory is not an artifact of window selection or sample composition. The increase from D_2 onward persists as the window widens, while the absence of detectable pre-trends strengthens the causal interpretation under the cohort-year and industry fixed-effects design.

6.2 Subsample analysis

From the trend of CSO, we can see a clear trend of new CSO appointments after 2020. To show the result is robust, we run same analysis only on the CSO appointments before 2020, reported in Table A13. We re-estimate the stacked event-study on log total emissions restricting cohorts to CSO appointments before 2020, with 28239 observations. The dynamic pattern closely aligns and slightly stronger than the baseline result. Pre-event coefficients are small and statistically indistinguishable from zero supporting parallel trends. Post-appointment effects emerge from 2 years after the appointment (coefficient 0.313, with $p < 0.05$) to 4 years after(0.477, $p < 0.01$). In percentage terms, these imply increases of roughly 36.7% at two years post and 61.1% at four years post. The control coefficients retain expected signs: negative for Tobin's Q, positive for size, ROA, and capital intensity, and the model fit is comparable to the baseline.

Relative to the full-sample baseline, the pre-2020 subsample delivers very similar or slightly larger post-event magnitudes with the same qualitative timing. This robustness check alleviates concerns that the main results are driven by the 2020–2024 adoption wave or contemporaneous shocks like COVID, and reinforces the interpretation that CSO appointments are followed by higher reported total emissions over the subsequent 2–4 years rather than an immediate

reduction.

7 Conclusions

Our paper presents a hand-collected panel of first-generation Chief Sustainability Officer (CSO) appointments in S&P 500 firms (2004–2024) and links these appointments to firms' environmental performance using a stacked event study methodology and the local projections difference-in-differences.

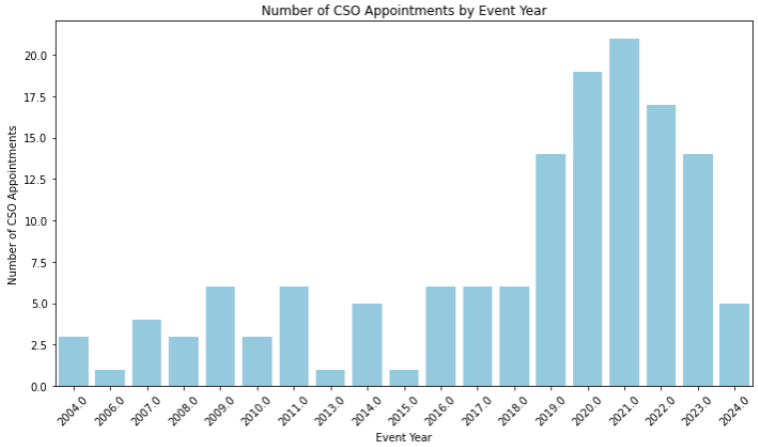
We find that larger firms with higher ESG scores and gender-balanced boards are more likely to appoint a CSO, and nearly sixty percent of appointees are female. We also find female CSOs are associated with better corporate ESG performance comparing to male CSOs. This gender difference is present in all components of the ESG score as well as in dynamics of firms' GHG emissions following the appointment.

We document a clear post-appointment rise in gross (Scope 1–2) emissions, alongside a sizable increase in voluntary carbon offsets. These dynamic effects are robust across alternative event windows and to restricting cohorts to pre-2020 adoptions, and pre-trends are generally flat. When we net out carbon offsets, average net emissions do not increase significantly above the previous three years. At the same time, ESG scores also do not significantly change.

Taken together, we interpret these results to indicate that CSOs are hired to manage ESG consequences of increasing carbon emissions. When we split firms by ex-post GHG trajectories, we find that firms without a CSO appointment experience significantly lower ESG scores when their emissions rise, whereas firms with CSOs do not exhibit a comparable decline for increasing emissions. Our findings suggest that, in the short to medium run, CSO appointments seem to function less as immediate levers for real-emissions reductions and more as a role that mitigates deterioration in ESG scores.

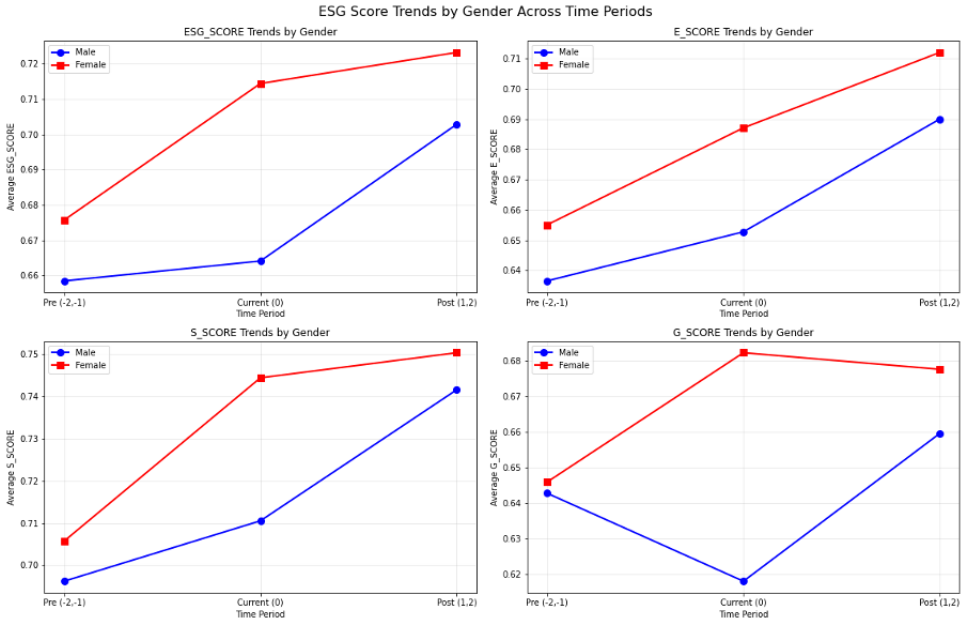
Figures

Figure 1: The 1st generation CSO appointments in S&P500 by year



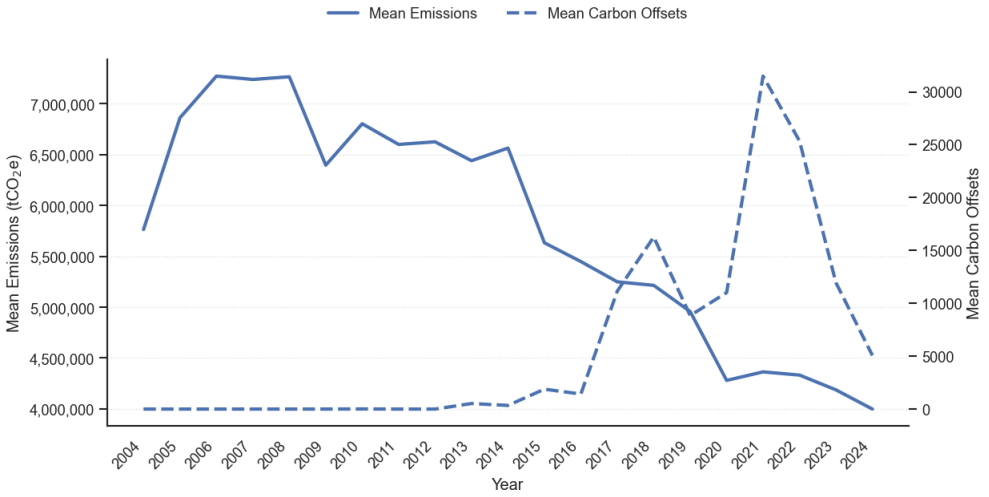
Note: This figure shows the count of new CSO appointments each year in S&P500; only first generation of firm CSO is counted, turnover is not taken into account

Figure 2: The mean E,S,G score and total ESG score plot around the years of CSO appointment by different gender group



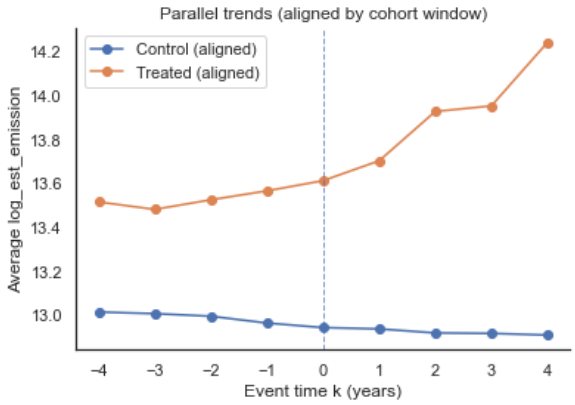
Note: This figure shows the mean ESG score and each sub score for two gender groups CSO. Red line is female CSO nad blue line is male CSO. Each value represents the firm-level average within one of three periods: pre-appointment ($t = -2$ to $t = -1$), appointment year ($t = 0$), and post-appointment ($t = +1$ to $t = +2$). Values in parentheses indicate the change from the pre-appointment period.

Figure 3: Total carbon emissions and carbon offsets for S&P 500 by year

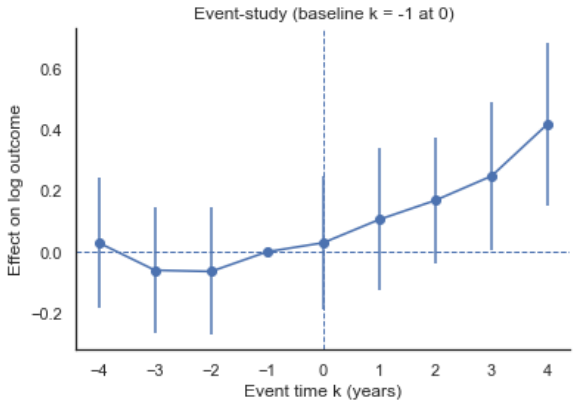


Note: This figure shows the trend of mean total GHG emissions (scope 1&2) and mean carbon offsets for S&P500 firms. The blue line is total emissions correspond to the left y-axis, while the dotted line is carbon offsets correspond with right y-axis.

Figure 4: Parallel Trend and Dynamic Effects of CSO Appointment on log total emissions



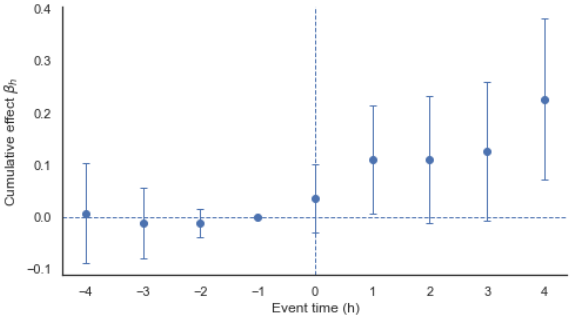
Panel A: Parallel Trend of log total emissions



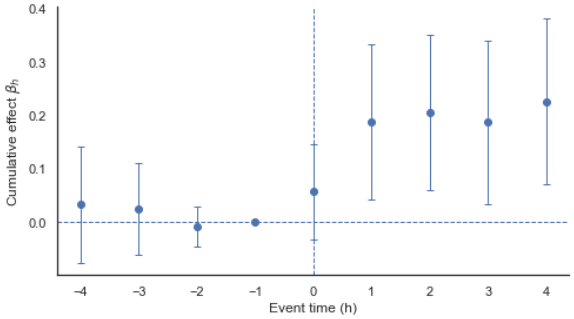
Panel B: Event Study Dynamic Effects on log total emissions

Panel A *shows the raw parallel trends between treated firms (yellow line: with CSO appointment) and control firms (blue line: without CSO) over event time $k = t - g$, where g is the first CSO appointment year. Control firms are aligned to the same calendar years as each treated cohort within the estimation window.* ***Panel B*** *reports estimated event-time coefficients $\{\beta_k\}_{k \neq -1}$ from a cohort-stacked event study, where $k = 0$ is the appointment year and coefficients are relative to $k = -1$ (omitted). Dots indicate point estimates and vertical bars are 90% cluster-robust confidence intervals. The specification includes cohort×year fixed effects, industry fixed effects (SIC2), and state fixed effects with standard lagged firm-level controls. The vertical line on each dot indicate the 90 percent confidence interval. The errors are clustered to firm level.*

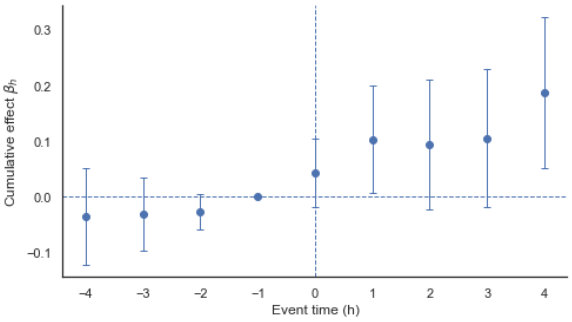
Figure 5: Dynamic effect plot of Local Projection DiD results for total emission and intensity using balanced and unbalanced setting



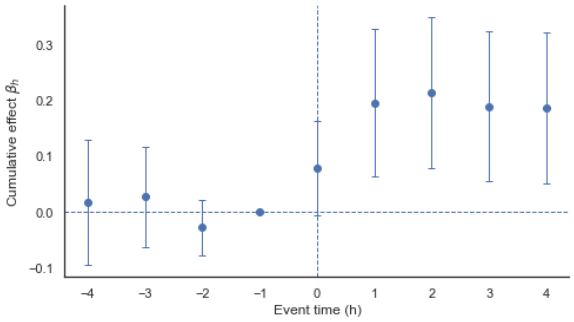
Panel A: total emissions without balanced panel restriction



Panel B: total emissions with balanced panel



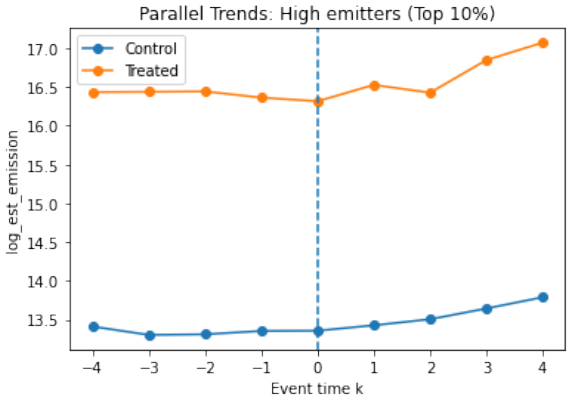
Panel C: emission intensity without balanced panel restriction



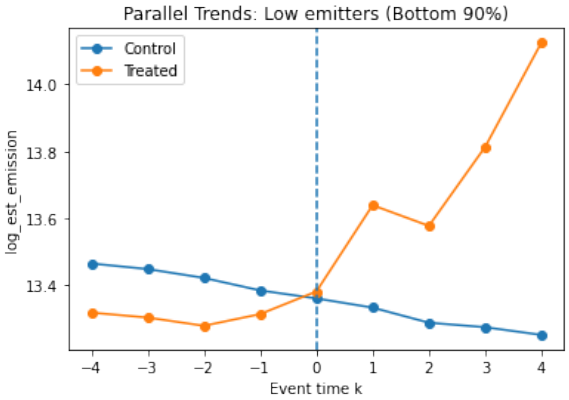
Panel D: emission intensity with balanced panel

Note: This figure plots the dynamic effect of local projection estimation for both corporate total emissions and emission intensity with unbalanced and unbalanced setting. The vertical line for each dot indicates the 90% confidence intervals. The controls variables are the same with stacked event study, with year, state, and industry fixed effects. The errors are clustered in firm level.

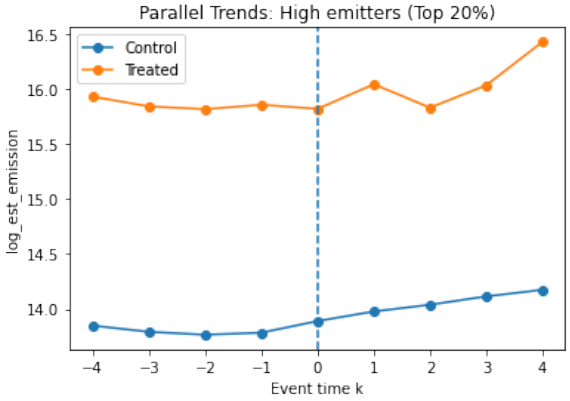
Figure 6: Event-Time Trends in Log Scope 1&2 emissions by emissions Strata (Top 10/20% vs Bottom 90/80%)



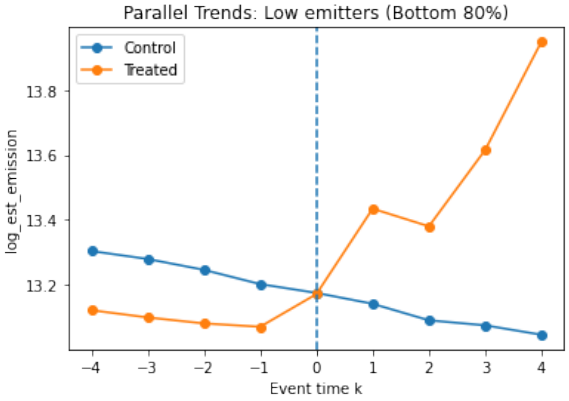
Panel A: Top 10% High Emitters



Panel B: Bottom 90% Low Emitters



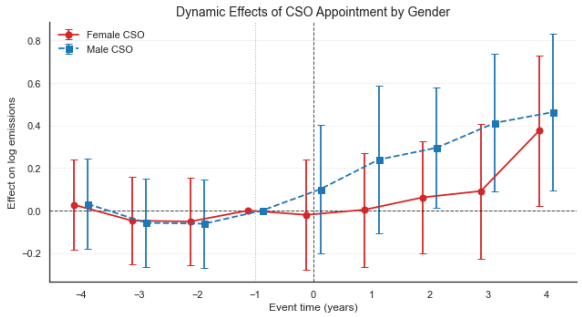
Panel C: Top 20% High Emitters



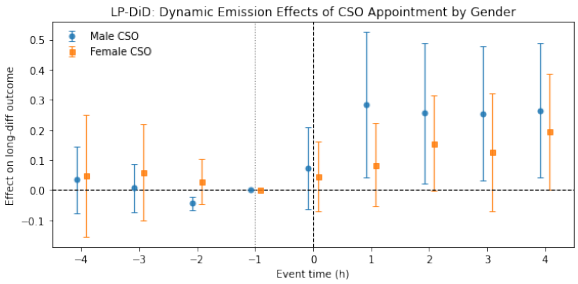
Panel D: Bottom 80% Low Emitters

Note: This figure plots event-time trends in log total emissions (Scope 1&2) for treated and control firms, separately by total emissions strata. Panels A and B show results for high emitters (Top 10%) and low emitters (Bottom 90%), while Panels C and D use a Top 20% vs Bottom 80% split. Event time is defined as $k = t - g$, where g is the first CSO-appointment year for each treated cohort. Thus, $k = 0$ corresponds to the appointment year, $k < 0$ to pre-appointment periods, and $k > 0$ to post-appointment periods. Control firms (never-treated or not-yet-treated) are aligned by calendar year with each treated cohort, filtered with propensity matching score method (1:4). Treated curves show average emissions for firms that appoint a CSO at $k = 0$; control curves represent matched or aligned control firms.

Figure 7: Dynamic Effects of CSO Appointment on log total emissions with different CSO gender



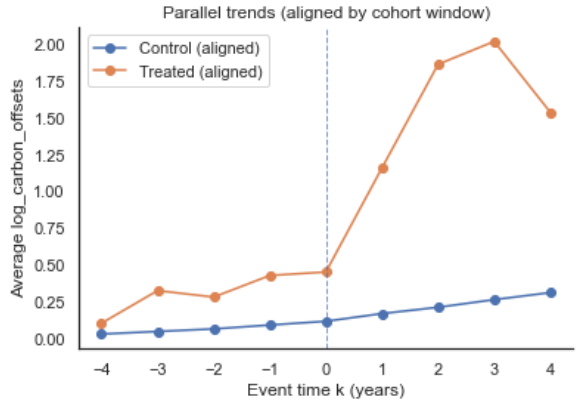
Panel A: Dynamic effects using stacked event study



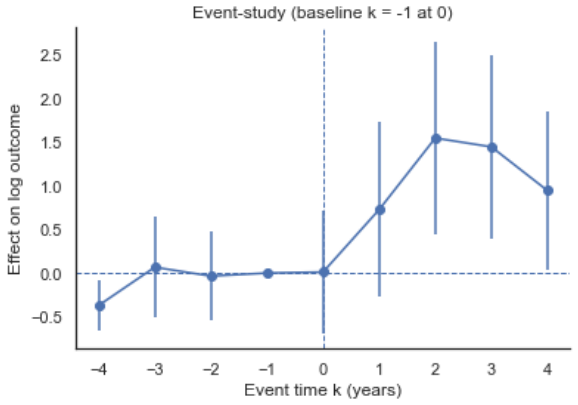
Panel B: Dynamic effects using LP DiD

This figure plots the dynamic effects for total emissions with different gender group of CSO using different estimators (stacked event study and local projection DiD). We seperately measure the coefficients for female and male CSO as treatment group, with control groups are firms never appointed a CSO or not-yet appointed in the window of estimation. The control variables are the same with the baseline results. Industry, state fixed effects are included for both regressions, while stacked event study has additional cohort-year fixed effect and local projection did has year fixed effect. Error are clustered to firm level.

Figure 8: Parallel Trend and Dynamic Effects of CSO Appointment on Log Carbon offsets



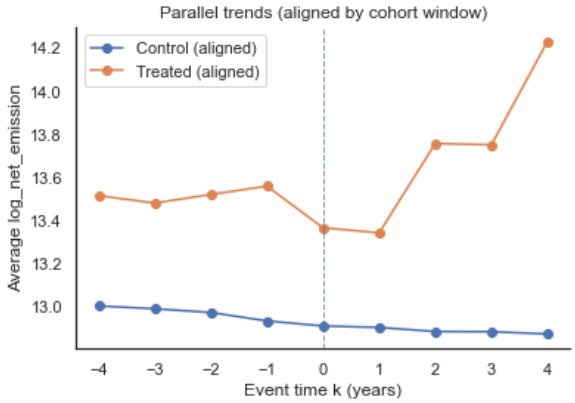
Panel A: Parallel Trend of Log Carbon offsets



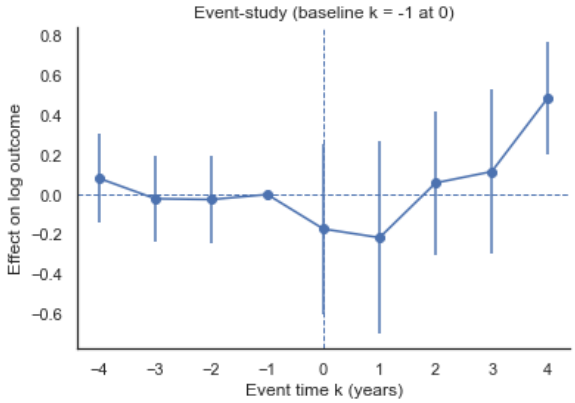
Panel B: Event Study Dynamic Effects on Log Carbon offsets

This figure presents the evolution of log carbon offsets quantities around the appointment of Chief Sustainability Officers (CSOs). ***Panel A*** *displays the raw trends in log carbon offsets between treated firms (yellow line, CSO-appointed) and control firms (blue line, without CSO) over event time $k = t - g$, where g is the CSO appointment year. Control firms are aligned to treated cohorts' calendar years within the estimation window.* ***Panel B*** *shows estimated event-time coefficients $\{\beta_k\}_{k \neq -1}$ from a cohort-stacked event study, with $k = -1$ omitted as the baseline. The specification includes industry (SIC2) and cohort-year fixed effects, plus standard lagged firm controls. Point estimates are displayed with 90% cluster-robust confidence intervals. Positive post-appointment estimates indicate increases in log carbon offsets following CSO appointment.*

Figure 9: Parallel Trend and Dynamic Effects of CSO Appointment on Log Net emissions



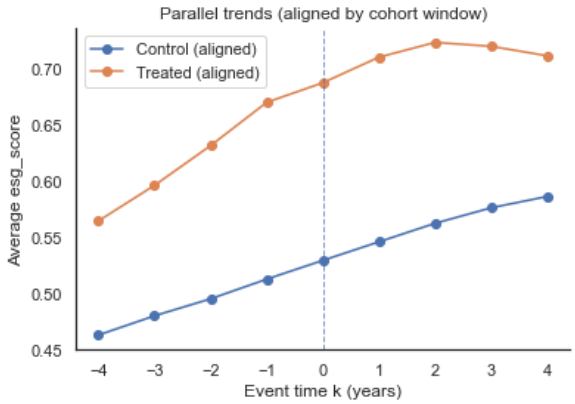
Panel A: Parallel Trend of Log Net emissions



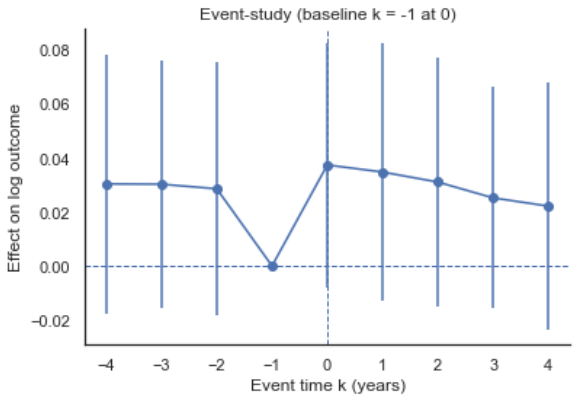
Panel B: Event Study Dynamic Effects on Log Net emissions

This figure shows the relationship between CSO appointments and log net GHG emissions, defined as total emissions minus carbon offsets. ***Panel A*** *plots the average trends for treated firms (yellow line, with CSO) and control firms (blue line, without CSO) over event time $k = t - g$, where g is the year of CSO appointment. Control firms are aligned to treated cohorts' calendar years within the estimation window.* ***Panel B*** *shows estimated event-time coefficients $\{\beta_k\}_{k \neq -1}$ from a cohort-stacked event study regression for log net emissions. Coefficients are relative to the omitted pre-period $k = -1$ (normalized to zero). Dots show point estimates and vertical lines represent 90% cluster-robust confidence intervals (clustered by firm). The specification includes cohort×year fixed effects, industry (SIC2) fixed effects, and lagged firm-level controls. Positive post-appointment estimates indicate increases in net emissions following CSO appointment.*

Figure 10: Parallel Trend and Dynamic Effects of CSO Appointment on ESG Score



Panel A: Parallel Trend of ESG Score



Panel B: Event Study Dynamic Effects on ESG Score

This figure examines the relationship between CSO appointment and firm-level ESG performance. ***Panel A*** *plots the average ESG score over event time $k = t - g$ for treated firms (yellow line, with CSO) and control firms (blue line, without CSO), where g is the year of CSO appointment. Control firms are aligned to treated cohorts' calendar years within the estimation window.* ***Panel B*** *reports estimated event-time coefficients $\{\beta_k\}_{k \neq -1}$ from a cohort-stacked event study regression, with $k = -1$ omitted as the reference period. Dots represent point estimates and vertical bars denote 90% cluster-robust confidence intervals (clustered by firm). All specifications include cohort×year and industry (SIC2) fixed effects, as well as lagged firm-level controls. Positive post-k estimates suggest improvements in ESG performance following CSO appointment.*

Tables

Table 1: CSO Appointments by Industry Sector

Industry Sector	Has CSO	No CSO	Total Firms	Appointment Rate
Communication Services	7	13	20	35.0%
Energy	2	21	23	8.7%
Materials	12	14	26	46.2%
Real Estate	3	27	30	10.0%
Utilities	9	21	30	30.0%
Consumer Staples	22	15	37	59.4%
Consumer Discretionary	14	38	52	26.9%
Health Care	13	47	60	21.7%
Information Technology	17	52	69	24.6%
Financials	18	53	71	25.4%
Industrials	24	52	76	31.6%
Total	141	353	494	28.5%

Note: The table reports count of firms that have a CSO (or C-level officer focusing on sustainability, ESG related field) from 2004 to 2024 in S&P500. Vice-president/director titles below the C-suite are not counted. Sectors follow the 11 GICS sectors. To avoid double counting from reclassifications, we assign each firm to its modal GICS sector over the sample (results are similar if using sector at the appointment year or the last available year). These descriptives include Financials for completeness; all regression analyses in later sections exclude financial firms (SICS 6000–6999) following standard practice. When multiple individuals are appointed in different years, we retain the first C-level appointment.

Table 2: Summary of CSO Demographic and Professional Characteristics

Category	Subgroup	Total (N = 141)	Female (N = 77)	Male (N = 64)
Gender				
	Female	77 (54.6%)	–	–
	Male	64 (45.4%)	–	–
ESG Prior Experience				
	With ESG experience	45 (31.9%)	27 (35.1%)	18 (28.1%)
	Without ESG experience	96 (68.1%)	50 (64.9%)	46 (71.9%)
Ethnicity[*]				
	Minority	24 (17.0%)	14 (18.2%)	10 (15.6%)
	Majority	103 (73.0%)	57 (74.0%)	46 (71.9%)
Appointment Type				
	Insider Appointment	106 (75.2%)	60 (77.9%)	46 (71.9%)
	Outside Appointment	35 (24.8%)	17 (22.1%)	15 (23.4%)

This table summarizes the demographic and professional characteristics of the 141 first-time C-level sustainability appointees across firms between 2004 and 2024. Only one appointee per firm is retained (the earliest appointment). ESG Prior Experience equals one if the individual previously held a role with primary ESG/sustainability/climate/CSR/HSE responsibility. Appointment Type indicates whether the CSO was promoted internally (Insider) or hired externally (Outsider). Gender and ethnicity are determined from company filings and publicly available information. [*]Ethnicity data is incomplete; percentages are based on available cases.

Table 3: ESG, E, S, and G Scores by CSO Gender and Event-Time Period

Panel A: ESG Score

Gender	Pre	Appointment Year	Post
Female	0.676	0.714	0.723
		(+0.038)	(+0.047)
Male	0.658	0.664	0.703
		(+0.006)	(+0.045)

Panel B: E Score

Gender	Pre	Appointment Year	Post
Female	0.655	0.687	0.712
		(+0.032)	(+0.057)
Male	0.637	0.653	0.690
		(+0.016)	(+0.053)

Panel C: S Score

Gender	Pre	Appointment Year	Post
Female	0.706	0.744	0.750
		(+0.038)	(+0.044)
Male	0.696	0.711	0.742
		(+0.015)	(+0.046)

Panel D: G Score

Gender	Pre	Appointment Year	Post
Female	0.646	0.682	0.678
		(+0.036)	(+0.032)
Male	0.643	0.618	0.660
		(-0.025)	(+0.017)

Note: This table reports the average ESG, E, S, and G scores for firms grouped by the gender of their appointed CSO (Female or Male). Each value represents the firm-level average within one of three periods: pre-appointment ($t = -2$ to $t = -1$), appointment year ($t = 0$), and post-appointment ($t = +1$ to $t = +2$). Values in parentheses indicate the change from the pre-appointment period.

Table 4: Descriptive Statistics

Panel A. Firms With CSO

Variable	Mean	Std	25%	50%	75%
Tobin's Q	2.491	1.626	1.378	1.950	3.011
Firm Size (log)	10.063	1.412	9.225	10.164	10.997
ROA	0.067	0.089	0.031	0.064	0.105
Leverage	0.287	0.203	0.166	0.262	0.388
Capital Expenditure Intensity	0.044	0.035	0.020	0.035	0.057
Board Gender Ratio	0.658	0.237	0.507	0.698	0.857
Board Size	11.725	2.806	10.000	12.000	13.000
ESG Score	0.624	0.189	0.504	0.666	0.764
Total emissions % Change	0.064	0.438	-0.074	-0.005	0.079
Sales Growth	0.077	0.176	-0.001	0.054	0.123
Log(Estimated emissions)	13.914	2.068	12.489	13.941	15.460
CSR Committee (Dummy)	0.631	0.351	0.725	0.779	0.871

Panel B. Firms Without CSO

Variable	Mean	Std	25%	50%	75%
Tobin's Q	2.740	2.214	1.448	2.029	3.108
Firm Size (log)	9.047	1.418	8.108	9.141	10.059
ROA	0.068	0.108	0.032	0.070	0.113
Leverage	0.268	0.270	0.114	0.235	0.361
Capital Expenditure Intensity	0.048	0.046	0.018	0.034	0.063
Board Gender Ratio	0.575	0.259	0.376	0.600	0.786
Board Size	10.404	2.839	9.000	10.000	12.000
ESG Score	0.519	0.193	0.366	0.536	0.680
Total emissions % Change	0.068	0.429	-0.079	0.007	0.112
Sales Growth	0.107	0.222	0.010	0.077	0.164
Log(Estimated emissions)	12.924	2.398	11.073	12.710	14.494
CSR Committee (Dummy)	0.465	0.405	0.000	0.746	0.812

Note: Panel A presents summary statistics for firms with a CSO. Panel B presents statistics for firms without a CSO. The detailed definitions of the variables are provided in the appendix.

Table 5: Stratified Cox Regression Results for CSO Appointment

Variable (Lagged)	**(1)**	**(2)**	**(3)**	**(4)**
Firm Size (log)	0.40***	0.42***	0.39***	0.41***
	(0.12)	(0.14)	(0.07)	(0.09)
Board Gender Ratio	0.75*	0.73*	0.58**	0.58**
	(0.41)	(0.42)	(0.23)	(0.26)
ESG Score	2.06***	2.63***	2.69***	2.88***
	(0.69)	(0.68)	(0.35)	(0.33)
Log(Estimated Emissions)	0.05	0.02	0.01	0.03
	(0.07)	(0.08)	(0.04)	(0.04)
Year Strata	Yes	Yes	Yes	Yes
SIC2 Strata	No	No	Yes	Yes
SIC2 Fixed Effects	Yes	Yes	No	No
State Fixed Effects	No	Yes	No	Yes
Observations	3333	3333	3696	3333

Note: This table reports estimates from stratified Cox proportional hazard models examining the likelihood of appointing a Chief Sustainability Officer (CSO). The dependent variable is the hazard of first-time CSO appointment. All explanatory variables are lagged by one year. Columns (1) and (2) stratify by year; columns (3) and (4) stratify by year and industry. Industry fixed effects are included in column (1) and (2), State fixed effects are included in columns (2) and (4). Coefficients are reported in log-hazard form, with robust standard errors in parentheses. Statistical significance is denoted as * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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Appendix

A Definitions and Data Sources

Table A1: Variable Definitions and Data Sources

Variable (code)	Construction / Definition	Source
A. Outcomes		
log total emissions	ln(1 + Estimated CO_2e emissions Total, Scope 1+2). The LSEG ESG "Estimated CO2 Equivalents emissions Total" field is used.	LSEG ESG
log emission intensity	ln((1 + Estimated CO_2e emissions Total, Scope 1+2)/Total Asset). The LSEG ESG "Estimated CO2 Equivalents emissions Total" field is used.	LSEG ESG, Compustat
Log Carbon offsets	ln(1 + sum of voluntary carbon offsets in the same calendar year). offsets aggregated from the Berkeley Carbon Trading Project (VCS, CAR, Gold Standard).	Berkeley Carbon Trading Project
Log Net emissions	$\ln(est_emissions - carbon_offsets)$, defined where the difference is strictly positive, else 0. If the Log Total emissions is missing, this term remains NaN (missing).)	LSEG ESG; Berkeley CTP
ESG Score	LSEG ESG score and MSCI. Higher values indicate better ESG performance.	LSEG ESG, MSCI
B. Treatment / Interaction Term		
CSO Appointment	Indicator = 1 in the first year a firm appoints its first C-suite Sustainability Officer (CSO) or C-level Officer operating in sustainability or ESG related field, 0 otherwise.	Hand collection
GHG Increase	Firm–cohort indicator = 1 if log(emissions) at the last observed period of the cohort window exceeds log(emissions) at $k = 0$ (the appointment/middle year); 0 otherwise.	Constructed
C. Firm Fundamentals		
Tobin's Q	`market_value`/`at`, where `market_value` = `at` − `ceq` + `prcc_c` × `csho`.	Compustat
Firm Size (log)	ln(`at`).	Compustat
Return on Assets	`ni`/`at`.	Compustat
Leverage	`dt`/`at`.	Compustat
Capital Intensity	`capx`/`at`.	Compustat
R&D Dummy	$1\{\texttt{xrd} > 0\}$.	Compustat
Sales Growth	Firm-level %Δ in `sale`; when used: $\texttt{sales_growth}_{it} = \frac{\texttt{sale}_{it} - \texttt{sale}_{i,t-1}}{\texttt{sale}_{i,t-1}}$.	Compustat
D. Governance / Board		

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Variable	Construction / Definition	Source
Board Size	Number of directors.	LSEG ESG
CEO Duality	1{CEO is also Board Chair}.	LSEG ESG
Independent Directors	Share of independent directors on the board.	LSEG ESG
Board Gender Ratio	Fraction of female directors.	LSEG ESG
E. Industry		
GHG-Crucial Industry	Industry classified following SASB. A dummy set to 1 if the industry in which the firms' GHG emissions are crucial and closely linked to firm performance and risk.	SASB mapping
Industry Trend	Within same 2-digit SIC and same calendar year: count of firms with a CSO existing.	CSO data

B Robustness tests tables

Table A2: Regression Results for CSO Appointment Probability (Logit and LPM Models)

Variable (Lagged)	Logit (1)	Logit (2)	LPM (3)
Tobin's Q	0.099	0.161*	0.003
	(0.094)	(0.091)	(0.002)
Firm Size (log)	0.518***	0.518***	0.013***
	(0.182)	(0.184)	(0.004)
ROA	-2.233	-3.599**	-0.077*
	(1.885)	(1.697)	(0.040)
Leverage	0.717	0.530	0.009
	(0.695)	(0.778)	(0.018)
Board Gender Ratio	1.238*	1.493**	0.011
	(0.669)	(0.660)	(0.013)
Board Size	0.075	0.095	-0.000
	(0.071)	(0.072)	(0.002)
ESG Score	2.895***	2.116**	0.048**
	(1.108)	(1.042)	(0.023)
Total Emissions % Change	0.137	0.044	-0.001
	(0.270)	(0.267)	(0.006)
Sales Growth	-1.528**	-1.604**	-0.023*
	(0.648)	(0.729)	(0.012)
Log(Estimated Emissions)	-0.077	-0.073	-0.000
	(0.126)	(0.117)	(0.003)
GHG-Crucial Industry (Dummy)	0.766	0.129	0.014
	(0.476)	(0.408)	(0.009)
Year Fixed Effects	Yes	Yes	Yes
SIC2 Fixed Effects	Yes	No	Yes
State Fixed Effects	No	Yes	Yes
Observations	3,157	3,157	3,157

*Note: This table reports estimates from logistic regression (columns 1 and 2) and linear probability model (LPM, column 3) predicting the likelihood of appointing a Chief Sustainability Officer (CSO). The dependent variable equals one in the year a CSO is first appointed, and zero otherwise. All covariates are lagged by one year. Column (1) includes 2-digit SIC and year fixed effects; column (2) includes state and year fixed effects. Due to singular matrix issues when including all three fixed effects in the logit model, we estimate column (3) using LPM with SIC2, state, and year fixed effects. Robust standard errors (clustered at the firm level) are reported in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

Table A3: Event Study Estimates for Total Emissions: Different Window Lengths

Regressor	**[-5,+5]**	**[-3,+3]**	**[-2,+2]**
Controls (Lagged)			
Tobin's Q	-0.076^{***}	-0.074^{***}	-0.073^{***}
	(0.022)	(0.022)	(0.021)
Log Firm Size	0.807^{***}	0.810^{***}	0.812^{***}
	(0.049)	(0.047)	(0.046)
ROA	0.919^{***}	0.927^{***}	0.947^{***}
	(0.327)	(0.329)	(0.328)
Leverage	0.072	0.109	0.128
	(0.179)	(0.177)	(0.177)
Capital Intensity	7.571^{***}	7.870^{***}	7.980^{***}
	(2.080)	(2.027)	(1.998)
R&D Dummy	-0.231	-0.216	-0.212
	(0.219)	(0.216)	(0.215)
Sales Growth	-0.423^{***}	-0.403^{***}	-0.378^{***}
	(0.107)	(0.106)	(0.105)
Total Emissions Change (Lagged)	0.244^{***}	0.246^{***}	0.242^{***}
	(0.038)	(0.038)	(0.038)
Event Time			
D_{-5}	0.039		
	(0.113)		
D_{-4}	0.034		
	(0.113)		
D_{-3}	-0.063	-0.059	
	(0.111)	(0.102)	
D_{-2}	-0.065	-0.062	-0.053
	(0.111)	(0.103)	(0.097)
D_0	0.027	0.034	0.046
	(0.115)	(0.107)	(0.102)
D_{+1}	0.103	0.113	0.126
	(0.121)	(0.115)	(0.111)
D_{+2}	0.164	0.175^{*}	0.188^{*}
	(0.110)	(0.103)	(0.100)
D_{+3}	0.243^{*}	0.255^{**}	
	(0.126)	(0.121)	
D_{+4}	0.413^{***}		
	(0.139)		
D_{+5}	0.475^{***}		
	(0.169)		
Cohort-Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
R-squared	0.832	0.831	0.830
Observations	33,038	23,130	17,288

*Notes: This table reports stacked cohort-based event-study regressions of the natural log of Scope 1+2 CO_2 emissions (LSEG ESG) on event-time indicators and lagged firm controls, estimated under three window lengths $[-5,+5]$, $[-3,+3]$, and $[-2,+2]$. The baseline $[-4,+4]$ specification is reported in Table A5 first column with identical controls and fixed effects. Coefficients on D_k trace dynamic effects relative to $k=-1$. Because the outcome is in logs, approximate percentage effects are $100\times(\exp(\beta_k)-1)$. Statistical significance: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.*

Table A4: Event Study Regression for Total Emissions (Subsample: CSO Appointments Before 2020)

Variable	Coefficient (Std. Error)
Tobin's Q	-0.075^{***}
	(0.022)
Log(Firm Size)	0.806^{***}
	(0.048)
ROA	0.931^{***}
	(0.331)
Leverage	0.090
	(0.178)
Capital Intensity	7.703^{***}
	(2.066)
R&D Dummy	-0.219
	(0.218)
Sales Growth	-0.424^{***}
	(0.107)
Total Emissions Change (Lagged)	0.247^{***}
	(0.038)
Event Time Dummies	
D_{-4}	0.030
	(0.108)
D_{-3}	-0.058
	(0.106)
D_{-2}	-0.063
	(0.106)
D_0	0.122
	(0.152)
D_1	0.264
	(0.168)
D_2	0.313^{**}
	(0.145)
D_3	0.413^{**}
	(0.161)
D_4	0.477^{***}
	(0.167)
Cohort-Year Fixed Effects	Yes
Industry Fixed Effects	Yes
State Fixed Effects	Yes
Observations	28,239
R-squared	0.831
Adjusted R-squared	0.830

*Notes: This table reports event-study estimates for total emissions using a subsample restricted to CSO appointments prior to 2020. Standard errors are clustered and reported in parentheses. The purpose of this table is to demonstrate that the main results are robust to excluding appointments after 2020, a period with a sharp increase in CSO adoptions. Other settings are the same as baseline result. Statistical significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

C Tables of regressions reported in Figures in the main text

Table A5: Baseline results of Stacked Event Study Regressions for Carbon Emissions and Emission Intensity

	Total Emissions (Unbalanced)	**Total Emissions** (Balanced)	**GHG Intensity** (Unbalanced)	**GHG Intensity** (Balanced)
Event Time				
D_{-4}	0.029	0.081	-0.010	0.051
	(0.108)	(0.128)	(0.101)	(0.120)
D_{-3}	-0.061	-0.032	-0.082	-0.051
	(0.106)	(0.120)	(0.098)	(0.107)
D_{-2}	-0.065	-0.106	-0.084	-0.120
	(0.107)	(0.120)	(0.099)	(0.111)
D_0	0.030	0.042	0.009	0.053
	(0.111)	(0.132)	(0.101)	(0.118)
D_1	0.106	0.211	0.047	0.186
	(0.119)	(0.133)	(0.110)	(0.123)
D_2	0.169	0.202	0.109	0.167
	(0.106)	(0.127)	(0.099)	(0.118)
D_3	0.249**	0.301**	0.180	0.234*
	(0.124)	(0.141)	(0.113)	(0.128)
D_4	0.420***	0.407***	0.321**	0.313**
	(0.137)	(0.142)	(0.126)	(0.132)
Controls (Lagged)				
Tobin's Q	-0.075***	-0.067***	-0.075***	-0.071***
	(0.022)	(0.023)	(0.019)	(0.021)
Firm Size (log)	0.808***	0.824***	-0.143***	-0.134***
	(0.047)	(0.048)	(0.042)	(0.044)
ROA	0.928***	0.791**	0.791***	0.673**
	(0.329)	(0.356)	(0.291)	(0.321)
Leverage	0.092	-0.000	0.131	0.051
	(0.177)	(0.180)	(0.156)	(0.162)
CapEx Intensity	7.752***	7.419***	6.899***	6.534***
	(2.055)	(1.975)	(1.899)	(1.879)
R&D Dummy	-0.223	-0.237	-0.245	-0.245
	(0.216)	(0.208)	(0.198)	(0.198)
Sales Growth	-0.423***	-0.484***	-0.437***	-0.501***
	(0.107)	(0.115)	(0.099)	(0.109)
Emission % Change	0.247***	0.265***	0.216***	0.235***
	(0.038)	(0.038)	(0.034)	(0.036)
Cohort-Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	28,402	20,548	28,394	20,540
R-squared	0.831	0.846	0.736	0.739
Adj. R-squared	0.830	0.845	0.734	0.737

*Note: This table reports stacked event study regression results for log total carbon emissions (columns 1–2) and log emission intensity (columns 3–4), with and without a balanced panel restriction. Event time coefficients (D_k) reflect deviations from the year prior to CSO appointment ($k = -1$, omitted). Cohort-year fixed effect is based on appointment year relevant to calander year. industry fixed effect based on 2 digit SIC, and state fixed effect based on state of corporate headquarters. All covariates are lagged by one year. Standard errors are clustered at the firm level. Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

Table A6: LP-DiD Event Study Estimates for Carbon Emissions

	Log Total (Unbalanced)	**Log Total** (Balanced)	**Log Intensity** (Unbalanced)	**Log Intensity** (Balanced)
Event Time				
D_{-4}	0.007	0.033	-0.036	0.017
	(0.058)	(0.066)	(0.053)	(0.069)
D_{-3}	-0.013	0.024	-0.032	0.027
	(0.041)	(0.052)	(0.040)	(0.055)
D_{-2}	-0.012	-0.009	-0.028	-0.028
	(0.016)	(0.023)	(0.020)	(0.030)
D_0	0.035	0.057	0.043	0.078
	(0.040)	(0.054)	(0.037)	(0.052)
D_1	0.110*	0.187**	0.102*	0.196**
	(0.064)	(0.088)	(0.059)	(0.081)
D_2	0.109	0.205**	0.094	0.214***
	(0.074)	(0.088)	(0.071)	(0.083)
D_3	0.125	0.187**	0.105	0.190**
	(0.081)	(0.093)	(0.075)	(0.082)
D_4	0.226**	0.226**	0.187**	0.187**
	(0.094)	(0.094)	(0.083)	(0.083)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes

*Note: This table reports LP-DiD event-time estimates for log total carbon emissions and log emission intensity (log emissions divided by total assets). D_{-1} is omitted as the reference period. Standard errors are in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All specifications include control variables and fixed effects for year, industry, and state.*

Table A7: Event Study and LP-DiD Estimates on firm emissions by CSO Gender

Event Time	ES Female	ES Male	LP-DiD Female	LP-DiD Male
-4	0.027	0.031	0.048	0.034
	(0.108)	(0.108)	(0.123)	(0.067)
-3	-0.048	-0.058	0.059	0.007
	(0.106)	(0.106)	(0.097)	(0.049)
-2	-0.052	-0.062	0.029	-0.043***
	(0.105)	(0.107)	(0.047)	(0.014)
0	-0.021	0.100	0.047	0.073
	(0.132)	(0.155)	(0.070)	(0.082)
1	0.004	0.239	0.084	0.283*
	(0.137)	(0.177)	(0.084)	(0.147)
2	0.062	0.295**	0.156	0.256*
	(0.134)	(0.145)	(0.096)	(0.142)
3	0.091	0.412**	0.126	0.255*
	(0.162)	(0.165)	(0.119)	(0.136)
4	0.375**	0.463**	0.194*	0.266*
	(0.180)	(0.189)	(0.117)	(0.137)
Control Variables	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes

*Note: This table reports stacked event study and local projection difference-in-differences estimates of the dynamic effect of CSO appointment on firm emissions, separately for firms appointing female and male CSOs. Each coefficient represents the estimated effect at a given event time (year relative to appointment). Standard errors clustered at the firm level are reported in parentheses. All models include control variables and fixed effects for industry (2-digit SIC), state, and year. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

Table A8: Stacked Event Study and LP-DiD Regressions for Carbon Offsets

	SES (Unbalanced)	**SES** (Balanced)	**LP-DiD** (Unbalanced)	**LP-DiD** (Balanced)
Event Time				
D_{-4}	-0.426***	-0.371**	-0.242	-0.253
	(0.095)	(0.145)	(0.233)	(0.301)
D_{-3}	-0.099	0.067	0.028	0.073
	(0.210)	(0.295)	(0.191)	(0.249)
D_{-2}	-0.038	-0.035	0.012	-0.068
	(0.240)	(0.261)	(0.143)	(0.221)
D_0	0.269	0.011	0.292	-0.046
	(0.318)	(0.363)	(0.288)	(0.355)
D_1	0.797**	0.729	0.722*	0.537
	(0.376)	(0.510)	(0.382)	(0.519)
D_2	0.943**	1.550***	1.000**	1.173**
	(0.406)	(0.566)	(0.390)	(0.537)
D_3	1.206***	1.449***	1.235**	1.170*
	(0.426)	(0.540)	(0.513)	(0.620)
D_4	0.826*	0.946**	0.626	0.626
	(0.434)	(0.463)	(0.640)	(0.640)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	28,496	20,607	3728	2790
R-squared	0.152	0.148	0.06	0.08

*Note: This table reports stacked event study (ES) and local projection difference-in-differences (LP-DiD) estimates for log carbon offsets. Event time D_{-1} is omitted as the reference period. Treatment and control groups settings are identical to the baseline results. All specifications include lagged control variables and industry, and state fixed effects. Cohort-year fixed effect for stacked event study and year fixed effect for LP-DiD. Standard errors are clustered at the firm level and reported in parentheses. The sample covers S&P 500 firms from 2004–2024, excluding financial industries (SIC 6000–6999). Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

Table A9: Stacked Event Study Regression for Net Emissions

Variable	Coefficient (SE)
Event Time	
D_{-4}	0.081
	(0.115)
D_{-3}	-0.021
	(0.111)
D_{-2}	-0.025
	(0.112)
D_0	-0.173
	(0.219)
D_1	-0.216
	(0.247)
D_2	0.058
	(0.184)
D_3	0.115
	(0.212)
D_4	0.485***
	(0.144)
Control Variables (Lagged)	
Tobin's Q	-0.107***
	(0.031)
Firm Size (log)	0.794***
	(0.053)
Return on Assets (ROA)	0.960**
	(0.409)
Leverage	0.190
	(0.189)
Capital Expenditure Intensity	7.995***
	(2.129)
R&D Dummy	-0.268
	(0.228)
Sales Growth	-0.488***
	(0.130)
Total Emission Change (Lagged)	0.280***
	(0.045)
Industry FE	Yes
Cohort-Year FE	Yes
State FE	Yes
Observations	28,402
R-squared	0.777

Note:The table reports coefficients of stacked event study for log net emissions (total emissions - carbon offsets). For each cohort g (the firm's first CSO appointment year), we build a window $k \in [-3, +3]$ around g, stack cohorts, and estimate formula (1). D_k is the calendar year dummy and $k = -1$ is omitted, so each estimated β_k is relative to the year prior to the CSO appointment. In each cohort window, treated observations are firms with their first CSO in year g; control observations are firms that never appoint a CSO or are not-yet treated within that window but appear in the same calendar years. Stacking across cohorts yields the reported sample size. All covariates are lagged one year. Standard errors are clustered at the firm (CUSIP) level. Since dependent variable is log transformed, percentage effects can be computed as $\exp(\beta_k) - 1$. *Statistical significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample covers S&P 500 firms from 2004–2024, excluding financial industries (SIC 6000–6999).*

Table A10: Stacked Event Study Regression for ESG Scores (MSCI and LSEG)

Variable	MSCI ESG Score	LSEG ESG Score
Event Time		
D_{-4}	0.388	0.030
	(0.349)	(0.025)
D_{-3}	-0.032	0.030
	(0.373)	(0.024)
D_{-2}	-0.186	0.029
	(0.395)	(0.024)
D_0	0.076	0.037
	(0.395)	(0.023)
D_1	0.147	0.035
	(0.373)	(0.024)
D_2	-0.232	0.031
	(0.459)	(0.023)
D_3	0.111	0.025
	(0.396)	(0.021)
D_4	-0.240	0.022
	(0.437)	(0.024)
Control Variables (Lagged)		
Tobin's Q	0.066	-0.001
	(0.051)	(0.003)
Firm Size (log)	0.197**	0.067***
	(0.089)	(0.008)
Return on Assets (ROA)	1.284	0.238***
	(0.973)	(0.061)
Leverage	0.221	-0.022
	(0.367)	(0.027)
Capital Expenditure Intensity	0.056	0.103
	(2.412)	(0.194)
R&D Dummy	0.552	0.076***
	(0.357)	(0.025)
Sales Growth	-1.124***	-0.162***
	(0.270)	(0.018)
Total Emissions Change (Lagged)	-0.117	-0.007
	(0.086)	(0.006)
Industry FE	Yes	Yes
Cohort-Year FE	Yes	Yes
State FE	Yes	Yes
Observations	18,921	19,892
R^2	0.214	0.576

*Note:The table reports coefficients of stacked event study for ESG score from two resources. The first column is industry adjusted score from MSCI, and the second column is LSEG ESG score. For each cohort g (the firm's first CSO appointment year), we build a window $k \in [-4, +4]$ around g, stack cohorts, and estimate formula (1). D_k is the calendar year dummy and $k = -1$ is omitted, so each estimated β_k is relative to the year prior to the CSO appointment. In each cohort window, treated observations are firms with their first CSO in year g; control observations are firms that never appoint a CSO or are not-yet treated within that window but appear in the same calendar years. Stacking across cohorts yields the reported sample size. All covariates are lagged one year. Standard errors are clustered at the firm (CUSIP) level. Since dependent variable is log transfered, percentage effects can be computed as $\exp(\beta_k) - 1$. Statistical significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample covers S&P 500 firms from 2004–2024, excluding financial industries (SIC 6000–6999).*

Table A11: Stacked diff-in-diff on ESG score: CSO vs. No CSO with increasing GHG Interaction

Variable	CSO with interaction	Mirror Experiment
Tobin's Q (lagged)	0.000	0.000
	(0.003)	(0.003)
Firm Size (log, lagged)	0.069***	0.068***
	(0.007)	(0.007)
Return on Assets (lagged)	0.220***	0.221***
	(0.053)	(0.052)
Leverage (lagged)	-0.028	-0.030
	(0.024)	(0.023)
Capital Intensity (lagged)	0.105	0.129
	(0.182)	(0.181)
R&D Dummy (lagged)	0.075***	0.076***
	(0.024)	(0.024)
Board Size (lagged)	0.004	0.004
	(0.002)	(0.002)
CEO Duality (lagged)	0.020	0.020
	(0.012)	(0.011)
Independent Board Members (lagged)	0.103***	0.101***
	(0.019)	(0.018)
GHG Increase	-0.019**	-0.008
	(0.006)	(0.007)
CSO Appointment	0.010	–
	(0.018)	–
CSO Appointment × GHG Increase	0.018	–
	(0.024)	–
No CSO Post	–	-0.012
	–	(0.014)
No CSO Post × GHG Increase	–	-0.018***
	–	(0.005)
Industry FE	Yes	Yes
Cohort-year FE	Yes	Yes
R-squared	0.547	0.550
Adjusted R-squared	0.544	0.547
Observations	32,610	32,610

Note: The table reports stacked difference-in-differences (DiD) regressions of firm ESG score on treatment and emissions-growth interactions. We build cohort windows around each firm's first CSO appointment year g (event time $k = t - g$, with $k \in [-4, +4]$), stack cohorts, and include cohort-by-year fixed effects to absorb calendar shocks within each cohort window and any cohort-specific dynamics. Industry fixed effects are at the 2-digit SIC level. All control variables are lagged one year. The dependent variable is the firm's ESG score (higher values indicate better ESG performance). In first column, `CSO Appointment` *equals one for observations in the treated cohort after the appointment year ($k \geq 0$) and zero otherwise; untreated observations in the same cohort window are never- or not-yet-treated firms. In Column 2 (*Mirror Experiment*),* `No CSO Post` *equals one for observations in the same cohort window that belong to never/not-yet treated firms with $k \geq 0$, and zero otherwise.* `GHG Increase` *is a firm–cohort indicator equal to one if the firm's total emissions at the last observed period of the cohort window exceed emissions at $k = 0$ (the middle/appointment year for treated cohorts, and the same calendar year for matched controls), and zero otherwise. This construction permits unbalanced windows: if the last observed k is $< +4$, we compare that last k to $k = 0$. Regressions include cohort-year and industry fixed effects and the lagged controls listed in the table. Standard errors (in parentheses) are clustered at the firm (CUSIP) level. Statistical significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Firms*

Table A12: Event Study Estimates for Total Emissions: Different Window Lengths

Regressor	**[-5,+5]**	**[-3,+3]**	**[-2,+2]**
Controls (Lagged)			
Tobin's Q	-0.076^{***}	-0.074^{***}	-0.073^{***}
	(0.022)	(0.022)	(0.021)
Log Firm Size	0.807^{***}	0.810^{***}	0.812^{***}
	(0.049)	(0.047)	(0.046)
ROA	0.919^{***}	0.927^{***}	0.947^{***}
	(0.327)	(0.329)	(0.328)
Leverage	0.072	0.109	0.128
	(0.179)	(0.177)	(0.177)
Capital Intensity	7.571^{***}	7.870^{***}	7.980^{***}
	(2.080)	(2.027)	(1.998)
R&D Dummy	-0.231	-0.216	-0.212
	(0.219)	(0.216)	(0.215)
Sales Growth	-0.423^{***}	-0.403^{***}	-0.378^{***}
	(0.107)	(0.106)	(0.105)
Total Emissions Change (Lagged)	0.244^{***}	0.246^{***}	0.242^{***}
	(0.038)	(0.038)	(0.038)
Event Time			
D_{-5}	0.039		
	(0.113)		
D_{-4}	0.034		
	(0.113)		
D_{-3}	-0.063	-0.059	
	(0.111)	(0.102)	
D_{-2}	-0.065	-0.062	-0.053
	(0.111)	(0.103)	(0.097)
D_0	0.027	0.034	0.046
	(0.115)	(0.107)	(0.102)
D_{+1}	0.103	0.113	0.126
	(0.121)	(0.115)	(0.111)
D_{+2}	0.164	0.175^{*}	0.188^{*}
	(0.110)	(0.103)	(0.100)
D_{+3}	0.243^{*}	0.255^{**}	
	(0.126)	(0.121)	
D_{+4}	0.413^{***}		
	(0.139)		
D_{+5}	0.475^{***}		
	(0.169)		
Cohort-Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
R-squared	0.832	0.831	0.830
Observations	33,038	23,130	17,288

Notes: This table reports stacked cohort-based event-study regressions of the natural log of Scope 1+2 CO_2 emissions (LSEG ESG) on event-time indicators and lagged firm controls, estimated under three window lengths $[-5,+5]$, $[-3,+3]$, *and* $[-2,+2]$. *The baseline* $[-4,+4]$ *specification is reported in Table A5 first column with identical controls and fixed effects. Coefficients on* D_k *trace dynamic effects relative to* $k=-1$. *Because the outcome is in logs, approximate percentage effects are* $100\times(\exp(\beta_k)-1)$. *Statistical significance: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.*

Table A13: Event Study Regression for Total Emissions (Subsample: CSO Appointments Before 2020)

Variable	Coefficient (Std. Error)
Tobin's Q	-0.075^{***}
	(0.022)
Log(Firm Size)	0.806^{***}
	(0.048)
ROA	0.931^{***}
	(0.331)
Leverage	0.090
	(0.178)
Capital Intensity	7.703^{***}
	(2.066)
R&D Dummy	-0.219
	(0.218)
Sales Growth	-0.424^{***}
	(0.107)
Total Emissions Change (Lagged)	0.247^{***}
	(0.038)
Event Time Dummies	
D_{-4}	0.030
	(0.108)
D_{-3}	-0.058
	(0.106)
D_{-2}	-0.063
	(0.106)
D_0	0.122
	(0.152)
D_1	0.264
	(0.168)
D_2	0.313^{**}
	(0.145)
D_3	0.413^{**}
	(0.161)
D_4	0.477^{***}
	(0.167)
Cohort-Year Fixed Effects	Yes
Industry Fixed Effects	Yes
State Fixed Effects	Yes
Observations	28,239
R-squared	0.831
Adjusted R-squared	0.830

*Notes: This table reports event-study estimates for total emissions using a subsample restricted to CSO appointments prior to 2020. Standard errors are clustered and reported in parentheses. The purpose of this table is to demonstrate that the main results are robust to excluding appointments after 2020, a period with a sharp increase in CSO adoptions. Other settings are the same as baseline result. Statistical significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*